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Discussion and Practice of "Three-Dimension Five-Star" Teaching Method under OBE Concept—Take the Course "College Computing" for Example

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Abstract: Under the background of engineering education certification, "taking undergraduate education as the foundation", curriculum ideological and political education, taking the concept of OBE, aiming at the overall conception of curriculum teaching and the design and implementation of classroom teaching, this paper proposes a "three-dimension five-star" three-dimensional teaching method, which integrates with "five-star teaching mode" and takes "graduation requirements", "learning situation", "ideological and political education" as three main dimensions. Taking the general content arrangement of "College Computing" course and the classroom teaching design of "sorting algorithm" as an example, the concrete implementation plan of "Three-dimension five-star" method in classroom teaching is introduced. Through many rounds of practice and continuous improvement, the effectiveness and practicability of the "Three-dimension five-star" method are verified, and some suggestions for further discussion and improvement of the teaching method are put forward.

1. Introduction

With the rapid development of a new generation of information technology, a series of transformations have been triggered in many fields such as engineering technology, natural sciences, humanities and social sciences, and economic finance. This has led to the emergence of the "Four New" professional systems comprising new engineering, new liberal arts, new medical science, and new agricultural science. At the same time, under the concept of Outcome-Based Education (OBE), taking engineering accreditation as an opportunity and graduation requirements as a goal-oriented approach, a comprehensive professional training program has been established, defining the course objectives for each course.

On the other hand, as pointed out in the report of the 20th National Congress, "Education, science and technology, and talent are the basic and strategic supports for the comprehensive construction of a socialist modernized country. It is necessary to provide satisfactory education for the people, fully implement China's educational policy, accomplish the fundamental task of fostering character and civic virtue, and cultivate well-rounded socialist builders and successors with moral, intellectual,

physical, aesthetic, and labor education." Therefore, the construction of ideological and political education in courses remains an important means for educating and nurturing students in every course. Whether it is graduation requirements or ideological and political education in courses, it is essential to start from the understanding of student's learning conditions and focus on student-centered approaches to achieve significant results.

"University Computer Science" as a general education course characterized by breadth, specialization, and integration, plays a solid supporting role in the construction of every specialized course. As mentioned in the literature [1], the "University Computer Science" course is transforming towards empowerment education on the basis of strengthening computational thinking. This is precisely the graduation requirement under the context of engineering accreditation. How to implement "empowerment" in the specific teaching process to achieve the integration of graduation requirements, ideological and political education, and student learning conditions is a topic worth exploring for every teacher.

2. "Three-Dimensional Five-Star" Teaching Method

The "Five-Star Teaching Model," proposed by the contemporary famous educator Merrill, mainly includes five elements: "Focus on Problem-Solving," "Activate Prior Knowledge," "Demonstrate and Argue New Knowledge," "Attempt Application Practice," and "Integrate and Master Knowledge." These five stages, stemming from students' cognitive patterns, progressively enhance teaching effectiveness and are widely used by educators in various fields in practical teaching.

In higher education, particularly in science and engineering, against the backdrop of engineering accreditation, how can we implement the principles of "student-centered" and "fostering character and civic virtue" into concrete teaching? To address this, the authors propose the "Three-Dimensional Five-Star" teaching method. Utilizing a blended online and offline mode [2], this method centers around course objectives and intersects the three main dimensions of graduation requirements, student learning conditions, and ideological and political education with the Five-Star teaching method in a multi-faceted approach.

Student Learning Conditions. Just as enterprises start with raw materials to create good products, schools must also start from students' learning conditions to cultivate excellent talents, reflecting the Ministry of Education's intent of "student-centered" education.

Graduation Requirements. For engineering-focused institutions, since China became a formal member of the Washington Accord in 2016, engineering education accreditation has been used to assess whether talent cultivation meets internationally recognized standards. Thus, the rationality of the curriculum system can be measured by graduation requirements. The same applies to individual courses, which are designed according to knowledge and skill targets set by graduation requirements [3].

Ideological and Political Education. Fostering character and civic virtue, and advancing technology for the nation, are both the historical mission and long-term goal of talent cultivation in our higher education institutions. Each course continuously explores the construction of ideological and political education in teaching [4], with the main form being ideological and political case studies [5].

3. Implementation of the "Three-Dimensional Five-Star" Method

3.1. Overall Course Implementation Strategy

Taking the "University Computer Science" course as an example, the three dimensions and the five stages of the "Five-Star Method" are closely integrated to form the overall teaching strategy of

the course. The "Three-Dimensional Five-Star" method is then applied in the teaching of each knowledge point.

"University Computer Science" covers fundamental knowledge essential for various majors, focusing primarily on computational thinking, which is at the heart of this course. Based on the course objectives, the content is divided into three modules: the first module includes basic computer knowledge, hardware basics, software basics, and network basics, corresponding to the first two "stars" of the Five-Star Method; the second module includes computational theory, algorithm, and basic programming, corresponding to the third and fourth "stars"; the third module covers new IT technologies and computer literacy, corresponding to the fifth "star." Each of the three modules aligns with three detailed sub-goals, integrating graduation requirements, student learning conditions, and ideological and political education with the course content.

3.2. Implementation Methods for Knowledge Points

Sorting algorithms are a classic example, illustrating the specific implementation of the "Three-Dimensional Five-Star" method in learning a knowledge point. Under the OBE concept, the learning objectives of this algorithm are clearly defined. Using the "Five-Star" model, the focus and difficult points are designed into the teaching segments of before, during, and after class. Ideological and political case studies relevant to the student learning conditions are then selected based on the content of the knowledge point, ultimately forming a teaching design map.

3.2.1. Pre-Class Focus on Key Points

Pre-class activities mainly embody the first star: focusing on key points. According to the difficulty level of the knowledge points, students are assigned to read, view text videos, complete exercises, discussions, quizzes, etc., introducing them to the key content through pre-class assignments.

Specific implementation methods can involve online tests, Q&A discussions, etc., on digital teaching platforms; test and discussion content should be relatable and engaging for students. For example, discussing "How are Taobao stores ranked?" not only introduces sorting algorithms but also inspires students to think about their future career and required attitudes and skills, aligning with graduation requirements. This also guides students towards qualities like fairness, integrity, self-reliance, and service awareness, aligning with course ideological and political education. Pre-class progress is monitored through WeChat, QQ, etc., to focus on problems while understanding individual student situations.

3.2.2. In-Class Three Stars to Solve Three Puzzles

During class, face-to-face Q&A sessions allow for joint exploration of advanced and innovative issues. Building on pre-class preparation, key and difficult points are introduced through advanced questions, using teaching methods like questioning, testing, demonstrating, and discussing to address students' doubts about graduation requirements, ideological and political education, and student learning conditions.

(1) Activate Prior Knowledge. Through discussions and in-class quizzes, students are prompted with questions that can be solved with existing knowledge, then raising the difficulty to introduce new knowledge. For example, sorting the total scores of 30 students in a class might be done using Excel or Word. But what about ranking 1 million Taobao stores? Or dynamic ranking?

(2) Demonstrate and Argue New Knowledge. Students present and explain sorting algorithms at the podium, engaging and encouraging thorough pre-class preparation. Peer explanations and discussions are particularly engaging. Teachers provide feedback during these presentations, also addressing key and difficult points.

(3) Expand Application Practice. Using the example of China's annual power generation ranking, students learn about different types of sorting, while also appreciating examples of the country's technological progress. In cases of large data volumes, sorting is a crucial method to test technological capability, as illustrated by the achievements of Alibaba Cloud, Baidu, and other Chinese companies in the Sort Benchmark competitions, subtly enhancing national pride.

3.2.3. Post-Class Integration and Mastery

Post-class assignments, both online and offline, test whether students can integrate and master the knowledge point. Additionally, challenging and innovative assignments encourage students to expand application and practice creativity.

Throughout the pre-class, in-class, and post-class phases, questionnaires, discussions, tests, and assignments not only provide comprehensive insights into student learning conditions but also facilitate student-student and teacher-student interactions, engaging students' interest. Ideological and political education is seamlessly integrated into the classroom through cases closely related to the knowledge points. Through discussions comparing old and new knowledge, students realize that each algorithm has its applicable scope and limitations, and appropriate methods should be chosen based on the key aspects of specific problems, supporting the graduation requirements.

4. Effectiveness Analysis

4.1. Improvement in Achievement

Taking Inner Mongolia University of Technology as an example, the overall score of the course includes 5 components, corresponding to 3 course objectives and 1 graduation requirement, with midterm and final exams being uniform across the university. Regarding the final unified exam, since the pilot of the "Three-Dimensional Five-Star" teaching method in 2018, not only has there been an increase in the overall average scores of students taught under this method, but the proportion of high scores has also been notably higher than that under the traditional teaching model. After the comprehensive implementation of the blended model in 2020, continuous improvements have been made, as shown in Table 1, which compares the grade distribution of various classes of the 2022 cohort with that of the 2021 cohort. This implementation has reduced the proportion of low scores and increased the proportion of high scores.

Table 1: Distribution of Score Ranges for the 2022 and 2021 Cohorts

Score Range	Number of Classes in 2021 Cohort	Percentage in 2021 Cohort	Number of Classes in 2022 Cohort	Percentage in 2022 Cohort	Difference in Percentage between 2022 and 2021
0-59	0	0	0	0	0
60-64	1	0.7	0	0	-100%
65-69	5	3.6	1	0.7	-81%
70-74	31	22.5	16	11.6	-48%
75-79	65	47.1	64	46.4	-1%
80-84	31	22.5	45	32.6	45%
85-90	5	3.6	11	8	122%
90-94	0	0	1	0.7	70%
95-100	0	0	0	0	0

Due to the overall improvement in scores, the achievement level of course objectives has also significantly increased. Figure 1 shows a comparison of the achievement levels in a certain major

during the pilot phase for the 2019 cohort and after the full implementation of the "Three-Dimensional Five-Star" teaching method for the 2020 cohort. This approach has provided strong support for the successful passing of engineering accreditation for majors such as architecture, transportation, environmental building, electronics, and others at our university.

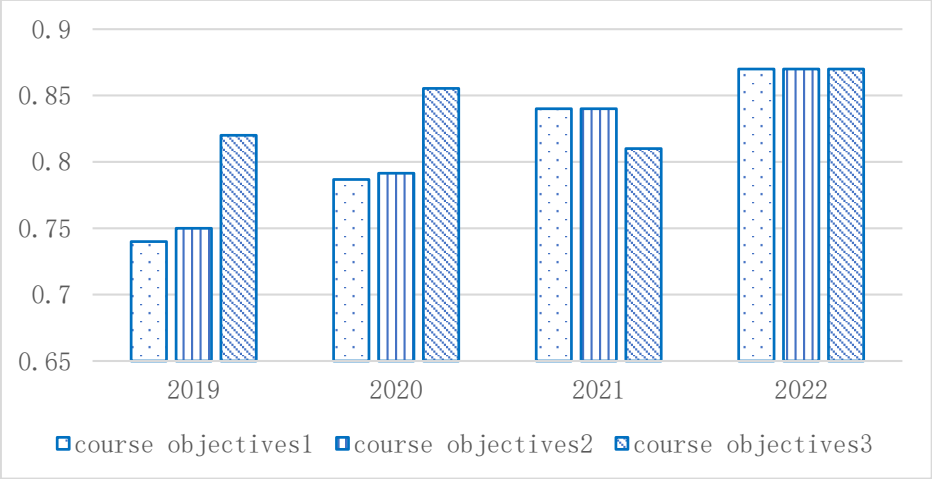

Figure 1: Comparison of Course Achievement Levels

4.2. Increased Student Interest

Interactive online and offline activities have effectively enlivened the classroom atmosphere and enhanced students' interest in learning. Apart from actively enrolling in the NCRE (National Computer Rank Examination), a survey conducted at the end of the first semester for first-year students showed that not only did they recognize the course as beneficial for subsequent studies, but also 19% of the students voluntarily participated in innovation projects to develop their creative abilities.

4.3. Enhanced Learning Ability

During the teaching period, students showed high enthusiasm for participating in online learning on the SPOC (Small Private Online Course) platform. The course often ranked among the top in terms of visitation across the university's courses. By the end of 2022, the course's SPOC platform had accumulated over 1.16 million visits, frequently leading in daily visitation.

4.4. Improved Teaching Abilities of Instructors

In the process of teaching improvement, teachers communicated and learned from each other, leading students in exploration and practice. The growth of students also inspired the teachers to continue improving. The entire teaching team actively applied for teaching reform projects and explored methods to enhance teaching quality.

5. Experience Discussion

Through continuous improvement and practice, the "Three-Dimensional Five-Star" teaching method has achieved relatively successful experiences in teaching design and practice, but there are still some aspects that need further discussion and research.

5.1. Precise Alignment of Key Knowledge Units with Graduation Requirements

The core content of course objectives is mainly formed by the key content of each knowledge point, and these objectives need to align with graduation requirements, as per OBE (Outcome-Based Education) standards. Thus, when designing teaching content, it is crucial to refine key points, keep up-to-date, and design reasonable cases for demonstration and alignment with outcomes.

5.2. Ideological and Political Education Integrated with Professional Knowledge to Subtly Influence Students

Showcasing new knowledge and integrating it involves primarily the learning of professional knowledge. At the same time, integrating ideological and political concepts and awareness into professional knowledge, deeply rooted in students' minds, requires patient exploration by teachers. Starting from knowledge points, a large number of relevant cases should be selected to distill ideological and political cases that seamlessly interface with professional knowledge, subtly influencing students' hearts and minds.

5.3. Student-Centered Approach to Deeply Analyze Learning Conditions for Personalized Education

In addition to understanding students' learning status through surveys, questioning, and discussions, it is also necessary to explore how to use effective algorithms to mine students' learning patterns from their online and offline activities. Predicting learning outcomes allows for targeted reminders for students to improve learning methods and to emphasize the importance of course learning. For students with good learning habits and effectiveness, innovative and challenging tasks should be arranged to maximize their potential.

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