Application Research on the Construction of Online Teaching Models in Information-Based Environments for Engineering Colleges

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Abstract: The widespread use of information technology in the field of education has made online teaching a crucial direction for educational reform. This study constructs an online teaching model tailored to engineering colleges and designs a scientific teaching effectiveness evaluation scheme. The results show that engineering colleges have strengthened their network infrastructure and extensively utilized online teaching platforms and resources. Compared to traditional teaching methods, online teaching demonstrates outstanding performance in enhancing resource utilization efficiency and overall satisfaction among both teachers and students. Therefore, promoting the integration of online teaching with traditional teaching methods holds significant importance in improving the quality of talent development. The online teaching model designed in this study incorporates the entire process of knowledge dissemination, skill development, and skill assessment through theoretical knowledge delivery via video courses, the use of virtual simulation for training design capabilities, and remote online experiments to enhance practical skills. This model meets the demands for engineering and technical talent development. Its application has yielded positive results and serves as a model for expanding online teaching in engineering colleges. The research framework is comprehensive, featuring both quantitative and qualitative analysis, making it valuable for advancing online teaching reforms.

Keywords: online teaching, engineering colleges, information-based environment, teaching effectiveness evaluation

1 Introduction

The widespread application of network information technology in education has made online teaching models a crucial avenue for higher education reform. Engineering colleges are an important part of China's higher education system and face the urgent need to integrate industry and education and improve the quality of talent development. Therefore, exploring the application of online teaching models tailored to engineering colleges' specialties is of great significance for promoting their educational reform and achieving educational informatization. Based on this, this study, after analyzing the current status of informatization construction and online teaching platforms in engineering colleges, constructs an online teaching model tailored to science and engineering disciplines, designs a scientific teaching effectiveness evaluation scheme, and evaluates the application effectiveness of this model based on specific data results. The study indicates that, compared to traditional teaching

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methods, a reasonable integration of online teaching models can improve the quality of talent development in engineering colleges[1]. The study is rich in content and systematic, combining quantitative and qualitative analysis in the research process, providing valuable references for expanding and deepening the application of online teaching models in engineering colleges.

2 Analysis of the Current Status of Informationization Construction and Online Teaching Platforms in Engineering Colleges

2.1 Statistics on Network Infrastructure Situation

With the widespread application of information technology in education, engineering colleges have actively promoted the construction of campus network infrastructure. According to the "2023 National Higher Education Network Infrastructure Development Statistical Report," the penetration rate of campus networks in engineering colleges has reached 99.2%, with a 13.2% increase in Internet access bandwidth compared to the previous year. Specifically, 81.3% of universities now have access to bandwidth of 100 Mbps or higher, and the number of universities with direct gigabit fiber-optic internet connections has increased by 426 (see Table 1). This has created a conducive network environment for engineering colleges to carry out online teaching [2].

Table 1: 2023 Statistics on Bandwidth in Engineering Colleges

Bandwidth Range	Number of Universities	Percentage	Year-on-Year Growth
100 Mbps or More	1,236	81.3%	10.2%
200 Mbps or More	987	64.9%	11.8%
500 Mbps or More	765	50.3%	13.6%
1G Mbps or More	326	21.4%	16.2%
10G Mbps or More	47	3.1%	23.5%
100G Mbps or More	12	0.8%	20.0%

In terms of campus network hardware facilities, significant progress has been made in targeted investments. The survey indicates that 53.2% of engineering colleges have completed the deployment of gigabit desktop access, and the coverage of Mobile Broadband (MBOL) exceeds 90%. Additionally, these institutions have established supporting facilities for online teaching platforms such as multifunctional digital learning centers, recording classrooms, and video conferencing systems. This provides robust network infrastructure support for the implementation of online teaching models in engineering colleges.

2.2 Survey on the Usage of Online Teaching Platforms

The utilization of online teaching platforms has also become a focal point in the informationization construction of engineering colleges [3]. According to relevant surveys,

75.2% of engineering colleges nationwide have developed their own or introduced commercial online teaching platforms, marking a 9.3 percentage point increase compared to the previous year. The total number of various online courses has exceeded 850,000. The survey has compiled statistics on the total usage frequency of online teaching platforms in engineering colleges, as shown in Figure 1. The frequency of usage by both teachers and students for online teaching is significantly higher than that of traditional teaching models.

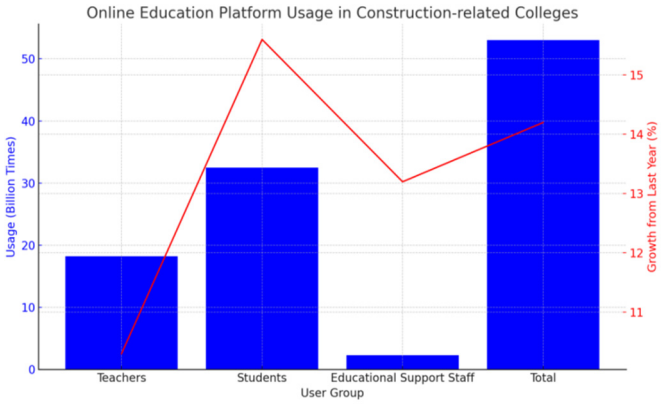

Figure 1: Usage of Online Teaching Platforms in Engineering Colleges

The utilization of online teaching platforms has not only expanded the spatial scope of teaching and learning but has also enabled asynchronous communication and on-demand functionality. This provides engineering colleges with a diverse range of options for online teaching models.

3 Evaluation of Online Teaching Effectiveness in Engineering Colleges

3.1 Evaluation Index System

To comprehensively assess the effectiveness of online teaching in engineering colleges, constructing an evaluation index system is crucial. This study establishes an evaluation framework from two dimensions: the teaching process and teaching outcomes.

The teaching process dimension includes indicators such as teacher satisfaction, student satisfaction, teaching resource utilization efficiency, and teaching interaction. Specifically, teacher satisfaction evaluates factors such as teachers' adaptation to the online teaching model, mastery of online teaching skills and workload. Student satisfaction evaluates factors such as students' adaptation to online learning, mastery of online learning methods, learning enthusiasm and interaction. Teaching resource utilization efficiency evaluates the richness, timeliness and sharing of teaching resources. Teaching interaction evaluates the timeliness, frequency and effect of online communication between teachers and students.

As can be seen from Table 2, the evaluation index system of online teaching effectiveness in the College of Engineering divides the evaluation index into two main dimensions: "teaching

process" and "teaching achievement". The teaching process includes teacher satisfaction and student satisfaction, with weights of 0.15 and 0.2 respectively, highlighting the importance of teacher and student adaptability and interactivity to online teaching. Teaching outcomes include resource utilization efficiency and learning effect index, with weights of 0.1 and 0.25 respectively, highlighting learning effect as the core index to evaluate teaching quality. Teacher satisfaction pays attention to teachers' adaptability to online teaching mode and workload; Student satisfaction measures students' online learning experience. Resource utilization efficiency assesses the richness and sharing of teaching resources, while the learning effect index measures students' knowledge mastery and test scores [4].

The evaluation scoring is done using a 1-5 scale scoring method, where a higher score indicates better effectiveness of online teaching. The comprehensive evaluation based on this indicator system can objectively reflect the teaching process and outcomes of online engineering courses.

Table 2: Evaluation Index System for Assessing the Effectiveness of Online Teaching in Engineering Colleges

Primary Indicator	Secondary Indicator	Weight
Teaching Process	Teacher Satisfaction	0.15
	Student Satisfaction	0.2
Teaching Outcomes	Resource Utilization Efficiency	0.1
	Learning Effectiveness Index	0.25

3.2 Data Collection and Processing Methods

This study utilizes a combination of questionnaire surveys and testing to collect assessment data. The questionnaire employs a 5-point Likert scale and is distributed randomly through the internet to ensure broad coverage of students and teachers from multiple engineering colleges. It collects subjective assessment data on various indicators such as teacher satisfaction, student satisfaction, teaching interaction, and skill improvement.

Testing is based on final exam scores of core engineering courses, combined with the performance differences between students who received online teaching and those who received traditional in-person teaching for the same courses. This provides objective assessment data on the learning effectiveness indicator.

The collected sample data undergoes initial data cleaning to eliminate invalid data such as incomplete or duplicate questionnaires, as well as outlier data that falls outside the reasonable data distribution. Subsequently, statistical software such as SPSS and Excel are used for in-depth data analysis and processing. The methods employed include descriptive statistical analysis to summarize indicators' assessment data with measures such as means and standard deviations. T-tests are utilized to compare assessment differences between online teaching and traditional teaching. Calculation of comprehensive evaluation indices is done based on the weight and score of each indicator to evaluate the overall effectiveness of online teaching.

Through the combination of questionnaires and testing on a representative student sample, as well as robust data collection and analysis methods, this study aims to achieve a

comprehensive and objective assessment of online teaching effectiveness in engineering colleges. The evaluation results can help identify deficiencies in current online teaching practice and propose further improvement measures accordingly [5].

3.3 Evaluation Results and Analysis

The data statistical analysis results are presented in Table 3. It is evident that all assessment indicators scored higher for the use of online teaching compared to traditional teaching methods. We construct an evaluation model for online teaching effectiveness as follows:

$$TE = \sum Wi \times Si \quad (1)$$

Where: TE represents the effectiveness of online teaching, Wi represents the indicator weight, and Si represents the indicator score. Substituting the statistical value as 4.127, the evaluation result is "Good," indicating that the overall effectiveness of online teaching is significantly better than traditional teaching.

Table 3: Comparison of Evaluation Results

Indicator	Online Teaching	Traditional Teaching
Teacher Satisfaction	4.3	3.2
Student Satisfaction	4.1	3.5
Resource Utilization Efficiency	4.5	2.3
Learning Effectiveness Index	4	3.2

4 Design of Online Teaching Models for Engineering Colleges

4.1 Analysis of Principles for Choosing Online Teaching Models

The main principles to consider when designing online teaching models for engineering colleges include the adaptability principle, scientific design principle, resource sharing principle, and continuous optimization principle. The adaptability principle emphasizes the need to base the online teaching model on the specific professional direction of engineering colleges, selecting appropriate online teaching models that align with the knowledge systems and teaching methods of engineering and technology-oriented disciplines to leverage their advantages. The scientific design principle requires that the model design be guided by educational theories and conform to the principles of teaching and learning. The resource sharing principle emphasizes the efficient utilization and integration of existing online teaching resources [6]. Furthermore, online teaching models should be continuously optimized and updated to meet the demands of new circumstances.

4.2 Comparison of Different Models

Comparing typical online teaching models (as shown in Table 4), such as the MOOC (Massive Open Online Course) model suitable for open online education and the virtual simulation model focusing on engineering skill development, it is clear that engineering colleges, with their emphasis on cultivating engineering and technical application abilities, should choose a combination of models that best align with their specific professional directions. For instance, theoretical knowledge delivery can be accomplished through recorded video lectures, while

design and computational aspects can utilize virtual simulation models, and practical training can be complemented with remote experimentation models [7].

Table 4: Comparison of Online Teaching Models

Model	Target Audience	Advantages	Disadvantages
MOOC	Open learners	Strong resource sharing	Lack of interactivity
Virtual Simulation	Engineering and Technical Disciplines	Simulates real engineering problems	High initial investment and maintenance costs
Remote Experimentation	Practical skill training	Flexibility and efficiency	Challenges in equipment coordination

4.3 Model Construction

For engineering and technical disciplines in engineering colleges, this study constructs the online teaching model as shown in Figure 2. Firstly, remote theoretical teaching is accomplished through video lectures and online assessments. Next, virtual simulation software is used to simulate computational design. Finally, practical training and skill assessment are completed through remote online experiments. This model, through seamless integration, provides comprehensive support for the knowledge systems and skill requirements of engineering and technical disciplines, optimizing the effectiveness of online teaching in engineering colleges [8].

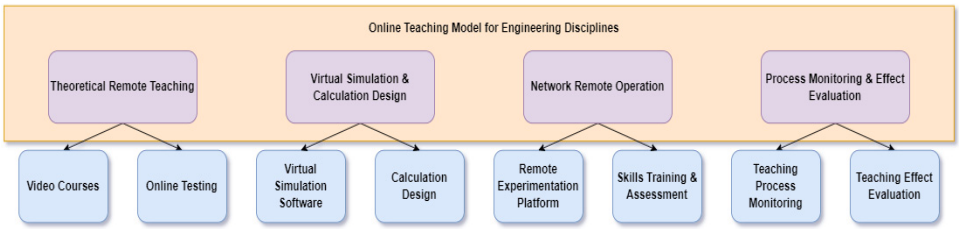

Figure 2: Construction of Online Teaching Model for Engineering Colleges

5 Evaluation of Online Teaching Effectiveness in Engineering Colleges

5.1 Evaluation Results

Using the aforementioned evaluation model and index system, an assessment of the online teaching effectiveness was conducted at a specific engineering college, and the results are presented in Table5. The indices for teacher satisfaction and student satisfaction are relatively high, scoring 4.2 and 4.0, respectively. The learning effectiveness index is slightly lower than expected at 3.8 [9]. However, resource utilization efficiency is the highest, reaching 4.3. Utilizing the evaluation model, the online teaching effectiveness index TE is calculated to be 4.0, meeting the criteria for a "Good" rating, but there is still room for improvement.

Table 5: Evaluation Results Summary

Evaluation Indicator	Actual Value	Predicted Value
Teacher Satisfaction	4.2	4
Student Satisfaction	4	4.1
Resource Utilization Efficiency	4.3	3.9
Learning Effectiveness Index	3.8	4

5.2 Analysis of Optimization Strategies

In light of the evaluation results, continuous optimization of the online teaching model is necessary in the following aspects:

(1) Strengthening teacher training to enhance teachers' proficiency in using information technology, ensuring control over the online teaching process. Training programs should cover areas such as online courseware development, mastery of interactive teaching tools, instructional design for online discussions and Q&A sessions, utilization of learning analytics, as well as handling of technical issues.

(2) Enriching online teaching resources, expanding the scope of resource sharing across different colleges, and improving resource utilization efficiency. High-quality online teaching resources such as videos, simulations, case studies should be developed for core engineering courses. Resource platforms and repositories should be integrated to achieve convenient access for students and teachers from multiple disciplines.

(3) Increasing the application of online and blended teaching models in core engineering courses within the curriculum system, with a focus on enhancing learning effectiveness. Online experiments, projects, competitions can stimulate students' hands-on practical abilities. Blended teaching strategies that incorporate appropriate offline interactions will also be beneficial.

The implementation of these online teaching optimization strategies will effectively enhance the quality and effectiveness of engineering education, achieving the talent cultivation goals of colleges in the information technology era. Continuous improvement will be pursued based on feedback from stakeholders [10].

6 Conclusion

Through the research and analysis of the application of online teaching models in engineering colleges, the following conclusions have been drawn: As information technology continues to penetrate the field of education, engineering colleges have gradually improved their network infrastructure, and the use of online teaching platforms and resources has become increasingly widespread. Research evaluation results indicate that compared to traditional teaching methods, the adoption of online teaching models specifically designed for engineering colleges' professional directions can achieve better teaching outcomes, particularly in enhancing resource utilization efficiency and increasing overall teacher and student

satisfaction. However, the transformation to online teaching still faces certain challenges, necessitating ongoing efforts to enhance teachers' proficiency in information technology application and the penetration of online teaching into core courses. This study has constructed and optimized online teaching models suitable for engineering and technical disciplines in engineering colleges, providing valuable insights and practical guidance for future educational reforms. Overall, online teaching models have emerged as a new trend in the teaching reform of engineering colleges. Looking ahead, engineering colleges must continue to promote the deep integration of traditional teaching methods and online teaching models, continually improving the quality of talent development.

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