INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN PROGRESSIVE EDUCATION & DEVELOPMENT

OPEN ACCESS JOURNAL

Vol 13, Issue 1, (2024) E-ISSN: 2226-6348

Integrating Digital Tools in Art Education: A Study of TPACK Development in Chinese Pre-Service Teachers

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To Link this Article: http://dx.doi.org/10.6007/IJARPED/v13-i1/20016 DOI:10.6007/IJARPED/v13-i1/20016

Published Online: 23 January 2024

Abstract

The research aims to assess the proficiency levels across various TPACK domains, understand the interconnections among these domains, and evaluate the impact of specific knowledge areas on overall TPACK development. A quantitative research methodology was employed, utilizing a survey questionnaire based on the TPACK framework. Data were collected from a sample of pre-service primary art teachers and analyzed using SPSS and SmartPLS. The findings reveal a spectrum of proficiency levels in TPACK domains, with notable strengths in Technological Content Knowledge (TCK) and Technological Pedagogical Knowledge (TPK). Correlation analysis showed significant relationships among the TPACK domains, while path analysis highlighted the substantial influence of Technical Knowledge (TK) and TPK on TPACK development. The conclusion of the study underscores the critical role of technological integration in art education and the necessity for targeted improvements in teacher education programs. The results advocate for a more nuanced approach in preparing pre-service art teachers, emphasizing the importance of a well-rounded TPACK framework that balances technological skills with pedagogical and content knowledge. This research contributes significantly to the theoretical understanding of TPACK in the context of Chinese art education and offers practical insights for curriculum development, professional training, and policy formulation in the digital era.

Keywords: Art Education, TPACK, Pre-Service Teachers

Introduction

The integration of digital tools in art education represents a significant shift in teaching methodologies, aligning with the evolving technological landscape. The incorporation of multimedia tools like sound, picture, and video has transformed the traditional art classroom, offering new avenues for creativity and learning. Studies like that of Umit Izgi-Onbasili et al (2022) have explored the impact of digital storytelling in science education, revealing its effectiveness in enhancing pre-service teachers' self-confidence in technological pedagogical content knowledge (TPACK) (Izgi-Onbasili et al., 2022).

Understanding the TPACK development among pre-service primary art teachers in China is crucial, given the rapid advancement of digital technologies in education. The study by S. Strydom et al (2021) emphasizes the value of digital literacy courses in enhancing technological pedagogical content knowledge among student teachers, highlighting the need for technology-enhanced curriculum practices (Strydom et al., 2021). This underscores the importance of equipping future art educators with the necessary skills to integrate digital tools effectively.

This study aims to investigate the level and development of TPACK among Chinese pre-service primary art teachers, focusing on how they integrate digital tools in art education. It seeks to answer key questions about the current state of TPACK among these teachers and the effectiveness of existing teacher education programs in preparing them for the digital age. The research by Kivunja (2013) on embedding digital pedagogy in pre-service higher education provides a relevant context, demonstrating the necessity of preparing teachers for the digital generation (Kivunja, 2013).

Literature Review

The Technological Pedagogical Content Knowledge (TPACK) framework is pivotal in understanding the integration of technology in teaching. It emphasizes the convergence of technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK) to effectively teach using technology. A study by Li et al (2023) developed and validated the Secondary Mathematics Teachers' TPACK Scale (SMTTS) in China, demonstrating its reliability and validity in assessing TPACK among secondary mathematics teachers. This scale is subject-oriented and culturally relevant, addressing the specific needs of mathematics education in China (Li et al., 2023).

Digital tools have revolutionized art education, offering new ways to engage students and enhance learning. The maker movement, gaining traction in K-12 schools and higher education, exemplifies this shift. Lindstrom et al (2017) discuss how makerspaces support design thinking and STEM education, aligning with the Next Generation Science Standards. These spaces are becoming more common in schools, indicating a growing recognition of the importance of integrating technology in education (Lindstrom et al., 2017).

In China, the integration of technology in teacher education is evolving, with increasing emphasis on developing TPACK among pre-service teachers. Hodges (2019) notes the importance of technology integration in teacher education, highlighting the need for educators to adapt to the changing educational landscape. This reflects a global trend towards enhancing technological competencies in teacher training programs (Hodges, 2019).

Methodology

The study employed a quantitative research design, focusing on a survey-based approach to collect data from pre-service primary art teachers in China. This design was chosen for its effectiveness in quantifying the relationships and impacts within the TPACK framework.

Instrument :Technological Pedagogical Content Knowledge (TPACK) Scale

The TPACK scale used in this study was adapted from the instrument developed by (Schmidt et al., 2009). This scale is designed to measure pre-service teachers' self-assessments across

seven TPACK domains: Technological Knowledge (TK), Content Knowledge (CK), Pedagogical Knowledge (PK), Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and Technological Pedagogical Content Knowledge (TPACK).

The scale comprises 75 items, with each domain represented by a specific number of items. Respondents rated each item on a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The scale's reliability, as reported by Schmidt et al (2009), indicates a Cronbach's alpha coefficient of 0.850 for the overall instrument, with subscales ranging from 0.800 to 0.920.

For cultural appropriateness, the original TPACK scale items were translated into Chinese. This translation process involved expert review by Chinese specialists in fine arts education and English language experts to ensure accuracy. The instruments were then retranslated into English to maintain the integrity of the original scale.

Data Collection

Data were collected through the adapted TPACK questionnaire, distributed to a sample 350 of pre-service primary art teachers across various educational institutions in China. The questionnaire was administered electronically, ensuring a wide reach and efficient data collection process. The participants were assured of anonymity and confidentiality to encourage honest and accurate responses.

Data Analysis

The collected data were analyzed using SPSS and SmartPLS software. SPSS was utilized for descriptive statistical analysis, providing insights into the general trends and proficiency levels across the TPACK domains. SmartPLS was employed for structural equation modeling to examine the relationships among the TPACK domains and assess the impact of individual domains on the overall TPACK development. This combination of analytical tools provided a comprehensive understanding of the TPACK framework among pre-service primary art teachers in China.

The integration of quantitative analysis with the adapted TPACK scale offers a robust methodological approach to exploring the integration of digital tools in art education and contributes to the broader understanding of TPACK development in pre-service teachers.

Research Findings

The research findings primarily focus on the development of Technological Pedagogical Content Knowledge (TPACK) among pre-service primary art teachers in China. The key findings are presented in three tables, each corresponding to a specific hypothesis of the study.

Table 4.1 presents the average scores for each TPACK domain, providing insights into the proficiency levels of pre-service primary art teachers in these areas.

Table 4.1
Descriptive Analysis

TPACK Domain	Mean Score	Standard Deviation
TK (Technological Knowledge)	3.308	0.684
CK (Content Knowledge)	3.209	0.756
PK (Pedagogical Knowledge)	3.410	0.760
PCK (Pedagogical Content Knowledge)	3.398	0.787
TCK (Technological Content Knowledge)	3.537	0.694
TPK (Technological Pedagogical Knowledge)	3.423	0.762
TPACK (Technological Pedagogical Content Knowledge)	3.407	0.792

The data from Table 4.1 offers a nuanced view of the proficiency levels in the TPACK framework among pre-service primary art teachers in China. It reveals a spectrum of competencies across different domains, with the highest proficiency noted in Technological Content Knowledge (TCK) at 3.537, indicating a strong ability to integrate technology with content. This is closely followed by Technological Pedagogical Knowledge (TPK), with an average score of 3.423, suggesting effective integration of technology in teaching methods. In contrast, Content Knowledge (CK) and Technological Knowledge (TK) present moderate scores of 3.209 and 3.308, respectively, highlighting areas where further development could be beneficial. Pedagogical Knowledge (PK) and Pedagogical Content Knowledge (PCK) show relatively higher scores, indicating a solid grasp of teaching methodologies and the integration of content with pedagogical skills. Overall, these findings underscore the varied levels of TPACK-related skills among these educators, with particular strengths in the integration of technology with content and pedagogy, and opportunities for growth in foundational technological and content knowledge.

Table 4.2 presents the Pearson correlation coefficients between various constructs within the Technological Pedagogical Content Knowledge (TPACK) framework for pre-service primary art teachers. These constructs include Content Knowledge (CK), Pedagogical Content Knowledge (PCK), Pedagogical Knowledge (PK), Technological Content Knowledge (TCK), Technological Knowledge (TK), Technological Pedagogical Knowledge (TPK), and Technological Pedagogical Content Knowledge (TPACK).

Table 4.2
Correlation

	CK	PCK	PK	TCK	TK	TPK	TPACK
CK	1						
PCK	0.820	1					
PK	0.830	0.800	1				
TCK	0.810	0.790	0.780	1			
TK	0.840	0.820	0.810	0.800	1		
TPK	0.750	0.760	0.770	0.740	0.780	1	
TPACK	0.790	0.780	0.760	0.770	0.790	0.730	1

CK shows moderate to strong correlations with all other constructs, ranging from 0.750 to 0.840. This indicates a significant relationship between CK and other domains, suggesting that

content knowledge is integrally related to technological, pedagogical, and their combined forms of knowledge. PCK is moderately correlated with other constructs, with coefficients ranging from 0.760 to 0.820. This suggests that PCK, which combines content and pedagogical knowledge, is meaningfully related to other forms of knowledge, though the relationships are not exceptionally strong. PK exhibits moderate correlations with other constructs, with coefficients between 0.760 and 0.830. This indicates a significant association between pedagogical knowledge and other domains, reflecting its importance in the broader educational framework. TCK's correlations with other constructs range from 0.740 to 0.810, reflecting moderate relationships. This suggests that the integration of technological and content knowledge is relevant to other knowledge domains, though not the strongest link. TK shows moderate to strong correlations with other constructs, with coefficients ranging from 0.780 to 0.840. This indicates a substantial relationship between technological knowledge and other forms of knowledge, highlighting its central role in the TPACK framework. TPK displays moderate correlations with other constructs, with coefficients between 0.730 and 0.780. This suggests that the integration of technology with pedagogy is significantly related to other knowledge areas, but not overwhelmingly so. TPACK is moderately correlated with all other constructs, with coefficients ranging from 0.730 to 0.790. This indicates that the holistic integration of technology, pedagogy, and content knowledge is meaningfully related to each of its constituent parts.

In summary, the table indicates that all constructs within the TPACK framework are interrelated to varying degrees. This interconnectivity underscores the complexity of the TPACK framework and the importance of considering all aspects of teacher knowledge in the context of technology integration in education.

The bellowed table shows the impact of various knowledge domains on TPACK, as measured by path coefficients, t-values, and p-values.

Table 4.3
Path Coefficients

Predictor Domain	Path Coefficient	T-Value	P-Value
TK	0.158	2.690	0.007
CK	0.021	0.299	0.765
PK	0.115	1.459	0.145
PCK	0.036	0.386	0.699
TCK	0.072	1.022	0.307
TPK	0.582	11.243	0.000

In the analysis of the effects of various knowledge domains on Technological Pedagogical Content Knowledge (TPACK) among pre-service primary art teachers, the data reveals distinct influences. Technological Pedagogical Knowledge (TPK) emerges as the most impactful domain, with a strong path coefficient of 0.582 and a highly significant p-value of 0.000, underscoring its crucial role in shaping TPACK. Technological Knowledge (TK) also shows a notable, albeit more moderate, positive impact on TPACK, indicated by a path coefficient of 0.158 and a significant p-value of 0.007. In contrast, other domains such as Content Knowledge (CK), Pedagogical Knowledge (PK), Pedagogical Content Knowledge (PCK), and Technological Content Knowledge (TCK) display minimal and statistically non-significant effects on TPACK. This pattern highlights the paramount importance of integrating technology

with pedagogical methods and possessing strong technological skills in the development of TPACK among these pre-service teachers.

Discussion

The study's findings contribute significantly to the theoretical and practical understanding of art education and teacher education, particularly in the context of TPACK and technology integration. These contributions can be further contextualized by comparing and contrasting them with existing literature.

Significance of Findings in Art Education and Teacher Education: The study underscores the importance of TPACK in the professional development of pre-service primary art teachers in China. It highlights the critical role of technological and pedagogical knowledge in enhancing teaching effectiveness. This is in line with Voithofer and Nelson's (2020) study, which reveals varying conceptions of TPACK among teacher educators in the United States, suggesting a need for a more unified and comprehensive approach to TPACK in teacher education. Similarly, Karchmer-Klein and Konishi's (2021) research on novice K-12 teachers indicates a gap between the perceived importance of technology integration and its actual implementation, resonating with the current study's emphasis on practical application of TPACK knowledge.

Connection with Existing Literature: The study's focus on TPACK in art education aligns with the broader trends observed in TPACK literature. For instance, Stapf and Martin's (2019) review on TPACK in mathematics education underscores the importance of developing self-efficacy and collaborative learning in TPACK application, themes that are relevant to the current study. Additionally, Septiyanti et al (2020) investigation into student-teachers' perceptions of TPACK in English language education suggests a positive reception of the TPACK framework across different subject areas, supporting the current study's findings on the favorable perception of TPACK among pre-service art teachers(Septiyanti et al., 2020).

In conclusion, the study's findings not only enhance our understanding of TPACK in the context of art education but also align with global trends in teacher education. The comparison with existing literature highlights the multifaceted nature of TPACK development and its relevance across different educational contexts. This comparative analysis underscores the importance of integrating technology, pedagogy, and content knowledge in teacher education programs, offering valuable insights for future research and practice in the field.

Conclusion

This study provides a comprehensive analysis of the development of Technological Pedagogical Content Knowledge (TPACK) among pre-service primary art teachers in China, offering valuable insights into the integration of digital tools in art education. The research underscores the importance of TPACK in enhancing the effectiveness of art education and highlights the need for a strategic approach in teacher education programs.

The study's main findings reveal a moderate to strong proficiency in various TPACK domains among pre-service primary art teachers, with particular strengths in Technological Content Knowledge (TCK) and Technological Pedagogical Knowledge (TPK). These findings contribute

to the understanding of how digital tools can be effectively integrated into art education, emphasizing the role of technology in modern teaching methodologies.

The study offers several recommendations for educational policymakers and practitioners. It suggests the need for curriculum development in teacher education programs that focus on enhancing technological and pedagogical skills. Additionally, the study advocates for professional development opportunities for educators to stay abreast of technological advancements and their applications in art education. These recommendations aim to equip future art teachers with the necessary skills to integrate technology effectively into their teaching practices.

The significance of this research lies in its contribution to the evolving field of art education, particularly in the context of digital integration. The study highlights the dynamic nature of teaching methodologies in the digital age and the need for continuous adaptation and development in teacher education. Looking forward, the research opens avenues for further exploration into the application of TPACK in different educational contexts and subject areas, aiming to enhance the overall quality and effectiveness of education in the digital era.

This research significantly contributes to both theoretical understanding and practical application in the field of art education, particularly in the context of digital integration. Theoretically, it extends the existing body of knowledge on TPACK by providing empirical evidence from the perspective of pre-service primary art teachers in China, a context that has been relatively underexplored in existing literature. The study's findings enrich the TPACK framework by highlighting the critical roles of TCK and TPK, thereby offering a nuanced understanding of how these domains interact within the broader TPACK construct. This contributes to a more comprehensive theoretical model of TPACK, which can be used to guide future research and curriculum development in teacher education.

Contextually, the study is significant as it addresses the integration of digital tools in art education within the unique educational landscape of China. By focusing on pre-service primary art teachers, the research provides insights into the preparedness of future educators to integrate technology in art classrooms effectively. This is particularly relevant in the rapidly evolving educational context of China, where there is a growing emphasis on digital literacy and technology integration across all levels of education. The study's recommendations for curriculum development and professional training are directly applicable to Chinese educational policy and practice, offering a roadmap for enhancing the quality of art education in the digital age. Furthermore, the findings have broader implications, serving as a valuable reference for other regions undergoing similar educational transformations.

In summary, this research not only adds to the theoretical discourse on TPACK but also provides practical insights for educators, policymakers, and stakeholders in China and beyond. Its contributions lie in bridging the gap between theory and practice, offering a comprehensive understanding of the challenges and opportunities in integrating digital tools in art education.

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