The Construction of Teacher TPACK Ability Evaluation System Under the Ecological Environment of Smart Classroom

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Abstract: With the continuous innovation of information technology, smart classrooms have emerged from time to time, which puts forward higher requirements for teachers' teaching ability. As a new knowledge structure of teachers under the product of information technology, TPACK is the main basis for measuring teachers' professional ability in the era of smart education, and an important means to improve teachers' ability to integrate technology, teaching methods and content. Through the analysis of the smart classroom ecological environment and TPACK theory, this study extracts the evaluation index of teachers ' TPACK ability in the smart classroom ecological environment, and constructs the model of teachers' TPACK ability evaluation system with the help of YAAHP software, and carries out matrix consistency test and data analysis. Through the effective evaluation system to promote teachers to innovate teaching philosophy, improve teaching methods and enhance teaching effective.

1 INTRODUCTION

'Opinions on the Implementation of the National Primary and Secondary School Teachers' Information Technology Application Ability Improvement Project 2.0' (Ministry of Education 2019) clearly states that teachers should promote the deep integration and innovative development of information technology and their own education and teaching. At the same time, the Education Informatization'2.0 Action Plan (Ministry of Education 2018) has promoted the model change and ecological reconstruction of education supported by emerging technologies such as artificial intelligence, internet of things and big data. The traditional classroom has gradually transitioned into a smart classroom. The smart classroom has given teachers a new role and put forward higher requirements for teachers' information technology application ability. Smart classroom involves all aspects of computer technology and information technology. It is necessary to break the barriers between various technologies and solve the problem of collaborative integration of interdisciplinary work (Mukesh 2019). Smart classroom requires teachers to have the consciousness of integrating technology, the ability of using technology and the thinking of innovating technology.

To promote development by evaluation, TPACK is one of the bases to measure teachers' professional ability. The construction of teachers' TPACK ability evaluation system can positively motivate teachers to improve TPACK ability. Nowadays, the evaluation of teachers' TPACK ability still stays on the teaching evaluation of traditional classrooms. Zhang Lin (Zhang 2019) and others have explored teachers' information-based teaching ability in traditional classrooms, but this does not match the evaluation required by teachers' TPACK ability in the smart classroom ecological environment. Therefore, this study aims to design the evaluation index of teachers' TPACK ability in the ecological environment of smart classroom, and explore the ability of teachers to integrate information technology in the teaching process in the ecological environment of smart classroom with TPACK theory as the core.

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2 THEORETICAL BASIS

2.1 Smart Classroom Ecological Environment

With the continuous change of education, the traditional classroom of single teaching mode has been unable to carry the needs of modern teaching, and the intervention of new technology has promoted the emergence of smart classroom. With the support of information technologies such as big data and learning analysis, teachers can fully implement diagnostic analysis and intelligent resource push in the teaching process, and carry out 'cloud + terminal' learning activities and support services. The smart classroom ecological environment generally includes interactive screens, freely assembled desks and chairs, tablets, cameras and other hardware, as well as software such as e-schoolbag systems and intelligent recording and broadcasting systems (Li 2020),as shown in Table 1. The intelligent teaching equipment of smart classroom provides a new situation for teachers' teaching and students' learning. Teachers can simplify and optimize the three teaching processes before, during and after class according to their characteristics.

Table 1 Smart classroom software ecological environment

Component	Technical support	Features
E-Schoolbag System	Big date	Rich subject resources
	Smart push	Directional push job exercises
	Learning analysis	Objective exercises automatic correction, instant feedback
Intelligent recording and broadcasting system	face recognition,multi media technology	Support remote broadcast, screen switching, teacher-student behavior close-up, online editing, intelligent inspection and tracking of teacher-student behavior

2.2 TPACK Element Analysis

The full name of TPACK is Technological Pedagogical Content Knowledge (Charles R 2011), which is translated into the subject teaching knowledge of integrated technology. This theory interprets the complex overlapping relationship between teachers' knowledge structures, including three core elements and four composite elements generated by the interaction of core elements. The core elements are content knowledge-content knowledge of the subject taught by the teacher, pedagogical knowledge-teaching related theoretical knowledge, technical knowledge-related knowledge about the use of information technology. The composite elements are pedagogical content knowledge-what kind of teaching theory knowledge is used to impart subject content knowledge, technical pedagogical knowledge -what kind of information technology is used to present subject content knowledge, technical content knowledge-what kind of information technology is used to support the development of teaching theory, technical pedagogical content knowledge-integrating technology, teaching method and content, that is, changing teaching and learning in some way through technology.

3 METHODS AND MATERIALS

At present, how to effectively and objectively evaluate the TPACK ability of teachers in the ecological environment of smart classroom is still in the blank. In view of the above cognition of the smart classroom ecological environment and TPACK elements, this study establishes a comprehensive evaluation index system to provide reference for the evaluation of teachers' TPACK ability in the smart classroom ecological environment.

3.1 Construction Method of Evaluation Index System

AHP, also known as analytic hierarchy process, is a hierarchical weight decision analysis method that decomposes the elements related to decision-making into levels, index the indicators and assigns them weights, and combines quantitative and qualitative analysis (Xu 2018). AHP has the advantages of systematization, simplicity, practicality and less quantitative data, and is widely used in the construction of evaluation index system. The general process is to determine the research problem, construct the hierarchical structure, construct the judgment matrix and test the consistency of the matrix, use the sum product method to calculate the weight by column normalization, and finally draw the corresponding conclusion.

Generally speaking, the artificially constructed judgment matrix is difficult to meet the consistency requirements. It is often necessary to adjust and correct the judgment matrix many times, and the data processing process is complicated. The release of YAAHP software solves this problem. Based on the principle of analytic hierarchy process, YAAHP software provides users with convenient hierarchical model construction, judgment matrix data entry, sorting weight calculation, calculation data export and sensitivity analysis. It is flexible and easy to use and simplifies the data processing process. This study uses YAAHP software to process the data to ensure the credibility, real-time consistency and sensitivity of the entire model.

3.2 Construction Principle of Evaluation Index System

The evaluation of teachers' TPACK ability in the smart classroom can promote teachers to consciously and actively integrate information technology into the curriculum, so as to innovate the educational concept and improve their TPACK ability In the process of constructing the indicators of the evaluation system, the following four principles should be followed: First, the evaluation objectives are clear, and the evaluation is based on the wisdom classroom and TPACK theory. Therefore, the evaluation objectives must be clear, and the evaluation index system is only applicable to the TPACK ability of teachers in the ecological environment of wisdom classroom. Second, the evaluation methods are diverse, smart classroom evaluation is not limited to a single evaluation, process evaluation, formative evaluation and summary evaluation of integrated applications, from a variety of evaluation methods, systematic and complete construction of the entire evaluation process; Third, the evaluation content is diverse. Based on the TPACK framework, it can be seen that teachers' ability is generated by the interaction of the three elements of content, teaching method and technology, so the evaluation content is based on the three elements; Fourth, the evaluation design is scientific. The construction of the evaluation index system adopts the analytic hierarchy process, in which the hierarchical structure is constructed by the expert brainstorming method, the weights of the indicators at all levels are determined by a small amount of data, and the TPACK ability of teachers is explored by combining quantitative and qualitative methods, which is scientific.

3.3 Evaluation Index System Index

Based on the above elaboration of the ecological environment and TPACK elements of smart classrooms, it can be seen that smart classrooms are more important than traditional classrooms in terms of what technology to use, when and how to use technology. This paper invites a total of 20 experts at all levels and types, and uses the brainstorming method to determine the evaluation index system as four first-level indicators and twelve second-level indicators, and forms the corresponding observation perspective. The specific evaluation index system is detailed in Table 2.

3.3.1 First Grade Indexes

Generally speaking, the smart classroom includes three stages: before class, in class and after class (Liu 2016). The concept of smart education runs through the three stages. Before class, teachers should understand the content knowledge, and on this basis, select appropriate teaching strategies according to the content knowledge, and list the technical list, and finally form the teaching design, which provides a blueprint for the whole teaching implementation process. Teachers should dynamically carry out the teaching process according to the instructional design, use technology to promote teacher-student interaction, support learners' personalized learning, and optimize the teaching process. After class, teachers should review, evaluate and reflect on the teaching method, content and technology to improve TPACK ability. In summary, the first-level indicators are smart classroom teaching philosophy, smart classroom teaching design, smart classroom teaching implementation, smart classroom teaching evaluation.

3.3.2 Second Grade Indexes

Smart classroom teaching philosophy is the cornerstone of smart classroom teaching. The primary requirement of the traditional classroom reform for the smart classroom is that teachers should innovate the concept of self-teaching, from the 'teacher-centered' in the traditional classroom to the 'student-centered' in the smart classroom, and always adhere to the 'student-centered' teaching philosophy in teaching design, teaching implementation and teaching evaluation. At the same time, teachers should aim talents with high intelligence and creativity as the goal (Zhu 2012), he information age under the background of knowledge

learning is secondary, knowledge to ability is the main, knowledge to ability transformation requires students to have certain innovation ability. Therefore, the secondary indicators under the concept of smart classroom teaching are student-centered and aimed at cultivating innovative talents.

Intelligent classroom teaching design is an important guarantee for intelligent classroom teaching. At this stage, teachers should understand the content of the subject, select teaching strategies on the basis of understanding, and use technology to build a personalized and diversified teaching environment and resources for students, thus forming a detailed teaching process. Therefore, the secondary indicators under the design of smart classroom teaching are the understanding of subject content, the selection of teaching strategies, the use of technology, and the relevance of subject content, teaching strategies, and technology.

The implementation of smart classroom teaching is the core of smart classroom teaching. Before the implementation of teaching in the smart classroom, teachers can use technology to make intelligent diagnosis of students' learning situation, and carry out accurate teaching dynamically according to the diagnosis results. In the process of teaching, teachers can use technology to promote teacher-student interaction, support learners' personalized learning, and carry out a series of activities to promote students' innovative thinking. After implementing the teaching process, teachers should intelligently push appropriate resources according to students' learning status, so as to promote students' ability to transfer knowledge. In addition to the above three points, there should be the embodiment of teachers' basic teaching skills throughout the whole teaching implementation process. Therefore, the secondary indicators under the implementation of smart classroom teaching are learning intelligence diagnosis, learning activities, knowledge transfer, teachers' basic teaching skills.

Smart classroom teaching evaluation is the fundamental guarantee of smart classroom teaching. Evaluation is an important means to ensure the quality of personnel training and monitor the quality of teachers' teaching, and to promote development by evaluation. The evaluation here refers to the organizational ability of teachers to evaluate the teaching effect. Teachers should be able to make evaluation scales scientifically according to the learning situation. In view of the interaction between TPACK elements to produce a variety of composite elements, TPACK has a certain complexity. In order to improve TPACK ability, teachers need to feel the specific situation of teaching and learning in the process of practice. After-school immediate self-evaluation and reflection can effectively improve teachers' TPACK ability. Therefore, the secondary indicators of smart classroom teaching evaluation are evaluation of organizational ability and teacher self-evaluation.

3.4 Weight Calculation of Evaluation Index System

This study uses analytic hierarchy process to calculate the weight of each index, according to the percentile conversion index weight score, the specific score is shown in Table 2.

(1) According to the analytic hierarchy process evaluation scale, the fixed quantitative value is obtained by comparing the two factors, and the judgment matrix A is constructed:

$$\begin{pmatrix} A11 & A12 & \cdots\cdots & A1n \\ A21 & A22 & \cdots\cdots & A2n \\ \cdots\cdots & \cdots\cdots & \cdots\cdots & \cdots\cdots \\ An1 & An2 & \cdots\cdots & Ann \end{pmatrix}$$

(2) The judgment matrix A is normalized by column to obtain matrix B:

$$B_{ij} = \frac{A_{ij}}{\sum_{i=1}^{n} A_{ij}} (i = 1, i \le n, j = 1, j \le n)$$

(3) The weight value: ω:

$$\omega_j = \frac{\sum_{i=1}^{n} B_{ij}}{n} \quad (j = 1, j \le n)$$

(4) Weight multiplied by matrix:

$$(A\omega)_j = \sum_{j=1}^{n} \omega_j \bullet A_{ij} \quad (i = 1, i \le n)$$

(5) Find the maximum positive eigenvalue λ of the judgment matrix A:

$$\lambda = \sum_{j=1}^{n} \frac{(A\omega)_j}{n\omega_j}$$

(6) Consistency test, if each layer index CR < 0.1, that the inconsistency of the matrix within the allowable range, can determine the matrix through the consistency test. On the contrary, the judgment matrix should be modified until it

passes the consistency test. The RI value comes from the analytic hierarchy process RI value table.

(7) From the above calculation process, it can be known that the data processing process of the analytic hierarchy process is cumbersome, which is not conducive to the full play of the application advantages of the analytic hierarchy process. Using computer technology- YAAHP software, you can quickly obtain accurate weights and simplify data processing.

Table 2 Evaluation index system of teachers ' TPACK ability in smart classroom ecological environment

First grade indexes	Second grade indexes	Observation perspective	Grade
Intelligent Classroom Teaching Concept（12 points）	student-centered（7 points）	Teachers can weaken self-role, highlight students ' status and cultivate students ' autonomous learning ability	7 5 3 1 0
	Aiming at Cultivating Innovative Talents（5 points）	Teachers can make full use of problem-based, project-based and STEAM courses to stimulate students ' interest in learning and promote their ability to solve problems	5 3 2 1 0
Intelligent Classroom Teaching Design（28 points）	Understanding of subject content（7points）	Teachers can fully understand the structure of the subject content, the content and extension of the concept, establish three-dimensional teaching objectives	7 5 3 1 0
	Selection of Teaching Strategies（4points）	Teachers can select appropriate teaching strategies according to the characteristics of subject content	4 3 2 1 0
	implementation of technology（8points）	Teachers can list technology, that is, what technology to use, when to use technology, how to use technology.	8 6 4 2 0
	The Suitability of Subject Content, Teaching Strategy and Technology（9points）	Teachers can fully consider the characteristics of subject content, teaching strategy and technology, use technology to present subject content and support teaching strategy	9 6 4 2 0
Intelligent classroom teaching implementation（41 points）	Intelligent Diagnosis of Learning Situation（8points）	Teachers can intelligently diagnose students ' learning based on the use of technology and dynamically carry out precise teaching based on diagnostic results	8 6 4 2 0
	learning activities（16points）	Teachers can create learning situations for learners and carry out a series of activities to promote students ' innovative thinking based on innovative applied technical knowledge	16128 4 0
	knowledge migration（12points）	Teachers can push resources intelligently according to students ' learning situation to promote learners ' knowledge transfer ability	129 6 3 0
	Teachers ' basic teaching skills（5points）	Teachers ' language expression ability and ability to deal with classroom crisis	5 3 2 1 0
Intelligent classroom teaching evaluation	Evaluation of organizational capacity（8points）	Teachers can formulate evaluation scale scientifically according to students ' situation	8 6

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（19 points）		and teaching content	4 2 0
	self evaluation（11points）	Teachers can timely and effectively carry out self-evaluation and reflection	118 5 2 0
Remarks : 90 points or more for level A, 80-90 points for level B, 70-80 points for level C, 60-70 points for level D, 60 points or less for level E			

4 CONCLUSIONS

With the support of emerging technologies such as artificial intelligence, internet of things and big data, hot spots such as smart classrooms and smart education have impacted the education industry. The education model has changed and the ecological environment has been reconstructed. Smart classroom puts forward higher requirements for teachers' information technology application ability, requiring teachers to have the consciousness of integrating technology, the ability to use technology and the thinking of innovative technology. As a new knowledge structure of teachers under the product of technology, TPACK is the main basis for measuring teachers' professional ability in the era of smart education, and an important means to improve teachers' ability to integrate technology, teaching methods and content. In the process of implementing smart classroom teaching, teachers can't treat all elements in isolation. They should examine the shortcomings of self-ability through the scientific TPACK ability evaluation system, and actively seek promotion strategies, so as to realize the high integration of technology, teaching methods and content, and the deep integration of TPACK and smart classroom.

All in all, the smart classroom is more urgent to need appropriate evaluation methods to improve the quality of teachers' teaching. This study uses the brainstorming method to determine that the evaluation index system is four first-level indicators and twelve second-level indicators, and forms the corresponding observation perspective. Through the combination of quantitative and qualitative methods, the scores of each index are calculated, and finally an effective, objective and scientific evaluation index system of smart class is formed. The table fills the gap in the evaluation index system of teachers' TPACK ability under the ecological environment of smart class, and provides reference for the evaluation of teachers' TPACK ability under the ecological environment of smart class.

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