



A Study on the Influencing Factors of Teachers' TPACK Growth and Their Influencing Paths

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Abstract. As the application of information technology in education continues to deepen, the issue of teachers' TPACK structural development has become a hot issue for research in teacher education. Taking the teacher students in their senior year at a teacher training university who are undergoing internship and in-service teachers in Yunnan Province as the research subjects, the article conducted an empirical study on the influencing factors on the development of teachers' TPACK structure in China by using the TPACK influencing factors questionnaire. The results of the study showed that the policy factors indicated have a significant favorable influence on the use of the environment, practice sessions, and participation in TPACK training for teachers to develop TPACK competence; the attitude factors indicated a significant positive correlation with the involvement of teacher trainees and teachers in TPACK training; and the attitude factors of the teachers and their self-efficacy to acquire TPACK had a significant reciprocal positive correlation with each other. On this basis, the article proposes relevant strategies to promote teachers' TPACK development.

Keywords: teachers; TPACK; influencing factors; developmental strategies

1 Introduction

The theory of TPACK (Subject Teaching Knowledge for Integrating Technology) is a knowledge structure teachers should have to be competent in teaching and self-development in the age of informatization. TPACK is an indispensable knowledge structure for contemporary teachers. Although scholars at home and abroad have begun to pay extensive attention to the study of factors influencing the development of teachers' TPACK and related strategies, and a few researchers in China have already conducted some studies in this field, further in-depth investigations are still needed to address the current situation of the structure and level of teachers' TPACK, the specific factors influencing the formation and development of this structure, and the cultivation strategies of teacher training colleges and universities.

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H. Kassim et al. (eds.), *Proceedings of the 2023 8th International Conference on Modern Management and Education Technology (MMET 2023)*, Advances in Social Science, Education and Humanities Research 798, https://doi.org/10.2991/978-2-38476-146-3_43

Taking pre-service teachers of a teacher training university and in-service teachers of a province in China as the research subjects, this study explores the relationship between the control parameters affecting the development of teachers' TPACK competence and the relationship between the control parameters and the subsystems, to provide a reference for the development of teacher education in China.

2 Research design and implementation

2.1 Related Research

The research results on the influence of the elements within the TPACK framework are as follows: Koh and other scholars believe that TK, PK, and CK in the TPACK framework have a direct effect or indirect significance on the development of TPACK competence^[1], and Chai and other scholars found that pre-service teacher's TK, PK, and CK have an indirect effect on TPACK through TPK, TCK, and PCK^[2]. Zhang Li and other scholars found that primary and secondary school teachers' information technology teaching ability is deeply affected by many factors such as teachers' TPK, TCK, and TPACK^[3]; foreign scholars believe that factors such as the configuration of teaching hardware and software will affect teachers' TPACK ability to a greater extent^[4]. Peter Albion pointed out that teachers' use of technology in the classroom is affected by various factors^[5]. Douglas D. Agyei states that a teacher's ability to integrate information technology into the classroom effectively can be influenced by the teacher's beliefs, computer skills, and the condition of computer hardware and software^[6].

2.2 Research design

Research tools and questionnaire.

Overall, the Cronbach alpha coefficient of the total scale is 0.975, higher than the standard value of 0.7. The overall reliability of the questionnaire is good; there is stability and consistency within the variables, and all the questions meet the requirements, so there is no need to delete the questions. The validity analysis of the TPACK control parameter questionnaire showed that the KMO value was 0.992, indicating that the questionnaire was very suitable for factor analysis; the Bartlett test result of $P=0.000<0.05$ suggested that the questionnaire was valid.

In this section, the TPACK Competency Development Control Parameter Scale was adopted. A total of 633 questionnaires were collected, and after the background of Questionnaire Star screened out the invalid questionnaires with too short response time, 604 valid questionnaires were obtained, and the effective recovery rate of the questionnaires was 95.4%. These 604 samples will be used as the TPACK contextual factor relationship analysis data.

3 Data analysis

3.1 Formulation of the hypothesis of correlation between control parameters

As shown in Fig. 1, this study makes the following research hypotheses based on the six control parameters extracted from the research results of other researchers, according to the constructivist learning theory, contextual learning theory and social learning theory, and combined with the empirical research of previous researchers:

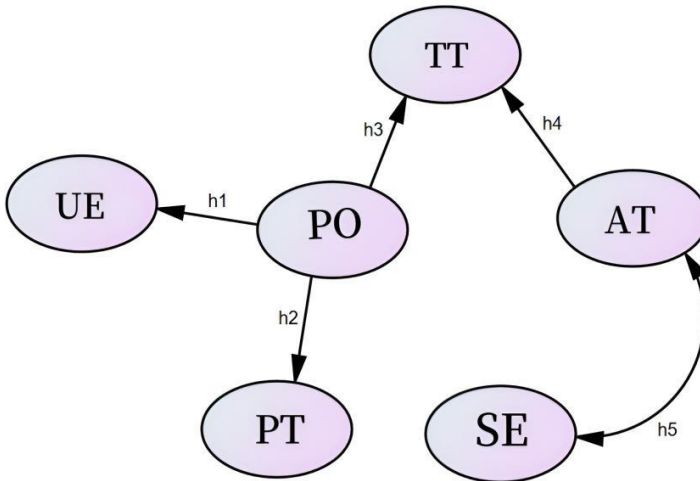


Fig. 1. Hypothetical structural model of TPACK control parameters

- H1: Policies have a direct positive role effect on the context of use; and
- H2: Policy has a direct positive effect on internship or practicum; and
- H3: Policy has a direct positive effect on training; and
- H4: Attitude has a direct positive effect on training.
- H5: There is an interaction effect between attitude and self-efficacy.

3.2 Validation of the relationship between control parameters for the development of TPACK capable systems

This study used AMOS 26.0 software to analyze the data. Based on the previous theoretical analysis of the hypothesis of the relationship between the control parameters of TPACK ability development proposed in the last section, we plotted the relationship path diagram of the control parameters of TPACK ability development in AMOS software. Using the structural equation analysis method, we explored the interrelationships among each control parameter. As shown in Fig. 2. There are six latent variables in the TPACK Competency Development Control Parameter Relationship Pathway Diagram, and the arrows between each latent variable represent the degree of influence between the two.

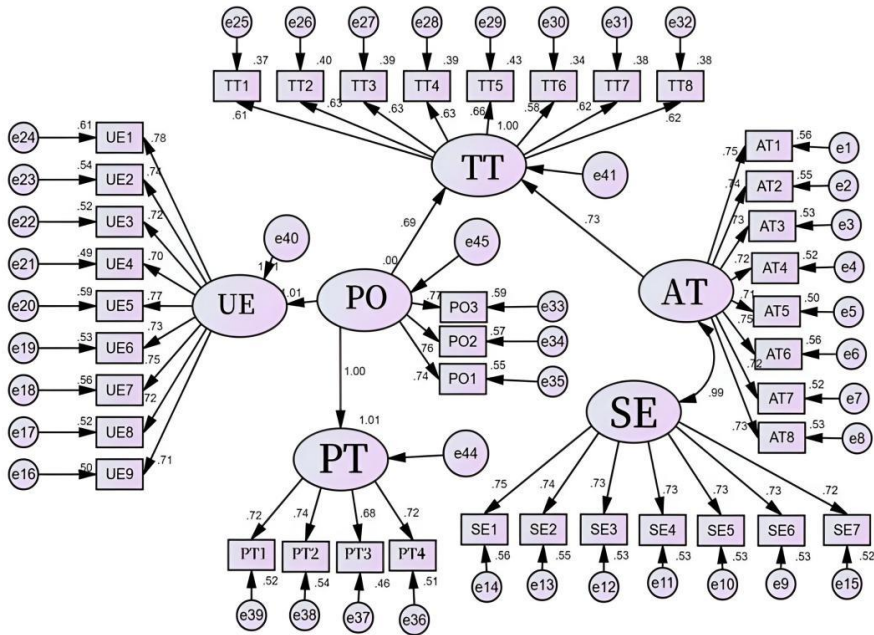


Fig. 2. Structural equation diagram of the relationship between control parameters for the development of the TPACK capacity system

From Table 1, it can be learned that the fit of the model is ideal. The value of CMIN/DF is 2.966, which meets the requirements of the reference standard value of less than 3, and the fit is good. The importance of GFI is 0.908, the value of IFI is 0.914, the value of TLI is 0.908, the value of CFI is 0.914, the value of RMSEA is 0.057, and the various indexes have reached the ideal standard.

Table 1. Control parameter relationship structural equation model fitting indices

Fitting Indicator	CMIN	DF	CMIN/df	GFI	RMSEA	IFI	TLI	CFI
Reference stand-ard value			<3	>0.9	<0.08	>0.9	>0.9	>0.9
Measured value of the fitted indicator	2067.253	679	2.966	0.908	0.057	0.914	0.908	0.914

From Table2 it can be learned that the coefficients of all paths of the TPACK control parameter relationship structural equation model for teacher trainees and in-service teachers reached the significance level, and the ways of the influence relationship were also supported. Therefore, the structural equation model of the TPACK control parameter relationship for teacher trainees and in-service teachers is well-fitted.

Table 2. Path coefficients of the structural equation model of TPACK control parameters

			Standardized coefficient	Non-standardized coefficient	S.E.	C.R.	P	Label
UE	<---	PO	1.01	.894	.049	18.336	***	h1
TT	<---	PO	0.69	.451	.048	9.347	***	h3
TT	<---	AT	0.73	.528	.055	9.659	***	h4
PT	<---	PO	1.00	.903	.048	18.781	***	h2
AT	<-->	SE	0.99	.896	.071	12.590	***	h5

4 Conclusion

The analysis led to the above results, $P < 0.05$, which verified the previous assumptions, all of which were valid.

It can be seen that the policy factor influences teachers' TPACK competence by affecting the environment and atmosphere for teachers to develop TPACK competence, teachers' participation in internships or practicums, and teachers' participation in training. Policies affect the investment and construction of facilities and equipment in the school, which in turn affects the frequency of teachers' use of the school's hardware and software infrastructure; policies also have a specific impact on the school's curricula and the arrangement of internships, which affects teachers' self-efficacy for TPACK, which in turn affects their TPACK ability.

Teachers' attitudinal factors will positively correlate with participation in TPACK training and their self-efficacy to acquire TPACK. When schoolteachers or colleagues adopt the latest modern educational technology in their daily classroom teaching and can appropriately model the application of modern educational technology in the classroom for teachers, teachers' peers are keen to acquire knowledge of current educational technology and their teaching subjects welcome their application of modern educational technology in teaching and believe that the integration of technology and education is more helpful to learners' mastery of knowledge points, teachers' acquisition of TPACK knowledge, their self-efficacy and motivation will also increase, as well as promote their serious participation in the training, which will lead to the mastery of TPACK competencies. Therefore, good learning attitudes can also serve as intrinsic motivation for teachers to acquire and improve their TPACK competencies, thus influencing their TPACK competencies.

Teachers' self-efficacy also affects their attitudes. When teachers gain a sense of accomplishment through using TPACK in their teaching, it increases their interest in using educational technology to promote the quality of teaching and learning. Teachers compete with each other, and if they see their classmates or colleagues using educational technology to integrate subject matter and improve their teaching quality, they will naturally be attracted to learn the corresponding educational technology, which will enhance their attitudes toward learning TPACK.

5 Development proposals

This section provides some feasible suggestions for improving teachers' TPACK competence from the perspective of each of the influencing factors.

Policy: Improving teachers' TPACK level and ability requires policy guidance and support to escort them, and policy factors are also critical external factors for teachers' TPACK level. Therefore, localities and schools should make good use of the relevant policies and regulations on educational technology, introduce educational technology infrastructure equipment at the right time, and increase the financial investment in the school's hardware and software facilities so that teachers can get better teaching resources during the learning process, practice their own TPACK knowledge in practice, motivate teachers to carry out skill learning and research, improve their self-efficacy and motivation, and further enhance their TPACK competence.

Environment of Use: In terms of using the environment, schools should leverage financial, human, and material resources such as state support, enterprise co-construction, and alums sponsorship to build online teaching platforms, subject classrooms, recording rooms, etc., to clear the external resistance that limits the development of teachers' TPACK capabilities. In constructing information technology hardware and software facilities, universities should continuously expand new digital teaching resources to provide a high-quality platform for teachers to observe and learn.

IT Training: Schools can set up additional elective courses related to educational technology to enrich teachers' technological knowledge and invite experts in educational technology to carry out various forms of academic lectures so that the concept of integrating technology into teaching can penetrate all aspects of teachers' learning at school, thus promoting the enhancement of teachers' TPACK abilities.

Attitude: Creating a Good Learning Attitude for TPACK Knowledge. For teachers to create good learning attitudes, schools need to create a good learning atmosphere. The organization of a learning and research community for teachers can enable them to use their respective technological strengths, thus forming an excellent interactive learning mechanism and driving all students to further integrate their technical knowledge with their subject and pedagogical expertise by acquiring more specialized knowledge. At the same time, combining cutting-edge digital technology and teachers' mature subject-teaching experience can also create new conditions for teachers to enhance their TPACK knowledge.

Practice: Making good use of people, things, and objects to create TPACK learning conditions. The development of practical activities for teachers should focus on the selection of the internship or practicum school, paying particular attention to the availability and accessibility of the relevant educational technology resources in the internship or practicum school, the teaching concepts, and the ability of the instructors in the internship or practicum to use educational technology for teaching and learning, and examining whether the people, events, and things in the internship or practicum school can bring help to the teachers' TPACK ability.

Self-efficacy: Enhancing the self-motivation of TPACK acquisition. Schools should stimulate teachers' motivation to learn TPACK and their self-efficacy in applying TPACK knowledge through a variety of ways and channels. Learning can provide

teachers with specialised professional identity training, leading them to realise the nobility of being a teacher in the future and the teacher training qualities required to engage in teaching, etc.

Acknowledgment

The research is one of the Yunnan Normal University results of the 2023. Graduate Research Innovation Fund Project (project number: YJSJJ23-B168).

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