

# Exploring Chinese Secondary Physical Education Teachers' Readiness for AI Integration: An AI-TPACK Perspective

Zixiang Zhao \*

Faculty of Education, Monash University, Melbourne, Victoria, Australia

\* Corresponding Author Email: obsidian4815@gmail.com

**Abstract.** The application of Artificial Intelligence in the education field attracted a lot of attention in global research field. However, the physical education teacher, especially middle school PE teachers, are remain unprepared in the field of integrating AI technology in education practices. This article takes physical education teachers in Chinese middle schools as samples, analyzing their readiness and influencing factors based on the AI-TPACK framework. Research results showed that PE teachers perform generally satisfying in CK, PK and PCK dimensions, but relatively weaker in dimensions with technology knowledge, such as TK, TCK, TPK and AI-TPACK. Further analysis indicated that the age and teaching experience cannot be considered as significant influencing factors, while whether receiving training and using AI tools can be considered as significant influencing factors on multiple technology-related dimensions. Trained teachers or teachers who use AI tools tend to score higher. Based on this, this paper puts forward the following suggestions: strengthen the situational AI-TPACK training of physical education teachers, encourage teachers to gradually integrate AI tools in the classroom, optimize the resource allocation and environmental support at the school level, strengthen teachers' cognition of the usefulness of AI tools, and enhance their willingness to adopt.

**Keywords:** TPACK; physical education; Artificial Intelligence; digital education.

## 1. Introduction

In the past decade, the amount of AI research in the field of education has increased dramatically. This trend has increased exponentially since 2015, and research hotspots include intelligent teaching systems, learning analysis, and student-centered personalized learning, highlighting the internationally significant growing interest in the application of AI in Education [1]. Artificial intelligence in education has been widely used in the customization of learning content, the personalized evaluation of students' learning progress to improve learning efficiency and motivation, the automatic scoring system, the generation of course content and the analysis of students' behavior and has significantly promoted the digital and intelligent transformation of the education field and the corresponding evaluation mechanism [2, 3].

This transformation also provides unprecedented opportunities for the interdisciplinary application of AI, especially in physical education, which has traditionally been marginalized in the digital context. The integration of AI and digital tools may improve students' interest, engagement, and provide personalized scaffolding. However, the empirical research on whether PE teachers are willing to participate in such technological innovation in the context of Chinese middle schools is extremely limited. Despite the fact that China's education reform officially claims that digital literature and AI literature should be introduced into the national curriculum standards, a lopsided situation persists in the coverage of various subjects or aspects, and in the style of teachers' training. Therefore, it is of great practical value for AI literacy, technology acceptance, and teaching integration of Chinese PE teachers. The findings illustrate that the teachers' TPACK and context influence their intention and ability to use AI tools [4, 5]. The purpose of this study is to address this significant gap by employing the TPACK-based theoretical framework to measure Chinese middle school PE teachers' level of AI literature and digital tool integration, which can contribute to increasing understanding of the academic field's readiness for given subjects, enabling the design of tailored teacher professional development programs.

## **2. Methodology**

### **2.1. TPACK Framework**

The framework by Mishra and Koehler (technological pedagogical content knowledge, TPACK) will be used as a starting point for the present study. Such interrelations among three core categories of knowledge (technological, pedagogical, and content knowledge) are represented through this framework. This feature allows educational researchers to conduct a broad study of the ways in which educators are integrating technology across the curriculum.

Adopting AI educational tools in middle school physical education readiness, knowledge, and attitudinal dispositions, along with the application of AI-based educational tools in education practice, the TPACK model can deepen teachers' awareness and perception regarding AI educational tools [6]. In this paper, the TPACK model was examined in terms of the affective determinants of it, and contextual variables of the TPACK model were elaborated by it emphasizing contributing to the active use of digital educational tools in the classroom.

The original TPACK framework elements are given below:

Content Knowledge (CK) is the subject-specific knowledge that is taught by teachers and learned by students. This includes what constitutes the subject area, the established universal truths, ideas, theories, and programs. So, teachers also have to know how to establish the framework of ideas and how to make the rules clear and easily demonstrable.

Pedagogical Knowledge (PK) constitutes a broad knowledge of the habits and techniques of teaching, the purposes and values of education. Teachers had to know how to learn how their students learn, manage the classroom, prepare and implement lesson plans, and assess how well students are learning.

Technological Knowledge (TK) can be defined as the knowledge of understanding and using the technical tools required by teaching activities, including the operating knowledge of computer software and operating systems. Most standard technical seminars and training usually focus on Developing Teachers' knowledge, and this knowledge is also changing with the continuous development of teaching technology.

Pedagogical content knowledge (PCK) can be defined as teachers' knowledge of how to combine teaching methods with specific subject content for effective teaching. Different from the general educational methodology and subject-specific knowledge, PCK attaches importance to the expression of concepts, teaching skills, epistemology theory and the evaluation of students' prior knowledge.

Technological content knowledge (TCK) can be defined as the knowledge of how educational technology changes, displays or redefines the existing subject knowledge. For example, 3D modeling software not only provides a new educational medium for learning geometry, but also fundamentally changes the teaching method of geometry by providing proof by construction.

Technological pedagogical knowledge (TPK) can be defined as the knowledge of how technology affects the teaching methods applicable in a specific teaching environment. TPK includes the ability to select specific technology to teach specific knowledge, the strategy of using the tool effectively, and the ability to apply corresponding technical tools according to different teaching methods.

### **2.2. Research Design**

This study will adopt the design of a quantitative cross-sectional survey, aiming to investigate the TPACK level and their perception and readiness of integrating AI tools into teaching practices. The main data collection tool is the structured questionnaire, which is modified from the original TPACK questionnaire and the AI-TPACK questionnaire developed by Ning et al. This questionnaire will be more focused on AI-related technology dimensions.

Technological Pedagogical Content Knowledge (TPACK) can be defined as the comprehensive knowledge combining TK, PK and CK, emphasizing the ability of integrating technological, pedagogical and content knowledge in subject-specific teaching scenarios. Effective TPACK means

teachers need to understand how to represent theoretical concepts, choose appropriate teaching methods to cooperate with technical support content learning, and solve students' cognitive difficulties through technical means. TPACK also involves teachers' understanding of students' prior knowledge, learning styles and learning difficulties, then improving the teaching effect through the use of technology in teaching.

In recent research, these dimensions have been extended to AI-related traditional knowledge and AI-specific TPACK. This trend reflects the rise of AI in educational practices. Considering the attention paid to the integration of AI in physical education, this study will emphasize the AI-related Technological knowledge fields, including TK, TCK, TPK and AI-TPACK, because these dimensions can better predict whether teachers are ready to implement AI-enhanced teaching practices.

The questionnaire will be divided into two parts. The first part is the basic information of the tested teachers, including gender, age, teaching years and other details, while the second part involves the investigation of AI-TPACK literacy of the tested teachers.

The questionnaire will be distributed to teachers in different grades, teaching experiences and age groups, covering PE teachers from junior high school to senior high school, new teachers to senior teachers with more than 15 years of teaching experience. The questionnaire star platform will be used to distribute the structured questionnaire. All items are set as mandatory, which helps to maintain the integrity of the data set and subsequent quantitative analysis.

The final version of the questionnaire consists of 24 items, each item is measured with the 5-point Lichten scale (1=very disagree, 5=very agree). In this study, the Cronbach  $\alpha$  test scale will be used to evaluate internal consistency, confidence level and validity. Descriptive statistics and one-way ANOVA will also be used to analyze the data of group differences based on demographic factor variables.

### 3. Findings

Research indicated that the AI-TPACK level of tested Chinese middle school PE teachers can be considered generally desirable. Descriptive statistics show that the average value of each dimension of AI-TPACK is between 3.6-4.2, especially CK, PK and PCK are higher than 4, which indicates that the interviewed teachers have a strong foundation in content knowledge, pedagogical knowledge and the integration ability of these dimensions, and further indicates that the interviewed PE teachers have a strong basic teaching literacy under the traditional TPACK framework. In comparison, the score of technology-related dimensions is relatively low. The average score of TK, TCK, TPK, TPACK and AI-TPACK is generally lower than 3.75, especially the average score of TK is only 3.62, which is the lowest among all dimensions. Results show that the surveyed teachers' Technological knowledge and the integration of technology with other dimensions are insufficient, especially in the integration and application of AI technology. This trend echoes the previous research's findings, indicating that the level of Technological knowledge is an important factor in predicting the willingness and ability of AI teaching integration, and this level is easy to lag behind the teaching methods and subject knowledge in the absence of continuous training and practice [7,8].

This research provides empirical evidence that supports technology knowledge, especially AI knowledge, can be a strong predictive factor of pre-service teachers' intention to utilise AI in teaching practices in their future educational career. Their findings suggest that the confidence and attitude towards educational AI tools are associated with teachers' AI efficacy and the training they received from school. Furthermore, research has further supported the development of the TPACK framework in the context of integrating AI. Tram emphasized that teachers' self-efficacy in education AI is closely connected with broader technology knowledge, suggesting that targeted professional development and training can increase teachers' technology adoption [9]. Sun et al. also confirmed that Teachers' understanding of the role and ease of use of technology in teaching practice, especially perceived usefulness (PU) and perceived ease of use (PE) [8]. It plays a significant role in predicting

teachers' behavior of integrating AI technology into teaching practice. The TPACK level of teachers not only plays a predictive role in technology integration but also has a positive correlation with PU and PE as mediators.

The received training significantly predicted the score of various technology-related dimensions, which shows that technology-related professional training not only provides technological knowledge but also enhances the integration ability of TCK and TPK, as well as the comprehensive AI-TPACK literacy. Additionally, middle school PE teachers using technological education tools, or AI education tools, have significantly higher scores in TK, TCK, TPK, TPACK and AI-TPACK dimensions than those who are not using them, which indicates that the use of technology-based teaching tools is an important manifestation of AI-TPACK literacy.

According to the conclusion drawn from one-way ANOVA analysis, the age and teaching experience of the tested teachers are not significant influencing factors on the scores of various dimensions, but age is close to significant in the TK, TCK, TPACK&AI-TPACK dimensions ( $p \approx 0.05-0.08$ ), while teaching experience is close to significant in the TK and TPK dimensions ( $p \approx 0.06-0.07$ ). Although not statistically significant, this trend reveals the age and teaching experience of the teacher population, as well as the potential impact of different generations of teachers' acceptance of digital education tools, self-efficacy, and adaptability on technology-related dimensions.

## **4. Discussion**

This study analyzed the questionnaire data gathered from Chinese middle school physical education teachers and revealed their readiness levels in various dimensions under the AI-TPACK framework.

### **4.1. Problem and Reason Analysis**

Although the average scores of all dimensions are above the average level ( $>3.5$ ), the CK, PK, and PCK dimensions, which can be considered more valued in traditional physical educational contexts, score more ideally. However, there are shortcomings in the performances of various technology-related dimensions that involve the adoption and integration of emerging educational technologies.

This result confirmed the results of previous research, indicating that teachers often possess competence in a single technology or teaching method, but face challenges in interdisciplinary integration. The underlying cause behind this phenomenon may be the specificity of physical education. Compared to subjects that have various on-the-shelf digital educational resources, physical education places more emphasis on physical activity, movement demonstration, and practical operation. Therefore, physical education teachers often lack existing developed cases at the TCK and TPK levels, resulting in relatively low adaptability of educational technology and causing a lag in the development level of AI-TPACK readiness [10]. In addition, physical education teachers often face more severe contextual barriers when integrating educational technology than other subjects, such as the nature of the classroom and the special needs of physical education teaching, which present greater resistance compared to general subject teachers [11].

Empirical evidence shows that pre-service physical education teachers lack systematic support for educational technology integration during their university education stage, and teachers of pre-service PE teachers often fail to demonstrate their technological skills effectively, thus weakening their ability to integrate educational technology in teaching practice [12,13]. In addition, although there have been improvements in recent years, the academic and professional backgrounds of PE teachers in China (most of whom have transitioned from retired professional athletes and have a relatively low proportion of higher education) also hinder professional development in the field of educational technology, such as their tendency to emphasize CK and PK, while cross dimensional integration under the TPACK framework lags and has shortcomings. Considering the factors above,

the phenomenon of lagging development in the Technological dimensions of AI-TPACK readiness among the physical education teachers surveyed in this study can be partially explained.

Furthermore, this study found that demographic variables such as age, teaching experience, and teaching grade did not have a significant impact on the AI-TPACK readiness scores of the tested teachers, while training and the use of AI tools significantly predicted the ideal performance of the tested teachers in the four dimensions of TK, TCK, TPK, and AI-TPACK, which confirms the significant role of systematic professional training in improving the technological literacy of PE teachers.

This is compatible with empirical research which suggests that self-efficacy is one of the main variables that can predict the adoption of educational technology in pre-service STEM teacher education during pre-service training [8]. Teacher professional development training highly related to AI increases teachers' TPACK performance on several sub-dimensions, as it makes it easier to combine technology and pedagogical knowledge and increases AI tool-using readiness [14].

Pre-service teachers enrolled in AI-related courses obtain better scores across all components of the AI-TPACK framework and demonstrate enhanced perceived effectiveness, resulting in a heightened willingness to incorporate AI technology into future educational practices (Runge et al., 2025). Even in contexts that are not specific to AI, structured TPACK training programs can help teachers improve their technical integration skills and overall TPACK literacy. This suggests that there is a direct link between structured support and training and teachers' technical integration skills.

Those in preservice teacher programs in AI-related classes show better scores across all aspects of the AI-TPACK framework and feel more effective, therefore are more willing to integrate AI technology into their future teaching [15]. Even within non-AI contexts, AI-specific TPACK training programs can support teachers in developing their technical integration capability and TPACK literacy generally. This indicates a direct relationship between formal support and training and the technical integration skills of teachers.

The use of the AI tools is also predictive of both the high-level AI-TPACK readiness and content knowledge representation, and it may have positive influences on teaching improvement and integration. Such a phenomenon can be explained based on the theoretical concepts of perceived usefulness and adoption intention. It has been argued that the teachers' perception of usefulness is strongly predictive of adoption and integration intentions of digital education tools [16]. One further research suggests a positive relationship between the TPACK level of teachers and their intention to integrate technologies [17]. Some recent research revealed that the frequency and competence of using digital educational tools may have predictive power for the further development of teachers' AI-TPACK literacy [18]. These results suggest that the extent of teachers' competencies does not depend so much on demographic variables like age, sex, and teaching experience, but rather on teachers' professional education and the knowledge and use of tools. This finding also contradicts prior studies indicating a negative correlation between teachers' age and years of teaching experience and their propensity to embrace technology. Older teachers are more likely to refuse to use new educational tools because they are used to traditional teaching methods and don't trust new ones [19].

## **4.2. Suggestions**

Thus, a number of implications can be considered necessary to enhance the AI-TPACK readiness of PE teachers in Chinese middle schools, particularly technology-related dimensions and factors. First, schools can provide specialized AI-TPACK professional training programs for sports disciplines, which not only teach the use of general AI tools, but also provide technical use cases specific to sports scenarios, such as motion capture, physical fitness testing, etc. In addition, teachers should be encouraged to use low-threshold AI tools in daily teaching to enhance their willingness to integrate technology by improving perceived usefulness, while also encouraging teachers to share their usage experience and lowering the threshold for technology integration. At the school level, it is necessary to provide appropriate support and resources, such as improving the integration of technology barriers in the teaching venues of physical education classrooms, such as network and

equipment layout, and encouraging physical education teachers to actively participate in digital teaching in the dimensions of teacher assessment and evaluation, rather than relying solely on traditional teaching models.

## 5. Conclusion

This study investigated AI-TPACK readiness among Chinese middle school PE teachers. The results indicated that while teachers performed well in content knowledge, pedagogical knowledge, and pedagogical content knowledge, their technological knowledge and related integration dimensions (TK, TCK, TPK, and AI-TPACK) remained promising. Demographic variables such as age and teaching experience did not show significant effects, while training and use of artificial intelligence tools were found to significantly predict higher readiness in technology-related dimensions. These results suggest that professional development and active integration of AI educational tools are more decisive in shaping AI-TPACK readiness than the demographic characteristics of the teachers studied. This study also highlights the unique challenges facing physical education, including practice-oriented teaching methods and limited teaching environments, which further constrain effective technology integration. Therefore, policymakers and institutions should consider introducing targeted training and professional development programs, contextualized resource support, and policies to enhance teacher readiness for AI educational tools.

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