Research on College Mathematics Education Based on TPACK theory

Fengmei Xin[1,*], Hui Wang[1] and Ying Guo[1]

College of Modern Manufacturing Engineering, HeiLongJiang University of Technology, Jixi, Heilongjiang 158100, China
[*]Corresponding author. Email: 18245904309@163.com

ABSTRACT
In order to solve the main contradiction between the weak technical skills and the subject teaching ability required by the society at that time, the TPACK knowledge structure of mathematics teachers was explored based on TPACK theory, aiming at the bottleneck of current university teaching and education. It provides a new development direction for modern mathematics teaching methods. After research and discussion, the teaching method based on TPACK is suitable for mathematics teaching in applied colleges and universities.
Keywords*: TPACK theory, technology teaching, teaching ability, Mathematics*

1. INTRODUCTION

In recent years, with the continuous deepening and development of information technology, a new generation of information technology such as the Internet, big data, and cloud computing has been integrated into the education field, promoting the further development of education and opening up a new path for educational practice[1].At present, China has entered a new era of education informatization 2.0. In order to solve the main contradiction between the weak technical skills of teachers and the subject teaching ability required by the society at that time[2].The lack of deep integration of subject knowledge and information technology leads to the stagnation of the development of education modernization[3].

Many experts and scholars at home and abroad have studied TPACK theory and framework in various aspects. Xiao [4] combines folk art education with TPACK framework. The results show that compared with traditional teaching, TPACK based ethnic folk art space course can improve teaching efficiency and promote students' mastery of various skills of national folk art. Na et al. [5] discussed the structure and characteristics of excellent high school English teachers. Under the framework of TPACK, they designed teaching activity records, formulated TPACK coding rules for high school English teachers, and explored the relationship between TPACK elements and classroom teaching behavior. Zhao et al. [6] established the factors influencing the TPACK structure of primary school Chinese teachers by analyzing TPACK. The results can help the teacher training department to change the curriculum and improve the training mechanism. It helps novice teachers become expert teachers who adapt to the society. Huang [7] research shows that information technology is an essential quality for teachers. Teachers use their TPACK knowledge structure and information technology environment to design teaching and promote the development of students' mathematical thinking. Luo et al. [8] analyzed the knowledge structure characteristics of MOOC teachers under the TPACK framework. MOOC teachers need to pay more attention to the integration of technical knowledge and teaching knowledge or content knowledge to achieve effective teaching. On this basis, this paper puts forward the development strategy of MOOC teachers TPACK. Research by Baran and Li et al. [9-10] shows that there is a positive correlation between teacher education strategies and TPACK of pre service teachers. Reflection and teacher educators' role models are the most commonly used teacher education strategies in this study. The results provide suggestions for further research on the relationship between teacher education strategies and TPACK of pre service teachers in teacher education program. Fan et al. [11] have proved that TPACK framework can be used as an analytical tool for researchers to study teachers' online teaching practice.

TPACK theory is proposed to reposition and integrate teaching, subject content and technology. The above literature found that the relevant research mainly concentrated in primary and secondary schools, and there was little research on how university mathematics teachers use TPACK knowledge structure to reconstruct mathematical knowledge and how to guide students' mathematical thinking. Stem education integrates science, technology, engineering and mathematics. Mathematics, as the basic tool of technology and engineering, plays an important role [12]. Therefore, based on TPACK theory, this paper studies how to develop college mathematics teachers.

2. TPACK SYSTEM

TPACK (technical academic content knowledge) was further studied by Koehler and Mishra [13] under the

framework of Shulman's[14] subject teaching knowledge (PCK). It is mainly divided into three core elements and four composite elements. The specific classification and content are shown in Figure 1 and Table 1.

Table 1. Composition and connotation of TPACK

Sensor numbers	Aspect	Essential Factor	Connotation
1	Core elements	Content Knowledge(CK)	The knowledge that the teacher should grant the course, including concepts, theories, ideas, organizational framework, etc.
2		Pedagogical Knowledge(PK)	Teachers have an in-depth understanding of the teaching process and methods, including the purpose and goals of education.
3		Technological Knowledge(TK)	Knowledge about thinking methods and cooperation with technology, practical tools, and teaching resources can continuously adapt to changes in information technology.
4	Composite elements	Pedagogical Content Knowledge(PCK)	According to Shulman[14], this transformation is when teachers find multiple ways to explain the topic, and adjust and value the syllabus or teaching content based on the students' prior knowledge. PCK covers teaching, learning, courses, assessment and reporting. Core Business.
5		Technological Content Knowledge(TCK)	The knowledge points and depth of the teacher's mastery are far beyond what he teaches. They must have a deep understanding of how specific technologies can be applied to change the topic, understand which specific technology is most suitable for solving the topic of their field, how the content determines or even changes the technology.
6		Technological Pedagogical Knowledge(TPK)	Teaching and learning how to change in a specific way
7		Technological Pedagogical Content Knowledge(TPACK)	TPACK is the basis for the effective use of technology for teaching, and it is necessary to understand the concept of using technology. Teaching techniques that use technology in a constructive way to teach content. Understand what makes concepts difficult or easy to learn, and how technology can help solve some of the problems faced by students. Understand students' prior knowledge and epistemological theories and how to use technology in existing On the basis of knowledge, develop new epistemology or strengthen the knowledge of old epistemology.

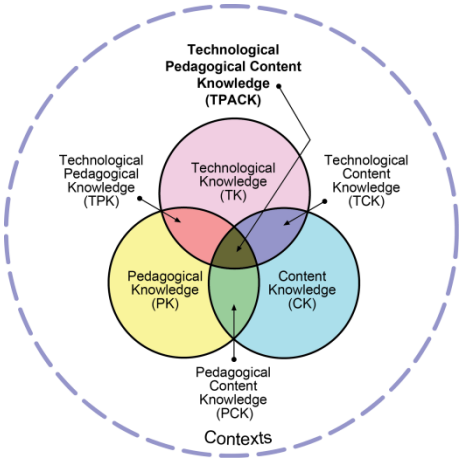

Figure 1. TPACK classification[13]

3. TPACK CONCEPT OF UNIVERSITY MATHEMATICS EDUCATION

Yuan Zhiqiang [15] explained the importance and creativeness of TPACK concept theory by taking an education course - "teaching mathematics and science with technology" in the University of British Columbia as an example. In particular, he was impressed by the importance of mathematics in curriculum planning - how to focus on the integration of mathematics and science teachers, and how to support teachers to use technology in teaching. Based on this, a new model of College Mathematics Education Based on TPACK is proposed. This paper discusses how to integrate technology into teaching, how to represent the tedious knowledge and how to promote the healthy development of students' mathematical thinking. Let "knowledge - Teaching - technology" fully integrate to promote the education of college mathematics interesting, complete and scientific. Let "knowledge - Teaching - technology" fully integrate to promote the education of college mathematics interesting, complete and scientific. Figure 2 shows the optimization model of College Mathematics Education Based on TPACK.

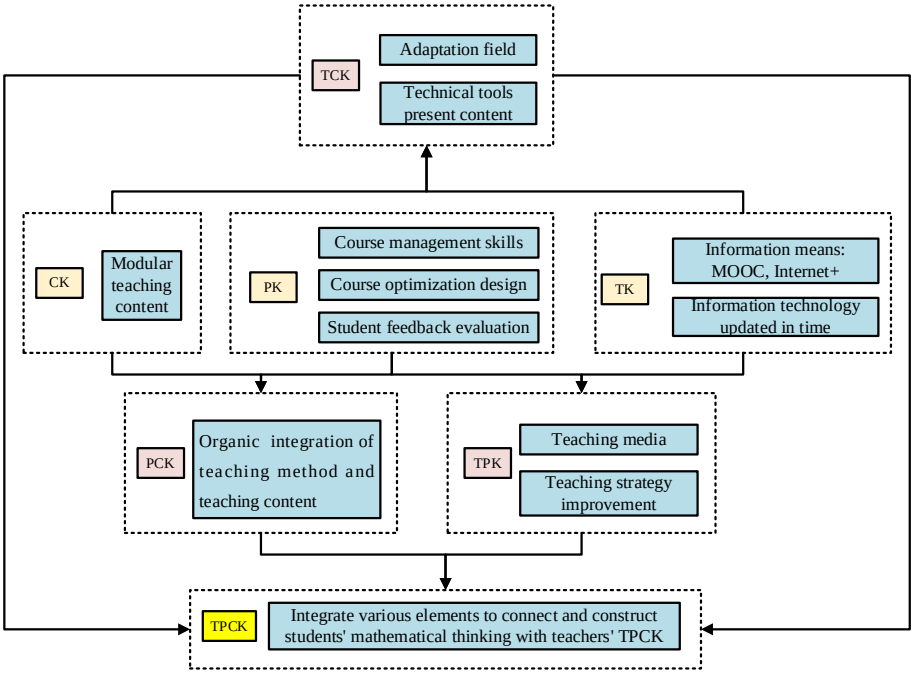

Figure 2. Optimization model of College Mathematics Education Based on TPACK

4. THE DEVELOPMENT BOTTLENECK OF COLLEGE MATHEMATICS EDUCATION

4.1. Lack of change ideas

For a long time, China has adopted the teaching method of "cramming and passive". Teachers who are used to traditional teaching methods and students who are taught by traditional teaching methods are not willing to accept new education methods, which conflicts with the huge benefits brought by information technology. All of these need teachers to carry out self-reform and try to adapt to the profound changes brought about by the information of the times. Teachers who are used to the traditional education and teaching mode often lack the idea of change and instinctively resist or reject the great changes brought by information technology to education and teaching.

4.2. The deep integration of subject teaching and technology teaching is weak

Teachers are familiar with the teaching knowledge and can grasp the contents that students need to master. However, the quality of teaching is very poor and the knowledge accepted by students is very limited. Fully exposed the lack of skills and skills in teaching. Teachers should make full use of teaching means and teaching platform, form the teaching idea of integrated technology, have professional teaching methods, and can effectively integrate and use. At present, colleges and universities only focus on how to impart technical knowledge and how students passively accept it, rarely involving how to integrate information technology and practical application disciplines. However, there are essential differences between learning technology and learning using technology.

5. PRACTICAL NAVIGATION OF COLLEGE MATHEMATICS BASED ON TPACK

5.1. Modularization of teaching content and adaptation to local conditions

The traditional teaching method is to master knowledge first and then to apply skills. This way leads to poor application ability and weak practical operation ability of students. There are two aspects of teaching content modularization. The first is to integrate the repeated teaching contents. For example, the places in micro integration and linear algebra that are used to solve equations can be taught together to avoid repeated teaching The second is to combine the knowledge learned with the real life situation, and the mathematical modeling can be organically combined with the college mathematics teaching if the examples are involved. According to different majors, different teaching syllabus are formulated, and different science learning software is adopted for different courses, such as geogebra software, Geometer's Sketchpad, maple, Mathematica, etc.

5.2. Promoting the transformation of teachers' status

Different from the previous teaching methods, TPACK theory planning teachers should fully reflect the leading role in teaching, fully combine the value of teaching knowledge and teaching technology, and become the guide of students' active learning and active thinking. In the past, mathematics teaching mostly reflected the dominant way of "active guidance + blackboard writing", while TPACK strengthened the recessive way of information technology teaching. It can reflect that teachers are no longer the transmitter of passive knowledge, but should be more active through information technology to reform teaching methods, give full play to the learning autonomy of accepting new things, and become the creators and designers of teaching ideas.

5.3. In depth integration of information technology

In the process of college mathematics learning, some concepts and theories are very abstract or difficult to be directly observed. In order to understand the meaning of the knowledge more intuitively, some software can be used to display the content. For example, in calculus, it is easy for students to understand two-dimensional calculus. In the later stage of surface integral and curve integral, some students will fall into space thinking. At this point, we can design an asynchronous long volume accumulation process through the GUI of MATLAB, which can make students understand the definition more simply and enhance their desire for learning. You can also take students to design this type of small program. Information technology provides a good platform for university education. How to apply it better requires teachers to learn independently, find a good interface between technology and teaching knowledge, and further enrich and improve the quality of teaching.

6. CONCLUSION

With the rapid development of information technology, teaching is rarely used. This paper makes a response to the teacher's problem of how to take students as the center and use the teaching concept of TPACK theory to carry out education thinking and exploration. In view of the difficulties existing in college students' teaching, this paper gives a solution based on TPACK theory.

ACKNOWLEDGMENT

This work was supported by Education and teaching reform project of HeiLongJiang and University of Technology and Provincial special project for Youths(GJD1319023).

REFERENCES

[1] H. Pargmann, D. Euhausen and R. Faber, "Intelligent big data processing for wind farm monitoring and analysis based on cloud-technologies and digital twins: A quantitative approach," 2018 IEEE 3rd International Conference on Cloud Computing and Big Data Analysis (ICCCBDA), Chengdu, 2018, pp. 233-237. DOI: 10.1109/ICCCBDA.2018.8386518.

[2] Y. Zhang and N. Ge, "The Current Situation and Countermeasures of Chinese Vocational Education Resources Construction in the Era of Informatization 2.0," 2018 Seventh International Conference of Educational Innovation through Technology (EITT), Auckland, New Zealand, 2018, pp. 225-228, DOI: 10.1109/EITT.2018.00052.

[3] Swallow M J C, Olofson M W. Contextual Understandings in the TPACK Framework, in Journal of Research on Technology in Education, vol. 49, pp.228-244, 2017. DOI: 10.1080 /15391523.2017. 1347537

[4] X. Huifeng. An Ethnic and Folk Art Space Course based on TPACK, in International Journal of Emerging Technologies in Learning (iJET), vol. 14, pp. 110-121, 2019. DOI：10.3991/ijet.v14i03.10101

[5] R. Na, H. Zhang, Y. Wang, Y. Wang, T. Yoneda and Z. Li, "A Study of TPACK Structure of Outstanding English Teacher," 2017 International Conference of Educational Innovation through Technology (EITT), Osaka, 2017, pp. 299-302, DOI: 10.1109/EITT.2017.78.

[6] N. Zhao, H. Zhang, Y. Wang and Z. Li, "A Case Study of Analysis on TPACK Structure of Teachers in Primary School in China," 2017 International Conference of Educational Innovation through Technology (EITT), Osaka, 2017, pp. 18-21, DOI: 10.1109/EITT.2017.13.

[7] Z.Huang, Theoretical Analysis of TPACK Knowledge Structure of Mathematics Teachers Based on T-TPACK Mode, in Educational Sciences: Theory & Practice, vol. 18, pp. 2044-2053, 2018. DOI: 10.12738/estp.2018.5.103

[8] L. Luo, H. Zhang, Y. Tao, X. Yang, B. Yan and Y. Wang, "A Study on Characteristics of TPACK Structure for MOOC Teachers," 2017 International Conference of Educational Innovation through Technology (EITT), Osaka, pp. 5-9, 2017.DOI: 10.1109 /EITT.2017.10.

[9] Baran E , Canbazoglu Bilici S, Albayrak Sari A, et al. Investigating the impact of teacher education strategies on preservice teachers' TPACK, in British Journal of Educational Technology, vol. 50, pp 357-370, 2019. DOI: 10.1111/bjet.12565.

[10] D. Li, X. Yang, H. Zhang and Y. Wang, "Study of Relationship between Pre-Service Information Technology Teacher and TPACK," 2017 International Conference of Educational Innovation through Technology (EITT), Osaka, 2017, pp. 47-50. DOI: 10.1109/EITT.2017.19.

[11] Fan O Y, Scharber C . Adapting the TPACK Framework for Online Teaching Within Higher Education, in International Journal Of Online Pedagogy And Course Design, vol. 8, pp. 42-59, 2018. DOI: 10.4018/IJOPCD.2018010104.

[12] D. Bues, "STEM Education: How Best to “Illuminate the Lamp of Learning”," 2019 IEEE Integrated STEM Education Conference (ISEC), Princeton, NJ, USA, 2019, pp. 402-405. DOI: 10.1109/ISECon.2019.8882034.

[13] M. Koehler, P. Mishra, W. Cain, What Is Technological Pedagogical Content Knowledge (TPACK)? in Journal of Education, Boston, vol. 193, pp. 13-19, 2013.

[14] L. Shulman, Those Who Understand: Knowledge Growth in Teaching, in Educational Researcher, vol. 15, pp. 4-14, 1986.

[15] Y. Zhi-qiang, M.M B, A Study of a TPACK-Based Subject-Specific Educational Technology Course and Its Implications -The Case of “Teaching Mathematics and Science through Technology” Course at The University of British Columbia, in Journal of Mathematics Education, vol. 29, pp. 23-28, 2020. (In Chines)