

A Survey on the Current Status of Informatization Teaching Ability of University Teachers in Hunan Province based on TPACK

Yanling Yuan*, Jiaqi Hu

School of Languages and Literature, University of South China, Hengyang 421001, China

* Corresponding author: Yanling Yuan (Email: 89718864@qq.com)

Abstract: Based on the TPACK theoretical framework, this study conducted a questionnaire survey among 946 university teachers across various institutions in Hunan Province to investigate the current status of informatization teaching ability among university teachers in Hunan and to propose corresponding suggestions. The findings indicate that the overall TPACK level of university teachers in Hunan Province is above average, with the levels of various dimensions ranked as follows: PK > CK > TK > PCK > TCK > TPK > TPACK. At the gender level, there are no significant differences in the various dimensions of TPACK between male and female teachers. In terms of teaching experience, the levels of PK and CK dimensions increase with the accumulation of teaching years, whereas teachers with the least teaching experience (1-5 years) exhibit the highest levels in the technology-related TK and TCK dimensions. Regarding professional differences, computer science teachers have the highest levels of TPACK and TK, while teachers in liberal arts majors have the lowest TK levels. At the educational attainment level, the levels of various dimensions increase with the enhancement of educational qualifications. To enhance the informatization teaching ability of university teachers in Hunan Province, this study proposes pathways for improvement from the perspectives of university teachers, higher education institutions, and the government.

Keywords: Informatization Teaching Ability, Questionnaire Survey, TPACK, University Teachers.

1. Introduction

In the context of the digital era, with the acceleration of informatization in China, modern information technology has been widely applied in various social domains. In China's education sector, there is also a growing emphasis on teachers' professional development and the deep integration of information technology with education and teaching in the context of the information age. To this end, a series of technical standards for teacher education have been introduced. The digital transformation of higher education represents a decisive factor and a significant strategic issue influencing the high-quality development of education in China. In the face of the development opportunities brought by modern information technology, achieving effective integration between higher education and information technology, and accelerating the development of information technology in teaching at colleges and universities have become core tasks in the reform of higher education teaching. However, in practice, some university teachers demonstrate limited capability in utilizing information resources, with relatively monotonous instructional designs and inadequate skills in employing information technology for teaching management, which has hindered the popularization of informatization teaching in higher education. Therefore, analyzing the current situation of university teachers' informatization teaching ability and deriving pathways to enhance them are topics worthy of further research. Based on the Theoretical Framework of Technological Pedagogical and Content Knowledge (TPACK), this study explores the current situation of university teachers' informatization teaching ability in the digital era and proposes relevant suggestions, aiming to provide references for improving the informatization teaching ability of university teachers.

2. Theoretical Framework and Related Research on TPACK

The rapid advancement of information technology has triggered profound transformations in higher education models. Building upon the "PCK" (Pedagogical Content Knowledge) theory proposed by psychologist Shulman, Koehler and Mishra^[1] from Michigan State University innovatively integrated the element of technology (T) and the connecting word "and" (A) to establish the TPACK theoretical framework (Technological Pedagogical and Content Knowledge). As a new knowledge structure system, the TPACK model achieves a deep integration of information technology, subject content, and pedagogy, and clearly defines the crucial role of technological knowledge in higher education teaching. The TPACK framework encompasses three core elements: Content Knowledge (CK), Pedagogical Knowledge (PK), and Technology Knowledge (TK). Additionally, it includes four composite elements formed by the interweaving of these core elements: Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and Technological Pedagogical Content Knowledge (TPACK)^[2]. This framework emphasizes the integration of TK, CK, and PK, requiring teachers not only to possess professional knowledge and pedagogy-related knowledge but also to have the ability to integrate information technology with professional subject knowledge and pedagogy. Therefore, TPACK represents a new definition of teachers' professional knowledge structure and teaching ability in the information technology era, which is essential for teachers to use technology to facilitate effective teaching. This aligns well with the requirements of the Ministry of Education for university teachers and is of great value to teachers'

development.

The TPACK framework does not isolate technology from traditional teaching practices but instead promotes mutual coordination and deep integration among technology, subject content, and pedagogy. It provides significant theoretical guidance and practical foundations for instructors to effectively integrate knowledge of technology, subject content, and pedagogy, as well as to facilitate teachers' professional development [6]. Upon its introduction, this theory garnered widespread attention. Current research on TPACK internationally focuses on the following four areas: ① Research on the ontology or essence of TPACK. Broadly, this can be summarized into three perspectives: first, viewing TPACK as an extension and supplement to Pedagogical Content Knowledge (PCK); second, considering TPACK as a unique and independent knowledge system; and third, seeing TPACK as arising from the interaction and intersection of the three knowledge components in specific contexts, namely, teaching contexts. ② Research on methods for measuring teachers' TPACK levels. There is a variety of methods for measuring TPACK internationally. Based on a summary of relevant TPACK measurements, Koehler and Mishra, among others, categorized these methods into self-reporting, performance evaluations, semi-structured interviews, observations, open-ended questionnaires, and more. Among these, the TPACK measurement scale developed by Schmidt [1] and others for pre-service teachers is currently the most influential questionnaire for evaluating teachers' TPACK knowledge levels, offering high reference value. ③ Research on designing and developing teacher training models under the TPACK framework. Guided by TPACK theory, such research typically focuses on teacher training, designing related courses, creating models, or proposing steps and strategies to effectively enhance teachers' technological pedagogical content knowledge literacy. ④ Research on practical implementations of integrating information technology into curriculum, based on the recognition of TPACK theory and framework.

Research on TPACK in China began in 2008, primarily focusing on the following aspects: ① Ontological research and reviews of TPACK theoretical development: There is a wealth of related research, primarily involving explanations and introductions of the concept and connotation of TPACK, translations and introductions of foreign research theories, and various interpretations, definitions, and modifications of the connotations of each element within its framework. ② Applied research in specific subjects or courses: Researchers, based on the theoretical foundation or framework of TPACK, design and implement instructional designs or teaching strategies for particular courses, and teachers engage in practical teaching activities that integrate technology into specific courses. ③ Teacher development and TPACK cultivation: Relevant research accounts for a smaller proportion of the literature, and the results need to be enriched. This type of research often begins by designing courses for teacher TPACK development, forming a collaborative model for teacher TPACK, and the effectiveness of this model is demonstrated through experimental methods. ④ Research on TPACK measurement: Current measurements of TPACK primarily categorize dimensions based on the components of TPACK. The primary measurement method in China is the questionnaire survey method, which involves self-assessment (or self-reporting) by teachers, supplemented by interview or

observation methods. Questionnaire design is often based on translations and modifications of authoritative foreign questionnaires.

Through a review of the literature, we find that research on TPACK in China is still not mature. Regarding the cultivation and enhancement of teachers' TPACK abilities, China is still in the exploratory stage. This study designs a questionnaire based on the TPACK assessment scale to investigate the current status of TPACK abilities among university teachers in Hunan province, proposes countermeasures, and provides empirical evidence and strategic support for the enhancement and cultivation of university teachers' TPACK abilities.

3. Questionnaire Survey and Statistical Analysis of University Teachers' Informatization Teaching Ability in Hunan Province under the Framework of TPACK

3.1. Questionnaire Development

Currently, research on teachers' informatization teaching ability, both domestically and internationally, is predominantly conducted based on the TPACK framework. Among these, the five-point Likert scale designed by Schmidt et al. is widely adopted to assess teachers' seven categories of TPACK knowledge levels in the teaching process. This study, grounded in the "Teacher TPACK Level Measurement Scale" developed by Schmidt et al., has designed the "Questionnaire on the Current Status and Influencing Factors of TPACK Capability Development among University teachers in Hunan Province," taking into account the reality of university teachers in our province. The questionnaire is divided into three parts: basic information about teachers, the level of teachers' TPACK levels, and the influencing factors of teachers' TPACK levels.

The first part, Basic Information, includes fundamental details such as the gender, age, teaching experience, major, and highest academic qualification of university teachers.

The second part, Survey on Teachers' TPACK Level, is based on the TPACK theoretical framework and covers seven knowledge dimensions (related capability in Technological Knowledge (TK), Content Knowledge (CK), Pedagogical Knowledge (PK), Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and Technological Pedagogical Content Knowledge (TPACK)). Specifically, TK includes utilizing the internet for resource collection, compiling electronic lesson plans, creating courseware, and proficiently using multimedia equipment; CK encompasses disciplinary expertise and knowledge growth strategies; PK involves selecting appropriate teaching plans and organizing classroom teaching activities; PCK involves selecting suitable teaching methods based on disciplinary knowledge to make knowledge more easily understandable; TCK involves using technology to optimize teaching resources, and design teaching activities; TPK involves using technology to conduct teaching activities, encouraging students to communicate with each other using technology, and managing classrooms with technology; and TPACK involves studying online courses and organizing student learning through platforms. This section employs a Likert five-point scale to assess the informatization ability of university teachers, with the five levels of the scale corresponding to "Completely Disagree,"

“Somewhat Disagree,” “Neutral,” “Somewhat Agree,” and “Completely Agree,” assigned values of 1, 2, 3, 4, and 5, respectively.

The third part, Influencing Factors, based on the TPACK theory and preliminary literature reviews, initially proposes an investigation focusing on university teachers’ motivation and self-efficacy, participation in educational technology training, and participation in pedagogical training.

3.2. Questionnaire Survey

To ensure the reliability and validity of the questionnaire, this study conducted a reliability analysis using Cronbach’s α coefficient. Based on the test results, the questionnaire was appropriately revised to form the official survey instrument. The overall reliability coefficient of the questionnaire was 0.897, with Cronbach’s α coefficients ranging from 0.856 to 0.938 across various dimensions, indicating a high degree of measurement reliability and consistency among dimensions. Furthermore, this study validated the questionnaire through both content validity and construct validity. In terms of content validity, the questionnaire was developed based on the Schmitt scale and revised through multiple rounds, incorporating feedback from the research team, to ensure the validity of its content. For construct validity, the questionnaire underwent KMO and Bartlett’s Test of Sphericity. The KMO value of the questionnaire was 0.883 (>0.6), and the significance level of Bartlett’s Test of Sphericity was 0.000 (<0.01), indicating good construct validity. Considering all indicators, the questionnaire demonstrated excellent fit and adaptability, meeting ideal standards and indicating strong content and construct validity.

This study employed a sampling survey method, targeting university teachers in Hunan Province, including frontline teachers from first-tier, second-tier, and third-tier universities. The survey covered various majors, including liberal arts majors, science majors, art majors, computer majors, education majors, educational technology majors, and others. A total of 1000 questionnaires were distributed, with 963 returned and 946 deemed valid, resulting in an effective recovery rate of 95%.

3.3. Statistical Analysis of Data

In this section, comprehensive and systematic statistical analyses of the overall TPACK level and its various dimensions among university teachers in Hunan province were conducted using SPSS 24.0 and AMOS 26.0 software. By synthesizing the analyses from various aspects, the current status of TPACK abilities among university teachers in Hunan province was derived.

3.3.1. Overall TPACK Levels of University Teachers in Hunan Province

Among the survey respondents from various universities in Hunan Province, over 60% of frontline teachers have more than ten years of experience in technology-assisted teaching. Specifically, 69.45% of the teachers are relatively familiar with informatization teaching, 7.32% are very familiar with it, 13.68% are not very familiar, and 9.55% are completely unfamiliar with informatization teaching. This indicates that nearly 77% of university teachers in Hunan Province are relatively familiar with informatization teaching.

Table 1 presents the statistical scores of each dimension of TPACK among university teachers in Hunan Province based on the survey questionnaire. The average score of each dimension is 3.90, reflecting an overall moderate-to-high

level of informatization teaching ability among university teachers in Hunan. In terms of the average scores of each TPACK dimension, the scores are ranked from highest to lowest as follows: PK (4.05) $>$ CK (4.03) $>$ TK (3.98) $>$ PCK (3.91) $>$ TCK (3.87) $>$ TPK (3.76) $>$ TPACK (3.68) (as shown in Table 1). Among the seven dimensions, the PK dimension has the highest average score, indicating that university teachers in Hunan Province possess strong capabilities in organizing teaching activities and classroom management. This phenomenon may be related to the fact that over 80% of the teachers in this study’s sample have more than ten years of teaching experience, thereby accumulating extensive teaching knowledge and expertise. Instead, the TPACK dimension has the lowest average score, suggesting that the ability of university teachers to integrate pedagogical knowledge, content knowledge, and technological knowledge needs improvement. Furthermore, the average score of the TK dimension is lower than those of the CK and PK dimensions, implying that university teachers’ technological knowledge-related capabilities are inferior to their content knowledge and pedagogical knowledge capabilities. Enhancing technological knowledge-related capabilities to a level comparable to content and pedagogical knowledge would effectively improve university teachers’ TPACK capabilities.

Table 1. TPACK scores of university teachers in Hunan Province

Dimensions of TPACK	Average	Standard deviation
CK	4.03	0.65
PK	4.05	0.63
TK	3.98	0.58
PCK	3.91	0.53
TCK	3.87	0.56
TPK	3.76	0.52
TPACK	3.68	0.43
Average	3.90	0.56

Table 1 indicates that the mean values of TCK (Technological Content Knowledge) and TPK (Technological Pedagogical Knowledge) among university English teachers are lower than those of CK (Content Knowledge) and PK (Pedagogical Knowledge), suggesting a decline in teachers’ levels of content knowledge or pedagogical knowledge after technology integration. Further observation reveals that before technology integration, the PK value was higher than the CK value, implying that the surveyed university teachers had more confidence in their pedagogical knowledge than in their content knowledge, indicating a need for enhancement in their subject expertise. After technology integration, however, the TPK level was lower than the TCK level, indicating that teachers had higher confidence in their ability to integrate technology into content knowledge than into pedagogical knowledge. This also reflects room for improvement in teachers’ ability to utilize technology to facilitate teaching, optimize teaching effectiveness, and select appropriate instructional technologies based on teaching activities. The PCK (Pedagogical Content Knowledge) level was higher than both TCK and TPK, suggesting that university teachers have strong confidence in traditional teaching methods (where content knowledge and pedagogical knowledge are integrated), whereas their capabilities in both the pedagogical and content knowledge dimensions after integrating technology need further enhancement.

Analysis of the data in Table 1 reveals that the capability levels corresponding to TK, TCK, TPK, and TPACK are

relatively lower than those of other dimensions, with the ranking from highest to lowest being TK (3.98) > TCK (3.87) > TPK (3.76) > TPACK (3.68). This indicates that in dimensions involving the use of information technology for teaching, teachers' instructional capability levels are not high, and they lack proficiency in information technology as well as the ability to integrate it into content knowledge and pedagogical methods. Furthermore, as the dimensions of integration increase and deepen, the capability levels show a downward trend.

3.3.2. Analysis of Capability Differences Among University Teachers Based on Characteristics

There exist certain differences in various dimensions of informatization teaching abilities among university teachers in Hunan Province in terms of basic information such as gender, teaching experience, major, and highest educational attainment. Details are as follows:

In terms of gender, the sample sizes for male and female teachers are 368 and 578, respectively. An independent-samples T-test was conducted with gender as the grouping variable, and the results showed no significant differences in any dimension based on gender. Male teachers demonstrated slightly higher levels of capability in technology-related aspects, while female teachers exhibited higher levels of capability in the dimensions of PK (Pedagogical Knowledge) and PCK (Pedagogical Content Knowledge).

Regarding teaching experience, the samples were divided into five groups: 1-5 years, 6-10 years, 11-15 years, 16-20 years, and over 20 years, with sample sizes of 118, 106, 146, 216, and 360 teachers, respectively. The significance analysis results showed that there were significant differences in CK (Content Knowledge), PK (Pedagogical Knowledge), TK (Technological Knowledge), TCK (Technological Content Knowledge), and PCK (Pedagogical Content Knowledge) based on teaching experience ($p < 0.05$), while no significant differences were found in TPK (Technological Pedagogical Knowledge) and TPACK (Technological Pedagogical Content Knowledge) dimensions. As teaching experience increased, the levels of PK and CK among university teachers showed an increasing trend, with teachers with over 20 years of teaching experience having the highest levels of PK and CK. However, the levels of technology-related TK and TCK dimensions were highest among teachers with 1-5 years of teaching experience and lowest among those with over 20 years. This may be related to younger teachers' higher interest, acceptance, and proficiency in information technology, while teachers with longer teaching experience have relatively fixed teaching methods and lower acceptance of new technologies.

In terms of majors, teachers' majors include liberal arts majors, science majors, art majors, computer majors, education majors, educational technology majors, and others. The significance analysis results showed that TK, TCK, and TPACK had significance ($p < 0.05$), while CK, PK, PCK, and TPK did not. Teachers in the educational technology major had the highest level of TPACK, while those in computer major had the lowest; teachers in computer major had the highest level of TK, and those in liberal arts had the lowest. This may be related to computer major teachers' in-depth understanding and proficiency in information technology, while their low level of TPACK reflects their insufficient grasp of the integration of technology and teaching.

Regarding the highest educational attainment, the sample sizes for teachers with bachelor's degrees, master's degrees, and doctoral degrees are 132, 485, and 329, respectively. The

research results showed that there were significant differences in all dimensions of TPACK among teachers with bachelor's, master's, and doctoral degrees ($p < 0.05$), and the levels of all dimensions increased with educational attainment. Teachers with doctoral degrees scored highest on all dimensions. This should be related to the fact that university teachers with doctoral degrees have more solid and in-depth disciplinary professional knowledge, pedagogical knowledge, and technological knowledge. Additionally, teachers with doctoral degrees participate in relevant educational training most frequently, which further strengthens their knowledge and ability advantages.

4. Paths for Enhancing the Informatization Teaching Ability of University Teachers within the TPACK Framework

While nearly 77% of university teachers in Hunan Province are relatively familiar with informatization teaching, there are still nearly 14% who are not very familiar with it, and even 9.55% who have absolutely no understanding of it. Moreover, during the data analysis process, it was found that there is still a significant disparity in the level of informatization teaching among university teachers. To improve the overall TPACK level of university teachers in Hunan Province and even nationwide, relevant suggestions are proposed here from the perspectives of teachers, universities, and the government.

4.1. Establish a Concept of Lifelong Learning, Autonomous Learning, and Continuous Innovation

University teachers should actively respond to the challenges of informatization teaching, demonstrate enthusiasm for proactive learning of information technology and smart teaching methods, and increase their investment in enhancing their informatization teaching ability. The primary task is to continuously update teachers' information-based professional knowledge and skills, actively study technological knowledge (TK), content knowledge (CK), and pedagogical knowledge (PK), select appropriate information-based teaching resources, and become proficient in operating related information-based teaching tools. Secondly, the core of informatization teaching lies in effectively integrating dimensions such as TK, CK, and PK, scientifically incorporating information technology into the entire teaching chain. From the mean values of each dimension (as shown in Table 1), the higher the degree of integration across dimensions, the declining trend in teachers' teaching capability is observed. Therefore, emphasis should be placed on strengthening university teachers' ability to integrate dimensions, enabling them to design appropriate information technology teaching plans based on subject content and teaching method characteristics, and achieving deep integration of CK, PK, and TK abilities.

4.2. Construct an Informatization Teaching Community for Teachers

Teachers and universities should strive to build an informatization teaching community by organizing activities such as information-based teaching salons and seminars, providing a platform for teachers to explore information technology-assisted teaching, and promoting interactive

exchanges and collective learning and progress among teachers within the community. Traditional teacher education and teaching communities generally consist solely of teachers, which is relatively homogeneous. Communication and exchanges between teachers and teaching-related personnel can also have a positive impact on teachers' informatization teaching ability [7]. Therefore, in the future construction of teacher informatization teaching communities, an informatization community that includes teachers, school leaders, domain experts, and other personnel should be established. Through communication and exchanges with community members, teachers' reflective teaching and teaching capability can be enhanced.

4.3. Strengthen the Construction of an Informatized Environment and Create an Informatized Teaching Atmosphere

Universities should actively respond to the national call by enhancing the construction and atmosphere creation of an informatized environment. The primary task is to improve hardware facilities and increase investment in informatized equipment, including large-scale network servers, mobile learning terminals, and online course resources, while implementing regular maintenance to ensure timely updates of teaching resources. Secondly, optimizing the informatization training system for teachers and formulating incentive measures to stimulate teachers' enthusiasm for informatized teaching are necessary. Lastly, organizing thematic training to enhance teachers' TPACK (Technological Pedagogical Content Knowledge) capabilities should be carried out, with a focus on improving teachers' ability to integrate various dimensions. A hierarchical training strategy is implemented: for newly-hired teachers, training on content knowledge (CK) and pedagogical knowledge (PK) is intensified; for senior teachers, the emphasis is on enhancing technological knowledge (TK). To promote teachers' autonomous learning, TPACK informatization teaching capabilities should also be incorporated into the teacher evaluation system as a basis for promotion assessments.

4.4. Conduct Top-down Planning and Establish a Universal Platform

The government needs to strengthen top-down planning and establish a national platform for the exchange and interaction of informatized teaching among university teachers. The government should not only plan and implement initiatives to promote the development of university teachers' informatized teaching capabilities, playing a guiding, coordinating, and facilitating role, but also lead the establishment of a national platform for sharing informatized educational resources among university teachers, providing high-quality teaching resources, improving resource utilization efficiency, and maximizing the effectiveness of informatized teaching resources. For example, Hong Kong offers training focused on learning areas and disciplines for teachers; Singapore encourages teachers in the same field to establish communities on specific learning websites and sets up information technology applications for general education courses and leadership professional courses; countries such as South Korea, the United Kingdom, Finland, and New Zealand deliver training courses and teaching case video files through websites, providing teachers with various consulting services and advice on improving teaching methods; and the New Zealand

government provides outstanding primary and secondary school teachers with a one-year opportunity to apply information technology in teaching, during which they do not have to teach but instead participate in academic organizations to work on related projects and share their knowledge and teaching experiences with schools across the country [4].

5. Conclusion

This study conducted a survey on the current status of informatization teaching ability of university teachers in Hunan Province based on the TPACK framework. The survey results indicate that although most teachers are relatively familiar with informatization teaching, there is still considerable room for improvement in terms of technology integration, pedagogical innovation, and the comprehensive application of professional knowledge. This current situation suggests that university teachers need to demonstrate stronger self-learning awareness and innovation capabilities when facing the transformation towards informatization education. They should continuously refine their informatization teaching ability to meet the teaching demands of the new era. At the same time, the important roles of universities and governments in promoting the development of teachers' informatization teaching ability should be emphasized. To ensure that teachers can effectively utilize information technology to enhance teaching quality, universities need to increase investment in resource construction and provide teachers with diverse informatization teaching tools and resources. The government, on the other hand, should provide guidance and support from the policy level, establishing platforms and bridges for informatization teaching to provide a solid external guarantee for the construction of teachers' informatization teaching abilities.

In summary, this study not only reveals the current status and challenges of university teachers' informatization teaching ability in Hunan Province but also provides valuable insights for future development directions: university teachers should continuously engage in self-learning and be bold in innovation; universities and governments need to collaborate to jointly support and enhance the informatization teaching ability of teachers.

Acknowledgments

Hunan Provincial Education Science "13th Five-Year Plan" Project: Research on TPACK Ability Development of University Teachers in the Context of Education Informatization (No. XJK20BGD050).

References

- [1] M. Koehler and P. Mishra. "What is technological pedagogical content knowledge (TPACK)?" *Contemporary issues in technology and teacher education*, vol. 9, pp. 60-70, 2009.
- [2] Y. M. Duan, Z. M. Yan and S. Y. Yu. "Research on the Composition Mechanism of Technological Pedagogical Content Knowledge (TPACK) among Senior-Year Normal University Students," *Journal of Teacher Education Research*, vol. 28, pp. 50-58, 2016.
- [3] X. Y. Hu and Z. T. Zhu. "Information-Based Teacher Education," *China Educational Technology*, pp. 25-27, 22003.
- [4] X. H. Ren and F. Ren. "A Survey and Analysis of the Current Situation of TPACK among University Teachers," *Modern Educational Technology*, vol. 25, pp. 38-44, 2015.

- [5] Y. N. Wang, J. H. Wang, H. M. Han, et al. "A Survey on the Current Situation of Information-Based Teaching Ability of English Teachers in Chinese Universities," *Foreign Language World*, pp. 54-61, 2023.
- [6] C. H. Xu, G. S. Fu, and X. J. Hou. "The Level of TPACK among University Teachers in China and Its Development Strategies," *Modern Educational Technology*, vol. 28, pp. 59-65, 2018.
- [7] P. Xu and Y. N. Wang. "Research on the Knowledge and Ability Structure of Excellent Teachers with Technological Integration," *China Educational Technology*, pp. 89-93+101, 2020.
- [8] K. Zhang and Z. Z. Wang. "On the Information-Based Teaching Ability of Vocational College Teachers and Its Improvement Path under the Framework of TPACK," *China Vocational and Technical Education*, pp. 779-84, 2022.