Research on Blended Teaching of Computer Network Course under the Guidance of TPACK Theory

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Abstract. The deep integration of information technology into education and teaching is the definitive indicator for assessing teachers' information-based teaching competence. To solve the problems of blended teaching of computer network courses, the theory of Technological Pedagogical Content Knowledge (TPACK) is applied to integrate information technology, computer network knowledge, and case-driven teaching methods into the curriculum. Investigate blended-learning reform of computer network courses for teaching programmes, digital resources, teaching process, and assessment procedures, with a view to satisfying learners' pluralistic and in-depth learning needs.

Keywords: TPACK Computer Network blended teaching case-driven

1 Introduction

The rapid development of modern technology and the informatization of education has made information technology a core driving force in educational reform [1]. Blended learning has gradually gained attention as a combination of face-to-face and online education [2]. However, there is still a lack of a systematic theoretical framework for the effective integration of information technology into subject teaching. The theory of TPACK (Technological Pedagogical Content Knowledge) offers a new perspective for addressing this issue [3], which is illustrated in Figure 1. It helps teachers determine how to integrate online teaching, classroom instruction, and hands-on activities, as well as how to select and use technological tools to support learning.

The Computer Networks course emphasizes the integration of theory and practice, requiring students not only to understand networking principles and protocol design concepts, but also to solve real-world networking problems [4]. Although the nation has promoted practical teaching in application-oriented undergraduate institutions, the integration of theory and practice still faces challenges. Therefore, there is an urgent need to explore a new type of blended teaching mode based on the theory of TPACK. This approach aims to further strengthen the organic combination of theory and practice, to enhance the effective interaction between the teacher's "guiding" and the student's "learning", and to deeply cultivate students' abilities for autonomous and in-depth

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learning [5-6]. Detailed problem analysis and solutions will be discussed in subsequent sections.

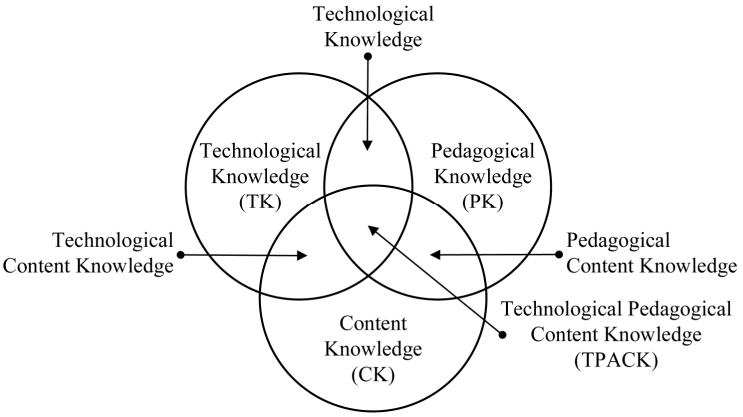

Fig. 1. TPACK Framework

2 Existing Problems in Blended Teaching of Computer Network Course.

2.1 Lack of a Comprehensive Teaching System Theory

In previous blended learning approaches to Computer Network courses, the absence of a unified and comprehensive teaching system has prevented the effective integration of teaching content, methods, and technical support [7]. For example, instructional design may not have fully utilized online resources and tools to enhance the learning experience, or there may have been a lack of clear teaching strategies to improve and assess teaching quality. This lack of a systematic approach can make teaching and learning activities appear fragmented and haphazard, making it difficult to develop coherent learning pathways and meet the learning needs of different students.

2.2 Disconnection Between Theoretical and Practical Teaching

In traditional blended teaching for Computer Network courses, theory and practice are often treated as two separate components rather than designed and implemented as a cohesive whole. In such cases, students learn abstract concepts and principles in theoretical classrooms but find it difficult to apply them to concrete operations and problem-solving in practical sessions. This disconnect not only reduces students' interest and motivation but also leads to a superficial understanding of the core content of the course, which hinders the development of their problem-solving skills.

2.3 Separation of Online and Offline Assessments

In the blended learning environment of Computer Network courses, the integration of online and offline evaluation systems is often insufficient, leading to evaluation and feedback mechanisms that lack efficiency and comprehensiveness. For example, online learning activities may lack effective monitoring and evaluation, while offline practical teaching may fail to promote learner progress due to a lack of timely feedback. Such a separate assessment system is not conducive to teachers' comprehensive understanding of students' learning and adjustment of teaching strategies. It can also lead to a lack of clarity in students' understanding of learning outcomes, which in turn affects their motivation and sense of achievement.

3 Blended Teaching Design for Computer Network Course under the Guidance of TPACK Theory

Aiming at the shortcomings of Computer Network teaching, this research is based on the TPACK theory and adopts the blended teaching mode of "online teaching & classroom teaching & practical teaching", which fully embodies the teaching concept of "student-centered".

3.1 Teaching Programmes Design

Firstly, select appropriate information representation technologies for knowledge transfer based on the characteristics of the specific subject content, such as using the SuperStarLearn platform to convey basic concepts. We then carry out project practice by carefully designing cases, building the Educoder visual simulation platform, and using case-driven teaching methods to promote the organic integration of online and offline blended teaching, while integrating ideological and political elements at the right time.Taking the data link layer as an example, we designed blended teaching content based on the TPACK framework, as illustrated in Table 1.

4 Digital Resource Development

Through the multi-dimensional construction of digital resources, we have created a resource library that integrates multimodal teaching materials and a visual simulation platform and constructed online resources that meet our teaching objectives.

***Multimodal learning materials*:** Use the SuperStarLearn platform to create open online courses, including syllabi, teaching animations, mind maps, and other complete knowledge systems.

***Visual simulation platform*:** Based on practical tasks, build Educoder online practical training platform to deepen the learning of theoretical knowledge in a case-based and project-oriented way.

Table 1. Blended teaching design form based on the TPACK theory

Teaching Case	Upgrade of the Core Switch System in the Campus Network
Practical Project	Bridge and Switch Communication
CK	Characteristics of shared network communication, MAC address configuration and forwarding, CSMA/CD protocol
PK	Case-driven method, group cooperation method
TK	SuperStarLearn, Educoder, PacketTracer, eNSP
Ideological and Political Elements	Discusses the role and responsibilities of network equipment in social informatization.
Teaching Case	Internal Network of a Subsidiary of a Certain Enterprise
Practical Project	LAN Construction Experiment
CK	LAN protocols, subnetting, switch working principles
PK	Case-driven method, inquiry-based learning, group cooperation method
TK	SuperStarLearn, Educoder, PacketTracer, eNSP
Ideological and Political Elements	Explores how resource sharing can improve work efficiency and encourages thinking about using technological innovation to solve practical problems, reflecting the concept of innovation-driven development.
Teaching Case	Interconnection of Networks Across Different Regions in an Enterprise
Practical Project	WAN Construction Experiment
CK	WAN data exchange methods, IP address and protocol principles, routing protocols and forwarding algorithms
PK	Case-driven method, inquiry-based learning, group cooperation method
TK	SuperStarLearn, Educoder, PacketTracer, eNSP
Ideological and Political Elements	Discusses how WAN supports the national "Internet+" strategy and its role in promoting regional coordinated development and reducing the urban-rural digital divide.
Teaching Case	Network Segmentation Management in an Enterprise
Practical Project	VLAN Construction Experiment
CK	VLAN applications, complex Hybrid interface applications
PK	Case-driven method, inquiry-based learning, group cooperation method
TK	SuperStarLearn, Educoder, PacketTracer, eNSP
Ideological and Political Elements	Demonstrates the application of VLAN in supporting internal information hierarchical management and preventing data leakage, cultivating students' awareness of information security and confidentiality.
Teaching Case	Internal Network Security Drill for an Enterprise
Practical Project	MAC Address and Flood Attack Experiment
CK	Role of MAC addresses and network device identification principles, flood concept, characteristics and principles, network security mechanisms and protection strategies
PK	Case-driven method, simulation method, group cooperation method
TK	SuperStarLearn, Educoder, PacketTracer, eNSP
Ideological and Political Elements	Emphasizes the importance of network security and cultivates awareness of information security.

4.1 Teaching Process Design

Under the TPACK framework, the formation of the blended teaching mode of the computer network course is a dynamic and iterative process [8]. The teaching process imparts knowledge through well-designed cases, the introduction of practical projects, the selection of online teaching resources for Computer Networks (a first-class undergraduate course in Hunan Province) from Hengyang Normal College, and the teacher organizes diversified classroom interactions and encourages students to actively participate in discussions and exchanges. The teaching process is divided into three parts: before, during, and after class, and its teaching process design framework diagram is shown in Figure 2.

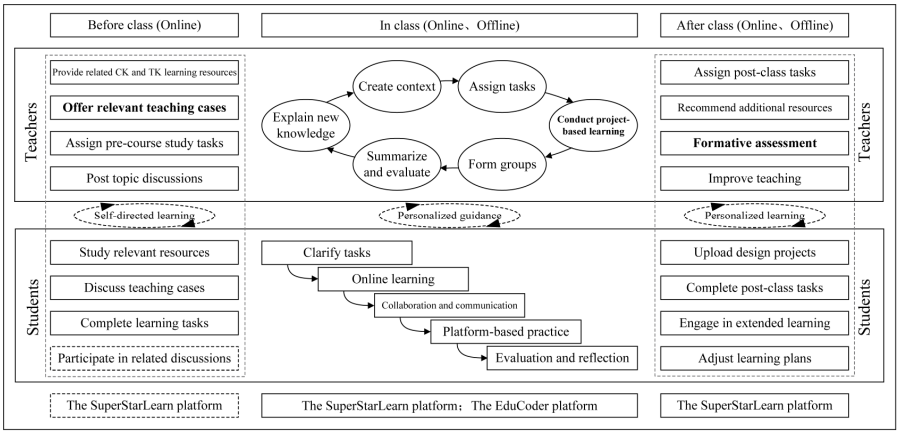

Fig. 2. Teaching process design

Pre-Class Activities. The main teaching or learning behaviors at this stage are carried out online, with teachers uploading learning resources related to the knowledge of CK, TK, etc., and providing relevant teaching cases on the SuperStarLearn platform. Pre-course learning assignments and thematic discussions are published, driven by engineering cases to motivate students to engage in in-depth learning.

In-Class Activities. This phase is mainly conducted both offline and online. Teachers use the SuperStarLearn platform to display teaching PPTs and briefly explain new concepts to students, allowing them to further consolidate their knowledge in the classroom. Teachers then create relevant teaching scenarios and identify teaching problems based on students' inquiries and course content. After, experimental tasks are assigned, and students complete the work through small-group cooperative learning on the Educoder platform to deepen their theoretical understanding.

Post-Class Activities. The after-school phase is divided into online and offline. Post-lesson assignments and recommended extension resources are posted on the

SuperStarLearn platform. Subsequently, a personalized evaluation of the entire blended learning process for students is conducted.

4.2 Teaching Assessment Design

The blended teaching process evaluation emphasizes assessing the entire learning process, encompassing both online and offline activities. The blended teaching process assessment indicator system is detailed in Table 2.

The evaluation of online learning activities primarily involves tracking platform resource usage, completion of online assignments, and participation in discussions, with data automatically collected from the SuperStarLearn platform. Offline learning evaluation includes classroom participation, experimental performance, homework completion, project design, and communication and collaboration activities, which are completed by teachers and students evaluating each other and students evaluating each other.

Table 2. Blended teaching process assessment indicator system

Primary Indicators	Secondary Indicators	Weight Coefficient
Learning Attitude (0.14)	Attendance	0.07
	Learning Engagement	0.04
	Learning Participation	0.03
Learning Process (0.30)	Classroom Performance	0.12
	Experimental Performance	0.08
	Communication and Collaboration	0.06
	Online Learning	0.04
Learning Outcomes (0.39)	Unit Assessment	0.15
	Assignment Submission	0.12
	Project Presentation	0.06
	Classroom Test	0.06
Higher-order Skills (0.17)	Innovation and Creativity	0.06
	Problem-Solving	0.05
	Mathematical Literacy	0.03
	Critical Thinking	0.03

5 Conclusion

This paper integrates the Technological Pedagogical Content Knowledge (TPACK) framework to explore the teaching model for the Computer Network course. The model combines online and offline instruction, merges theory with practice, and extends learning both inside and outside the classroom. Additionally, it incorporates immersive ideological and political education, promoting a new teaching approach that encourages active student participation, self-directed learning, and innovation.

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