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Practice of Multi-Dimensional Collaborative Teaching Model for Ceramic Science and Technology English

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Abstract: This paper centres on the innovative reform of the teaching model for the specialized course “Ceramic Science and Technology English,” set within the rapidly evolving landscape of emerging engineering education. It introduces a multi-dimensional collaborative teaching model, which is propelled by the strategic development of tailored teaching materials and resources. Through in-depth research into the talent demands of the ceramic industry, the paper meticulously clarifies teaching objectives and content, ensuring alignment with real-world needs. It further details the methodology for crafting three-dimensional teaching materials and outlines a comprehensive teaching model that integrates online learning platforms, offline project-based classroom activities, and extracurricular practical experiences. By conducting teaching experiments in parallel classes, the paper comparatively analyses the impacts of teaching content, methods, and evaluation systems. The results demonstrate that this novel teaching model significantly enhances students' overall competencies, precisely meets the ceramic industry's talent requirements, and offers valuable insights and a replicable framework for the teaching reform of analogous courses.

1. Introduction

In the wave of emerging engineering construction, engineering education is undergoing profound transformations [12]. Emerging engineering emphasizes the interdisciplinary integration, innovative practice, and close alignment with industrial demands, aiming to cultivate high-quality engineering talents that adapt to the development of the times [3]. As a traditional advantageous industry in China, the ceramic industry, driven by technological innovation and industrial upgrading, has an increasingly urgent demand for compound talents who possess both ceramic expertise and good English communication skills [2]. The course "Ceramic Science and Technology English" serves as an important bridge connecting ceramic expertise with the English language, making the reform and innovation of its teaching model particularly crucial [1].

Traditional teaching of "Ceramic Science and Technology English" often focuses on the imparting of language knowledge, neglecting the in-depth integration with ceramic expertise and the cultivation of students' practical abilities, making it difficult to meet the talent demand of the ceramic industry in the context of emerging engineering. As an important carrier of teaching, the quality of teaching material development directly affects teaching effectiveness. Therefore, constructing a multi-dimensional collaborative teaching model driven by the development of teaching materials and resources is of great significance for improving the teaching quality of the "Ceramic Science and Technology English" course and cultivating high-quality talents that meet the demands of the ceramic industry.

2. Research on Talent Demand in the Ceramic Industry

2.1 Research Objectives and Methods

To gain an in-depth understanding of the talent demand in the ceramic industry and provide a basis for the teaching reform of the "Ceramic Science and Technology English" course, this study employed a combination of interviews and on-site visits to conduct research on multiple ceramic enterprises. Interviewees included corporate executives, technical experts, and human resources managers to gain insights into the challenges encountered during talent recruitment, training, and utilization, as well as suggestions for talent cultivation in universities, and to understand the knowledge, abilities, and qualities required for ceramic science and technology English talents. On-site visits were conducted to the production lines of enterprises to understand ceramic production processes, technological equipment, and product research and development, providing references for updating the course content.

2.2 Analysis of Research Results

(1) Knowledge Requirements

The knowledge requirements for talents in the ceramic industry exhibit characteristics of diversification and specialization. In addition to requiring a solid grasp of ceramic expertise, such as ceramic materials science, ceramic technology, and ceramic machinery, talents are also expected to possess certain English language knowledge, including scientific and technological English vocabulary, grammar, reading, writing, and translation abilities. Furthermore, with the internationalization of the ceramic industry, enterprises also hope that talents understand the dynamics, standards, and regulations of the international ceramic market and possess cross-cultural communication skills.

(2) Ability Requirements

In terms of abilities, enterprises place the highest value on students' practical and innovative capabilities. The ceramic production process involves numerous complex technological and technical issues, requiring students to possess the ability to solve practical problems. Meanwhile, with continuous technological advancements, the ceramic industry is constantly innovating, and enterprises hope that talents can propose new ideas and solutions to drive technological progress and product upgrades within the companies [10]. Additionally, teamwork, communication, and self-directed learning abilities are also important abilities that enterprises focus on.

(3) Quality Requirements

Enterprises generally believe that good professional ethics, a dedicated work ethic, and a sense of responsibility are essential qualities for talents. The working environment in ceramic production is relatively arduous, requiring employees to possess a spirit of hard work and perseverance. Simultaneously, with intensifying market competition, enterprises need employees to demonstrate a high degree of responsibility and dedication to ensure product quality and production efficiency. Furthermore, innovative consciousness, teamwork spirit, and an international perspective are also qualities that enterprises value [13].

2.3 Implications for Course Teaching

Based on the research findings regarding talent demand in the ceramic industry, the teaching of the "Ceramic Science and Technology English" course should focus on the following aspects: First, teachers should strengthen the integration of ceramic expertise with the English language, which will enable students to master professional terminology and expressions in the field of ceramic science and technology while they are learning English. Second, educators ought to reinforce practical teaching components, cultivating students' practical and innovative abilities by means of project research, internships, and practical training. Third, schools need to emphasize the cultivation of students' cross-cultural communication abilities and international perspectives, allowing students to adapt to the international development trend of the ceramic industry. Fourth, institutions should strengthen professional ethics and quality education, cultivating students' dedicated work ethic, sense of responsibility, and teamwork spirit [8].

3. Methodology for Developing Three-Dimensional Teaching Materials

3.1 Concept and Characteristics of Three-Dimensional Teaching Materials

Three-dimensional teaching materials refer to a multi-dimensional and multi-layered teaching resource system formed by integrating traditional printed materials with various multimedia resources, such as electronic textbooks, online courses, teaching videos, case libraries, and question banks, based on traditional printed teaching materials [5]. Three-dimensional teaching materials possess the following characteristics: First, they are resource-rich, meeting the diverse learning needs of different students. Second, they are diverse in form, stimulating students' learning interest. Third, they are updated in a timely manner, reflecting the latest developments in the academic field. Fourth, they offer strong interactivity, promoting communication and collaboration between teachers and students, as well as among students themselves.

3.2 Principles for Teaching Material Development

(1) Goal-Oriented Principle

Teaching material development should be guided by teaching objectives and closely aligned with the talent demand in the ceramic industry to determine the content and structure of the teaching materials. The content should cover professional knowledge in ceramic science and technology English, language skills, and the cultivation of comprehensive qualities, with a focus on cultivating students' practical and innovative abilities.

(2) Student-Centered Principle

Teaching material development should be student-centered, fully considering students' learning needs and characteristics. The content should be interesting and practical, stimulating students' learning interest) and initiative. Meanwhile, the teaching materials should provide diverse learning resources and methods to meet the different learning needs of students [6].

(3) Discipline Integration Principle

Teaching material development should emphasize the integration of ceramic expertise with the English language, incorporating ceramic science and technology knowledge into English language teaching. Through case analysis, project research, and other methods, students can learn and apply English in practice, improving their comprehensive application abilities.

(4) Dynamic Update Principle

With the continuous development of ceramic science and technology and changes in the international ceramic market, the content of teaching materials should be updated in a timely manner to reflect the latest research findings and industry trends in the academic field. Meanwhile, a feedback mechanism should be established for the teaching materials to continuously improve and refine the content based on feedback from teachers and students.

3.3 Textbook Development Process

(1) Needs Analysis

Through surveys on talent demands in the ceramic industry and students' learning needs, we ascertain the societal and student requirements for the "Ceramic Science and Technology English" textbook, thereby defining its objectives and content.

(2) Content Design

Based on the results of the needs analysis, we design the content framework and chapter structure of the textbook. The content should encompass fundamental knowledge of ceramic science and technology English, specialized vocabulary, reading comprehension, writing and translation, case studies, etc., while also integrating developments and cutting-edge technologies in the ceramic industry.

(3) Resource Integration

We collect and organize various media resources related to the textbook content, such as electronic textbooks, instructional videos, case studies, question banks, etc., and categorize and label them for easy access by teachers and students [9].

(4) Textbook Compilation

Professional teachers are organized to compile the textbook according to the content framework and chapter structure. The compilation should emphasize linguistic norms, content accuracy, and logical clarity, while also reflecting the textbook's interest and practicality.

(5) Review and Revision

After the textbook is compiled, experts are organized to review it, and modifications and improvements are made based on their feedback. The review covers aspects such as the scientific validity, accuracy, and applicability of the content, as well as the format and layout of the textbook.

(6) Publication and Distribution

The reviewed and revised textbook is published and distributed by a publishing house. Simultaneously, an online platform for the textbook is established, providing electronic versions of the textbook, instructional videos, case libraries, and other resources to facilitate learning and use by teachers and students anytime, anywhere.

4. Establishment of a Multi-Dimensional Collaborative Teaching Model for the Ceramic Science and Technology English Course

4.1 Design Philosophy of the Teaching Model

Driven by textbook development resources, we construct a multi-dimensional collaborative teaching model based on an online learning platform, offline project-based classroom instruction, and extracurricular practice. This model is student-centered, fully leveraging the advantages of textbook resources, and achieving collaborative innovation in teaching content, methods, and evaluation approaches through a combination of online and offline learning, thereby cultivating students' values, knowledge, and abilities [4].

4.2 Components of the Teaching Model

4.2.1 Online Learning via Chaoxing Platform

Online learning primarily relies on the Chaoxing platform and includes independent autonomous learning and collaborative learning.

(1) Independent Autonomous Learning

Students can autonomously select learning resources based on their learning progress and needs, such as course videos, courseware, and literature, for language and skill input. The course videos are meticulously recorded by professional teachers and cover specialized vocabulary, sentence patterns, discourse structures, and reading and writing techniques for scientific papers in ceramic science and technology English. The courseware presents knowledge points in a visually appealing manner with graphics and text, facilitating student understanding and memorization. The literature includes the latest research findings and academic papers in the field of ceramic science and technology both domestically and internationally, enabling students to stay abreast of developments and cutting-edge issues in ceramic science and technology through reading.

(2) Collaborative Learning

Students can communicate and collaborate with classmates through functions such as discussion forums and group tasks on the Chaoxing platform to jointly complete learning tasks. For example, the teacher can assign a discussion topic on trends in ceramic science and technology development, allowing students to express their viewpoints and engage in exchanges and interactions with peers in the discussion forum. Additionally, the teacher can divide students into groups and assign group tasks, such as jointly translating a ceramic science and technology paper or writing an English product manual for a ceramic product. During the completion of group tasks, students need to divide responsibilities, learn from each other, and collectively improve.

4.2.2 Offline Classroom Instruction Based on PBL - Project-Based Research

Offline classroom instruction adopts the PBL (Problem-Based Learning) project-based research teaching model.

(1) Teacher Instruction Component

Teachers summarize, expand upon, and supplement knowledge points learned online through a project-task teaching approach. Based on course objectives and teaching content, teachers design challenging and practically meaningful project tasks, such as translating ceramic science and technology papers and conducting reading comprehension of new ceramic materials [7]. In the process of completing these project tasks, students need to apply the ceramic science and technology English knowledge and skills they have learned to solve practical problems. Teachers play a guiding role in this process, helping students understand the essence of scientific English writing and cultivating their scientific research spirit [11]. For example, when students are translating ceramic science and technology papers, teachers can guide them to understand the structure and content requirements of the papers, instruct them on how to use appropriate vocabulary and sentence patterns for expression, and how to highlight the characteristics and advantages of the papers.

(2) Student Presentation Component

Students present their project research results in groups. Presentation formats can include PPT reports, video clip screenings, etc. Each group selects a representative to give a presentation, introducing the project background, objectives, methods, results, and conclusions. Students from other groups can ask questions and provide evaluations, while the teacher offers a summary and feedback. Through student presentations, not only can students' learning outcomes be assessed, but their presentation skills and teamwork abilities can also be cultivated.

(3) Offline Extracurricular Practice

Offline extracurricular practice serves as an extension and supplement to classroom instruction. Students can apply the ceramic science and technology English knowledge and skills they have learned to practical work by visiting ceramic museums, participating in ceramic science and technology competitions, and other activities. For instance, students can engage in project research and technological innovation work in enterprises, combining their ceramic science and technology knowledge with English skills to contribute to the development of the enterprises. Visiting ceramic museums allows students to understand the history and development of ceramic culture, appreciate ceramic works from different periods and styles, and broaden their cultural horizons. Participating in ceramic science and technology competitions can stimulate students' innovative and competitive spirits, enhancing their practical abilities and overall qualities.

4.3 Synergistic Effects among Modules

The three major modules are interconnected, with online and offline components organically integrated to form a holistic systemic effect. Online learning provides a foundation and support for offline classroom instruction and extracurricular practice, enabling students to acquire basic knowledge and skills through online study and prepare for offline learning. Offline classroom instruction and extracurricular practice, in turn, deepen and expand upon online learning, allowing students to apply the knowledge and skills they have learned in practical settings and improve their comprehensive abilities. Meanwhile, feedback and evaluations during the online and offline learning processes can also mutually reinforce each other, enabling teachers to adjust teaching strategies and methods in a timely manner based on students' online learning performance and offline presentations, thereby improving teaching quality.

5. School-Based Practice of the Multi-Dimensional Collaborative Teaching Model for the Ceramic Science and Technology English Course in the Context of Emerging Engineering Education

5.1 Experimental Design

(1) Experimental Subjects

Two parallel classes from a certain university were selected as experimental subjects, designated as the experimental class and the control class, respectively. The students in both classes had similar entrance scores, English proficiency levels, and professional foundations, making them comparable.

(2) Curriculum Setup and Schedule

Both the experimental class and the control class offered the "Ceramic Science and Technology English" course, with a total of 64 class hours, including 32 hours of online learning, 24 hours of offline classroom instruction, and 8 hours of offline extracurricular practice. The experimental class adopted the multi-dimensional collaborative teaching model, while the control class used the traditional teaching model.

(3) Teaching Content

The teaching content for the experimental class was based on three-dimensional teaching materials and integrated resources from the online learning platform, incorporating the latest research findings and industry trends in the field of ceramic science and technology. The teaching content for the control class mainly relied on traditional textbooks, focusing on the imparting of language knowledge.

(4) Teaching Methods

The experimental class employed a combination of online and offline teaching methods, with online autonomous and collaborative learning via the Chaoxing platform and offline PBL-project-based classroom instruction and extracurricular practical activities. The control class adopted the traditional classroom teaching method, with teachers delivering lectures and students passively receiving knowledge.

(5) Evaluation Methods

The experimental class used a diversified evaluation approach, considering students' learning processes, learning outcomes, and overall qualities. Evaluation criteria included online learning attendance, homework completion, discussion participation, project research result presentations in offline classroom instruction, group collaboration abilities, and competition achievements. The control class used the traditional examination evaluation method, primarily relying on final exam scores as the basis for evaluation.

5.2 Experimental Process

(1) Pre-Experimental Preparation Stage

Before the experiment began, pre-tests were conducted on students in both the experimental and control classes to understand their English proficiency levels, professional foundations, and learning abilities. Meanwhile, teachers in the experimental class were trained to familiarize them with the teaching procedures and methods of the multi-dimensional collaborative teaching model.

(2) Experimental Implementation Stage

Teaching was carried out according to the experimental design plan for both the experimental and control classes. Teachers in the experimental class guided students in online learning and offline practice based on teaching content and project tasks, providing timely guidance and feedback. Teachers in the control class taught according to the traditional teaching model, focusing on knowledge explanation and transmission.

(3) Post-Experimental Testing Stage

After the course concluded, post-tests were conducted on students in both the experimental and control classes, including English proficiency tests, professional knowledge tests, and practical ability tests. Additionally, students' coursework, project research results, and internship reports were collected as evidence for evaluating their learning outcomes.

5.3 Analysis of Experimental Results

(1) Improvement in English Proficiency

English proficiency tests revealed that students in the experimental class showed significant improvements in listening, speaking, reading, and writing skills, with a notably larger increase compared to the control class. This indicates that the multi-dimensional collaborative teaching model can effectively enhance students' comprehensive English application abilities.

(2) Mastery of Professional Knowledge

In professional knowledge tests, students in the experimental class also outperformed those in the control class. This suggests that through the combination of online and offline learning, students in the experimental class better mastered professional knowledge in ceramic science and technology English.

(3) Development of Comprehensive Qualities

Through observation and evaluation of students' learning processes, it was found that students in the experimental class developed better teamwork, communication, and autonomous learning abilities. In group project research and extracurricular practice, students actively collaborated with others and took the initiative to learn and explore new knowledge.

6. Conclusions

6.1 Research Conclusions

Driven by teaching material development resources, this study constructed a multi-dimensional collaborative teaching model for the "Ceramic Science and Technology English" course and validated its effectiveness through school-based practice. The research findings indicate that this teaching model can meet the talent demands of the ceramic industry, enhance students' English proficiency, professional knowledge, and practical abilities, and cultivate their overall qualities. Specifically, this is reflected in the following aspects:

(1) The development of three-dimensional teaching materials provides abundant resources for teaching, catering to the diverse learning needs of students and enhancing their learning interest and initiative.

(2) The multi-dimensional collaborative teaching model integrates online learning, offline classroom instruction, and extracurricular practice, achieving collaborative innovation in teaching content, methods, and evaluation approaches, thereby improving teaching effectiveness.

(3) School-based practice demonstrates that students in the experimental class outperform those in the control class in terms of English proficiency, professional knowledge, practical abilities, and overall qualities, confirming the advantages of the multi-dimensional collaborative teaching model.

6.2 Research Prospects

Although this study has achieved certain results, there are still some shortcomings. Future research can delve deeper into the following aspects:

(1) Teachers and curriculum developers should further improve the content and format of three - dimensional teaching materials. They can do this by incorporating more interactive and practical elements, thereby enhancing the quality and applicability of these materials.

(2) Schools need to expand the scope of school - based practice. They can achieve this by increasing the number and types of experimental classes, which will further validate the universality and effectiveness of the multi - dimensional collaborative teaching model.

(3) Educational institutions should explore the application of new technologies, such as artificial intelligence and big data, in the teaching of "Ceramic Science and Technology English". This exploration aims to provide students with more personalized and intelligent learning services.

(4) Universities or educational bodies should strengthen cooperation with ceramic enterprises. They should establish industry - university - research collaboration mechanisms and introduce real - world enterprise projects and cases into teaching. By doing so, they can enhance students' practical abilities and employability.

In conclusion, the multi-dimensional collaborative teaching model for "Ceramic Science and Technology English" driven by teaching material development resources is a teaching approach that aligns with the requirements of emerging engineering education construction and holds broad application prospects. It is hoped that this study can provide valuable references and insights for the reform of the "Ceramic Science and Technology English" course and contribute to the cultivation of high-quality talents who meet the needs of the ceramic industry.

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