

# Review of Teachers' Technological Pedagogical Content Knowledge (TPACK) in China

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## Abstract

In this study, 169 journal papers retrieved from “China Article Full Text Database” of *China National Knowledge Infrastructure (CNKI)* were analyzed as the samples in this study. Quantitative visual statistic analyses were conducted in terms of annual volume and the top five contribution institutions to offer some basic information of teachers' TPACK study in China. What's more, qualitative deep content analyses were conducted through four research themes including “Introduction of Foreign Study on Teachers' TPACK” “Pre-Service Teachers' TPACK Level and Development Paths” “Development Paths of In-Service Teachers' TPACK” and “Teachers' TPACK Study of Specific Subjects”, which intends to show deeper analyses of teachers' TPACK study in China by qualitative deep content analysis.

## Keywords

TPACK, Journal Papers, Current Situation, Research Themes, Reflection and Outlook

## 1. Introduction of TPACK

Technological pedagogical content knowledge (TPACK) conforms to the requirements for teachers' professional ability in China in the information era. It also offers a very useful framework for Chinese teachers' development. So, in this study, 169 articles were analyzed in terms of annual volume, main research institutions and four research themes to offer reference for researchers and educators to develop teachers' TPACK more efficiently.

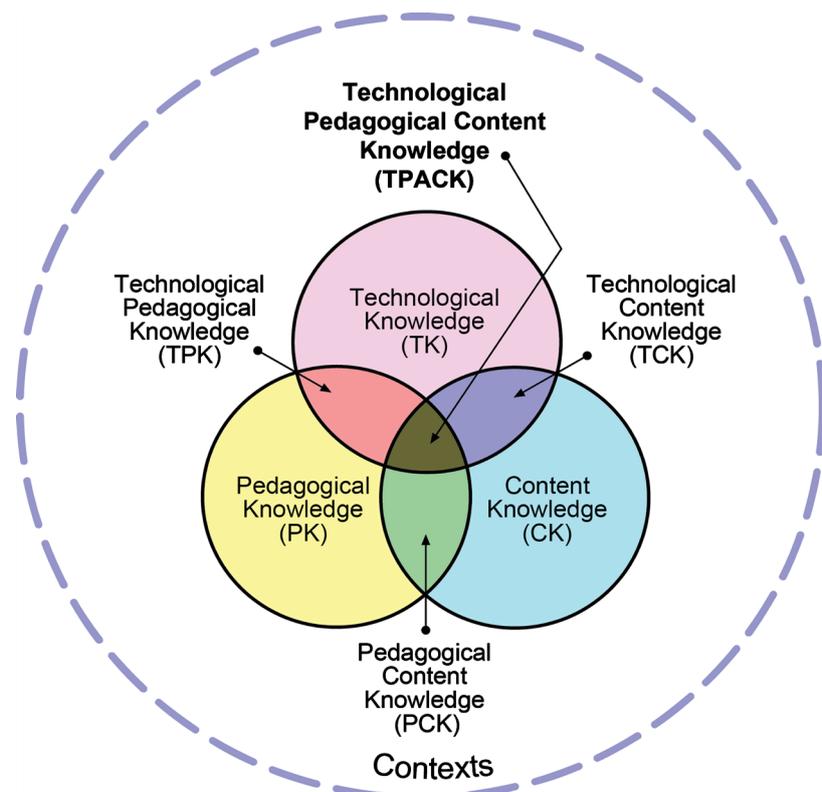
## 2. The Concept of TPACK

Matthew J. Koehler and Punya Mishra put forward the concept of TPACK

(Koehler & Mishra, 2005) on the basis of Shulman's PCK construct (Shulman, 1986; Shulman, 1987). In 2007, Thompson and Mishra changed TPCK into TPACK. In 2008, contexts were introduced into TPACK as the eighth element. So far, TPACK framework contains three core elements, content knowledge (CK), pedagogical knowledge (PK) and technology knowledge (TK), four interacted knowledge, pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogical knowledge (TPK) and technological pedagogical content knowledge (TPACK), and context (Koehler & Mishra, 2008), which can be shown in **Figure 1**.

Specifically, three major knowledge components form the foundation of the TPACK framework and four components in the TPACK framework address how these three bodies of knowledge interact, constrain, and afford each other as follows (Koehler, Mishra, Kereluik, Shin, & Graham, 2014).

- CK refers to any subject-matter knowledge that a teacher is responsible for teaching.
- PK refers to teacher knowledge about a variety of instructional practices, strategies, and methods to promote students' learning.
- TK refers to teacher knowledge about traditional and new technologies that can be integrated into curriculum.
- TCK refers to knowledge of the reciprocal relationship between technology and content. Disciplinary knowledge is often defined and constrained by



The source of the image is attributed as <http://tpack.org>.

**Figure 1.** The technological pedagogical content knowledge framework.

technologies and their representational and functional capabilities.

- PCK is to [Shulman's \(1986\)](#) notion of “an understanding of how particular topics, problems, or issues are organized, represented, and adapted to the diverse interests and abilities of learners, and presented for instruction” (p. 8).
- TCK refers to an understanding of technology can constrain and afford specific pedagogical practices.
- TPACK refers to knowledge about the complex relations among technology, pedagogy, and content that enable teachers to develop appropriate and context-specific teaching strategies.

### 3. The Importance of Teachers' TPACK in China

In the information era, teachers' TPACK development has become not only a requirement but also a declaration in China ([Wu, 2014](#)). Early in March, 2012, *The Ten Year Development Plan of Educational Informatization (2011-2020)* issued by [Ministry of Education of the People's Republic of China](#) stated clearly that educational modernization came from educational information and technology. In May, 2014, *The Standard of Primary and Secondary School Teachers' Information Technology Application Ability (Trial Implementation)* issued by [Ministry of Education of the People's Republic of China](#) also emphasized that it was the basic requirement for teachers to use information technology to optimize classroom teaching and change learning mode in the information age. In January, 2018, [the Central Committee of the Communist Party of China and the State Council](#) issued *The Opinions on Comprehensively Deepening the Reform of the Construction of Teachers in the New Era* clearly put forward that teachers should adapt to information technology actively. The latest *Educational Modernization of China 2035* issued by [the Central Committee of the Communist Party of China](#) and the State Council in February, 2019 advised strongly using modern technology to accelerate the reform of education mode.

It has become a hot topic in the field of education to improve teachers' teaching ability by using modern information technology ([Bai, 2017](#)). The knowledge possessed by teachers is the basis for teachers to carry out teaching activities. Its composition and structure will directly affect teachers' teaching behavior and students' learning outcomes ([Liu, 2019](#)). In the information and technology era, TPACK is the essential knowledge and key factor for teachers to integrate technology into teaching ([AACTE Committee on Innovation and Technology, 2008](#)). Teachers are the real “magicians” in the integration process of technology and curriculum ([Wu, 2017](#)).

Therefore, this study aims to offer a general understanding of current teachers' TPACK study in China by using statistic and content analyses, make some reflections and outlook for teachers' TPACK future study.

### 4. Methodology

In this study, we adopted a statistical visual analysis and a deep content analysis

with the samples that we retrieved from China Journal Full Text Database of *China National Knowledge Infrastructure* (CNKI) according to certain inclusion criteria.

#### 4.1. Inclusion Criteria

Here are the reasons for the inclusion criteria. First of all, China Journal Full Text Database of CNKI is a full-text database of Chinese high-quality journals with complete resources and dynamic updates. Moreover, Peking University Core Periodicals and Periodicals of Chinese Social Sciences Citation Index (CSSCI) are the two kinds of core periodicals of social sciences in China. In other words, articles in these two kinds of periodicals represent highest quality and latest topics to a great extent. In addition, “TPACK” is the acronym of technological pedagogical content knowledge and “TPACK” is originally called “TPCK” before 2007.

With regards to the above three reasons, the journal articles about teachers’ TPACK study retrieved from China Journal Full Text Database of CNKI can reflect current teachers’ TPACK study situation to a certain extent and offer some hints to predict the future research trend of teachers’ TPACK study, so the following four inclusion criteria items were utilized in the retrieving procedure in order to get the target research samples.

First, articles in China Journal Full Text Database of CNKI.

Second, articles published in Peking University Core Periodicals and Periodicals of Chinese Social Sciences Citation Index.

Third, the title of the article must include “TPACK” or “TPCK” or “Technological Pedagogical Content Knowledge”.

Fourth, no time limit for publication.

#### 4.2. Retrieve Procedure

In accordance with the above inclusion criteria, the retrieving procedure is the following six steps. First, selected China Journal Full Text Database of CNKI. Second, selected “basic science”, “philosophy and humanities”, “Social science I” and “Social Science II” in the classified catalogue. Third, chose “topic” in the “search criteria” and entered into “TPACK” or “TPCK” or “Chinese characters for technological pedagogical content knowledge”. Fourth, adopted exact matching. Fifth, selected “Core Journals (it refers to Peking University Core Periodicals here)” and “CSSCI” as the source category. Sixth, did not fix publication year parameter for all articles in the database meeting the criteria.

#### 4.3. Retrieve Result

The retrieval date is January 20<sup>th</sup>, 2020. As a result, we retrieved 169 journal papers related to our topic of interest with these keywords: “TPACK” or “TPCK” or “technological pedagogical content knowledge”. The earliest one was published on April 5<sup>th</sup>, 2008 and the latest one was published on December 2<sup>nd</sup>, 2019.

So 169 journal papers published in China Journal Full Text Database of CNKI from April 2008 to December 2019 were used as research samples for statistical visual analysis and a deep content analysis in this study.

## 5. Analysis on Teachers' TPACK Study Domains in China

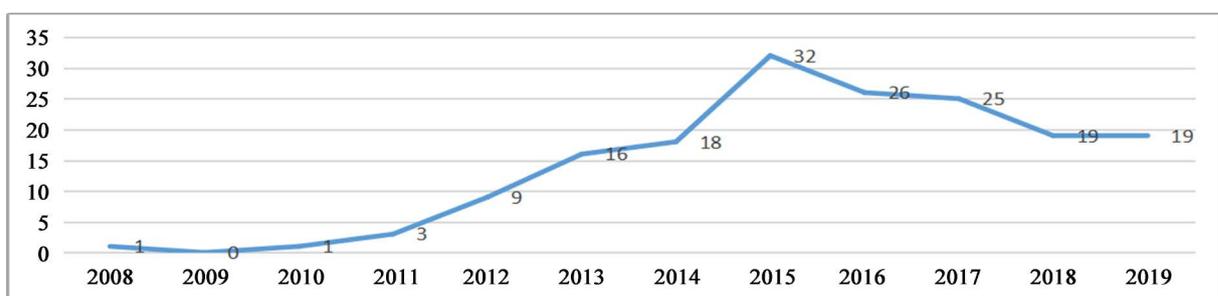
In this study, 169 journal papers were analyzed by means of quantitative statistical analysis and qualitative deep content analysis in terms of the following four domains. They were annual volume, main research institutions and research themes in teachers' TPACK development in China. The former two domains, annual volume and the top five contribution institutions of TPACK journal papers, offered some basic information of teachers' TPACK study in China by statistical visual analysis. The latter domain of research themes including "Introduction of Foreign Study on Teachers' TPACK" "Pre-Service Teachers' TPACK Level and Development Paths" "Development Paths of In-Service Teachers' TPACK" "Teachers' TPACK Study of Specific Subjects", intends to show deeper analyses of teachers' TPACK study in China by qualitative deep content analysis.

### 5.1. Annual Volume of Teachers' TPACK Journal Papers

The annual distribution of the 169 research samples from April 2008 to December 2019 was shown in **Figure 2**. From 2008 to 2019, the annual volume of teachers TPACK journal papers was numbered as 1, 0, 1, 3, 9, 16, 18, 32, 26, 25, 19 and 19 respectively, which showed the popularity and importance of teachers' TPACK in China. From 2010 to 2015, the number of published papers in the field of teachers' TPACK continued to rise and it reached its peak in 2015 with an annual volume of 32 articles. From 2015 to 2018, the number of published articles dropped from 32 to 19 continuously. The number of published papers in 2019 was the same as in 2018 with the annual volume of 19 journal papers and it showed a decline almost half of that in 2015.

### 5.2. The Top Five Contribution Institutions of Teachers' TPACK Journal Papers

According to statistical visualization analysis of CNKI, the top five institutions in terms of the number of published papers in the field of teachers' TPACK study were all normal universities. They were Beijing Normal University, Northeast



**Figure 2.** Annual volume of the 169 samples from 2008 to 2019.

Normal University, South China Normal University, East China Normal University and Qufu Normal University. The numbers of journal papers they contributed to were 14, 12, 11, 10 and 10 respectively, which can be shown in **Figure 3**. Altogether 57 journal papers of the total 169 samples were contributed by the top five institutions and it took up 33.73%.

Qufu Normal University is in the charge of Shandong Province and South China Normal University is in the charge of Guangdong Province. The other three normal universities are all in the charge of Ministry of Education of the People's Republic of China. To some extent, it showed that teachers' TPACK study had earned attention of national and provincial normal universities, but less local normal universities which are in the charge of municipal government and occupy a large number paid attention to teachers' TPACK study.

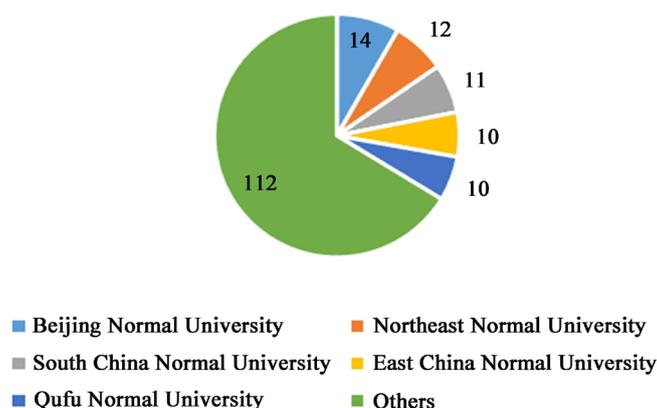
However, local normal universities are supposed to keep up with the pace of the information and technology era when teachers' TPACK is not only a mandate but also a manifesto (AACTE Committee on Innovation and Technology, 2008). They should begin to pay much more attention to teachers' TPACK study in order to serve for their local education respectively, which will be further explained in the latter reflection and outlook section.

### 5.3. Research Themes of Teachers' TPACK Study in China

We found there were mainly four research themes of teachers' TPACK study in China after a qualitative deep content analysis of the 169 journal papers retrieved from China Journal Full Text Database of CNKI. They were "introduction of foreign study on teachers' TPACK", "pre-service teachers' TPACK development paths", "in-service teachers' TPACK development paths" and "teachers' TPACK study of specific subjects", which would be expounded in the sub-sections.

#### 5.3.1. Introduction of Foreign Study on Teachers' TPACK

After a deep reading of the 169 journal papers, we found that 14 of the 169 samples are mainly about the introduction of foreign study on teachers' TPACK.



**Figure 3.** The top five contribution institutions and the numbers of their published papers.

The methods adopted were 1) we read and analyzed the 14 journal papers in detail and 2) classified them into four sub-themes: introduction of TPACK frameworks and schools, development paths, measurement methods and others including general analyses and an interview report. The detailed information of the introductory journal papers can be shown in **Table 1**.

### **5.3.2. Pre-Service Teachers' TPACK Level and Development Paths**

The quality and professional ability of pre-service teachers are closely related to the construction of Chinese teachers' capabilities (Wang & Wu, 2018). Developing pre-service teachers' application ability of information technology in practice plays a critical role in cultivating a group of qualified primary and secondary school teachers in the information age (Zheng & Zhang, 2019). TPACK provides a new point for pre-service teachers' education and how to promote pre-service teachers' TPACK has become an urgent and important issue. We found that Chinese researchers had done some investigations into the present level and the development paths of pre-service teachers' TPACK.

In this study, the journal papers of pre-service teachers' TPACK study were retrieved by the following method. First, we used the term "Normal Students" to search in the titles of the 169 journal papers retrieved from China Journal Full Text Database of CNKI and got 18 journal papers. In other words, 18 of the 169 titles of the journal papers included the term "Normal Students". Second, we used the term "Pre-Service Teachers" to search again in the rest of the 151 titles of the journal papers and retrieved another 10 journal papers. Third, we made a deep reading of the left 141 journal papers and figured out another two journal papers related to pre-service teachers' TPACK education. One is about masters' TPACK education in Geography and the other is about pre-service teachers TPACK in Chemistry teaching. Altogether we found 30 journal papers related to pre-service teachers' TPACK education. After a detailed content analysis, we found "normal students" and "pre-service teachers" referred to the same subject, the would-be teachers in normal universities, so we call both "normal students" and "pre-service teachers" as "pre-service teachers" for convenience and consistency with the latter "in-service teachers".

#### **1) Present Level of Pre-Service Teachers' TPACK**

Chinese researchers found the present TPACK level of pre-service teachers is not high. After an empirical study of 463 pre-service teachers of general education studies, Dong Yan, Sang Guoyuan and Cai Jingxin (2014) came to the conclusion that the TPACK level of pre-service teachers was comparatively low. Wang Lizhen and Fu Liping (2015) also came to the conclusion that the TPACK level of Chinese pre-service teachers was not very optimistic. Some other researchers also made some research works on the present TPACK level of pre-service teachers of specific subjects. For example, the TPACK level of pre-service mathematical teachers was low, especially in terms of the integrated factors of TPACK (Zhang & Wang, 2016) and the TPACK level of pre-service

**Table 1.** Four sub-themes of introduction of foreign study on teachers' TPACK.

| Numbers | Sub-Themes          | Published Year | Titles   | Author(s)                                    | Database(s)   |
|---------|---------------------|----------------|--|--|---|
| 1       | Frameworks          | 2015           | Study on Current Situation and Development Trend of Teachers' TPACK  | Ning Lianhua & Xiang Kun                     | ×   |
|         |                     | 2012           | Literature Review on Technological Pedagogical Content Knowledge   | Yuan Zhiqiang                                | ×   |
|         | Schools             | 2015           | Research on Technological Pedagogical Content Knowledge (TPACK): Progress and Trends   | Cai Jingxin & Deng Feng                      | ×   |
|         |                     | 2014           | Challenges Facing TPACK Theoretical Research   | Yu Yong, Bu Juanjuan & Zhang Hai             | Web of Science (2006-2013)  |
| 2       | Development Paths   | 2015           | Study on Current Situation and Development Trend of Teachers' TPACK  | Ning Lianhua & Xiang Kun                     | ×   |
|         |                     | 2014           | Inspiration of Foreign Teachers TPACK Development Paths  | Wu Huanqing                                  | CNKI, ProQuest, Springer-Link, Wiley Online Library (2005-2011)   |
|         |                     | 2012           | Literature Review on Technological Pedagogical Content Knowledge   | Yuan Zhiqiang                                | ×   |
|         |                     | 2012a          | TPACK—New Paths and Methods of American integration between curriculum and technology  | He Kekang                                    | ×   |
|         |                     | 2012b          | TPACK—New Paths and Methods of American integration between curriculum and technology  | He Kekang                                    | ×   |
| 3       | Measurement Methods | 2016           | Research Status and Thinking of TPACK Measure Methods at Home and Abroad   | Gu Yanxia & Qian Xuyuan                      | ×   |
|         |                     | 2013           | Reviews and Enlightenment of Foreign Measurement on Technological Pedagogical Content Knowledge                              | Xu Peng, Liu Yanhua, Wang Yining & Zhang Hai | ×   |
|         |                     | 2017b          | Reviews and Enlightenment of the American New Evaluation Tools on Teachers' Technological Pedagogical Content Knowledge      | Huang Fuqian                                 | ×   |
| 4       | General Analysis    | 2018           | Knowledge Mapping Analysis on English TPACK journal papers: Origin and Development   | Deng Guomin, Li Hui, & Luo Min               | Web of Science(No publish time limit)   |
|         |                     | 2013           | Foreign TPACK Study and Enlightenment  | Xu Peng, Zhang Hai, Wang Yining & Liu Yanhua | Education Resources Information Center(ERIC), SCOPUS, Wiley, Web of Science, Springer Link (2005-2013), TPACK Newsletters (2009.01-2013.05) |
|         | Interview Report    | 2015           | A Review on Theory Development and Practical Implications of Technological Pedagogical Content Knowledge ( TPACK): 2005-2014 | Zhang Zhe, Zhang Hai & Wang Yining           | Web of Science, Scopus (2005-2014)  |
|         | Interview Report    | 2013           | TPACK Latest Understanding about ICT for Subject Teaching and Learning: An Interview with Professor Matthew Koehler          | Zhang Baohui & Zhang Jing                    | ×   |

chemistry teachers was maintained at a low level (Wei & Zhou, 2015).

## 2) TPACK Development Strategies of Pre-Service Teachers

In order to promote pre-service teachers TPACK effectively, researchers put

forward different development strategies. Some researchers explored TPACK development strategies with reference to “learning by design”. They preferably suggested this strategy because of the efficiency of “learning by design” by group teaching experiment (Zheng & Zhang, 2019), searched how to use technology to carry out science teaching and pursued the synergistic effect between learning theory and technology (Huang, 2017a) and designed micro-courses to carry out teaching experiments (Ma & Liu 2018; Zhan & Ren, 2011). Other researchers introduced construction of waterfall model for pre-service teachers’ TPACK capacity building (Nie, 2017), TPACK Game (Huang, Jiang, & Zhang, 2017), and so forth to promote the development of pre-service teachers TPACK.

### **3) Curriculum Integration for Pre-Service Teachers’ TPACK Cultivation**

The construction of pre-service teachers’ education curriculum system is one of the key factors to assure the quality of teacher education and professional development, so optimizing the curriculum of pre-service teachers education is an important way to promote teachers’ TPACK. Some researchers put forward that normal universities should implement integrated curriculum to promote pre-service teachers’ TPACK. Liu Zhe (2016) carried out pre-service teachers’ TPACK study by integrating curriculum on the basis of empirical analysis of structural equation model (Liu, 2016). Some other researchers also suggested integrating technology course with the course of teaching theory and methods of specific subjects (Zhang, Zhang, Liu, & Wang, 2015), strengthening the integration between different teachers’ courses and making different courses contents from scattered and isolated to integrated and connected (Zhang & Yang, 2016).

In addition, some other researchers made some explorations in curriculum integration of specific subjects. Deng Feng, Chen Lingling, Li Ailing and Wu Songfa (2018) advocated to guide pre-service teachers to think and reflect on the integration of information technology and Chemistry teaching (Deng, Chen, Li, & Wu, 2018). Dai Jin, Ren Yanan and Li Weihai (2018) also suggested the design of pre-service Biology teachers’ curriculum should pay attention to two-dimensional integrated knowledge (Dai, Ren, & Li, 2018).

In summary, researchers in China have been searching how to integrate different courses to develop pre-service teachers’ TPACK.

### **4) Diversified Teaching Practice for Pre-Service Teachers’ TPACK Development**

TPACK is a kind of practical knowledge. It must be gradually cultivated in long-term learning and practice (Zhang & Yang, 2016). Chinese researchers also proposed to strengthen teaching practice to ensure the development of pre-service teachers’ TPACK. They suggested putting more emphasis on teaching practice and changing the relationship between theory and practice from separation to combination. For example, Huang Xuemei (2018) proposed promoting diversified teaching practice for pre-service teachers to accumulate experience to develop their TPACK in practice (Huang, 2018). Wang Lizhen and Fu Liping (2015) also advocated strengthening teaching practice and reconstructing

education mode to develop pre-service teachers' TPACK (Wang & Fu, 2015).

### 5.3.3. Development Paths of In-Service Teachers' TPACK

We found there were three main paths for in-service teachers' TPACK development after a deep content analysis of the rest of the 125 journal papers. The three main paths are promoting teachers' autonomous development, building learning community and establishing and improving guarantee mechanism.

#### 1) Promoting In-Service Teachers' Autonomous Development

Teachers' autonomous development referred to awakening and arousing teachers' potential creativity and reflecting on their teaching practice actively and continuously to reconstruct their TPACK (Zhang & Liu, 2015). Such autonomous development paths as promoting teachers' awareness of autonomous development (Shang & Cheng, 2017), stimulating teachers' intrinsic potentiality and enhancing the ability of teachers' reflection (Dong, He, Sikandier, & Xu, 2019) had been put forward in China.

TPACK was a new requirement for teachers' knowledge structure in the era of information technology. Teaching activity was no longer a simple process of teachers' lecturing and students' listening, but a process of analysis, design, practice and reflection. The teacher was not a fixed teacher any longer but a dynamic reflective practitioner (Liu, 2019). Reflection should run through the whole process of teaching practice and play a key role in the development of teachers' TPACK (Liuhuang & Huang, 2005; Xie, Song, & Liu, 2008).

If a teacher had been only satisfied with the daily teaching process and had not thought deeply about his own teaching practice, no matter how long his actual teaching age is, he would have only been a teacher and it was difficult for him or her to become an excellent teacher (Yan, Hui, & Ning, 2018). An excellent teacher was supposed to constantly revise and modify his or her understanding and practical application of the subject teaching content, teaching methods and technology for flexible and creative usage of TPACK in a comprehensive way. This was because it was the highest realm for a teacher to choose appropriate education technology to design teaching content and teaching methods that meet the students' learning context (Shu, 2014; Ruan & Yang, 2014).

The development of teachers' TPACK depended on Teachers' reflection ability, which was also an important factor to ensure teachers' continuous improvement and development in teaching practice (Wu, Yu, & Ma, 2014).

#### 2) Building Collaborative TPACK Learning Communities for Teachers

Social constructivists hold that "social interaction" is the basic form of individual learning. In other words, social individuals must interact with others to complete various cognitive activities (Zhang & Liu, 2015). Shulman and Hammerness K also argued that community is a key element in teachers' learning framework (Shulman, 2004; Hammerness, 2005). From the perspective of social culture, Kelly Peter put forward that an important principle to develop teachers' learning is to promote teachers to develop teaching expertise in the complex network of collaborative learning (Kelly, 2006).

Chinese researchers also put forward building collaborative communities to develop teachers' TPACK. Early in 2013, Li Haifeng advocated building TPACK curriculum research community (Li, 2013). Wu Huanqing put forward Collaborative Construction Model for teacher's TPACK development in 2014 (Wu, 2014) and further suggested Teachers' TPACK promotion path based on the collaborative knowledge construction (Wu, 2017).

Other Chinese researchers also advised the same idea of building collaborative TPACK learning communities, such as constructing community of teachers' professional learning (Zhang, Lin, & He, 2015), improving cooperation community and sharing mechanism of teaching resources (Liu, Guo, & Zhao, 2017), and developing rural teachers' TPACK by building teachers' learning community (Zhou & Huang, 2016). With the continuous development of network and information technology, teachers' TPACK development model based on online practice community and online learning community were also put forward (Deng, 2015; Zhao & Shen, 2019).

### 3) Establishing and Improving Guarantee Mechanism

The development of teachers' TPACK needed stable policies and measures (Xu, Fu, & Hou, 2018). In order to promote the development of teachers' TPACK, it was necessary to form a diversified evaluation mechanism (Yan, Hui & Ning, 2018), improve teaching resources sharing mechanism and promote the mutual aid mechanism of knowledge structure and subject development (Liu, Guo, & Zhao, 2017; Li, 2017).

#### 5.3.4. Teachers' TPACK Study of Specific Subjects

Research on teachers' TPACK of specific subjects has also become a hot topic in China. Teachers' TPACK Study must be combined with specific subjects (Duan, Yan, & Zhang, 2015) because different subjects have different nature and content. Therefore, TPACK has different forms in different subjects (Jiao & Zhong, 2010) and it would also be quite difficult to apply to specific subject matter courses.

We made a statistic analysis of the 169 journal papers of TPACK study in terms of different subjects. The statistical result was shown in Table 2.

After a deep content analysis of the 64 journal papers of specific subjects, we classified them into three domains. They are research on "TPACK frameworks of specific subjects", "particular applications of TPACK in specific subjects" and "development paths of teachers' TPACK of specific subjects".

#### 1) TPACK Frameworks of Specific Subjects

Chinese researchers have carried out TPACK study in line with Chinese society and culture on the basis of foreign research results in order to find suitable ways to integrate TPACK. It was of great significance for teachers' TPACK development to make clear the concrete embodiment of TPACK in specific subjects (Yu, Bu, & Zhang, 2014). Duan Yuanmei, Yan Zhiming and Zhang Kejun (2015) and Zhang Xinyan (2016) explored mathematics teachers' TPACK in middle schools through factor analysis. Lou Baiyu, Li Hongjuan and Ran Ming (2016) put forward Technological Pedagogical Chemistry Knowledge (TPCHK)

**Table 2.** Teachers' TPACK study in specific subjects.

| Subjects                      | Numbers | Subjects  | Numbers | Subjects                  | Numbers |
|-------------------------------|---------|-----------|---------|---------------------------|---------|
| Chinese                       | 1       | Physics   | 5       | Biology                   | 2       |
| Mathematics                   | 16      | Chemistry | 12      | Science                   | 2       |
| English<br>(Foreign Language) | 15      | Geography | 4       | Information<br>Technology | 4       |
| Physical Education            | 2       | Music     | 1       |                           |         |

Notes: Because English is a foreign language in China, we used “English” and “Foreign Language” as key words to search in the topics of 169 journal papers. We got 13 journal papers. In addition, through content analysis of the 169 samples, we found another two papers were related to English subject. One was about Translation Course of English majors and the other was about British and American literature, so there were 15 journal papers relating to English subject together. By searching “Physics” in the topics of the samples, we got 6 journal papers, but we found one of the six belonged to science subject after content analysis though “Physics” was included in the topic. So there were 5 journal papers relating to Physics subject. By searching “Information and Technology” in the topics of the samples, we got 11 journal papers, but we found there were only 4 journal papers relating to Information and Technology subject after deep content analysis.

and its components. Ruan Quanyou (2014) advised Technological Strategic and Content Knowledge (TSACK) with reference to TPACK based on an EFL Teaching Project. Zhang Pengtao and Lynn Moorman (2018) suggested the transformation from G-TPCK to G-PCK. Chinese researchers have been carrying out study on TPACK frameworks of specific subjects according to the particular context where they teach.

### 2) Particular Applications of TPACK in Specific Subjects

“Integrating TPCK into specific subject area” was explained in detail in *Handbook of Technological Pedagogical Content Knowledge (TPCK) for Educators* (AACTE Committee on Innovation and Technology, 2008). Chinese teachers had carried out practical exploration of specific applications of TPACK in specific subjects in Chinese context. You Leilei (2018) demonstrated that TPACK could help teachers effectively by the use of various information technology and digital means to make concept teaching more vivid and efficient with the practical teaching example of “ion reaction”. Huang Hua (2016) took the teaching practice of “vibration under external force” as an example and explored flipped classroom in physics in senior high school based on the TPACK framework. Li Mingxi (2018) also designed the construction dimension of College English learning cloud space based on TPACK.

### 3) Development Paths of Specific Subjects Teachers' TPACK

Chinese researchers in different subjects have also made some exploration and research on teachers' TPACK development paths with the consideration of the particularity of specific subjects. After a deep content analysis of the 64 journal papers which were related to teachers' TPACK of specific subjects, we found most development paths which were put forward in the 64 journal papers of TPACK study of specific subjects were similar to the former strategies which were suggested in the in-service teachers' TPACK development paths including promoting teachers autonomous development, building learning community and establishing and improving guarantee mechanism.

Some researchers of specific subjects promoted teachers' autonomous development. Zhu Guiqin and Lu Qiang (2012) proposed to improve the reflective ability of Information and Technology Teachers in secondary schools, cultivate their autonomous development and develop their TPACK. Fan Lin and Zhang Xichun (2016) also advised English teachers should hold the concept of lifelong learning and pay attention to self-improvement of basic knowledge. Some researchers of specific subjects proposed building learning community. Li Yaying (2017) put forward the construction of TPACK development community for English teachers. Liu Yangyang and He Minxue (2018) also advised the establishment of TPACK learning community for PE Teachers. Some other researchers also suggested establishing and improving guarantee mechanism. For example, Zhu Hongcui (2017) advised constructing EFL-TPACK evaluation index system in middle school to ensure teachers' TPACK development.

Apart from the above three development paths, promoting teachers autonomous development, building learning community and establishing and improving guarantee mechanism, researchers of specific subjects also put forward improving the curriculum system of teacher education in specific subjects (Zhu, 2017; Li, 2017), strengthening and improving teacher training with specific subject content (Lin, Zheng, Ke, & Lin, 2019; Zhu & Lu, 2012).

The quantitative visual statistic analyses of the annual volume and the top five contribution institutions of TPACK journal papers offer the basic research overview of teachers' TPACK development. The qualitative deep content analyses of such research themes as "Introduction of Foreign Study on Teachers' TPACK" "Pre-Service Teachers' TPACK Level and Development Paths" "Development Paths of In-Service Teachers' TPACK" "Teachers' TPACK Study of Specific Subjects", intends to show deeper analyses of teachers' TPACK study in China and offer references for researchers and educators in the field of teachers education.

## 6. Conclusion

This study provided a general review of the teachers' TPACK study in China. It showed that Chinese researchers have been interested in both pre-service and in-service teachers' TPACK development since TPACK was introduced to China in 2008. Although studies on TPACK development of both pre-service and in-service teachers, of specific subjects teachers have been carried on, there is still much room to explore in teachers' TPACK study in China like enhancing experimental or quasi-experimental research, developing in-service teachers' TPACK with consideration of particular contexts, cultivating pre-service teachers' TPACK with regards to different normal universities and subjects, promoting rural in-service teachers TPACK and deepening interactive reflection and negotiation community study to promote teachers' TPACK.

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### Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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