

A Survey Study on TPACK Framework for Normal Students of English Major in Ethnic Colleges and Universities: Empirical Analysis Based on Structural Equation Modeling

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Abstract: With the continuous advancement of education informatization, Technological Pedagogical Content Knowledge (TPACK), as a new theoretical framework, provides a novel method for measuring teachers' informatization teaching ability. This study takes normal students of English majors from three ethnic universities as the research object, collects relevant data through questionnaires, and uses structural equation modeling to conduct data analysis and empirical research to investigate the differences in the TPACK levels of these students at different grades and the structural relationships among the elements in the TPACK structure. The technological pedagogical knowledge element of the TPACK structure was not obtained by exploratory factors analysis but through path analysis and structural equation modeling, the results show that the one-dimensional core knowledge of technological knowledge (TK), content knowledge (CK), and pedagogical knowledge (PK) have a positive effect on the two-dimensional interaction knowledge of technological content knowledge (TCK) and pedagogical content knowledge (PCK); furthermore, TCK and PCK have a positive effect on TPACK; and TK, CK, and PK indirectly affect TPACK through TCK and PCK. On this basis, suggestions are provided to ethnic colleges and universities to develop the TPACK knowledge competence of normal students of English majors.

Keywords: TPACK; Ethnic colleges and universities; Normal students of English major; Structural equation modeling

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1. Introduction

Since the 19th National Congress of the CPC, cultivating teachers' information-based teaching ability has been the focus of China's education informatization work. However, most of China's ethnic areas are geographically remote, and due to the constraints of the educational environment, technology, concepts, and other factors, the development of teacher education is relatively lagging. Therefore, how to improve the technological integration ability of normal students of English majors in ethnic colleges and universities is a challenging issue in their

training programs at present.

Technological Pedagogical Content Knowledge (TPACK) consists of three core elements: content knowledge (CK), pedagogical knowledge (PK), and technological knowledge (TK). These three elements, in turn, interact to form four composite elements: pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), and technological pedagogical content knowledge (TPACK) ^[1]. The TPACK framework reflects the basic competence requirements for teachers in the information age and reflects the goal of teachers to use technical support to solve teaching problems and optimize teaching effectiveness. The proposal of TPACK answers the questions of what kind of knowledge teachers in this age should have, how to acquire such knowledge, and how to utilize it in teaching, providing ways to solve these problems. However, although the TPACK theory provides a theoretical basis and research foundation for the study of developing teachers' TPACK, many studies are deficient regarding the actual development and improvement of teachers' TPACK competence due to the theory's complexity and ambiguity regarding the precise description of the relationship between the components in the structure of teachers' TPACK.

To develop TPACK of normal students of English major in ethnic colleges and universities, this study adopts a structural equation modeling (SEM) analysis to measure and construct the structure of these students' TPACK. Suggestions for promoting the development of TPACK among normal students of English majors in colleges and universities are also provided.

The theory of TPACK was first proposed by Shulman in 1986, and many scholars carried out a lot of research since then. Scholars focus on the definition of the TPACK concept, the method of measuring TPACK, and the study of teacher training based on the development of TPACK. The concept of TPACK is mainly based on the following three views. First, TPACK is an extension of the technical knowledge based on PCK ^[2-4]; second, TPACK is a new construct, an innovative and complete structural system of teacher knowledge proposed by scholars ^[1]; and third, TPACK is a product of the interaction and integration of knowledge based on the three core elements of the particular teaching situation (technology, pedagogy, and content) ^[5]. With the depth of TPACK research, scholars gradually realize the importance of measuring TPACK levels. It mainly includes questionnaires ^[6-8], self-reported assessments ^[9,10], in-depth interviews, observation methods ^[3,11], etc. Research on TPACK development in teacher training includes both pre-service and in-service teachers. Internationally, pre-service teachers are often referred to as teacher trainees. Scholars, using the TPACK framework, have developed specific teacher training models and provided corresponding strategies to enhance technological, pedagogical, and content knowledge integration ^[12,13].

However, studies on teachers' TPACK knowledge competence usually neglected empirical studies on normal students of English majors in ethnic areas. Based on this, this study investigates the TPACK knowledge competence of normal students of English majors in colleges and universities in ethnic areas of China based on the TPACK theoretical framework.

2. Methods

2.1. Study samples

This study selected normal students of English majors from three ethnic universities in Xizang as the research object. Students from freshmen to seniors were sampled through the stratified sampling method. The survey was released in the form of electronic questionnaires, and the questionnaires were distributed from October 2023 to November 2023; excluding invalid questionnaires, 163 questionnaires were recovered.

2.2. Research questions

- (1) What is the status of the TPACK knowledge competence of normal students of English majors of different grades in Xizang?
- (2) Do the components in the TPACK structure of these students influence each other?
- (3) How to promote the formation and development of the TPACK structure?

2.3. Instruments

The questionnaire was based on a reference to the TPACK test scale already used by previous research on factors influencing TPACK^[6,14] and was adapted to the study participants to establish a scale with a balanced number of questions in each dimension and a broader coverage of content. The questionnaire contains two parts, the first part is the basic information of normal students of English major, which consists of gender, grade, school, and other information; the second part is the self-assessment question items corresponding to the seven indicator dimensions of TPACK knowledge, namely, CK, PK, TK, PCK, TCK, TPK, and TPACK. The scale consists of 33 items divided into seven subscales and scored on a five-point Likert scale.

3. Results

To show the relationship between the seven components in the structure of the TPACK theoretical framework, SPSS was used to conduct exploratory factor analysis to observe whether the obtained data could be extracted with the pre-determined seven factors. Through this method, the Kaiser–Meyer–Olkin (KMO) test result was 0.904 (> 0.6), and the significant level of Bartlett’s spherical test was 0.000 (< 0.01), which indicated that the TPACK theoretical model could be analyzed as a factor analysis; the six common factors were extracted, and the items with the loadings less than 0.5 were deleted, in which all the items of TPK dimension were deleted, and 22 items were kept at last. Then, the reliability and validity of the revised questionnaire were implemented by SPSS. We knew that the standardized Cronbach’s coefficient is 0.943 and the coefficient of the KMO test is 0.904. According to the results of the correlation analysis in **Table 1**, all the variables are significantly correlated at 99%, so they are all positively correlated. For example, the correlation coefficient between TK and PK is 0.584, which is a positive correlation.

Table 1. Correlation analysis of the six dimensions

Pearson correlation	TK	PK	CK	PCK	TCK	TPACK
TK	1					
PK	0.584**	1				
CK	0.304**	0.612**	1			
PCK	0.444**	0.717**	0.677**	1		
TCK	0.520**	0.621**	0.643**	0.711**	1	
TPACK	0.458**	0.494**	0.442**	0.650**	0.665**	1

**Significant correlation at 0.01 level (two-tailed)

There were 132 female and 31 male normal students of English major. According to the results of the independent samples *t*-test, the significance of the difference between TK, PK, CK, PCK, TCK, and PCK in terms of gender was greater than 0.005 (**Table 2**). It shows that there is no difference between genders on these six dimensions and that gender does not affect the development of their TPACK knowledge competence.

Table 2. Differences in the six dimensions by gender

Dimension	Gender	<i>n</i>	Average value	Standard deviation	<i>t</i>	sig
TK	Male	31	11.1	2.022	0.877	0.382
	Female	132	10.76	1.919		
PK	Male	31	14.68	2.522	1.565	0.12
	Female	132	13.92	2.385		
CK	Male	31	10.55	2.111	0.13	0.897
	Female	132	10.5	1.81		
PCK	Male	31	14.87	2.729	0.747	0.456
	Female	132	14.52	2.236		
TCK	Male	31	13.9	3.037	-0.081	0.936
	Female	132	13.95	2.639		
TPACK	Male	31	14.03	2.904	0.207	0.836
	Female	132	13.93	2.302		

The normal students of English major who participated were freshmen, sophomores, juniors, and seniors, with sample sizes of 31, 59, 37, and 36, respectively. Based on the results of the one-way ANOVA, each of the dimensions of TK, PK, CK, PCK, TCK, and PCK differed in terms of grade level as the results of the test of significance for each of the dimensions were significantly less than 0.05 (**Table 3**).

Combined with the multiple comparisons, we learned that the TCK of the senior students was significantly developed and improved after the freshman, sophomore, and junior academic years; in the various elements of TPACK, with the exception of the TPK dimension, senior students exhibited higher overall TPACK knowledge competence compared to freshmen and sophomores. Additionally, seniors had higher levels of CK and TCK compared to juniors. In addition, juniors were higher than sophomore students in TK, PK, PCK, TCK, and TPACK levels, indicating that TPACK knowledge competence is closely related to students' grade level, and the higher the student's grade level, the better the TPACK knowledge competence they mastered.

Table 3. Analysis of differences in each dimension by grade level

Variable	Item	<i>n</i>	Average value	Standard deviation	<i>F</i>	sig	LSD
TK	Freshman	31	9.81	2.548	12.651	< 0.001	2<3, 2<4, 1<3, 1<4
	Sophomore	59	10.24	1.546			
	Junior	37	11.46	1.483			
	Senior	36	12.00	1.493			
PK	Freshman	31	13.32	2.903	9.143	< 0.001	2<3, 2<4, 1<4
	Sophomore	59	13.24	2.16			
	Junior	37	14.68	2.082			
	Senior	36	15.44	1.934			
CK	Freshman	31	10.90	1.660	6.469	< 0.001	2<4, 2<1, 3<4
	Sophomore	59	9.85	1.595			
	Junior	37	10.35	2.263			
	Senior	36	11.42	1.574			

Table 3 (Continued)

Variable	Item	<i>n</i>	Average value	Standard deviation	F	sig	LSD
PCK	Freshman	31	14.35	2.058	8.81	< 0.001	2<3, 2<4, 1<4
	Sophomore	59	13.59	2.401			
	Junior	37	15.22	1.931			
	Senior	36	15.78	2.140			
TCK	Freshman	31	13.35	2.563	7.809	< 0.001	2<3, 2<4, 3<4, 1<4
	Sophomore	59	13.05	2.529			
	Junior	37	14.30	2.817			
	Senior	36	15.53	2.286			
TPACK	Freshman	31	13.68	2.663	5.440	0.001	2<3, 2<4, 1<4
	Sophomore	59	13.17	2.253			
	Junior	37	14.35	2.201			
	Senior	36	15.06	2.254			

Note: 1 = freshman, 2 = sophomore, 3 = junior, 4 = senior

The structural model of the TPACK framework was developed based on the impact pathways of TPACK proposed by Kohler and Mishra and the results of the exploratory factor analysis (see **Figure 1** for details). We intend to validate this model by constructing a TPACK structural equation model and a path analysis model, and to test the following hypotheses:

H1: Pedagogical knowledge (PK) and technological knowledge (TK) of normal students of English major are related.

H2: Technical knowledge (TK) and content knowledge (CK) are related.

H3: Content knowledge (CK) and pedagogical knowledge (PK) are relevant.

H4: Pedagogical knowledge (PK) has a positive effect on their pedagogical content knowledge (PCK).

H5: Content knowledge (CK) has a positive effect on their pedagogical content knowledge (PCK).

H6: Content knowledge (CK) has a positive effect on their technological content knowledge (TCK).

H7: Technological knowledge (TK) has a positive effect on their technological content knowledge (TCK).

H8: Pedagogical content knowledge (PCK) has a positive effect on their technological pedagogical content knowledge (TPACK).

H9: Technological content knowledge (TCK) has a positive effect on their technological pedagogical content knowledge (TPACK).

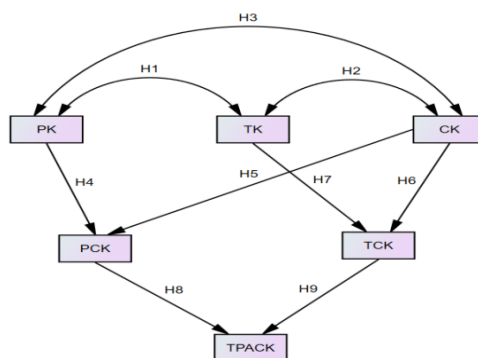


Figure 1. Theoretical model of TPACK structure for normal students of English major

AMOS was used to analyze and derive the TPACK path analysis model and structural equation modeling for normal students of English major (**Figure 2**). As the sample size was small, the four indexes of the chi-square degrees of freedom ratio (CMIN/DF), the goodness of fit index (GFI), the root mean squared error coefficient (RMSEA), and the comparative fit index (CFI) were chosen to observe whether the model was fitted or not. The overall fit index of the model was obtained as 2.16 for CMIN/DF, 0.98 for GFI, 0.08 for RMSEA, 0.99 for CFI, and the path analysis model is well. We got a TPACK structural equation model for normal students of English major (**Figure 3**) and the fitted data CMIN/DF of 1.48, GFI of 0.88, RMSEA of 0.06, and CFI of 0.96. The structural equation model was well-fitted.

All hypotheses passed the hypothesis test in the path relationship test (**Table 4**). Based on the TPACK structural equation modeling, we can see that there are six pathways of TPACK influencing factors for normal students of English major, four of which are TK, PK, and CK indirectly influencing TPACK through PCK and TCK, with their influence coefficients of 0.178, 0.198, 0.126, and 0.302, respectively, and the remaining two are PCK and TCK directly influencing TPACK, and their influence coefficients are 0.34, 0.48 respectively (**Figure 3**). In addition, based on the structural model (**Figure 3**), it can be seen that there is a significant correlation between the one-dimensional core knowledge TK, CK, and PK; there is also a significant correlation between the one-dimensional core knowledge TK, CK, and PK on the two-dimensional interaction knowledge PCK and TCK; and the one-dimensional core knowledge TK, CK, and PK has a positive influence on it. In addition, the one-dimensional core knowledge TK, CK, and PK has an indirect positive effect on three-dimensional interaction knowledge TPACK, and two-dimensional interaction knowledge PCK, TCK has a direct positive effect on three-dimensional interaction knowledge TPACK. The results of the study support Koehler and Mishra's view that TPACK knowledge competence is in overlapping interactions of TK, CK, and PK elements ^[15].

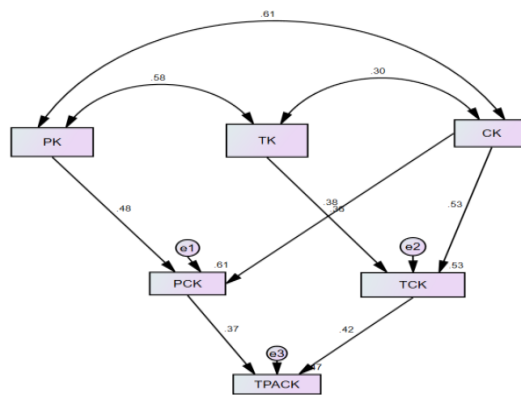


Figure 2. TPACK path analysis model for normal students of English major

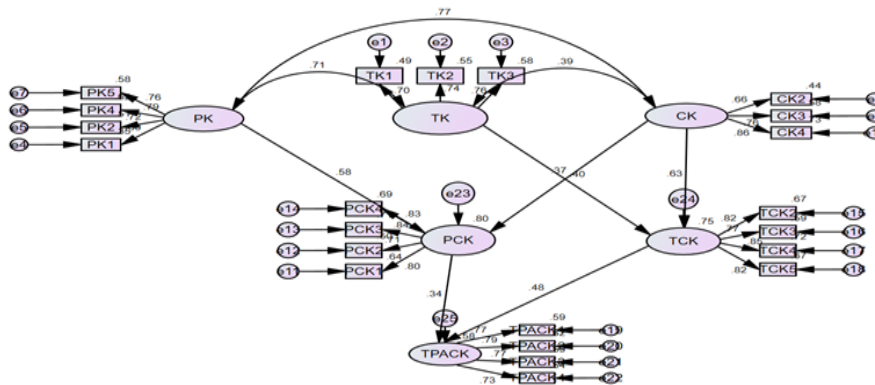


Figure 3. TPACK structural equation model for normal students of English major

Table 4. Standardized regression coefficients and hypothesis testing results

Hypothesis	Path	Path coefficient	<i>P</i>	Verification results
H1	PK \leftrightarrow TK	0.584	***	
H2	TK \leftrightarrow CK	0.304	***	
H3	PK \leftrightarrow CK	0.612	***	
H4	PK \rightarrow PCK	0.484	***	
H5	CK \rightarrow PCK	0.381	***	All passed inspection
H6	CK \rightarrow TCK	0.534	***	
H7	TK \rightarrow TCK	0.358	***	
H8	PCK \rightarrow TPACK	0.370	***	
H9	TCK \rightarrow TPACK	0.423	***	

4. Discussion and conclusion

With the multiple comparisons, we have found that except for the TPK dimension, grades of normal students of English major are positively correlated with the level of TPACK knowledge competence they have acquired, and freshman and sophomore students need to improve TPACK knowledge and competence in all aspects, whereas juniors need to strengthen their own knowledge and competence learning on CK and TCK dimensions regarding disciplinary knowledge content. Since students at this stage are basically required to participate in teaching internships, many of them pay too much attention to their own personal teaching practice during this time and tend to neglect the continued learning and improvement of their specialized subject knowledge content. Therefore, colleges and universities in ethnic areas need to pay attention to the learning of subject knowledge content in the academic year from junior to senior and try to offer courses related to subject knowledge content while cultivating the teaching ability of normal students of English major, to cultivate practicing English teachers with professional knowledge and literacy. Additionally, although TK, PK, and CK are the basis for the development of TPACK, their influence on TPACK is indirect, and the development of TPACK exists more in the process of dynamic interaction between PCK and TCK. Therefore, colleges and universities in ethnic areas should pay more attention to the learning of English normal students' two-dimensional interaction knowledge PCK and TCK, and offer more integrated courses to help students of different grades consciously look for the correlation of the one-dimensional core knowledge TK, CK, and PK in the process of learning and practicing, and then develop the two-dimensional interaction knowledge PCK and TCK, and finally improve the overall level of competence in TPACK knowledge.

TPACK, as one of the competencies of contemporary teachers' informatized teaching, should be included in the cultivation of normal students of English majors in colleges and universities. We aimed to investigate the TPACK of normal students of English major in ethnic colleges and universities and found that their TPACK is positively correlated with the number of years of study, and that their PCK and TCK have the greatest influence on TPACK knowledge competence. We have obtained some conclusions and suggestions, but due to the limited data collected in this study and the quantitative approach, conclusions and suggestions are only centered on the structural relationship of TPACK.

Disclosure statement

The authors declare no conflict of interest.

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