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Bioengineering Downstream Technology Online Open Course Drives SPOC Hybrid Teaching Reform Based on Ideological and Political Education

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Abstract: In the context of emerging engineering disciplines, a hybrid teaching reform for the Bioengineering Downstream Technology course, based on ideological and political education and online open courses, is being carried out. This reform focuses on aspects such as "building a professional teacher team for ideological and political education, scientifically designing the ideological and political teaching system, innovating classroom teaching methods, and improving both formative and summative evaluation systems." The "Craftsmanship in Education and Cultivating Soul and Roots" small private online course hybrid teaching reform for the Bioengineering Downstream Technology online open course provides a replicable model for the comprehensive implementation of ideological and political education in engineering courses and offers a reference for advancing ideological and political education and hybrid teaching reform in new engineering disciplines.

Keywords: Bioengineering Downstream Technology; Ideological and political; Online open course; Hybrid teaching

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1. Introduction

New engineering is set against the backdrop of new economies and industries. It is guided by the principle of cultivating virtue and character, with a construction concept focused on responding to changes and shaping the future. The approach involves inheritance and innovation, interdisciplinary integration, and coordinated sharing to cultivate innovative, diversified, and high-quality engineering talents who are well-prepared for future development [1]. The quality training of engineering talents in China generally reflects the lack of ability to solve practical problems and innovation ability [2]. In the global new ecosystem characterized by new technologies, industries, business models, and patterns, there is an urgent need to cultivate high-level applied talents in new engineering who are guided by virtue [3]. According to literature reports, there is a lack of research on ideological and political teaching reform under the background of new engineering in China, and less

research on ideological and political reform in practical teaching activities [4]. The decoupling of ideological and political courses is common, and the specialized courses of science and engineering have not formed a scientific and systematic integrated education concept [5]. Although many efforts have been made in universities to reform ideological and political education and some representative courses have been developed, there is still relatively weak normative construction and institutional support in aspects such as overall design, pathways and carriers, effectiveness evaluation, and safeguard mechanisms [6]. Domestic scholars have done a lot of research based on the teaching mode and evaluation system of the standard professional courses of "Two Characteristics and One Degree," but the research on ideological and political teaching of professional courses is still loose and randomized. Building ideological and political teaching and evaluation systems for professional courses according to the "Two Characteristics and One Degree" standard is a new challenge [7,8].

Hybrid teaching involves both face-to-face and online teaching, a mix of a variety of teaching methods, teaching tools, and teaching elements [9]. It fully leverages the teacher's guiding role while emphasizing the central position of students, extending the learning environment and expanding learning resources and activities. This approach enhances student learning efficiency, helps broaden and deepen the knowledge system constructed by students, and improves their abilities and overall quality [10]. Some researchers at home and abroad have constructed different hybrid teaching modes on the basis of relevant theoretical and practical research, such as based on the small private online course (SPOC) hybrid teaching mode, CRI hybrid teaching mode characterized by Combine, Re-design, and Independent elements [11], four-level hybrid teaching mode ranging from simple combination, integrated, to cohesive and fully blended models [12], and Synchronous Hybrid Learning[13].

Bioengineering Downstream Technology is an important core professional course in the bioengineering major. It is characterized by its comprehensive and practical nature, emphasizing not only the integration of different disciplines but also the enhancement of students' innovative thinking and practical skills. Scholars from other domestic universities have also done some research on the Bioengineering Downstream Technology courses. For example, Zhang *et al.* systematically explored the "value" gene contained in the curriculum and explored the effective path to realize the ideological and political of the curriculum from the aspects of teaching objectives, content, assessment systems, and team building [14]. Xia *et al.* aimed at the three pain points of unreasonable course structure, inadequate holistic education, and insufficient practical innovation. They innovated in teaching design, implementation, and evaluation to achieve an organic connection among the course, course system, holistic education, and practical innovation [15]. Fu *et al.* explored the hybrid teaching mode of "Bioengineering Downstream Technology Experiment." By integrating and optimizing online and offline teaching resources, and designing and organizing related activities, they aimed to improve learning outcomes and enhance support for cultivating biotechnology talent [10]. Su *et al.* organized course content based on the sequencing of work processes. By designing related case studies from enterprises in Hengshui, they achieved certain results in preparing students for employment after graduation [16].

Bioengineering major is the key major and a demonstration major of our school. Bioengineering Downstream Technology is the core professional course of the bioengineering major, and it is recognized as the first-class undergraduate course in Guangdong Province. According to the university's focus on application-oriented talent cultivation, it is crucial to explore the integration of "knowledge transmission, capability development, and ideological and political education" within the Bioengineering Downstream Technology course. This includes investigating the construction of online open courses, enhancing teachers' dual abilities in moral and intellectual education, and developing hybrid teaching methods and strategies for both classroom teaching and ideological and political education as pressing tasks in talent cultivation.

2. Online open course teaching reform of Bioengineering Downstream Technology

Focusing on the goal of cultivating high-quality application-oriented professionals with "moral integrity, practical expertise, innovative courage, and entrepreneurial spirit," this approach emphasizes the development of "professionalism, craftsmanship, and a sense of responsibility" to nurture high-quality, practice-oriented talent with innovative spirit in the field of bioengineering, contributing to local economic development and national needs [17]. Under the new engineering background, the teaching reform of the online open course for Bioengineering Downstream Technology integrates aspects such as "knowledge exploration, capability development, personality cultivation, and value shaping" into the talent cultivation plan. The teaching syllabus highlights ideological and political education, reconstructs the course content, and redefines the course objectives. It implements a philosophy that emphasizes a humanistic foundation, practical application, and alignment with professional needs. The integration of ideological and political education elements into the online open course and massive open online course (MOOC) content is designed to align with enterprise production processes and students' learning realities, aiming to reflect the educational value and impact of the course. The reform will focus on aspects such as "improving the ideological and political education capabilities of the teaching team, exploring integration pathways for ideological and political education into the curriculum, establishing a school-enterprise ideological and political education practice base, implementing a "Three Stages + Three Modes + Three Reflections" mixed teaching model, and improving the process and summative evaluation systems.

2.1. Improving the ideological and political education ability of the teaching team

Raising awareness of the ideological and political education tasks of professional course teachers and enhancing the professionalism of ideological and political education is crucial [18]. Improving the ideological awareness, political stance, and informatization teaching methods of professional teachers at various stages of talent cultivation is essential to building a development path where "knowledge system education and ideological and political education are organically integrated" [19]. The construction of curriculum ideological and political education is advanced through the collaboration of the school party committee, the college party committee, the grassroots party branches of teachers, and party members. The college party committee creates an ideological and political education environment in the second classroom and establishes exemplary "Sanquan Education" model colleges. It also leverages the pioneering and exemplary role of teacher party members in the construction of curriculum ideological and political education, mobilizing their reform wisdom and exploratory enthusiasm from the perspective of "educating people for the Party and training talents for the country" [20]. Strengthening the construction of teacher ethics and conduct, and establishing platforms for exchanging ideas on curriculum ideological and political education [21]. Promoting communication among professional teachers, administrators, ideological and political course teachers, and students through education on party history, implementing the important speeches of the General Secretary, and other activities.

Teacher teams should strengthen their own professional ethics and improve their vocational qualities; enhance teachers' teaching levels and their ability to use modern teaching tools; encourage teachers to serve in grassroots positions and take on roles in enterprises to gain practical production experience that can be used for problem-based learning (PBL) teaching; strengthen the construction of the curriculum ideological and political education team, comprising key teachers from both professional courses and ideological and political courses, to deeply explore ideological and political elements in the curriculum [22]. They should also leverage collective power and wisdom to effectively drive the reform and innovation of curriculum ideological and political education; organize teaching activities such as seminars, teaching salons, collaborative lesson planning, and peer review sessions; establish exemplary models and utilize outstanding teachers as role models to inspire others; form a curriculum ideological and political guidance and supervision team to provide support and

assistance for curriculum ideological and political education construction [23].

2.2. Constructing the course ideological and political teaching system to explore the integration methods

From the perspectives of the relevant profession, industry, national, international, cultural, and historical contexts of the course, we refine the ideological and political elements of the curriculum, and construct a curriculum ideological and political teaching system, integrating it into the development of professional course curricula [24]. Teachers should focus on "educational goals, talent cultivation systems, teaching teams, course content, teaching resources, and practical components," and innovate teaching concepts and methods for ideological and political education. Teachers should reflect innovative teaching concepts and educational methods in case design, practical teaching, and resource development; utilize open and shared online course resources to expand the temporal and spatial dimensions of ideological and political teaching design. Centered around the love for the Party, love for the country, love for socialism, love for the people, and love for the collective, they should optimize the content of ideological and political education focusing on political identity, patriotism, cultural literacy, constitutional and legal awareness, and moral development; refine the ideological and political elements of the course, develop the course syllabus, design ideological and political teaching guides and cases, and integrate the cultivation and practice of socialist core values [25], constitutional and legal education, career ideals, and professional ethics into both online and offline, inside and outside the classroom teaching. Teachers construct a network teaching platform for expanding ideological and political resources through online and offline knowledge delivery, Q&A, practical investigations, and thematic education, leveraging the "main channel" function of ideological and political education in the classroom [26]. Continuously expand the space for ideological and political education in both primary and secondary classrooms, improve the adaptability of ideological and political education, expand its coverage, innovate educational carriers, and explore ideological and political education approaches through extracurricular science and technology competitions and other practical activities.

The university Party committee leads the "moral education" initiative, while the departments guide "ideological and political education," forming a collaborative mechanism involving the "university Party committee–department Party committee–faculty branches–Party members," creating an ideological and political education system with a "macro environment–micro environment–microcosm." With the core of talent cultivation focused on "patriotism, dedication to one's work, and innovative thinking," a "six-in-one" ideological and political education model is established, comprising "secondary Party committees–departmental faculty Party branches–faculty Party members" and "theory–practice–extracurricular activities," fully implementing the "three-dimensional education" approach to form a comprehensive ideological and political education environment. Professional teachers and ideological and political course teachers work together to create a "four-in-one" ideological and political system involving "ideological and political courses–professional courses–general education courses–labor education," using teaching methods such as PBL, BOPPPS, and contextual teaching and learning (CTL), and leveraging virtual simulations, information platforms, and teaching software apps to build SPOC hybrid teaching. This achieves a multi-dimensional educational "new realm" encompassing "in-class–out-of-class–online–offline" environments, which serves as the small educational environment for the course. The education philosophy of "student-centered craftsmanship, soul-casting, and foundational building" sets knowledge, skills, qualities, and value shaping as the course teaching goals, refining six primary ideological and political points: "patriotism, craftsmanship spirit, scientific thinking, engineering ethics, innovative spirit, and professional qualities," with first-level dimensions and second-level indicators. A teaching guide compiling typical ideological and political cases is created, establishing a micro-environment

for ideological and political materials. Key ideological and political education elements include: "Party history and university history, red gene inheritance, promotional videos for the major, professional education, teacher ethics and style, industry-education-research practice bases, and COVID-19 related topics." These elements aim to cultivate moral integrity and academic breadth from a professional perspective, enhance patriotism, value judgment, and political identity; stimulate self-improvement and foster professional qualities and innovation from a career standpoint; and interpret ecological civilization and cultivate scientific thinking in students.

2.3. Constructing a school-enterprise ideological and political practice education base

Establishing off-campus practice bases for university students serves as a breakthrough point for reforming practical teaching. Emphasizing "integration of production and education," the goal is to co-create a long-term collaborative mechanism for off-campus practice teaching bases through innovative concepts, systems, and models [27]. The college signs agreements with enterprises to appoint enterprise-based mentors and add leading enterprises as cooperative practice and education bases, jointly creating practice education bases for student Party members. Enterprise practice mentors provide guidance and training in ideological leadership, professional ethics, and work skills. School-enterprise cooperation extends to enhancing the ideological and political awareness and consciousness of non-Party students.

The off-campus teaching internship bases play a crucial role in deepening the integration of production and education, promoting students' innovation and entrepreneurship education, and establishing a long-term practice education mechanism. By focusing on student Party members, a school-enterprise ideological and political practice education base is created, forming a mutually reinforcing system for effective Party building and talent cultivation. Student Party members participate in practice education activities in both the base and society. The college collaborates with leading enterprises and alumni companies to appoint enterprise mentors, extending the ideological and political content of the second classroom through the construction of school-enterprise practice education bases, thus forming a diversified "second classroom" for collaborative education enhancement.

2.4. Hybrid teaching of "three stages + three models + three reflections" based on ideological and political courses

The teaching team will produce an MOOC on downstream technologies in bioengineering with ideological and political education content, establishing high-quality and rich online learning resources. They will build an information-based teaching resource repository, integrating teaching content with cutting-edge discipline topics and continuously updating resources. Ideological and political education content will be combined with theoretical course content in both online and offline formats, creating an extracurricular ideological and political education resource area [28]. The diversified SPOC hybrid teaching model will adopt the "three stages + three models + three reflections" approach: three stages are "progressive goal setting, teaching design, and teaching evaluation," the three models are "integration of ideological and political education, PBL interaction, and clinical practice," and the three reflections are "process evaluation reflection, peer learning reflection, and team collaboration reflection" [17].

Using a "student-centered" approach and the OBE (outcome-based education) teaching philosophy, the SPOC hybrid teaching model is constructed based on enterprise production cases, virtual simulation experiments, and cutting-edge disciplinary topics. The teaching team focuses on the initial course design, organizing students into groups one week before the start of the semester, and collecting team information and personal introductions. Through initial class case teaching, scenario simulation, and game observation, ideological and political education points are integrated into the course using teaching methods such as BOPPPS, PBL, and OBE. Before, during, and after class, a project organization framework is created in small

groups using problem-based learning, guiding students in analyzing engineering issues such as separation and purification. PBL group collaboration and the iterative integration of new and old interdisciplinary knowledge drive the refinement of students' professional knowledge systems. In pre-class, project tasks are assigned, and group members define project goals and methods; during class, project discussions are conducted to identify problems and propose solutions; in post-class, revisions are made to form a final project report.

2.5. Process and comprehensive evaluations

Teachers explore the establishment of scientific and reasonable evaluation indicators for integrating ideological and political education into the curriculum, to effectively assess and verify the impact of educational efforts. Adhering to the principles of "diverse goals and emphasis on process," both formative and summative evaluations are conducted, focusing on teachers, students, educational content, and teaching methods. The aim is to use evaluation mechanism optimization as an opportunity to establish a scientific and reasonable set of ideological and political education evaluation indicators [29]. The course grade is 60%, and the final exam is 40%.

The teaching objectives shift from basic cognition to the design, implementation, and evaluation of bioseparation and purification processes. The evaluation criteria encompass knowledge, skills, and emotional aspects, utilizing information technology for formative assessment. The focus is on assessing professional knowledge and capabilities, with a particular emphasis on evaluating ideological and political education elements. Teachers use online learning platforms to track student interactions with ideological and political content, including click-through rates and viewing times, as well as students' reflections on the ideological content and their emotional expressions and submissions. These aspects are quantified as part of the ideological and political education evaluation, accounting for 5% to 10% of the total semester grade. The evaluation includes "task-driven" theoretical self-study, "feedback sharing" during class, and post-class reflection. During the final group defense, self-assessment, peer evaluation, and reflection reports are used to evaluate students' attitudes, abilities, and learning outcomes. Students participate in self-assessment and peer assessment, and feedback mechanisms are established for evaluations of teachers and classmates, creating a comprehensive evaluation model for learning attitudes, capabilities, and effectiveness.

3. Conclusion

In the context of new engineering, the SPOC hybrid teaching reform for the downstream technology of bioengineering integrates ideological and political education through the "big, small, and micro" environments. The reform innovates the "artisan education" model, integrating ideological and political education both online and offline, and within and outside the classroom. It focuses on student-centered, interdisciplinary, deep learning and reflection, enhancing teamwork and innovative thinking. This model provides a replicable and referable approach for applying ideological and political education in engineering courses and is of significant importance for the comprehensive promotion of ideological and political education in science and engineering education.

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