

# Improving Martial Arts Teachers' TPACK in Universities through Training: A Quantitative Study

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## Abstract

This study investigated how a targeted training program affects the Technology Pedagogical and Content Knowledge (TPACK) levels of martial arts teachers in Chinese universities. In the context of digital education, martial arts coaches face the challenge of integrating modern technology into a practical, culturally rich curriculum. Using a validated TPACK tool, data from 185 participants were collected and analyzed using SPSS 29.0. Results showed that the trained teachers' TK, PK, TPK, TCK, and overall TPACK levels significantly improved, especially in the area of comprehensive knowledge ( $p < 0.001$ ), while CK remained statistically unchanged. More notably, practical teacher training and campus exchange formats outperformed pure online training in promoting technology integration. Novice teachers showed more significant improvements, indicating that they were more willing to adopt new tools. This study provides empirical support for the development of a hybrid, practice-oriented professional development model for culturally contextualized disciplines. This is particularly beneficial for education policymakers, teacher developers, and physical education teachers who are committed to modernizing teaching while inheriting traditional cultural values.

**Keywords:** University Martial Arts Teachers, TPACK, Teacher Training, Teaching Experience, Technology Integration

## Introduction

### *Research Background*

In the digital age, the modernization of education requires teachers to be not only proficient in subject knowledge, but also adept at integrating technology into teaching. The Technology Pedagogy and Content Knowledge (TPACK) framework provides a perspective for assessing and cultivating such multifaceted abilities (Koehler et al., 2013). Although it has been widely used in STEM education and general education, its application in practice-based and culturally rooted subjects such as martial arts remains limited.

As a carrier of traditional Chinese values and sports disciplines, martial arts has become an important part of physical education in Chinese universities. However, martial arts teaching often lags behind in the application of educational technology. In today's era of visual, interactive, and personalized learning experiences, traditional demonstration and imitation methods have become inadequate (Zhao et al., 2021; Huang et al., 2024).

Therefore, improving martial arts teachers' TPACK is not only about teaching, but also a cultural mission. Without the integration of modern tools such as VR, motion capture, and video analysis, the communication of the complexity and philosophical concepts of martial arts may become rigid and unattractive to modern learners. This urgency is further underscored by government policies to promote digital innovation in physical education and improve teacher skills (Wang & Mangaliag, 2024).

This study fills this timely and practical gap by exploring how structured training can enhance martial arts teachers' ability to integrate technology into their teaching. In addition, this study explores the differences in effectiveness of different training models and the impact of teaching experience, providing a reference for sustainable and scalable teacher development programs in the digital age.

### *Research Significance*

This study has important theoretical and practical significance. From a theoretical perspective, the application of the TPACK framework in the field of education has been widely studied, but its application in martial arts teaching is still in the exploratory stage. This study enriched the application research of the TPACK framework in the field of physical education by exploring the TPACK level of martial arts teachers in colleges and universities and its improvement path (Zhang, Madhubala Bava Harji, et al., 2023), especially providing a new theoretical perspective for the integration of technology in martial arts teaching.

From a practical perspective, the particularity of martial arts teaching requires teachers to not only have solid martial arts skills (Li & Wen, 2023), but also master modern educational technology in order to better demonstrate the complexity and cultural connotation of martial arts movements (Zhao et al., 2021). By studying the TPACK level of martial arts teachers in colleges and universities and their training effects, this study provides data support for optimizing the martial arts teacher training system, which is helpful to promote the modernization of martial arts education. In addition, the hybrid training model, practical operation links and long-term tracking mechanism proposed in this study provide reference for TPACK training of teachers in other disciplines.

### *Research Questions*

This study focuses on the following questions:

- i) Does college martial arts teachers' participation in training significantly improve their TPACK level?
- ii) Is there a significant difference in the impact of different training methods (online training, teacher training, academic exchange) on the various dimensions of TPACK?

## Literature Review

### Overview of TPACK Framework

The TPACK (Technological Pedagogical Content Knowledge) framework was proposed by Mishra and Koehler (2006), emphasizing the integration of technology (TK), teaching methods (PK) and subject content (CK). The framework believes that teachers need to have seven core dimensions of knowledge in the teaching process: technical knowledge (TK), subject content knowledge (CK), teaching method knowledge (PK), technology and subject content integration knowledge (TCK), technology and teaching method integration knowledge (TPK), subject content and teaching method integration knowledge (PCK) and TPACK core knowledge (Absari et al., 2020; Nurhidayah & Suyanto, 2021). In recent years, the TPACK framework has been increasingly used in the field of education (Naveen, 2021), becoming an important criterion for measuring teachers' information-based teaching capabilities.

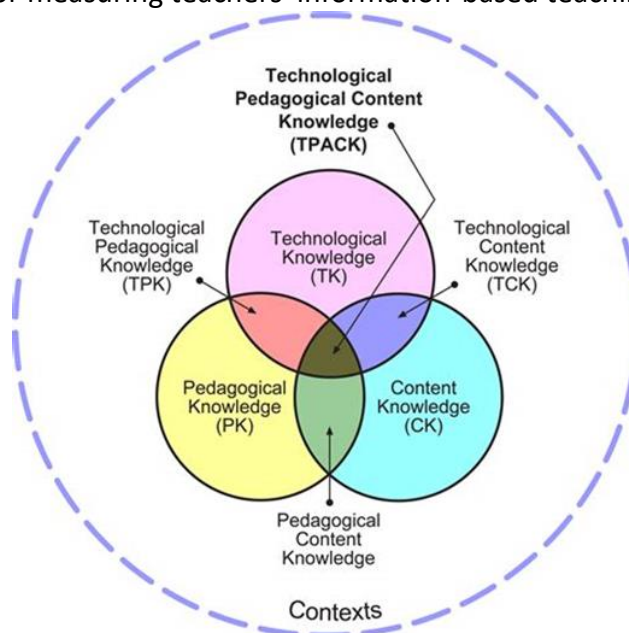


Figure 1. TPACK overlapping teaching framework

### *Characteristics of Wushu Teaching in Colleges and Universities and its Impact on Teacher Training*

As an important part of the excellent traditional Chinese culture, Wushu has unique teaching value in the physical education curriculum system of colleges and universities (Zhao et al., 2021). Wushu teaching in colleges and universities is not only responsible for teaching techniques, but also for inheriting martial arts culture, cultivating students' physical literacy and improving their physical fitness (Xiao, 2023). Therefore, martial arts teaching in colleges and universities is a general physical education course, and its teaching objectives, content system, teaching methods and evaluation methods all have disciplinary characteristics. These characteristics directly affect the teaching ability system of martial arts teachers (Liu, 2020), and ultimately determine the direction of TPACK training.

### *Comprehensiveness and Complexity of Martial Arts Teaching in Colleges and Universities*

Martial arts teaching in colleges and universities covers technical training, theoretical learning, cultural inheritance (Xiang et al., 2020), physical training and other aspects, and is highly comprehensive. Unlike general sports, martial arts emphasizes the accuracy of techniques, the characteristics of routines, and the multiple abilities of actual combat, and

also involves cultural factors such as martial arts philosophy, morality, and health theory (Li et al., 2020). Therefore, the professional knowledge of martial arts teachers not only includes martial arts techniques and training methods, but also needs to master the history, culture, background and style characteristics of martial arts and its integration with modern sports science.

In addition, martial arts teaching also needs to consider the needs of students at different levels. College martial arts courses usually require students at different levels to have a higher level of sports foundation and level of cognition (Sun, 2023), which increases the difficulty of teaching and requires teachers to have perfect course design capabilities and personalized guidance capabilities. How to use modern educational technology to optimize teaching design and enable students at different levels to learn effectively is a key issue that needs to be addressed in martial arts teacher training.

#### *Practicality and Demonstration of Martial Arts Teaching in Universities*

The core of martial arts teaching lies in practice, and movement learning is completed through teacher demonstration and student imitation. , Teachers must not only have the ability to strengthen the corresponding martial arts skills (Jiajia & Jingjing, 2022), but also have good teaching demonstration and error correction capabilities. In the teaching process, teachers need to promptly discover students' mistakes in technical movements and give accurate guidance. This teaching model places higher requirements on teachers' movement expression, language expression ability and instant feedback ability.

Under the TPACK framework, modern technology can effectively assist martial arts teachers in improving teaching quality. For example, by using video analysis technology, motion capture systems (motion capture) or augmented reality (AR) technology (Li et al., 2020), teachers can accurately disassemble martial arts movements and provide students with multi-angle, slow-motion cycle and movement trajectory analysis, thereby improving students' learning efficiency. At the same time, this requires martial arts teachers to have certain technical literacy and be able to use these application technology tools. Therefore, TPACK training should not only improve teachers' martial arts teaching ability, but also strengthen their information-based teaching skills.

#### *The Content of Martial Arts Teacher Training is Disconnected from Practice and is Single*

At present, the training of martial arts teachers in colleges and universities focuses on the imparting of theoretical knowledge and lacks practical links that are closely integrated with actual teaching. This disconnection between training and practice (Chen & Feng, 2020; Yang, 2020) makes it difficult for teachers to effectively apply the knowledge they have learned to teaching after training, affecting the sustainability and stability of the training effect. For example, many teachers learned how to use information technology to carry out more modern teaching methods in training, but lack the opportunity and support to apply these technologies in actual teaching.

Secondly, the existing training methods are mostly online training, lacking diversified training forms. Although online training is flexible and convenient (Peng, 2020), it lacks practical operation and interactive communication links, resulting in limited improvement in teachers' ability to apply technology. In contrast, practice-oriented training methods, such as

workshops and on-campus exchanges, can better improve teachers' ability to integrate technology, but the application of these training forms in the training of martial arts teachers in colleges and universities is still relatively limited.

## Research Methods

### *Research Design*

This study adopts a quantitative research method, collects data through questionnaire surveys, and uses SPSS 29.0 for statistical analysis, hoping to find out the differences in TPACK levels between martial arts teachers who have received training and those who have not received training through data analysis.

### *Research Subjects*

The research subjects are martial arts teachers in Chinese universities. Through random sampling, a total of 185 valid questionnaires were collected, including 63 teachers who have not received training and 122 teachers who have received training. All teachers are engaged in martial arts teaching and have different titles, teaching experience and training experience.

### *Research Tools*

This study uses the TPACK assessment questionnaire, covering seven core dimensions (TK, CK, PK, TCK, TPK, PCK, TPACK core). The reliability and validity of the questionnaire were verified by pre-test, and the Cronbach's  $\alpha$  coefficient was above 0.80, indicating that the questionnaire has high reliability and validity.

### *Data Analysis Methods*

Independent sample t-test: used to compare the mean differences in each dimension of TPACK between teachers who received training and those who did not.

One-way analysis of variance (ANOVA): used to analyze the impact of different training methods (online training, workshops, on-campus exchanges) on TPACK levels. Effect size calculation: Calculate the effect size (such as Cohen's  $d$ ) to evaluate the practical significance of the training effect.

## Research Results

### *The Impact of Training on TPACK Level*

The independent sample t-test was used to analyze the impact of whether college martial arts teachers received training on the various dimensions of their TPACK (see Table 1). The results showed that the teachers who received training scored significantly higher than those who did not receive training in terms of technical knowledge (TK), teaching method knowledge (PK), subject content and teaching method integration knowledge (PCK), technology and subject content integration knowledge (TCK), technology and teaching method integration knowledge (TPK) and TPACK core knowledge ( $p < 0.05$ ). Among them, the improvement of TCK and TPACK core knowledge was the most significant ( $p < 0.001$ ), indicating that training plays a greater role in promoting the deep integration of technology and subject content, technology and teaching method. However, the improvement effect of subject content knowledge (CK) was not significant ( $p = 0.055$ ), indicating that the training had a limited impact on the accumulation of teachers' martial arts professional knowledge.

Table 1

*Independent Sample t Test*

Dimensions	No training (n=63)	Received training (n=122)	t	p	Significance level
TK	2.87 ± 0.95	3.22 ± 0.87	-2.560	0.011	*
CK	3.38 ± 0.99	3.65 ± 0.85	-1.928	0.055	ns
PK	3.50 ± 1.08	3.82 ± 0.84	-2.053	0.043	*
PCK	3.77 ± 1.15	4.18 ± 0.79	-2.575	0.012	*
TCK	3.30 ± 1.19	3.97 ± 0.80	-4.020	0.000	***
TPK	3.81 ± 0.91	4.13 ± 0.73	-2.606	0.010	**
TPACK	3.28 ± 1.11	3.90 ± 0.76	-3.983	0.000	***

Note: \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ , ns means not significant

As shown in Table 1, the training of martial arts teachers in colleges and universities has a significant effect on improving the technical knowledge, teaching method knowledge and various technology integration capabilities of martial arts teachers in colleges and universities, especially in the dimensions of TCK and TPACK. This shows that training not only helps teachers master new technical tools, but also effectively promotes the deep integration of technology and martial arts teaching. However, the training has no significant effect on improving subject content knowledge (CK), which may be because martial arts teachers already have a solid foundation in professional knowledge, and short-term training is difficult to bring significant improvement. Therefore, future training designs can focus more on the combination of technology application and teaching methods to improve teachers' adaptability and innovation ability to modern teaching technologies.

*The Impact of Different Training Methods on TPACK Level*

The results of one-way analysis of variance (ANOVA) show that there are significant differences in the improvement effect of different training methods on TPACK level ( $p < 0.01$ ). The specific results are shown in the following table:

Table 2

*ANOVA Analysis*

Dimensions	Online training (n=45)	Teacher training (n=40)	On-campus exchanges (n=37)	F	p
TK	3.85 ± 0.52	4.45 ± 0.48	4.32 ± 0.51	10.23	<0.001
TPK	3.72 ± 0.45	4.32 ± 0.42	4.15 ± 0.48	12.56	<0.001
PK	3.65 ± 0.47	4.05 ± 0.43	4.23 ± 0.45	8.92	<0.001
PCK	3.56 ± 0.48	4.12 ± 0.45	4.05 ± 0.47	9.87	<0.001
TCK	3.30 ± 1.19	3.97 ± 0.80	3.85 ± 0.75	10.54	<0.001
TPACK	3.78 ± 0.46	4.23 ± 0.44	4.12 ± 0.46	11.34	<0.001

The post-test results showed that the martial arts teachers who participated in the teacher training scored the highest in all dimensions of TPACK, especially in the technical integration ability (TPK, TCK), which was significantly higher than other groups ( $p < 0.05$ ). The martial arts

teachers who participated in the campus exchange had significant improvements in teaching method knowledge (PK) and subject and teaching method integration (PCK), but the improvement in technical knowledge (TK) was relatively small. Although the teachers who participated in the online training gained some technical knowledge (TK), the improvement in the core ability of TPACK was small, and some teachers reported that there was a lack of practical operation links.

### *Effect Size Analysis*

The effect size (Cohen's *d*) calculation results showed that the training had a significant effect on improving the technical knowledge (TK), technology and teaching method integration knowledge (TPK) and TPACK core levels (effect size > 0.8).

Table 3

### *Cohen's d Analysis*

Dimensions	Cohen's <i>d</i>
TK	1.15
TPK	0.98
TPACK	1.02

As shown in the table above, the training has a strong effect on the improvement of martial arts teachers' technical knowledge (TK), technical and teaching method integration knowledge (TPK) and TPACK core competence ( $d > 0.8$ ), indicating that the training is effective in enhancing teachers' TPACK competence. Therefore, the training content can be further optimized in the future, such as strengthening case teaching, practical operation and hybrid training mode, to consolidate the training effect and enable martial arts teachers to apply technical means more efficiently in teaching.

## **Discussion and Suggestions**

### *Discussion*

The results of this study show that targeted training significantly improved the TPACK level of college martial arts teachers, especially in the dimensions of technical knowledge (TK), pedagogical knowledge (PK), and technology integration knowledge (TPK, TCK). These findings echo previous research results (e.g., Absari et al., 2020; Zhang et al., 2023), further highlighting the important value of professional development in enhancing teachers' information-based teaching capabilities. Through training, teachers' cognition and application capabilities of digital teaching tools have been significantly improved, especially in the use of online teaching platforms, the production of teaching videos, and smart device-assisted teaching (Ramírez-Montoya & Lugo-Ocando, 2020; Santos et al., 2022). However, due to equipment shortages and insufficient technical support, many teachers still face challenges in effectively integrating new technologies into classroom teaching. This shows that it is difficult to achieve in-depth application of technology through short-term training alone, and the subsequent practice environment and continuous support system are crucial for the long-term development of teachers' technology integration capabilities.

In terms of subject content knowledge (CK), the training effect was not significant, which may suggest that the current training program is insufficient in integrating subject-specific content. Further analysis of the effects of different training methods found that face-to-face

teacher training and on-campus exchange activities were more effective than online training, which may be attributed to the interactive and practice-oriented elements of the former. Some teachers still tend to use traditional teaching methods in the classroom, mainly because they do not have a deep understanding of new teaching methods, lack practical experience, or worry about students' adaptability to new methods (Schmidt et al., 2009; Serin, 2020; Shafira Aulia Putri et al., 2022; Shan & Shao, 2021). Therefore, future training programs should strengthen the sharing of practical cases and provide continuous teaching support to help teachers apply innovative teaching methods more confidently. This not only highlights the importance of practical experience and collaborative learning in the professional development of martial arts teachers, but also emphasizes that the training content needs to be closer to the actual needs of the subject.

It is worth noting that novice teachers have more significant improvements in TPACK than experienced teachers, especially in technology integration. This may be because novice teachers are more open to new tools and teaching innovations, while experienced teachers may need more time to adapt to new teaching strategies.

Overall, although the training has achieved significant results in improving teachers' TPACK capabilities, in order to truly promote the improvement of teaching quality, it is necessary to further strengthen the practice-oriented training design, provide long-term support, and promote experience exchange and cooperation among teachers.

### **Recommendations**

Based on the research results and actual needs, this study proposes the following practical suggestions to optimize the training system of martial arts teachers in colleges and universities.

In order to improve the training effect, the training system of martial arts teachers needs to pay more attention to the combination of theory and practice. Online learning can provide basic knowledge of technology and teaching methods, while offline training should focus on practical operations, such as teaching demonstrations, application of technical tools and interactive communication. For example, teachers can optimize martial arts action demonstrations through VR technology, or use smart devices to provide personalized teaching feedback, thereby enhancing the intuitiveness and accuracy of teaching.

The training content should also be more comprehensive, especially strengthening the integration of technology, teaching methods and subject knowledge (Barut & Wijaya, 2020; Celik, 2023; Chen & Zhou, 2022; Ching & Roberts, 2020). Studies have shown that although training has improved technical and teaching knowledge, the progress of subject content knowledge is relatively limited. Therefore, the training should cover traditional martial arts, health qigong and other content, so that teachers can have a deeper understanding of the cultural connotation of martial arts while mastering modern teaching methods. In addition, teachers can be guided to use information technology to systematically analyze martial arts movements, so that students can more intuitively understand the technical characteristics of different martial arts schools.

Finally, continuous support for training is crucial. It is recommended to establish a regular evaluation and teacher exchange mechanism, track the training effect through teaching observation, questionnaire surveys, etc., and provide follow-up support. At the same time, build a teacher mutual assistance platform to allow teachers to share teaching experience and jointly explore the deep integration of technology and martial arts teaching, so as to ensure the long-term effectiveness and practical application value of training.

### Conclusion

This study explored the impact of training on the TPACK level of college martial arts teachers through questionnaire surveys and data analysis. The results show that the teachers who participated in the training had significantly higher levels of technical knowledge (TK), pedagogical knowledge (PK), technology integration ability (TPK, TCK) and TPACK core knowledge than those who did not receive training. However, the improvement effect of subject content knowledge (CK) was not obvious, which means that the transformation of the effect of martial arts teachers in the process of receiving training and actual application is still affected by many factors.

The study found that the teachers who received training were significantly better than those who did not receive training in the cognition and application ability of digital teaching tools, especially in online teaching, video production and smart device-assisted teaching. However, the actual application of technology still faces certain obstacles, such as limited equipment resources, insufficient technical support and lack of practical opportunities, which makes it difficult for some teachers to effectively integrate new technologies into classroom teaching.

In terms of teaching methods, the training broadened the teachers' teaching horizons and made them pay more attention to the design of interactive, exploratory and contextualized teaching. However, some teachers still prefer traditional models in actual teaching (Li & Dai, 2021; Li et al., 2020; Li & Wen, 2023; Sun, 2023; Yang, 2020) and are cautious about the application of innovative teaching methods. This may be related to the teachers' lack of in-depth understanding of new methods, insufficient practical experience, and uncertainty about teaching effects. Therefore, theoretical training alone is difficult to promote a real change in teaching mode, and subsequent practical support and experience sharing mechanisms are crucial.

In contrast, the training has a relatively limited effect on improving subject content knowledge (CK). Wushu teaching not only involves competitive martial arts, but also covers traditional martial arts and health qigong. However, the current training mainly focuses on technology and teaching methods, and pays insufficient attention to the deepening integration of subject knowledge, resulting in teachers still facing content limitations in actual teaching.

Overall, training has a significant effect on improving the TPACK ability of college martial arts teachers, but a single training session is difficult to ensure the continuous application and development of teachers in actual teaching. Therefore, a more systematic training system should be constructed in the future, not only focusing on the improvement of technology and teaching methods, but also strengthening the integration of subject knowledge. At the same time, only by establishing a practice-oriented learning model, providing long-term technical

support, and encouraging experience exchange among teachers can we truly promote the continuous optimization and development of the quality of martial arts teaching.

#### *Theoretical and Practical Contributions*

This study is one of the first to empirically apply the TPACK framework to martial arts education in Chinese colleges and universities. It provides new insights into the differentiated effects of training modes and highlights the moderating role of teaching experience. Practically speaking, the findings provide guidance for designing sustainable, practice-oriented professional development programs for physical education teachers in the digital age.

#### **Research Limitations**

Although this study explored the role of martial arts teacher training in colleges and universities in improving TPACK levels and analyzed the moderating influence of teaching experience, there are still the following limitations:

##### i ) Sample representativeness limitation

The samples of this study mainly come from 17 public colleges and universities in Zhengzhou City, Henan Province, but fail to cover martial arts teachers in all colleges and universities, which may affect the generalizability of the research results. Future research can expand the sample range to improve the external validity of the conclusions.

##### ii ) Short-term training effect evaluation

The study is mainly based on short-term data before and after training, and fails to examine the impact of training on teachers' long-term teaching practice. In the future, a longitudinal research design can be adopted to track the integration and application of technology by teachers in actual classrooms to evaluate the sustained effect of training.

##### iii ) Single data collection method

The study mainly relies on questionnaire surveys, which may have social expectation bias. In the future, classroom observation, interviews and teaching case analysis can be combined to obtain more comprehensive and objective training effect evaluation data.

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#### *Conflict of Interest*

The research undertaken was executed without the influence of any commercial or financial affiliations, which may be perceived as potential conflicts of interest

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