An Empirical Study on the Current Status of TPACK among Music Education Majors in Three Municipal Universities in Beijing

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Abstract. Since the theoretical framework of TPACK was proposed, the studies in this realm at home and abroad has gradually become a leading-edge hot topic and showed a clear trend of going deep into various disciplines. The Musical TPACK Questionnaire was used in this study to survey 372 music education majors, and data analyses were conducted on one dimensional knowledge—CK, PK and TK, two-dimensional fusion knowledge—PCK, TCK and TPK and triple interactive knowledge—TPCK. The results show that the survey for Musical TPACK is sufficiently reliable and valid. The TPACK knowledge of the samples in this study is at a high level compared with that of pre-service music teachers in other studies. Furthermore, the TPACK knowledge level of the sample is affected by gender, university and grade, showing significant differences. Moreover, the results of the regression analysis show that one dimensional knowledge (CK, PK and TK) made a particularly significant contribution to TPACK level. Therefore, in the future, colleges and universities should consider how to strengthen the systematic learning of TPACK's one dimensional knowledge for the training of music education majors. First lay a good foundation, and then gradually advance.

Keywords: musical TPACK, music education majors, technology, PCK, municipal universities in Beijing.

1. Introduction

TPACK is a valuable framework for addressing the integration of ICT in classroom teaching and the complexities of teacher knowledge. The field of music education is growing in importance, necessitating professionals with both music knowledge and technological pedagogical content knowledge (TPACK). However, there is a lack of research on the TPACK status of music education students in Beijing-affiliated universities. Therefore, this study aims to explore the TPACK status of music education students in these universities, providing insights for improving talent cultivation and promoting music education reform. Understanding students' TPACK status is crucial for educational reform and talent cultivation. It informs curriculum design and implementation, identifies students' knowledge and skills in music education, and helps address deficiencies in TPACK through improved teaching methods. This research contributes to enhancing the quality of talent cultivation in music education.

2. Literature Review

2.1. Related Concepts

Shulman emphasized that there was a clear gap in long-term educational practice in a paper about the speech to the American educational research association. And he created a new structure of pedagogical content knowledge (PCK) [1]. Shulman's PCK was optimized through the research carried out by Koehler and Mishra, in which TPACK (technological pedagogical and content knowledge) was constructed as an enhanced framework [2]. Moreover, continuous exploration was conducted in depth. The TPACK framework consists of seven components in three main areas, as shown in the figure 1. And this framework which can be a useful measure for the degree of technical integration of educators is also the conceptual framework of this study [3].

CK, PK, and TK are included as the single-dimension knowledge in the framework. To be specific, CK (Content Knowledge) is the "knowledge about actual subject matter that is to be learned or taught" [4]. PK (Pedagogical Knowledge), referring to the process and method of teaching, is universally applicable knowledge. And TK (Technological Knowledge) includes digital technologies such as media convergence, Internet and mobile tablet, rather than merely traditional technologies such as paper, pencil, and blackboard.

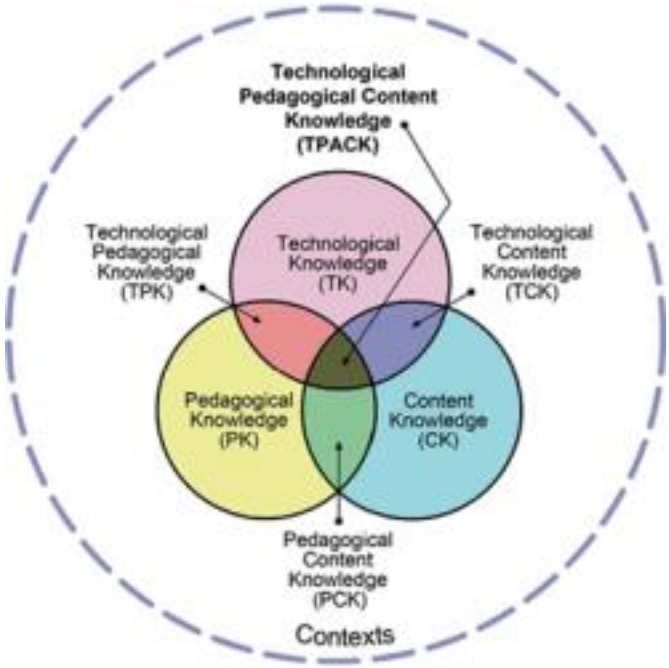

Figure 1. Technological pedagogical and content knowledge

There are PCK, TCK and TPK as the two-dimensional fusion knowledge included in the framework. Specifically, PCK (Pedagogical Content Knowledge) refers to the content knowledge related to the teaching process, which is similar to PCK proposed by Shulman. TCK (Technological Content Knowledge) is the knowledge of how a new representation is created for a particular content through technology, which results from a two-way interaction between technology and specific subject knowledge. And TPK (Technological Pedagogical Knowledge) refers to how to design and improve teaching methods resulting from the interaction of technology and general pedagogy through understanding and utilizing technologies.

Triple interactive knowledge in the framework is TPCK (Technological Pedagogical Content Knowledge), which refers to the knowledge that teachers use technology to effectively represent and show content beneficial for teaching and students' understanding [5]. It is generated by the interaction of three core elements.

2.2. TPACK in Music Education

Improving the TPACK level of music education majors plays an active role in their sustainable development, and in their technical knowledge and skills, teachers' self-efficacy and exemplary degree of educators as teachers in service, according to the classical research dominated by empirical research [6].

Some studies found that the application of TPACK allows a better understanding of the knowledge and skills required by teachers [7], and conducted in-depth research and national surveys to explore how the education plan of college music teachers prepares pre-service teachers with TPACK as a framework [8]. There are also studies that pay more attention to the relationship between TPACK and teachers and schools [9]. There are also studies carried out from the perspective of ecology [10]; research on technical support [11], methods [12], resources [13], and paths [14] and so on.

3. Research Questions

The main purpose of this study is to investigate the current status of Technological Pedagogical Content Knowledge (TPACK) among music education students in three Beijing-affiliated universities: China Conservatory of Music, Capital Normal University, and Beijing City University. Additionally, this study aims to uncover the problems and reasons behind the observed TPACK status. Understanding the current status of students' TPACK and the problems and their reasons can provide reference for further improving the training of music education professionals and enhancing their practical abilities and professional qualities. The specific research questions include:

1. What is the TPACK structure of students majoring in music education in the three universities?
2. Are there significant differences in demographic variables, different schools and grades?
3. What are the basic structural factors affecting the TPACK development of students majoring in music education?

4. Methodology

4.1. Instruments

In the research, a pre-test was conducted based on the questionnaire in Dr. Doherty Brian's doctoral thesis The Role of Content, Pedagogical, and Technological Knowledge in Explaining Music Teacher Self-Efficacy [15] and on its MTPACK-Q scale which was translated into Chinese. Besides, the demographic content of the respondents was revised for locals. All data collected is confidential with no respondents asked to provide personal information such as name or address.

4.2. Procedure

An online questionnaire link was sent by relevant college teachers to students. The study selected 374 students in music education from Beijing City University, China Conservatory of Music and Capital Normal University, obtaining 372 effective samples and 99.5% effective questionnaires. The respondents' gender and grade are shown in Table 1. The proportion of males and females in the samples was (n = 120, 32.3% for males; n = 252, 67.7% for females).

Table 1. Sample Distribution

	Category	Number	Percentage
Gender	male	120	32.3
	female	252	67.7
University	Beijing City University	150	40.3
	China Conservatory of Music	92	24.7
	Capital Normal University	130	34.9
Grade	Senior and above	108	29
	Junior	200	53.8
	Sophomore	64	17.2
Total		372	100

5. Results

5.1. Factor Analysis

KMO and Bartlett's check coefficient is. 978 upon the exploratory factor analysis of 47 items, indicating that information can be effectively extracted from the data. The cumulative variance interpretation rate upon rotation was 87.468 % > 50 %, indicating that the information of the research item can be effectively extracted.

5.2. Reliability Analysis

The reliability of scale reflects the stability and reliability of some measurement items in a certain dimension. In that case, the reliability of determined factors and items was analyzed via SPSS. In the table 2, both the subscale and the total scale have relatively high reliability, with the reliability coefficient of the total scale reaching 0.992, and that of the subscale between .944 and .980.

Table 2. Cronbach's Alpha Values for Each Scale of the TPACK

Factor	{1}	{2}	{3}	{4}	{5}	{6}	{7}	{8}
	TK	CK	PK	PCK	TCK	TPK	TPCK	ALL
Cronbach's alpha	.961	.980	.978	.966	.944	.967	.977	.992

5.3. Structural Factor Levels

In the table 3, the mean value of each factor from high to low is presented as TPK > TPCK > TCK > PK > PCK > CK > TK, since TPACK and the mean of each dimension reflect the factor level. TK is the lowest and PK is the highest in the dimension of knowledge. TK being the lowest indicates that students in music education lack adequate technical knowledge and efficacy on technical knowledge needed for classroom teaching. While TPK as the highest is likely to be due to their strong sense of control over network technology by frequent contact with computers including learning and communication on the Internet.

Table 3. Samples' Descriptive Data on Each Scale of the TPACK (N=372)

Combination Degree	Factor	Mean	Median	*SD*	Min.	Max.
1	TK	3.885	4.000	0.884	1.000	5.000
1	CK	4.008	4.000	0.816	1.000	5.000
1	PK	4.060	4.000	0.775	1.000	5.000
2	PCK	4.047	4.000	0.795	1.000	5.000
2	TCK	4.063	4.000	0.767	1.000	5.000
2	TPK	4.085	4.000	0.743	1.000	5.000
3	TPCK	4.079	4.000	0.754	1.000	5.000

5.4. Correlation Analysis

No significant interaction of TPACK was found in three variables such as gender, grade, and age in the interactive analysis of TPACK in these variables. Thus, only the main effect of TPACK on each variable shall be calculated.

5.4.1. Gender differences

The t test of the independent sample was used to study the difference of gender on the seven factors of TPACK. The table 4 shows that boys are superior to girls in all factors according to data, among which TK, CK and TPK are obviously different.

The knowledge of TK and TPK of boys is significantly better than that of girls, which is close to people's stereotypes. For example, boys have stronger hands-on and practical abilities. In addition, CK knowledge of boys is significantly better than girls, which may be related to the choice of subjects or to the test scale more inclined to efficacy. This may be due to the high interest and talent of boys in music, as well as their strong confidence in technical application, which leads to their advantages in TPACK.

Table 4. Comparison of Music Education Majors' Scores on the Scales of the TPACK between Gender

Factor	Gender (Mean ± SD)		*t*	*p*
	Male(n=120)	***Female(n=252)***		
TK	4.06±0.91	3.80±0.86	2.635	0.009**
CK	4.13±0.83	3.95±0.81	2.045	0.042*
PK	4.15±0.81	4.02±0.76	1.489	0.138
PCK	4.13±0.87	4.01±0.76	1.245	0.215
TCK	4.17±0.77	4.01±0.76	1.911	0.057
TPK	4.20±0.76	4.03±0.73	1.977	0.049*
TPCK	4.18±0.76	4.03±0.75	1.825	0.069
* p<0.05 ** p<0.01 *** p<0.001				

5.4.2. Differences Among the Three Universities

One-factory variance analysis was applied to study the differences between seven TPACK factors in different universities. The table 5 reveals that different university samples all showed significant differences in the seven TPACK factors, which means that different university samples have differences in these factors.

Research has found that students from relatively higher quality universities perform significantly better in TPACK than students from regular universities. This may be because students from relatively higher quality universities have a good foundation in music theory and practice, making it easier to apply TPACK knowledge to music education practice.

Table 5. Comparison of Music Education Majors' Scores on the Scales of the TPACK among three Universities

University (Mean ± SD)	TK	CK	PK	PCK	TCK	TPK	TPCK
Beijing City University (n=150)	3.85±0.92	3.90±0.90	3.95±0.84	3.96±0.87	4.01±0.81	4.03±0.77	4.02±0.77
China Conservatory of Music (n=92)	4.14±0.79	4.30±0.59	4.38±0.57	4.32±0.62	4.29±0.62	4.32±0.62	4.35±0.59
Capital Normal University (n=130)	3.74±0.88	3.93±0.81	3.97±0.76	3.96±0.77	3.97±0.78	3.99±0.76	3.96±0.80
F	5.824	8.405	10.686	7.650	5.374	6.376	8.538
p	0.003**	0.000***	0.000***	0.001***	0.005**	0.002**	0.000***
* p<0.05 ** p<0.01 *** p<0.001							

5.4.3. Grade difference

One-factory variance analysis was used to study the seven TPACK factors in different grades. The table 6 reveals that different grade samples all showed significant differences in the seven TPACK factors ($p<0.05$), which means that different grades have differences in these factors.

Different grades are different at the TPACK level. Interestingly, not the higher the grade, the higher the TPACK level of students. The students of the three universities all showed the "√" graphics before "junior is significantly lower than that of sophomore, senior and above". The possible reason is that the training programs of the three schools are highly overlapping, with sophomores at the peak of learning music education and teaching methods as well as information literacy courses to obtain more theoretically. Seniors are at the peak of teaching practice from which they gained a lot in the fourth year of study.

Table 6. Comparison of Music Education Majors' Scores on the Scales of the TPACK among Different Grades

Grade (Mean ± SD)	TK	CK	PK	PCK	TCK	TPK	TPCK
(1) Senior and above (*n*=108)	4.04±0.85	4.19±0.72	4.31±0.61	4.26±0.65	4.24±0.66	4.26±0.66	4.29±0.63
(2) Junior(*n*=200)	3.76±0.85	3.88±0.82	3.90±0.78	3.90±0.80	3.94±0.77	3.95±0.75	3.93±0.78
(3) Sophomore(*n*=64)	4.02±0.98	4.09±0.90	4.13±0.89	4.15±0.89	4.14±0.87	4.20±0.78	4.19±0.77
F	4.619	5.635	10.700	8.352	5.708	7.093	8.901
p	0.010*	0.004**	0.000***	0.000***	0.004**	0.001***	0.000***
LSD	(1)>(2); (3)>(2)	(1)>(2)	(1)>(2); (3)>(2)	(1)>(2); (3)>(2)	(1)>(2)	(1)>(2); (3)>(2)	(1)>(2); (3)>(2)
* *p*<0.05 ** *p*<0.01 *** *p*<0.001							

5.5. Predicted Analysis of TPACK knowledge

VIF was greater than 10, indicating that there may be multiple collinearities among variables. Therefore, TK, CK, PK, PCK, TCK, TPK, TPCK were taken as independent variables and TPACK as dependent variables for ridge regression analysis. With reference to figure 2, K value is taken as 0.010.

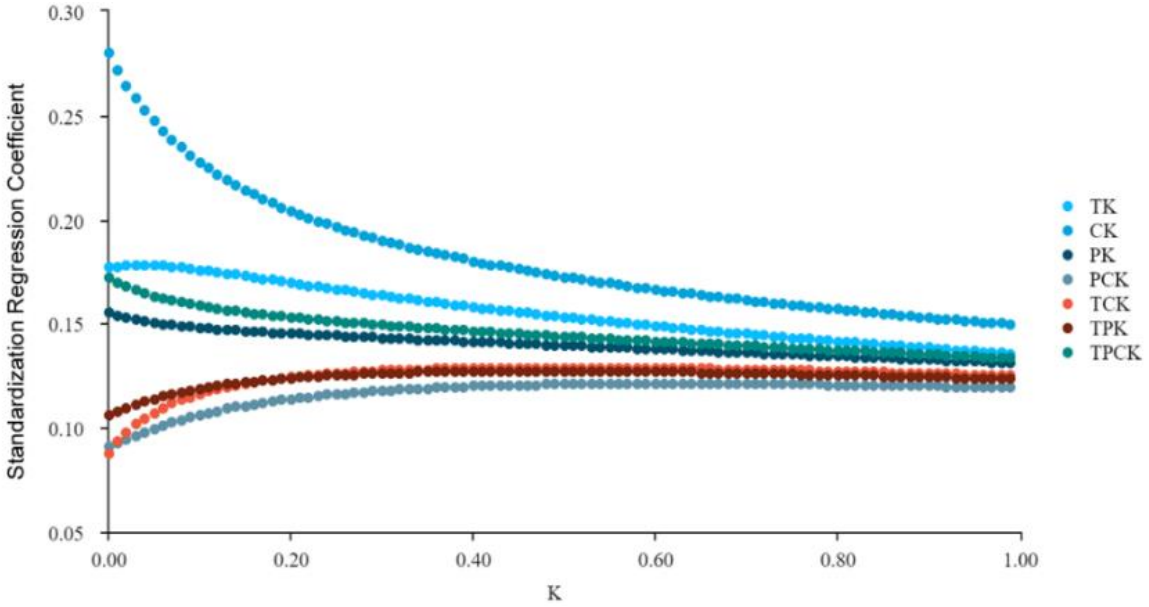

Figure 2. Ridge Trace

The table 7 shows that the R square value of the model was 1.000, which means that TK, CK, PK, PCK, TCK, TPK, and TPCK can explain 100.00% of the change in TPACK. Besides, the model passed the F test (F = 2894656.190, p = 0.000 < 0.05), which means that at least one of TK, CK, PK, PCK, TCK, TPK and TPCK will have an impact on TPACK with the model formula to be TPACK = 0.243 + 7.028*TK + 11.647*CK + 6.948*PK + 4.081*PCK + 4.256*TCK + 5.090*TPK + 7.887*TPCK. Thus, as shown in Figure 3, all seven factors of TPACK have significant positive effects on TPACK.

Table 7. Regression Analysis of TPACK

	Unstandardized Coefficients		**Standardized Coefficient**	***t***	***p***
	B	**Std. Err.**	***Beta***		
(Constant)	0.243	0.044	-	5.527	0.000***
TK	7.028	0.015	0.177	467.795	0.000***
CK	11.647	0.023	0.271	498.093	0.000***
PK	6.948	0.030	0.154	232.644	0.000***
PCK	4.081	0.027	0.093	150.673	0.000***
TCK	4.256	0.029	0.093	146.995	0.000***
TPK	5.090	0.029	0.108	174.728	0.000***
TPCK	7.887	0.030	0.170	267.085	0.000***
R^2	1.000				
Adj R^2	1.000				
F	F (7,364) =2894656.190, p =0.000				
Dependent Variable: TPACK					
* p<0.05 ** p<0.01 *** p<0.001					

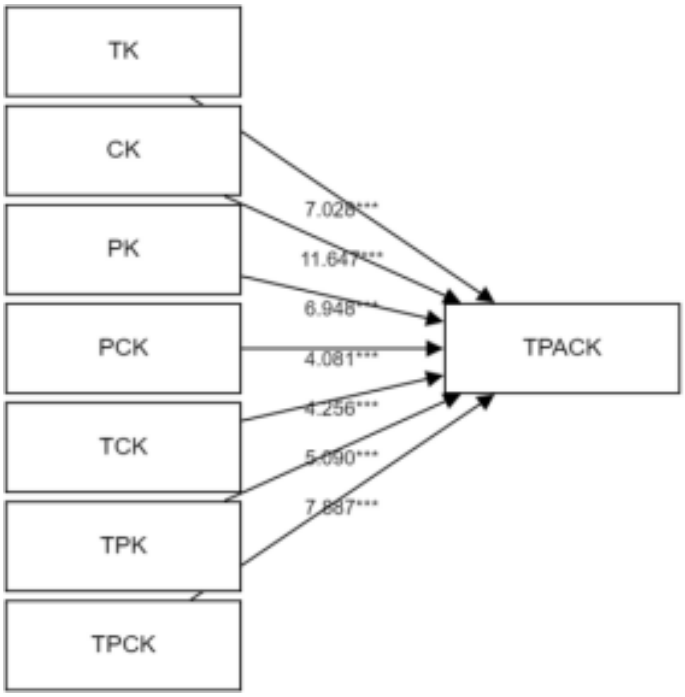

Figure 3. Model Diagram

The single dimension of knowledge (CK, TK and PK) included in the regression model has a significant contribution to TPACK knowledge. Among them, the contribution of CK is the largest, indicating that students in music education' subject knowledge has a great contribution to the development of their TPACK knowledge.

Two-dimensional integrated knowledge (PCK, TCK and TPK) was also included in the regression model, but their contribution to TPACK knowledge was significantly lower than the single-dimensional knowledge with specific reasons to be further clarified in future research.

Triple interactive knowledge (TPCK) was also included in the regression model, whose contribution to TPACK knowledge is higher than that of two-dimensional integrated knowledge, indicating that understanding the complex interaction between CK, TK and PK by using appropriate teaching methods and techniques to teach content is also very important for the development of TPACK knowledge.

6. Conclusions and Limitations

The research results reveal that the TPACK framework is indeed a generative framework that can measure as a good "ruler". Gender difference is also shown in seven TPACK factors that boys are superior to girls in all factors with significant differences in TK, CK and TPK. In addition, different school samples showed significant differences ($p < 0.05$) in all seven factors of TPACK and so are different grade samples.

On the one hand, the teaching quality of music education is different in different universities, on the other hand, different grades are different at the TPACK level. Interestingly, not the higher the grade, the higher the TPACK level of students. The students of the three universities all showed the "√" graphics before "junior is significantly lower than that of sophomore, senior and above". The possible reason is that the training programs of the three schools are highly overlapping, with sophomores at the peak of learning music education and teaching methods as well as information literacy courses to obtain more theoretically. Seniors are at the peak of teaching practice from which they gained a lot in the fourth year of study. While juniors are in the "empty window period" between the two peaks, lacking theoretical learning and practical feedback, this period is lower than the other two at the TPACK level.

The limitation of this study is that the quality of answers is affected by factors such as the evaluation level of respondents' knowledge and their integrity as the research adopts a questionnaire method, although MTPACK and TPACK as the basis of MTPACK have a solid foundation in research. Another limitation is the quantitative nature of the study. Qualitative research cannot be conducted for the time being due to the impact of pneumonia in China, which will be further improved in future research.

7. Discussion

Teachers of the music education major can adjust and contextualize the survey items according to the focus of their curriculum based on various studies with the proposed framework. Music education majors can attempt to apply technology to their learning practice and teaching practice in more dimensions. The music education major in colleges and universities can make the best use of technology in the training of music education talents by exploring the understanding of TPACK structure, adjusting the training program and paying attention to the areas with more problems.

Those who understand the teaching value related to emerging technologies and teaching themes better in the field of music education can gradually optimize and adapt to the development trend in the future more easily.

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