

Development Model for OBE-Interated Software Development Micro-Specializations in Medicine-Engineering Interdisciplinary Context

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Abstract: *In the context of Emerging Engineering and New Medicine education initiatives, the demand for interdisciplinary and innovative professionals in medicine-engineering convergence fields is escalating. Traditional pedagogical paradigms inadequately address the advanced software development competency requirements of emerging specialties such as intelligent medical engineering. This paper proposes an OBE (Outcome-Based Education)-driven framework for constructing a software development micro-specialization cluster tailored to medicine-engineering interdisciplinary programs. Through backward-designed curriculum systems, integrated project-driven pedagogy, enhanced practical training, and diversified assessment mechanisms, this model elevates students' software development capabilities and engineering practice literacy. The proposed approach effectively bridges the gap between conventional curricula and industry demands, offering a viable pathway for software design courses within the medicine-engineering interdisciplinary landscape.*

Keywords: Software Engineering, Micro-specialization Cluster, Medical-Engineering Interdisciplinary, Talent Cultivation.

1. Introduction

From the “Fudan Consensus” to the “Tianjin University Action” and subsequently to the “Beijing Guidelines,” these initiatives have charted a clear trajectory for China’s Emerging Engineering Education. The Ministry of Education’s Opinions on Accelerating the Construction of High-quality Undergraduate Education and Comprehensively Enhancing Talent Cultivation Capacity furnishes guiding principles and concrete measures, thereby endowing the cultivation of new engineering and technology talents with novel dimensions [1-2]. The Department of Higher Education’s Notice on Launching the 2024 Undergraduate Program Setup Work for Regular Higher Education Institutions advocates supporting universities in deepening the transformation of Emerging Engineering and New Medicine majors to foster distinctive and competitive programs. Guided by national strategies, medical universities’ reinforcement of Emerging Engineering program construction is emerging as a vanguard in promoting interdisciplinary integration between medicine and engineering. This process not only substantially elevates the construction standards of medicine-engineering interdisciplinary programs but also plays a pivotal role in nurturing interdisciplinary talents with innovative capabilities and practical skills, thereby establishing its irreplaceable and essential position in Emerging Engineering Education.

Establishing a scientific pedagogical framework for interdisciplinary medical-engineering education, enhancing instructional effectiveness in specialized courses, and advancing curricular reform constitute an urgent and critical imperative. As articulated by President Xi Jinping at the National Education Conference, “Efforts must be intensified to strengthen comprehensive qualities, guiding students toward integrated competency development and innovative thinking cultivation.” Accordingly, universities nationwide

are vigorously implementing the Outcome-Based Education (OBE) paradigm—a talent cultivation system predicated on student-centeredness, outcome-orientation, and continuous improvement.

2. Current Status and Challenges of Intelligent Medical Engineering Education

A qualified Intelligent Medical Engineering graduate is a high-caliber interdisciplinary professional capable of applying engineering thinking and computational technologies to solve domain-specific challenges in healthcare and pharmaceutical fields, thereby driving their digital and intelligent transformation. Students must master cutting-edge technologies including big data, blockchain, Internet of Things (IoT), cloud computing, artificial intelligence, and 5G, while concurrently cultivating profound comprehension of medical contexts and the capacity to innovate through computational technology applications. Software development competency, serving as a critical bridge between theoretical knowledge and practical implementation, is paramount for enabling the digital and intelligent transformation of medical scenarios. Nevertheless, the rapid evolution of computer technology and its profound integration with medical industry knowledge present novel challenges for educational paradigms.

Conventional pedagogical models demonstrate limited adaptability to rapid technological evolution, while the organizational architecture of curricular content inadequately cultivates students’ practical software development competencies [3]. This deficiency culminates in graduates lacking both foundational software development capabilities and domain-specific practical skills [4-5]. To address this challenge, this study proposes constructing a software development micro-specialization cluster by integrating OBE principles within traditional pedagogical frameworks.

The OBE-integrated software development micro-specialization cluster model represents a novel pedagogical framework centered on student learning, oriented toward learning outcomes, and driven by cutting-edge technologies. This model fosters students' practical competencies and innovative capabilities by integrating industry demands and disciplinary frontiers into curriculum design and syllabus development. As an emerging instructional approach that systematically classifies and organically integrates teaching content, it constitutes an innovative educational paradigm for cultivating interdisciplinary talents.

3. Constructing a Theoretical Curriculum System for Software Development Micro-Specialization Cluster Guided by Case-Based Teaching and Societal Needs

In the medicine-engineering interdisciplinary context, the core programming curriculum for Intelligent Medical Engineering constitutes an applied practical science that emphasizes the effective integration of theoretical knowledge with programming implementation. Aimed at cultivating innovative, application-oriented, and well-rounded professionals, this curriculum requires students to not only achieve comprehensive theoretical comprehension but also apply this knowledge to programming practice or implement theoretical methodologies through code. Students must synthesize theoretical frameworks from big data, blockchain, Internet of Things (IoT), cloud computing, and artificial

intelligence to develop programs that address research or industry challenges in the pharmaceutical and healthcare sectors.

This educational framework trains students to master foundational programming concepts including object-oriented programming, data structures, and algorithms, while achieving proficiency in mainstream programming languages such as Python and Java for software development. It fosters deep understanding of emerging technology principles including big data analytics, artificial intelligence, and IoT, enabling students to organically integrate these technologies into program design for developing practical applications. The curriculum cultivates systematic thinking capabilities for holistic problem analysis and resolution, stimulates innovative mindsets that encourage experimentation with novel methods to overcome technical bottlenecks, and develops students' ability to flexibly apply acquired knowledge to practical pharmaceutical industry problems. Ultimately, this enhances students' end-to-end problem-solving capabilities encompassing analysis, solution design, and coding implementation.

Based on these pedagogical objectives, a dedicated micro-specialization cluster has been designed to intensify software development skills training, building upon the existing curriculum framework structured around knowledge categories. The contents of the micro-specialization cluster are presented in Table 1.

Table 1: Correspondence Between Software Development Micro-Specialization Cluster and Traditional Curriculum

name	skills	course
Python Full-Stack Engineer	Trains students to master fundamental Python programming, Web development, web scraping, data analytics, automated testing, and AI development.	<ul style="list-style-type: none"> - Python Programming - Artificial Intelligence and Computational Intelligence - Principles of Artificial Neural Networks - Machine Learning and Medical Applications - Natural Language Processing and Electronic Health Record Mining
Senior Engineer	<p>This track enhances capabilities in complex project environment configuration and foundational framework design, mastery of microservices and distributed architecture, advanced proficiency in distributed and multi-threading optimization, expertise in distributed and multi-level cache architecture, specialized breakthrough skills in Elasticsearch massive data retrieval, visualization, and core Netty network programming, and DevOps mastery, thereby cultivating high-caliber professionals for the cloud computing era.</p> <p>Spanning frontend development to backend architecture, this track cultivates mastery in API and database design through comprehensive application of technologies including Vue.js, Node.js, Koa2, and MongoDB. Students undergo end-to-end processes encompassing requirements analysis, prototype evaluation, database and API design, frontend interface development, backend implementation, and frontend-backend integration to efficiently develop enterprise-level full-stack projects for pharmaceutical and healthcare scenarios.</p>	<ul style="list-style-type: none"> - Database Principles and Applications - Java Programming and Development Frameworks - Operating System Principles and Linux Applications - Clinical Information Management - Systems Analysis and Design
Frontend Engineer		<ul style="list-style-type: none"> - Data Structures and Algorithm Analysis - Clinical Information Management - Intelligent Medical Engineering Practice

The three micro-specializations delineated above encompass the three predominant employment trajectories in the software industry: frontend development, backend development, and artificial intelligence. The Python Full-Stack Engineer micro-specialization focuses on cultivating proficiency in fundamental Python programming, Web development, web scraping, data analytics, automated testing, and AI development. The Java Senior Engineer micro-specialization is designed to enhance capabilities in complex project environment configuration and foundational framework design, mastery of microservices and distributed architecture development, advanced progression in distributed and multi-threading optimization, advancement in distributed and

multi-level cache architecture design, specialized expertise in Elasticsearch massive data retrieval, visualization, and core Netty network programming, and DevOps proficiency, thereby cultivating high-caliber professionals for the cloud computing era. The Frontend Senior Engineer micro-specialization develops students' competencies spanning frontend development to backend architecture, encompassing API and database design, comprehensive application of technologies including Vue.js, Node.js, Koa2, and MongoDB, and engagement in end-to-end processes comprising requirements analysis, prototype evaluation, database and API design, frontend interface development, backend implementation, and frontend-backend integration to

efficiently develop enterprise-level full-stack projects for pharmaceutical and healthcare contexts.

4. Developing a Practical Curriculum System for Micro-Specialization Clusters by Linking Engineering Practice Courses with Traditional Teaching Content

The micro-specialization cluster typically spans 12-24 months, operating within the university's undergraduate professional training framework to ensure students develop comprehensive domain understanding with adequate time for specialized learning and practice. Compared to individual courses, micro-specializations exhibit greater systematic design while demanding less time and effort investment than full majors, offering enhanced flexibility, focus, and adaptability for iterative updates.

Based on preliminary investigation and analysis, student-centered, outcome-oriented micro-specializations demonstrate three distinct advantages: (1) diversified curricula stimulate learning motivation and foster comprehensive development and excellence; (2) precise career orientation with emphasis on interdisciplinary integration and joint cultivation; and (3) facilitation of institutional educational objectives as an effective supplement to conventional curriculum systems.

The OBE-integrated software development micro-specialization development model represents a novel educational paradigm centered on Intelligent Medical Engineering students and oriented toward software project learning outcomes, concurrently embodying OBE conceptual tenets and micro-specialization advantages. Within the medicine-engineering interdisciplinary context, addressing challenges such as undergraduate practical skill deficits and substantial misalignment between program offerings and enterprise talent demands, three specialized modules — Python Full-Stack Engineer, Java Senior Engineer, and Frontend Senior Engineer—have been established in response to emerging trends in future technology and industrial development, alongside industry talent requirements and student personalized development needs in the new technological era. This establishes the conceptual framework for OBE-integrated software development micro-specialization construction.

5. Curriculum Evaluation Reform and Effectiveness

To address the constraints of conventional “parallel scheduling with concentrated final assessment” models on deep learning and competency transfer, this study systematically restructures the evaluation system within the Outcome-Based Education (OBE) framework. First, leveraging the sequential nature of micro-specialization courses, parallel scheduling is replaced with serial “micro-classroom” sessions: each micro-course is delivered intensively for two consecutive weeks at four instructional hours daily, with subsequent courses commencing only after completion of the preceding one. This approach enables students to concentrate on a single knowledge domain within

a dedicated time block, substantially reducing cognitive load from context switching. Empirical results demonstrate that this model decreases inter-course task-switching frequency by 58%. Second, an immediate diagnostic assessment mechanism upon course completion is introduced: diagnostic evaluations administered immediately following each micro-course constitute the final grade for that course, transforming review workload from “end-term concentration” to “distributed throughout the learning process”.

These dual reforms collectively establish a “low-interference—high-immersion—rapid-feedback” evaluation paradigm, providing robust empirical evidence for the facilitative effects of this assessment system on micro-specialization cultivation models. The findings offer a replicable framework for pedagogical reform in software courses within medical-engineering interdisciplinary programs and furnish empirical support for quality assurance in micro-specialization clusters under the Emerging Engineering Education initiative.

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