ISSN 2618-1568 Vol. 5, Issue 2: 23-29, DOI: 10.25236/FAR.2023.050205

A Review of Technological Pedagogical Content Knowledge Research Frontier and Music Disciplinary Path

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Abstract: *Since the advent of the theoretical framework of technological pedagogical content knowledge (TPACK), this field has gradually become a research forefront and hotspot in China and abroad, demonstrating an evident trend of disciplinary development. In recent years, the research on TPACK has attracted increased attention with the increase in the importance of teacher competence and interest in the application of technology to education. Firstly, this study organises the theoretical basis of TPACK by explaining the concept and introducing the main models of related research. Second, it analyses the international trends in mainstream research, especially the research hotspots and cases in the field of music. Finally, this study summarises the advantages and disadvantages of relevant research in China on the basis of the current research situation in China and discusses potential development directions in the future.*

Keywords: *Music discipline, Technological pedagogical content knowledge, Frontier, Review*

1. Concept of Technological Pedagogical Content Knowledge (TPACK)

Shulman proposed pedagogical content knowledge (PCK) and elucidated that the concept is a unique knowledge system for teaching and a special combination of content and pedagogical knowledge, learners, and situations[1]. Schulman's conceptualisation of PCK extends beyond the understanding of teachers about themes and pedagogy itself and encompasses the dimensions of the teaching of content and its translation into forms or representations that learners can understand.

Since then, researchers have added 'technology' factors for further expansion and developed TPACK. This concept has been characterised by being comprehensive, situational, dynamic, individual, and practical. In teaching practice, teachers with TPACK can effectively use technology for teaching, which helps to achieve teaching objectives and results. TPACK has provided important theoretical guidance and a practical basis for guiding teachers in conducting effective technology integration teaching and in promoting teacher learning and teacher education and development in the information age.

2. Two Main Models of TPACK Research

The existing studies have focused on two main models of TPACK, namely, the integrative and transformative models. The two models have presented different perspectives and theoretical explanations in terms of teaching practice, instructional design and teaching context.

Figure 1 illustrates the TPACK integrative model, which was proposed by Koehler and Mishra[2]. It conceptualises TPACK as a comprehensive knowledge system represented by three intersecting circles, which represent the different knowledge bases. TPACK is created by the intersection of three knowledge systems, namely, technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK).

ISSN 2618-1568 Vol. 5, Issue 2: 23-29, DOI: 10.25236/FAR.2023.050205

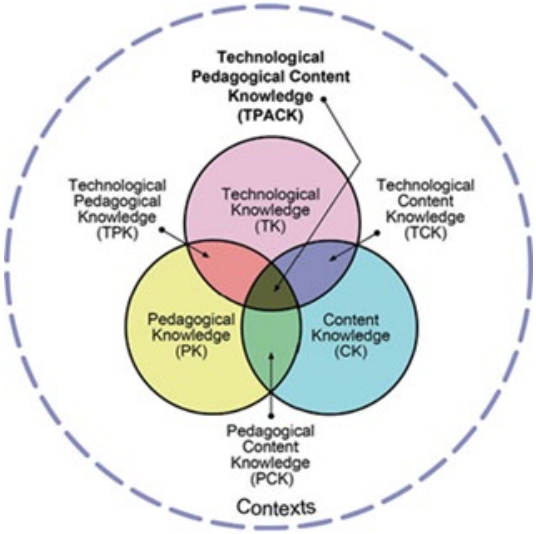

Figure 1: Graphical representation of technological pedagogical content knowledge (TPACK).

Among them, TK includes traditional and digital technologies, which are considered the most changeable components in the TPACK framework. PK refers to general pedagogical knowledge, which lacks the pertinence of subject content. CK includes not only specific subject knowledge but also the deep understanding of teachers about the subject. It is a form of knowledge that 'transcends facts and concepts' and varies significantly across disciplines.

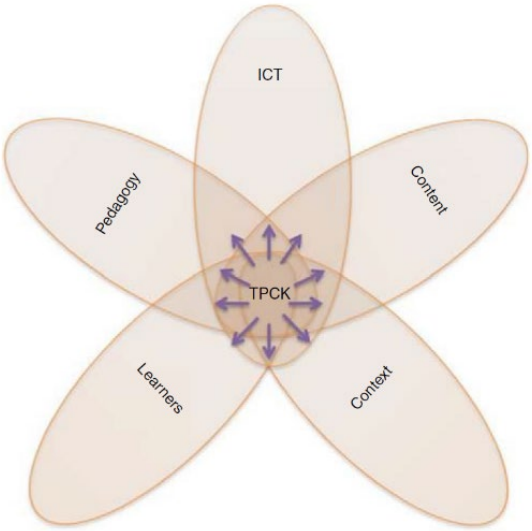

Figure 2: Framework of TPACK.

Figure 2 depicts the transformative model proposed by Angeli and Valanides [3]. In contrast to the integrative model, it conceptualises TPACK as a unique knowledge system that needs to be clearly taught by teachers and educators. It includes not only the integration or accumulation of knowledge bases but also the transformation of these contributed knowledge bases into novel and unique knowledge.

The TPACK transformative model is conceptualised on the basis of five knowledge bases (i.e. content, pedagogical, learner, educational background, and information and communication). In the transformative model, teaching content and method, learner and technology are considered important contributors to the development of TPACK. However, scholars are more inclined to use TPCK to demonstrate differences in this model due to its different perspectives.

In addition, Angeli and Valanides[4] proposed technology mapping as an instructional design method for guiding the integration of technology into the learning design and development of the TPCK of teachers. According to the technology mapping process, teachers initiate a curriculum design by identifying topics that are difficult to teach or master. They then define the content and goals and consider

ISSN 2618-1568 Vol. 5, Issue 2: 23-29, DOI: 10.25236/FAR.2023.050205

the misconceptions of students. The design process continues by finding effective representations to transform content for teaching, which helps students and teachers to overcome previously identified teaching problems. When considering appropriate representations for transforming content, teachers seek appropriate technical tools for implementing the curriculum design.

3. International Trends in Mainstream Research

3.1. Strong Research Trends

Since the introduction of the theoretical framework of TPACK, international research in this field has gradually become a frontier and hotspot, which has displayed an increasing trend and aroused widespread concern in the academic community. The initiation of the research on TPACK in China was late, such that concepts were introduced in 2010, but related research displayed a sharp upward trend[5]. At the 6th International Conference of Educational Innovation Through Technology, which was held in Japan in 2017, the increased attention to TPACK indicated that the technology integration of interdisciplinary knowledge in the digital age is an inevitable trend of teacher training[6].

3.2. Penetration of Research Fields into Disciplines

The importance of subject-exclusive TPACK research is becoming increasingly prominent, and the direction of disciplinary penetration in the research field is clear. Among the disciplines, those at the forefront of research mainly concentrate on the diverse needs of teachers with varying levels of the application of information technology, which tend to be in mathematics, geography, language, science and computer science. An increasing number of researchers point out that understanding the specific aspects of TPACK and achieving effective guidance and support of technological knowledge are necessary.

Chai et al. compiled the TPACK-ML (meaningful learning) scale[7][8] on the basis of Schmidt et al.[9] and explained the quantitative relationship and changes in the paths among the elements of the TPACK framework by elucidating changes between pre- and post-tests using the structural equation model. Since then, Chinese scholars translated and revised the scale by Chai et al., incorporated constructivist learning ideas and conducted a solid empirical study on the level of TPACK of teachers college students in China[10].

3.3. Frontier Analysis of Music Research in Three Countries

Foreign studies mainly focused on empirical research, which generally demonstrated that improving the TPACK level of music education students of teacher education majors exerted a positive effect on their sustainable development, TK and skills, self-efficacy, and model degree.

3.3.1. United States: Mature M-TPACK Survey Scale

Studies in the United States conducted TPACK research in the field of music discipline in earlier years, established a relatively complete training system for students of teacher education majors majoring in music education, and used a mature scale basis and feasible research plan in TPACK research.

For example, Kleiner et al., in collaboration with the National Center for Education Statistics, conducted a national survey on 2,512 fourth-year higher education institutions with level-IV degrees in the United States to explore the TPACK situation of pre-service teachers[11].

Moreover, Bauer found that using TPACK can help in improving the understanding of the knowledge and skills required of teachers to effectively integrate technology into teaching[12]. The authors examined how music educators obtain TPACK and their use of technology as a teaching tool.

Bauer et al. completed a TPACK national survey on students majoring in music teacher education and used TPACK as a framework for exploring how the education plans of college music teachers accordingly prepare pre-service teachers[13].

Doherty used quantitative research methods to examine the self-efficacy of music teachers in the fields of technology, teaching and TK (M-TPACK), with special attention to technical self-efficacy[14]. The study further verified that the factor structure of the M-TPACK survey by Bauer is suitable for music teachers to measure questions in each TPACK field. In addition, the study found that male music educators may have higher levels of self-efficacy and TK in using technology in their teaching.

ISSN 2618-1568 Vol. 5, Issue 2: 23-29, DOI: 10.25236/FAR.2023.050205

3.3.2. South Korea: Focus on the Research of TPACK Competence and Ability Analysis

Cho and Jung conducted a survey on the perceptions of music teachers about TPACK to determine the competence of music teachers for TPACK in the music curriculum for middle school[15]. The study recruited 71 music teachers and analysed their perceptions of seven components of TPACK (i.e. TK, PK, CK, TPK, TCK, PCK and TPACK). The results demonstrated that male teachers displayed significantly higher levels of perception of TK than female teachers and observed significant differences in the perception of TK. Moreover, the study pointed to a significant difference in the teaching time of teachers in PCK. In other words, the longer a teacher teaches, the higher cognitive ability they have. The correlation analysis of TPACK elements indicated that they were positively correlated, except for PCK. In particular, the study found a high correlation between TPK and TPACK. The results indicated that more efforts should be made to help music teachers acquire a positive attitude and confidence in technology, as well as experience and apply various technologies to music education to improve their TPACK ability.

Furthermore, Cho and Yoon analysed the status of utilising technology and TPACK competency for singing education to explore the practical application of technology and TPACK ability level of teachers in singing education in South Korea[16]. Firstly, this study reviewed the theory of vocal music education and TPACK and developed a questionnaire. The results illustrated that technology is rarely or effectively used in singing education. The teachers reported that their PCK ability is high but insufficient in detail. The study also found that the level of knowledge about TCK skills is extremely low in terms of understanding and using effective technologies for vocal music education. Thus, additional efforts were required to improve these skills.

3.3.3. UK: Pay Attention to the Relationship Between TPACK and Teachers and Schools

British scholar Marina Gall pay more attention to the relationship between TPACK and teachers and schools[17]. She had focused on the use of music technology in school education and teacher education since 2000. She also thought about in-service teachers' use of music technology in the classroom and their views on the use of music technology in schools under the framework of Shulman's Pedagogical Content Knowledge (PCK). The book analyzes TPACK of music education of primary teachers in secondary schools of England through a review of the development of music education and teacher education in secondary schools in England from 1986 to 2014, and of the theoretical process of PCK and TPACK. Moreover, it explores the awareness of music student teachers on their own development which leads to further reflection based on TPACK.

4. Research Status and Direction of Future Development in China

4.1. Research Status in China

Since the beginning of the 21st century, the major of music education in Chinese universities has made great progress. However, certain shortcomings have also been observed in professional development and problems, which do not adapt to the development of the times. Among them, the 'weak information literacy of students of teacher education majors' is one of the key problems. With the progress of technology, the importance and urgency of technology have become increasingly prominent. Nowadays, when music education is facing development opportunities and severe challenges, exploring the training of students that is more in line with the trend of the information age through teaching reform has become imperative.

TPACK research in the music discipline in China gradually received scholarly attention and the support of scientific research funding. In the research on the TPACK music discipline, the School of Education of Central China Normal University and the National Social Science Fund were at the forefront. Wang presented a doctoral dissertation entitled 'Research on the Cultivation of Teaching Ability of Music Students of Teacher Education Majors Supported by Information Technology'[18]. The study analysed the cultivation of the teaching ability of music students of teacher education majors supported by information technology in terms of mode creation, method innovation and process design in teaching. Among them, analysis of the teaching ability structure of music students of teacher education majors included the disciplinary extension of the theoretical framework of TPACK, which is called technological pedagogical music knowledge (TPMUK) and has been tested and evaluated in practice. It presented clear advantages in research depth and academic value. Wang also presented a paper entitled 'Experiential Teaching Design and Empirical Research of Music Discipline in Information Environment'[19], which was published as the stage achievement of the National Social Science Fund Project entitled 'Research

ISSN 2618-1568 Vol. 5, Issue 2: 23-29, DOI: 10.25236/FAR.2023.050205

on Theory, Method and Application of Intelligent Diagnosis of Discipline Knowledge and Ability'. Since then, as the phased research results of the special Dangui Plan project of Central China Normal University for basic scientific research business expenses, other papers were published, which further elaborated the significance and role of the TPMUK framework. Examples of these papers included 'Professional Development of University Music Teachers in the Context of Technology Diffusion' (a collaborative innovation research centre project on the balanced development of informatisation and basic education), 'The Dilemma and Breakthrough of Music Education in Rural Teaching Spots in Hubei Province', 'Research on the Teaching Mode of College Music Courses Based on the Cloud Integrated Teaching Platform' (a teaching and research project of Central China Normal University) and 'Integration of Information Technology and Music Curriculum: From the Perspective of TPACK Music Discipline' by Wang[20].

Other universities and research funds followed, which expanded the research on music teachers in primary and secondary schools. In 2016, the 13th Five-year Plan for Educational Science in Jilin Province included 'Research on the Measurement and Training of TPACK for Music Teachers in Primary and Secondary Schools', which included organising the training of the TPACK framework for music teachers in primary and secondary schools in the United States and exploring TPACK in the Chinese music discipline. In 2017, the national educational information technology research project of the Central Audiovisual Education Museum included 'Exploration and Countermeasures of the Training Methods of Music Teachers in Primary and Secondary Schools based on TPACK'. Moreover, the social science project of the Jilin provincial department of education, which was presented in the 13th Five-year Plan, included 'Research on the Measurement and Training of TPACK for Music Teachers in Primary and Secondary Schools' by Zhang and Li. The results included papers entitled 'Introduction to TPACK Framework Training for Music Teachers in Primary and Secondary schools in the United States'[21] and 'Design and Implementation of TPACK Ability Training Curriculum for Music Teachers in Primary and Secondary Schools'[22].

4.2. Major Advantages and Disadvantages

Related research on TPACK in the Chinese music discipline is in a vigorous stage of development, and its major advantages are as follows: support from scientific research funding is gradually increasing, and the research enthusiasm of scholars is increasing. We can learn from the mature path of related research abroad, and the international academic community is looking forward to the Chinese voice in this field.

Undoubtedly, the breadth and depth involved require further exploration due to the relatively late initiation of the research on TPACK in the Chinese music discipline. Its shortcomings mainly include a relative lack of special research in the literature on the current status of TPACK and the training path for students of teacher education majors majoring in music education. The existing studies mainly focus on theoretical discussions and practical summaries; large-scale empirical research is few, and the level of TPACK lacks objective description and reflection. Thus, the domestic exploration of this training path in China remains in its infancy.

4.3. Future Development Direction

In the future, a possible development direction of this field in China will be the exploration of the structural characteristics and methods of TPACK development for teachers from the perspective of music discipline. Further examination of the framework of instructional designs for the cognitive and emotional fields of learning will also be necessary.

Seeking development by drawing on experience: Foreign studies have accumulated and elucidated the difficulties that may be encountered in some aspects. Moreover, they have demonstrated that the level of TPACK of pre-service music teachers is insufficient compared with those of non-technical fields. The lack of teaching time and/or space and limited access to capital and/or technology are common obstacles to the development of the curriculum of pre-service music teachers. These points provide the necessary pre-experience for relevant research in China to avoid detours and wrong paths to a certain extent.

Reveal characteristics in the research: The improvement process of the training path of TPACK varies according to regional differences and school conditions. Therefore, objectively analysing the common and individual characteristics of different universities and exploring and examining them according to local conditions are necessary initiatives.

ISSN 2618-1568 Vol. 5, Issue 2: 23-29, DOI: 10.25236/FAR.2023.050205

5. Conclusion

Since the introduction of the theoretical framework of TPACK, it has attracted widespread attention from the academic community, and related research has been advancing. At present, it focuses on two major models and is characterised by increasing research trends and penetration of the research field into disciplines. Foreign studies on TPACK in the music field began early, which provides many valuable cases and paths for research. Thus, the research on TPACK in the Chinese music discipline needs not only to develop on the basis of drawing lessons from others but also to consider the local characteristics. In this manner, research in this field can seize opportunities and meet challenges due to this late start.

Acknowledgements

This research was supported by the "Beijing Education Science Planning Project". The title of the project is "Research on TPACK Status Quo and Training Path of Music Education Students in Beijing Municipal Universities" (Project No. CDDB22209).

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