

Mechanisms and Pathways for Construction of Teaching and Research Section of Food Engineering Course Group Based on Engineering Education Accreditation

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Abstract: The cultivation of students' engineering practice abilities in the Food Science and Engineering major is facing new challenges and requirements, driven by two key forces: new engineering construction and engineering education accreditation. The present study addresses the practical difficulties encountered by grassroots teaching organisations in local universities. It clarifies the practical needs and construction objectives of the Teaching and Research Section of the Food Engineering Course Group. In addition, it elaborates on the section's construction framework and connotations, constructs four mechanisms for building the section, and further proposes five core construction pathways. Empirical evidence has demonstrated the efficacy of these mechanisms and pathways in enhancing the quality of teaching in the course group and significantly promoting students' engineering practice abilities, particularly their ability to solve complex engineering problems. This study provides a reference model for the innovation of grassroots teaching organisations in food majors.

Keywords: Engineering Education Accreditation, Food Engineering Course Group, Teaching and Research Section, Outcome-Based Education Philosophy, Mechanisms and Pathways

1. Introduction

In the domain of higher engineering education, new engineering construction and engineering education accreditation have emerged as pivotal catalysts for the reforms of talent cultivation models [1]. The Outcome-Based Education (OBE) philosophy, as advocated by engineering education accreditation, emphasizes student-centeredness, output orientation, and continuous improvement, aiming to cultivate outstanding engineering talent capable of solving complex engineering problems [2]. The Food Science and Engineering major, as a conventional engineering major, is required to align its talent cultivation with the food industry's transformation and upgrading demands. This necessitates a continuous enhancement of students' engineering practice and innovation capabilities.

However, traditional Teaching and Research Sections often exhibit outdated concepts, inefficient organization, and a lack of vitality, resulting in imbalances in the teaching ecology [3]. The following specific manifestations are of particular relevance: structural contradictions between teaching supply and demand; traditional teaching and research reliant upon fixed physical spaces and linear teaching processes, which are incapable of meeting students' personalized learning needs; resource constraints on teacher collaboration and development, with teachers often working in isolation; and adaptive conflicts between educational innovation and institutional systems, where rigid management systems clash with the flexibility required for digital educational innovation [4]. These issues are especially evident in the instruction of food engineering courses, underscoring the need for systematic reform through the construction of Teaching and Research Sections.

The Teaching and Research Section, as the most fundamental grassroots teaching organization in universities, plays an irreplaceable role in implementing teaching tasks, conducting pedagogical discussions, enhancing teaching quality, and promoting teacher growth. Concurrently, the Virtual Teaching and Research Section, as a novel grassroots teaching organization, offers valuable insights into the innovative development of physical Teaching and Research Sections through its construction concepts and functions [5]. In consideration of the aforementioned background, the present study

systematically explores the mechanisms and pathways for integrating the concepts of engineering education accreditation into the construction of the Teaching and Research Section of the Food Engineering Course Group. This is done with a view to providing references for the innovation of grassroots teaching organizations and the improvement of the quality of talent cultivation in universities.

2. Theoretical Foundations and Practical Needs for Construction of Teaching and Research Section of Food Engineering Course Group

2.1. Core Concepts of Engineering Education Accreditation

The OBE philosophy underpins the core of engineering education accreditation, with its fundamental tenets comprising three core concepts: student-centeredness, output orientation, and continuous improvement [6]. Student-centeredness emphasizes that the design of teaching activities should center on students' learning outcomes and developmental needs. The output orientation requires a reverse design of the course system and teaching content, starting with graduation requirements, to ensure that each course's teaching objectives clearly support the indicators of those requirements. Continuous improvement emphasizes the establishment of a closed-loop quality assurance mechanism to optimize the teaching process through multi-dimensional evaluation and feedback constantly.

For the Food Science and Engineering major, engineering education accreditation places particular emphasis on students' ability to apply mathematics, natural sciences, fundamental engineering principles, and professional knowledge to solve complex engineering problems in food engineering. This requirement is directly pertinent to the design of teaching objectives and the organization of teaching content for core engineering courses, including Principles of Food Engineering, Food Machinery and Equipment, and Food Factory Design. The level of construction directly impacts the achievement of talent cultivation goals, as the Teaching and Research Section is the direct administrator of these courses.

2.2. Systems Theory Perspective on Course Group Construction

The Food Engineering Course Group is organically integrated from seven courses: Principles of Food Engineering, Principles of Food Engineering Laboratory, Principles of Food Engineering Course Design, Food Machinery and Equipment, Food Factory Design, Food Factory Course Design, and Comprehensive Food Engineering Laboratory. These courses form a logically rigorous and progressively layered teaching system. The Principles of Food Engineering serves as the core theoretical foundation of the course group, systematically elucidating the intrinsic principles of unit operations. The translation of theoretical principles into specific production equipment is the primary function of the Food Machinery and Equipment. Concurrently, the Food Plant Design integrates theoretical and equipment knowledge to apply them to the construction of entire production systems. The Principles of Food Engineering Laboratory assists students in consolidating their theoretical knowledge by engaging in fundamental operational verification. The Principles of Food Engineering Course Design prioritizes training in unit operations to enhance students' preliminary application skills. The Food Factory Course Design offers further guidance to students in mastering systematic engineering design methods. Finally, the Comprehensive Food Engineering Laboratory adopts a comprehensive and innovative project-based approach to cultivate students' ability to apply interdisciplinary knowledge to solve complex engineering problems, develop experimental design skills, and foster teamwork spirit. Consequently, each practical teaching component is systematically integrated with the theoretical courses, forming a cohesive sequence that collectively constitutes a comprehensive training program in engineering capability. This program encompasses the theoretical foundations, equipment recognition, and system design, culminating in comprehensive innovation. Research indicates that the logical organization of courses into course groups can effectively reduce content repetition, facilitate students' development of multidimensional thinking and holistic perspectives, and address disjointed course content [7]. Therefore, the establishment of a Teaching and Research Section grounded in the course group facilitates teachers' transition away from the insularity of standalone courses, thereby promoting effective connections and coordination among courses and cultivating a collaborative educational synergy.

2.3. Framework and Connotation of Teaching and Research Section Construction

The construction of the Teaching and Research Section of the Food Engineering Course Group follows the logical hierarchy of "foundation as root, motivation as core, implementation as key, and goal as guide," thereby promoting systematic progression across four levels. At the foundational level, it

builds a logically rigorous course system based on the seven courses, thereby establishing a progressive relationship from theoretical foundation, equipment recognition, system design, to comprehensive innovation, thus laying a solid foundation for the section construction. Based on the previously established foundation, the motivation level is oriented towards the construction of teams and mechanisms. To this end, a teaching team is to be constituted, comprising program leaders, core faculty members, and enterprise experts. In addition, growth programs are to be implemented for young faculty members to foster interdisciplinary integration. Furthermore, robust operational, evaluation, incentive, and feedback mechanisms are to be established. These mechanisms are intended to provide dual guarantees of human resources and institutional systems, thereby ensuring the sustainable development of the section. At the implementation level, the focus is on optimizing the course system and innovating pathways; developing digital teaching resources, such as case libraries and virtual simulations, for collaborative sharing; deepening industry-education integration by jointly building training bases to strengthen practical teaching; and continuously innovating the formats of teaching and research activities. The overarching objective is guided by the top-level design, which is clearly aimed at cultivating high-quality food talent that possesses strong engineering practice skills and an innovative spirit. This approach ensures that all construction activities contribute to the formation of a student's complete chain of engineering capabilities, from theoretical foundations to comprehensive innovation.

2.4. Practical Needs and Significance of Teaching and Research Section Construction

The practical needs for constructing the Teaching and Research Section of the Food Engineering Course Group are derived from the following aspects. First, the need to address repetition and disconnection in course content arises because courses are taught by different teachers who lack effective communication skills, resulting in repeated content or poor continuity. Second, some young teachers lack an engineering background, which hinders their ability to seamlessly integrate theoretical knowledge with engineering practice, thereby impacting the quality of their practical instruction. Third, engineering education accreditation requires students to possess strong engineering literacy and the ability to solve complex engineering problems. This necessitates the implementation of a systematic engineering training curriculum.

Addressing these needs, the section construction holds multiple significances. First, the section provides a convenient platform for teacher collaboration and exchange, promoting the sharing of teaching experiences and the exchange of teaching wisdom, helping coordinate course content arrangements, and effectively addressing issues of repetition and disconnection. Second, it offers a platform for teachers to practice and reflect. Through activities such as classroom observation, peer evaluation, and teaching seminars, teachers can continuously reflect on their teaching practice and thereby enhance their ability to teach engineering practice. Third, it helps train students in a real engineering environment by introducing enterprise resources that meet the requirements of engineering education certification. Fourth, the construction of the section is a crucial starting point for implementing the fundamental task of fostering virtue through education. Through the systematic design and implementation of course-based ideological and political education, it can achieve the organic unity of knowledge transmission, ability cultivation, and value guidance.

3. Mechanisms for Constructing the Teaching and Research Section of the Food Engineering Course Group

3.1. Organizational Operation Mechanism

The fundamental guarantee for the sustainable development of the Teaching and Research Section of the Food Engineering Course Group is an effective organizational operation mechanism. At the top-level design and planning level, the section has formulated the Mid-to-Long-Term Development Plan, clarifying the construction orientation of "building a distinctive teaching community for the group guided by engineering education accreditation and the OBE philosophy." The plan emphasizes the formulation and refinement of a series of management systems, the optimization of the course system, the establishment of a teaching assessment system, the enhancement of teaching syllabuses, the reinforcement of the teaching team, the deepening of teaching reform, the promotion of industry-education collaboration in talent cultivation, and the consolidation of teaching achievements. In terms of the organizational structure, a three-tier management system comprising "Section Head, Course Leader, and Core Faculty" has been instituted. Concurrently, teaching teams have been established to facilitate interdisciplinary teaching and research across various courses. In terms of the operational system, a

routine mechanism for teaching research activities has been instituted. This mechanism entails the regular organization of thematic teaching seminars and the archiving of comprehensive records. These records serve as indispensable evidence for the effective monitoring of teaching quality. This series of mechanisms, ranging from macro-planning to micro-implementation, ensures that all the section's work is carried out methodically and in an orderly manner.

3.2. Course Reconstruction Mechanism

The course serves as the core element in talent cultivation, while the course restructuring mechanism forms the cornerstone of the Teaching and Research Section. Based on the OBE philosophy, the section has instituted a three-dimensional course restructuring mechanism comprising "goal integration, content integration, and ideological-political integration." In terms of goal integration, the section initially decomposed the 11 graduation requirements for engineering education accreditation into teachable and assessable indicators. It then reverse-designed the overall teaching objectives of the course group. To illustrate this, the cultivation of "complex engineering problem-solving ability" is taken as an example. This ability is decomposed into four progressive levels: "problem identification and articulation", "mathematical modeling", "solution design and evaluation", and "engineering analysis and decision-making". These levels are assigned to the specific teaching objectives of the seven courses, forming a gradient progression in students' ability development. In terms of content integration, the section has organized the teachers of the seven courses to systematically review the course content, establish a knowledge graph for the course group, and clarify the prerequisite and subsequent relationships between knowledge points. Based on this foundation, the team has integrated and optimized overlapping course content. For instance, the repeated content on "fluid flow resistance" taught in both Principles of Food Engineering and Food Machinery and Equipment was integrated by establishing a theoretical foundation in the Principles of Food Engineering course and focusing on specific applications in the Food Machinery and Equipment course, achieving seamless inter-course integration. In terms of ideological-political integration, the section has organized teachers to systematically explore ideological and political education resources in each course. This exploration is intended to build a course-based ideological and political education material library. The library will be developed around three main themes: the "craftsman spirit," "serving the country through science and technology," and "green, sustainable development". The themes form a matching relationship of "knowledge point - case - ideological and political element" to ensure that each chapter of every course has clear ideological-political elements and integration pathways. Furthermore, the continuous improvement of teaching content is a crucial guarantee of the course restructuring mechanism. The section has established a dynamic updating mechanism for teaching content, regularly reviewing and adjusting it to ensure alignment with contemporary developments.

3.3. Teaching Model Innovation Mechanism

The integration of innovative pedagogical models into engineering education is imperative for cultivating students' practical engineering competencies. The Teaching and Research Section has explored and established a teaching model innovation mechanism characterized by "project-driven, virtual-actual combination." This mechanism emphasizes the synergistic cultivation of students' engineering practice ability and professional ethics. In terms of project-driven teaching, the section has transformed faculty research projects or enterprise cooperation projects into teaching cases, integrating them throughout practical activities such as course design and comprehensive experiments. For example, in the Comprehensive Food Engineering Laboratory, students are required to complete the entire process from raw material selection, process optimization, product preparation, to quality evaluation as a team. This transformation of conventional verification experiments into exploratory practices has been shown to significantly enhance students' innovative thinking and their ability to apply knowledge comprehensively. In terms of virtual-actual integrated experiments, the section has developed several virtual simulation experiment projects that rely on the university's Virtual Simulation Experiment Teaching Center. These projects have effectively improved students' understanding of the complexity of engineering problems. Concurrently, the enhancement and refinement of pedagogical methods have played a pivotal role in fostering innovation. In the context of classroom instruction, teachers adopt a teaching process that includes the introduction of problems, the promotion of heuristic thinking, the delivery of theoretical instruction, and the formulation of summaries. For instance, in the heat transfer chapter, an open-ended question was posed: "How to enhance the heat transfer efficiency of heat exchangers?" This approach was implemented to encourage students to engage in active thought before the systematic delivery of theoretical content. This pedagogical strategy has been shown to effectively

stimulate students' learning initiative and creativity. The section has built upon this foundation to systematically optimize the practical course system, forming a progressive practical teaching system of "basic experiment - course design - comprehensive innovation." This system is designed to systematically cultivate students' engineering practice capabilities. Concurrently, the incorporation of ideological and political education within courses serves to fortify students' professional ethics and sense of social responsibility.

3.4. Industry-Education Collaborative Talent Development Mechanism

The integration of industry and education is imperative for the cultivation of new engineering talents. The Teaching and Research Section has established an industry-education collaborative talent development mechanism, characterized by "resource co-construction, faculty mutual appointment, and platform sharing." This mechanism is made possible by the college's long-term cooperative relationships with enterprises. In terms of the resource co-construction, the section collaborates closely with leading regional food enterprises, inviting enterprise experts to participate in revising talent cultivation programs, selecting course design topics, and developing comprehensive experimental projects. This ensures that teaching content aligns with industry needs. In terms of the faculty mutual appointments, the section has instituted a mechanism to cultivate a "double-qualified" teaching team. On the one hand, the institution has appointed enterprise technical experts as adjunct professors to share cutting-edge industry technologies and engineering practices. On the other hand, it implements a system that enables young teachers to gain experience in enterprises, effectively compensating for their lack of engineering backgrounds. In terms of the platform sharing, the section and enterprises have collaboratively established internship and training bases, thereby establishing a progressive practical teaching system of "recognition internship - production internship - graduation internship." During the recognition internship phase, students are expected to visit enterprise production lines to gain perceptual knowledge. During the production internship phase, students engage in practical production operations through group-based, on-the-job training. During the graduation internship phase, students complete graduation design projects that are aligned with real enterprise needs. This mechanism enables students to engage in repeated practice in authentic engineering environments, thereby significantly enhancing their ability to solve complex engineering problems. It also facilitates the organic integration of the education, talent, and industrial chains.

4. Pathways for Constructing the Teaching and Research Section of the Food Engineering Course Group

4.1. Defining Development Direction to Steadily Advance Teaching and Research Section Construction

To ensure the correctness of the development direction and the stability of the construction process, the Teaching and Research Section has consistently adhered to strategic guidance during its construction, establishing a "three-step" development plan. The primary tasks of the first step are as follows: to refine the teaching syllabuses of the course group, clarifying course objectives, teaching content, teaching methods, and assessment approaches based on engineering education accreditation standards; to optimize the teaching team structure by recruiting or training teachers with engineering backgrounds and practical experience; to deepen teaching method reforms by exploring project-based learning, blended learning, case-based teaching and other approaches; and to implement the OBE philosophy by clarifying the overall learning outcome objectives of the course group and refining them into specific objective points for each course linked to graduation requirement indicators. The main tasks of the second step are as follows: to optimize the course system by adjusting and optimizing the course structure according to the OBE philosophy to ensure close content connection and avoid repetition among the courses; to construct a scientific and reasonable teaching assessment system by designing and implementing a teaching evaluation mechanism based on learning outcomes; to promote industry-university-research cooperation by strengthening corporate partnerships and establishing internship bases; and to integrate innovation and entrepreneurship education into the course group teaching by organizing students to participate in innovation and entrepreneurship competitions. The primary tasks of the third step are as follows: to comprehensively evaluate the teaching quality of the course group, summarize teaching experiences, identify problems, and propose improvement measures; and to summarize the section's construction achievements, comprehensively evaluate the implementation effect of the OBE teaching assessment system, and continuously improve and optimize the construction of the

teaching system, faculty, teaching methods, and practical teaching. This development plan provides a clear timeline and roadmap for the section's construction, ensuring the orderly advancement of all construction tasks.

4.2. Optimizing Organizational Structure to Build High-Quality Teaching Teams

Teachers are the core element of the Teaching and Research Section, and the construction of their teaching development community is crucial to its high-quality development. Therefore, the section has focused on optimizing the organizational structure to a well-structured and dynamic teaching team. In terms of organizational structure, the section has implemented a three-tier management structure comprising "Section Head, Course Leader, and Core Faculty." Additionally, it has constituted cross-course teaching teams comprising core teachers from relevant courses. These teams regularly conduct teaching research activities and jointly discuss issues such as articulating teaching content and coordinating teaching methods. These activities effectively break down barriers between courses and promote profound collaboration among faculty members. In terms of faculty development, the section has focused on structural optimization and capacity enhancement. To this end, the section has recruited high-level talent with an engineering background to strengthen practical teaching. The section has also invited enterprise experts to serve as adjunct instructors to enrich teaching with industry experience. Concurrently, a mentorship system has been established for the development of young teachers. This system guides in the domains of teaching design, teaching research, and method innovation through "peer-to-peer mentorship." The objective of this mentorship system is to foster mutual learning and collective advancement. At present, the section has established a faculty team that exhibits a reasonable age distribution, an optimized professional title structure, and a diverse array of academic backgrounds.

4.3. Integrating Internal and External Course Content to Improve Comprehensive Teaching Effectiveness

Integrating internal and external course content is an important way to enhance the efficiency of comprehensive teaching. The Teaching and Research Section is dedicated to the promotion of intra-course integration and cross-course collaboration to optimize resource allocation and utilization. In terms of the internal course integration, the section organizes teachers to discuss the division and articulation of teaching content based on the established course knowledge graph. This discussion is to promote the comprehensive application of multi-course knowledge in engineering practice. It also aims to effectively cultivate students' systematic thinking and their ability to apply knowledge comprehensively. On this basis, the section further advances the integration of external courses. Examples include incorporating knowledge from the Food Chemistry course into the comprehensive "Functional Food Development" experiment, integrating knowledge from the Food Microbiology course into the microbial control testing component of engineering experiments, and adding knowledge from the Food Analysis course to the product quality testing phase of course design. These initiatives have a substantial impact on students, broadening their intellectual horizons and cultivating their ability to solve engineering problems from a multidisciplinary perspective. Furthermore, the section integrates university and enterprise resources, leveraging enterprise resources to enhance teaching content. This is achieved by inviting enterprise experts to participate in course design and graduation project supervision, and by utilizing enterprise production lines for on-site teaching. This approach offers students the opportunity to engage with authentic engineering environments and practical problems during their university studies, thereby enhancing the practical nature of teaching.

4.4. Developing Digital Resources to Enhance Teaching Methods

The development and application of digital teaching resources are critical strategies for enhancing the quality of engineering education. The Teaching and Research Section is committed to the comprehensive integration of information technology and pedagogy. On the one hand, the section has developed three virtual simulation experiments, namely: canned fish processing, room-temperature extraction and separation of *Ganoderma lucidum*, and dietary analysis and nutritional meal planning. These experiments enable students to undertake operational training in a virtual environment, encompassing equipment structure, recognition, parameter adjustment, and fault diagnosis, thereby compensating for the limitations of physical experimental conditions. On the other hand, the section organizes teachers to establish a library of typical food engineering cases, thereby transforming real engineering problems into teaching cases that encompass process design, equipment selection, and factory layout. This facilitates shared use by teachers and students in classroom teaching, course design,

and comprehensive experiments. Concurrently, the section is engaged in a comprehensive exploration of blended online and offline teaching models. This exploration involves the utilization of online teaching platforms for flipped classrooms, discussions, and question-and-answer sessions, to foster students' learning autonomy. These measures have not only enhanced the richness and accessibility of teaching resources but also provided students with a learning experience that is more closely aligned with engineering practice.

4.5. Refining Construction Mechanisms to Stimulate the Vitality of the Teaching and Research Section

The fundamental guarantee for the sustainable and healthy development of the Teaching and Research Section is a sound mechanism. The section has established a scientific and rational operational and evaluation mechanism, and ensured the implementation of various systems to provide strong support for high-quality development. In terms of the operational mechanism, the section has established a regular teaching-research activity mechanism. At the beginning of each semester, a comprehensive plan is devised, delineating the activity themes and designated individuals responsible for their execution. Thematic teaching seminars are held monthly, focusing on core issues such as teaching method reform, experimental project development, and the integration of ideological and political education into courses. It is imperative to note that all activity records are meticulously archived, thereby serving as indispensable evidence for the effective monitoring of teaching quality. In terms of the evaluation mechanism, the section has developed a diversified teaching evaluation system that comprehensively covers both the teaching process and outcomes. The section utilizes a multifaceted evaluation approach, encompassing student evaluations, peer classroom observations, and regular inspections by teaching supervisors. This comprehensive strategy allows for a nuanced assessment of teaching objectives, content, methods, and effectiveness. This approach offers a comprehensive and objective framework for identifying and implementing instructional improvements. The section also actively introduces project management concepts by breaking down construction tasks into specific projects. Each project delineates the individual designated as the project leader, the participants, the construction objectives, and the contents. It also promotes implementation in a project-based manner, which significantly enhances the relevance and efficacy of construction work.

5. Conclusions

This study has systematically explored the mechanisms and pathways for constructing the Teaching and Research Section of the Food Engineering Course Group based on engineering education accreditation. The findings are derived from a thorough examination of the theoretical basis and practical needs that guided the section's construction. The study identifies four predominant construction mechanisms and refines five core implementation pathways. Practical results demonstrate the efficacy of these mechanisms and pathways in enhancing the course group's teaching outcomes and significantly strengthening students' engineering practice literacy. However, as a long-term, systematic endeavor, the section's construction still requires continuous exploration and improvement. In the future, the following directions will be the focal point of efforts: first, the incorporation of contributions to the section into the annual performance assessment and professional title evaluation and appointment system for teachers to further improve the incentive mechanism; second, the exploration of long-term mechanisms for university-enterprise collaboration in course development and talent cultivation to further deepen the integration of industry and education; third, the enhancement of the capability to analyze and apply teaching data to strengthen information technology development further; fourth, the establishment of more flexible and diverse forms of practical training to expand further channels for young teachers to gain engineering practice experience; and fifth, the establishment of an evaluation mechanism for the application of teaching research results further to promote the translation of teaching research outcomes into practice.

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