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Exploration and Practice of Road Engineering Course Teaching Innovation Based on IOPM

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Abstract. In response to the problems in talent cultivation and curriculum teaching, this paper analyzes the pain points in the current situation of curriculum teaching - traditional "teaching" and traditional "learning" teaching, including textbook writing, teaching objectives, teaching organization, and teaching evaluation; An analysis was conducted on students' learning methods, motivation, and goals. We have proposed a breakthrough in traditional innovative concepts and ideas, as well as an implementation path - IOPM, which is guided by ideological education, output-based education, project-based learning, and a multi-dimensional evaluation index system. The application of the IOPM model in teaching practice has verified the feasibility and promotion value of this teaching innovation path. Reflected on the weak points in teaching innovation practice and proposed prospects for continuously promoting teaching innovation.

Keywords. course teaching; Teaching innovation; Teaching pain points; Teaching evaluation

1. Introduction

Talent cultivation means future development and hope for every country [1]. Using a small incision in curriculum reform to drive and solve the major problems of talent cultivation models, and achieving strong breakthroughs in higher education reform, innovation, and development, is a requirement put forward by the Higher Education Department of the Ministry of Education of the People's Republic of China in the key work points for the education industry in 2023 [2]. Since the famous psychologist Carl Rogers first proposed the teaching concept of "student-centered" in the middle of the last century, this concept has been recognized by educators and various curriculum reform practices have been carried out around it [3-5].

Improving the curriculum system, promoting curriculum reform, and carrying out innovative practices in teaching methods, teaching methods, and assessment methods have received high attention from the education community [6-8]. Strengthening the

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construction of course groups and building virtual teaching and research rooms has also been proven to be very effective methods by many universities' teaching practices [9-12]. Implementing the integration of industry and education, through cooperation between schools and enterprises, creates more opportunities for talent cultivation, and various schools have made tremendous efforts to this end [13-16]. Vigorously promoting the "classroom revolution", eliminating "water courses", creating "gold courses", putting students at the center, and effectively improving the quality of students' learning are requirements put forward by the Ministry of Education for schools, and have also become conscious actions of school staff [17-20]. The improvement of education level and the rapid progress of outstanding talents are just around the corner.

2. Analysis of The Current Situation and Breakthrough Ideas Under the Principle of H-I-C

2.1. Current Situation of Curriculum Teaching - Obstacles to Achieving " H-I-C*"*

High-order, Innovation, and Challenge, which are abbreviated as H-I-C, and regarded as the standard for the construction of the "Golden Course" [21, 22].

High order refers to the organic integration of knowledge, abilities, and qualities, cultivating students' comprehensive abilities and advanced thinking. Innovation refers to the cutting-edge and contemporary nature of course content. Challenge refers to the degree to which a course must have a certain level of difficulty to stimulate students' vitality and potential. 'H-I-C' is the standard for 'Golden Class'. The traditional teaching mode has hindered the achievement of H-I-C.

(1) Traditional "teaching"

From the perspective of "teaching", "tradition" is mainly reflected in the following aspects:

1) Textbook writing: Most textbooks have similar structures, with a focus on explaining standard clauses, deducing and explaining principles, but not on guiding the application of knowledge systems [23];

2) Teaching objectives: Teachers spend a lot of classroom time helping students achieve general goals such as explaining concepts and principles while teaching, neglecting or having no time to challenge higher order goals;

3) Teaching organization: When teachers teach, they focus on the teacher and focus on teaching methods, lacking innovation. Not motivating students to actively explore and challenge;

4) Teaching evaluation: The evaluation of students is only based on the final exam scores, and the weight of process assessment results is low, without paying attention to students' evaluation of teachers.

(1) Traditional 'learning'

From the perspective of students, the main issues are:

1) Student learning methods: Some students overly rely on traditional classroom teaching with teacher explanations, neglecting pre class knowledge reserves and post class consolidation and improvement.

2) Students' learning motivation: Some students' learning motivation comes from the pressure of exams, rather than from the endogenous motivation generated by the improvement of their own understanding.

3) Students' learning goals: Some students, in their studies, are afraid of challenges, dare not innovate, do not engage in exploratory learning, and do not pursue the achievement of high-level goals.

2.2. "Breaking" and "Establishing" in the Teaching Revolution

There is a saying called 'never break, never stand'. The same is true for education. It is necessary to analyze the obstacles in the process of career progress to overcome them, clear the way forward, and make development and progress smoother. Based on the previous analysis of the problems from different perspectives of teachers and students, we can identify the underlying reasons and propose targeted solutions.

Taking the compulsory course "*Basic Theory and Technology of Road Engineering*" for transportation majors as an example, this paper evaluates the achievement of teaching objectives and provides feedback on the effectiveness from the perspectives of course ideological and political guidance, ability and achievement orientation, project-based learning methods, and the construction of a multi-dimensional evaluation index system.

3. Conception and Practice of Teaching Innovation

The teaching innovation [24-27] of the course adopts IOPM as the implementation path. Guided by ideological education in the curriculum, using moral education to stimulate students' endogenous motivation and drive the improvement of professional knowledge and skills. Design a teaching framework based on output-based education and ability. Starting from Project Based Learning, deconstructing, and reconstructing teaching content, designing and implementing teaching. Using a multi-dimensional evaluation index system as the starting point, evaluate the achievement of teaching objectives and provide feedback on the effectiveness.

3.1 "Ideological Education" is Taken as the Leading

Breaking through the tradition of students' learning motivation, by refining and sorting out the ideological and political elements of the course, identifying the connection points between ideological and political elements and teaching content, constructing a course ideological and political case library and a course ideological and political element mapping table, building a course ideological and political teaching implementation system, and integrating ideological and political elements into teaching design, as shown in Table 1. Using the achievements of moral education to stimulate students' internal motivation for learning is reflected in promoting the improvement of professional knowledge and skills in action.

Based on the above concepts and ideas, a mapping table for the ideological and political elements of the curriculum has been designed, as shown in Table 1.

Table 1. Mapping of ideological and political elements in the course

Course section	Teaching unit	Moral education elements
Design Basis	Introduction to General Theory	Macro: By analyzing the development process of road engineering in the world and China, we showcase the tremendous achievements of road engineering in China, enhance students' sense of pride and professional identity, and enhance patriotism and four confidences.
	Project 1 Road Plan and Vertical Section Design	Mid view: Establishing a scientific development concept and enhancing professional identity. Micro level: rigorous and pragmatic scientific attitude, love for hometown, serve Guangxi, and contribute to the construction of hometown.
Construction and maintenance knowledge	Project 1: Design of subgrade and pavement	Macro: patriotism and international perspective. Mid range: Innovation awareness and professionalism. Micro level: proactive learning, hardworking, proactive innovation, and pursuit of excellence
	Project 2: Discussion on Construction Technology of Roadbed and Pavement	Mid view: Team collaboration Micro level: rigorous and pragmatic work attitude
	Project 3: Maintenance and Management of Roadbed and Pavement	Macro: National pride Mid view: Scientific development concept, closely integrating personal career planning with national development and construction Micro level: High sense of responsibility, hardworking, and craftsman spirit of loving, protecting, and maintaining roads
Design Skills	Project 1: Practical Operation of Road Horizontal, Vertical, and Cross Section Design	Macro: Four Confidences Micro level: fearless of difficulties, pioneering and innovative qualities, and a spirit of craftsmanship that strives for excellence

3.2. Output-Based Education is Taken as the Leading

Breaking through the tradition of teaching objectives and learning methods. Distinguish between general learning objectives and higher-order objectives, emphasize the " H-I-C " of the curriculum, and design a teaching framework. A generative teaching model that emphasizes students as the main body of knowledge construction, with a student-centered approach. Using an information-based teaching platform as the medium, a blended teaching approach of "on the front line+off the middle line+off the line" is adopted. Students achieve general goals through learning on the front line, while off the line learning approaches high-level goals according to different levels of ability. After class, online learning completes the achievement, consolidation, and evaluation of high-level goals.

3.3 Project-Based Learning (PBL) is Taken as the Orientation

Breaking through the tradition of textbook writing and teaching organization. According to the scenario requirements of PBL, the course content is deconstructed and restructured into three project scenarios based on the characteristics of the entire life cycle of road

engineering, as shown in Table 1. Systematize the course content based on usage functions. In the implementation of teaching, teaching activities based on POPPS and flipped classrooms are organized, using teaching methods such as discussion and smart ambassadors, emphasizing student-centered participatory and experiential learning. Enable students to learn by doing and learn by doing and gain true feelings through learning and doing. While the level of knowledge and ability has improved, it has also achieved the goals of ideological and political education.

3.4. A Multi-Dimensional Evaluation Index System is Taken as a Foothold

3.4.1. Evaluation Index System for Students' Achievement of H-I-C

Breaking through the tradition of teaching evaluation, is has been customized a multi-dimensional process evaluation index system for students, including online, in class, and after class, to reflect the achievement of learning objectives objectively and truthfully in three aspects, as shown in Table 2.

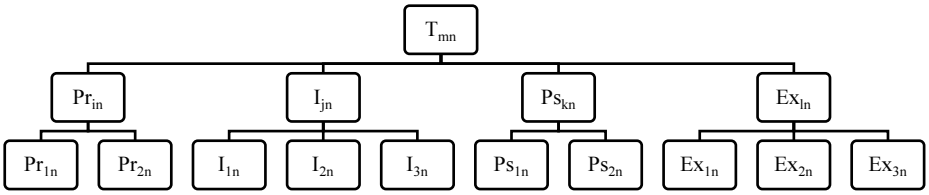

Figure 1. Evaluation index system for achieving H-I-C

Table 2. Evaluation Index System and Weight Assignment of "H-I-C"

Evaluation Indicators	Description	Weight (%)
T_{mn}	Evaluation Results	
Pr_{in}	Pre-class Evaluation	
Pr_{1n}	Preview Video Watching Progress	*10*
Pr_{2n}	Pre-class Test Scores	*10*
I_{jn}	In-class Evaluation	
I_{1n}	Attendance	*5*
I2n	Mutual Evaluation Among Students	*20*
I3n	Projects Participation	*15*
Pskn	Post-class Evaluation	
Ps1n	Post-class Test Scores	*10*
Ps2n	Teacher's Evaluation of the Projects	*30*
Exln	Extra Scores	
Ex1n	Participation in Research Projects	*0-5*
Ex2n	Awarded Prizes Related to the Course	*1-5*
Ex3n	Publication of Papers and Patents	*1-5*

The parameters involved in the table 2 have the following values:

i=1，2；j=1, 2, 3；k=1, 2, 3；m=Pr, I, Ps；n=1, 2, 3.

$$\sum Pr_{in}=20 \tag{1}$$

$$\sum I_{jn}=40 \tag{2}$$

$$\sum Ps_{kn}=40 \tag{3}$$

$$\sum T_{mn}\leq 100 \tag{4}$$

3.4.2. Teacher Teaching Evaluation

In addition to evaluating students, combined with the use of Mid term Student Feedback (MSF) consulting services. Counselors conduct classroom observation, collect student feedback, and provide corresponding teaching advice to help teachers identify and solve problems. Assist teachers in determining the direction and methods of teaching adjustment based on student feedback and teaching consultation, and implement them in teaching to improve classroom teaching, improve teaching level, achieve two-way evaluation between students and teachers, and facilitate teachers' timely teaching reflection and improvement adjustments.

4. Analysis of Teaching Innovation Achievements

4.1. Analysis of Course Assessment Quality

The teaching reform practice takes 2018 students as the control group, 2019 and 2020 students as the control group, with the average score as the observation point. Through the implementation of teaching reform, the average scores of students in both 2019 and 2020 levels have significantly improved, as presented in Figure 2.

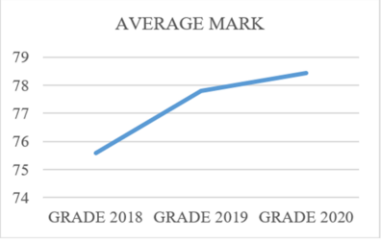

Figure 2. Growth chart of average score of final overall evaluation of road engineering theory and technology from 2018 to 2019

4.2. Student Feedback

The final student evaluation results showed that most students reported that the learning of the course was highly challenging and participatory, and the process was very difficult.

After class, they spent a lot of time, but when they saw their achievements, they felt very fulfilled. I feel like a true designer and construction technician, realizing that the work is not easy and cannot be a bit careless or casual. Feel your own shortcomings and spend more time learning to make up for them in the future.

4.3 Promotion Value

The curriculum emphasizes the output of abilities and achievements, with a student-centered approach and emphasis on students' autonomous knowledge construction, closely linked to the ideological and political aspects of the curriculum. The innovative concepts, ideas, and implementation paths of this course have been promoted to courses such as "Engineering Surveying" and "Traffic Investigation and Analysis", and initial results have been achieved. These courses have successively been approved by the school level curriculum construction project. The methods of course content reconstruction, course organization, and academic evaluation are all universal and applicable to many courses, with strong promotion value.

5. Conclusion

The objectives of this course possess a certain level of sophistication, innovation, and challenge. The teaching content has been restructured in a project-based manner, with a certain depth and breadth, seamlessly connecting with job positions, making students feel more engaged. During the implementation process, the curriculum design emphasizes participatory and experiential learning, cultivates students' autonomous learning and collaborative communication abilities, stimulates their innovative thinking, and embodies the idea of cultivating morality and cultivating people, as well as the educational and teaching philosophy of "student-centered and output oriented". The content and methods of assessment and evaluation are relatively innovative, strengthening the process assessment and the evaluation of achieving high-level goals and ideological and political goals. This course has been taught to three students and has been continuously improved and enhanced in teaching practice.

However, the starting point of online learning and evaluation before and after class is to appropriately increase students' burden and achieve the goal of high order. The quality of its completion directly affects the effectiveness of classroom teaching. However, the formation of students' endogenous learning motivation requires a certain amount of time. When students' endogenous learning motivation is still insufficient and their awareness of extracurricular learning is poor, it is necessary to add certain external measures to ensure the effectiveness of extracurricular online learning to achieve good complementarity between online, offline, and in class and out of class. In this regard, more extensive exploration should be carried out.

The development of information technology is advancing rapidly, and the research results in education and teaching are also changing day by day. Teaching work should also keep up with the trend of the times, carry out continuous reform and innovation. Teaching innovation work has a heavy and long way to go and requires continuous exploration and practice by educators.

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