

AI-EMPOWERED TEACHING REFORM OF OPERATIONS RESEARCH ORIENTED TOWARD DIGITAL TALENT DEVELOPMENT

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Abstract: Against the backdrop of the deepening digital economy and the pervasive penetration of artificial intelligence (AI) into all sectors, social demand for versatile digital talent continues to rise. Operations research (OR), a core foundational course for majors such as management science and engineering and business administration, plays an irreplaceable role in cultivating students' systematic optimization thinking and quantitative decision-making capabilities. Driven jointly by the rapid advancement of AI and the national digital talent strategy, traditional OR teaching has become increasingly inadequate in content provision, methods and tools, practical integration, and evaluation systems. Seizing the historic opportunity of AI-empowered education and anchored in the core objectives of digital talent cultivation, this paper systematically analyzes the existing pain points of current OR teaching, explores pathways for the deep integration of AI and OR instruction, and proposes a systematic reform framework encompassing five interlocking components: reconstructing an integrated OR+AI curriculum system, updating teaching content with intelligent optimization and data-driven methods, innovating project-based and generative-AI-assisted teaching approaches, building blended virtual-physical practice platforms, and constructing multi-dimensional dynamic evaluation. Implementation outcomes drawn from university reform practices are discussed, offering a reference for the high-quality development of OR courses in the era of the digital economy.

Keywords: Artificial intelligence empowerment; Digital talent; Operations research; Teaching reform

1 INTRODUCTION

Operations research (OR), with mathematical modeling, quantitative analysis, and system optimization as its core methods, is devoted to seeking optimal or near-optimal decisions under finite resource constraints [1-2]. It is a core foundational course for majors such as management science and engineering and information management and information systems, and a key vehicle for cultivating students' ability to “describe real-world problems in mathematical language and support managerial decision-making with optimization thinking.” For decades, OR has played an irreplaceable role in developing students' logical reasoning, model abstraction, and solution implementation skills [2]. Today, as the digital economy and new quality productive forces continue to accelerate, resource allocation efficiency has increasingly become a core determinant of the competitiveness of enterprises and even regions, endowing the optimization decision-making capability embodied in OR with renewed contemporary significance.

Higher education is currently undergoing a new round of profound transformation driven by AI. Generative AI, represented by large language models, has reshaped knowledge acquisition and teaching-learning interaction. In March 2024, the Ministry of Education launched the “AI-Empowered Education Initiative,” introducing four concrete actions: launching a dedicated “AI Learning” column, promoting the intelligent upgrading of smart education platforms, implementing demonstration programs for the application of large AI models across the education system, and integrating these efforts into the opening-up of digital education. The initiative aims to promote the integrated application of AI in teaching and learning, enhance digital literacy and skills nationwide, develop dedicated large models for education, and regulate the scientific and ethical use of AI.

Against this backdrop, the OR curriculum faces a dual tension. First, AI itself relies heavily on optimization theory: gradient descent, Lagrangian duality, regularization, combinatorial optimization, and reinforcement learning are all underpinned by the concepts and methods of OR. OR should therefore move from “behind the scenes” to “center stage,” becoming the infrastructure that connects data with decisions and supports the deployment of AI. Second, the composite capabilities required of digital talent—“data + algorithms + business + ethics”—impose higher demands on the currency of course content, the practicality of methods, and the comprehensiveness of competencies. However, OR teaching in many universities remains at the stage of classical models and manual computation, severely disconnected from authentic industrial scenarios and the AI technology frontier. Therefore, systematically examining and reforming OR teaching is both an inevitable requirement for responding to the national digital talent strategy and an intrinsic need for the high-quality development of the course itself.

2 CURRENT STATE OF OPERATIONS RESEARCH TEACHING AND ITS CHALLENGES

2.1 Teaching Content Lagging Behind Technological Development

Current textbooks and syllabi are structured primarily around classical branches such as linear programming, integer programming, graphs and networks, dynamic programming, queueing theory, inventory theory, and game theory, emphasizing manual solution techniques such as the simplex method, duality theory, and transportation tableau methods. Dominated by classical theory, traditional OR teaching content severs the intrinsic connection between OR and AI and fails to incorporate frontier digital content such as intelligent optimization algorithms, machine learning-based optimization, and big data-driven decision-making [3]. In digital industry scenarios, traditional manual modeling and static optimization can no longer cope with massive, dynamic, and complex big data problems, yet existing teaching content has not bridged classical OR theory with modern intelligent technologies. Consequently, students master only theoretical formulas without understanding digital applications, and their knowledge systems fail to match the requirements of digital positions. Even when algorithms are covered, the treatment often remains at the level of restating principles, lacking complexity analysis, parameter tuning, and large-scale benchmark comparisons. Cases are mostly drawn from dated textbooks rather than authentic industrial scenarios such as logistics scheduling, supply chain coordination, intelligent staff rostering, and portfolio optimization. Students therefore struggle to build a complete cognitive chain of “problem-model-algorithm-decision,” let alone appreciate the challenges that uncertainty, multiple objectives, and real-time requirements pose to optimization.

2.2 Teacher-Centered Lecturing Methods

Classrooms commonly adopt a one-way transmission model of “teacher derives formulas-students take notes-homework after class,” prioritizing deduction over inquiry and computation over modeling. Students can reproduce solutions to standard problem types yet find it difficult to translate ill-defined managerial problems into structured models or to reconstruct models when constraints change [4]. The absence of seminars, peer instruction, and immediate feedback results in insufficient learning initiative and inadequate training of higher-order thinking; when confronted with variations or integrative problems beyond the textbook, students are often at a loss, exposing the capability gap of “knowing that but not knowing why.”

2.3 Weak Practical Components and Insufficient Tool Application

OR is a highly practice-oriented course, yet traditional teaching suffers from the pervasive problem of “valuing theory over practice.” Laboratory sessions are mostly verification-oriented, relying on Excel Solver or the basic edition of LINGO for small-scale examples, with a shortage of digital tools such as Python, MATLAB, and intelligent optimization platforms, as well as large-scale authentic datasets and end-to-end project training. Students often “can solve textbook problems but cannot model, and can model but cannot implement computationally”; when facing real business data, they hardly know where to begin, and their quantitative decision-making capability fails to materialize. Practice scenarios are detached from industry realities and not aligned with digitalized sectors such as intelligent manufacturing, smart logistics, and digital finance, leaving students unable to master the ability to solve authentic complex problems by combining OR with intelligent technologies.

2.4 A Single-Dimension Evaluation System Overemphasizing Outcomes

The traditional OR assessment system relies mainly on a “final written examination plus coursework grades,” emphasizing the correctness of formulas and solution procedures while neglecting the modeling process, algorithm implementation, and data analysis, and thus remains one-dimensional. This model has evident drawbacks. First, it overemphasizes outcomes at the expense of process, ignoring students' classroom thinking, hands-on practice, digital modeling, and innovative exploration throughout the learning journey. Second, it overemphasizes knowledge at the expense of competency, entirely omitting the assessment of core digital talent competencies such as digital tool application ability, intelligent decision-making thinking, and innovative practice capability [5]. Third, the evaluation lacks precision: it cannot quantify students' capability weaknesses, hindering targeted instructional optimization and failing to align with competency evaluation standards for digital talent.

2.5 Systemic Disconnection from Digital Talent Goals

Digital talent emphasizes interdisciplinary composite capabilities, whereas OR often exists as an isolated technical course, lacking articulation with courses such as data structures, probability and statistics, machine learning, and data visualization, and thus failing to form the competency closed loop of data-model-algorithm-decision [6]. Moreover, the course pays insufficient attention to AI ethics, data compliance, and algorithm interpretability, making it difficult to support the overall goals of new engineering education and digital talent cultivation.

3 REFORM LOGIC UNDER AI EMPOWERMENT AND DIGITAL TALENT GOALS

3.1 Core Advantages of AI-Empowered OR Teaching

3.1.1 Empowering the upgrading of teaching content

AI technologies can align course content with industry frontiers by combining traditional static OR theory with intelligent optimization, big data modeling, and intelligent decision-making, thereby overcoming the lag of textbook content behind industrial development and enabling the dynamic updating of teaching content [7].

3.1.2 Empowering pedagogical innovation

Adaptive learning systems, intelligent teaching assistants, and knowledge graphs enable tiered and precision teaching, overcoming the drawbacks of the traditional one-size-fits-all model and accommodating the learning needs of students with different foundations.

3.1.3 Empowering the implementation of practical training

Virtual simulation platforms, enterprise digital project repositories, and intelligent modeling software construct authentic, scenario-based practice environments, resolving the abstraction and industrial disconnection that have long plagued OR practice teaching.

3.1.4 Empowering the improvement of evaluation systems

AI-powered big data analytics capture whole-process learning data, enabling the transition from a single final examination to process-oriented, comprehensive, competency-based multi-dimensional evaluation, and precisely measuring students' digital literacy and professional competence.

3.2 Core Competency Requirements for Digital Talent

Versatile digital talent in the digital economy era, unlike traditional specialists, is characterized by a three-dimensional set of core competencies. The first is mathematical-foundation literacy: solid capability in quantitative analysis, logical reasoning, and system optimization thinking, enabling the decomposition of complex problems through modeling. The second is digital-technology literacy: proficient command of digital tools including big data analytics, AI tools, and intelligent optimization algorithms, enabling the technical implementation of theory. The third is innovative-application literacy: the ability to apply OR optimization and intelligent technologies to authentic decision-making problems in industry scenarios, together with a capacity for digital innovation.

The optimization decision-making core of OR constitutes the mathematical foundation of digital talent thinking, while AI technology serves as the key vehicle through which OR theory is implemented in digital and intelligent form. Their integration thus provides the core support for cultivating the key competencies of digital talent.

3.3 Guiding Philosophy of the Reform

The reform follows the philosophy of “OBE (outcome-based education) + new-engineering interdisciplinarity + bidirectional integration.” Instruction is designed backward from intended learning outcomes; course content is reconstructed through the bidirectional integration of “AI in OR” (using AI to improve OR teaching) and “OR for AI” (using OR to support AI decision-making); and competency cultivation is driven by authentic application scenarios, implementing the construction requirements of “core courses, core textbooks, core faculty, and core practical projects” set forth in the Opinions of the five departments.

4 CONSTRUCTING THE OR TEACHING REFORM SYSTEM UNDER AI EMPOWERMENT AND DIGITAL TALENT GOALS

4.1 Updating Teaching Content: Integrating Intelligent Optimization and Data-Driven Approaches

Guided by the principles of “consolidating the classical, connecting with the intelligent, and aligning with industry,” course content is reconstructed to be modular, dynamic, and interdisciplinary, breaking the ossified traditional knowledge structure and achieving the deep integration of classical OR theory with AI and the frontiers of the digital industries.

4.1.1 Foundation module: consolidating the core theory of classical OR

Core foundational content is retained while cumbersome formula derivation and manual computation are streamlined, with the focus placed on model principles, applicable scenarios, and the cultivation of logical thinking. Classical topics—linear programming, dynamic programming, queueing theory, game theory, and decision theory—are emphasized to help students build systematic optimization decision-making thinking, to consolidate the mathematical foundation for subsequent digital applications, and to avert the weakened foundations that would result from excessive dilution of theory.

4.1.2 Advanced module: incorporating AI-interdisciplinary content

Frontier content on intelligent OR optimization is introduced to build an interdisciplinary knowledge system that spans “classical OR + AI.” Intelligent optimization algorithms such as genetic algorithms, particle swarm optimization, and simulated annealing, together with machine learning optimization, big data decision modeling, and dynamic system optimization, are integrated into the course. How AI technologies upgrade and iterate traditional OR models is expounded, enabling students to master intelligent optimization methods for big data and complex scenarios and to connect with the core capabilities of digital technology.

4.1.3 Extension module: engaging authentic digital industry scenarios

Case-based extension content is designed around prominent digital industry scenarios such as smart logistics, intelligent manufacturing, digital finance, and smart city management. Through authentic enterprise cases—inventory optimization,

route optimization, resource scheduling, and risk decision-making—the practical deployment of OR models and intelligent technologies is illustrated, helping students understand the demand of digital industries for OR optimization capabilities and enhancing the relevance of knowledge application.

4.2 Innovating an AI-Collaborative Teaching Model to Build Precise Smart Classrooms

Leveraging intelligent technologies such as AI, big data, and knowledge graphs, the traditional transmission-based classroom is transformed, and a smart teaching model of “AI empowerment + teacher-student interaction + tiered instruction” is constructed, making teaching more precise, process-oriented, and efficient [8].

4.2.1 Before class: AI learning diagnostics enabling personalized preparation

A course knowledge graph is built on the intelligent teaching platform to map the logical connections among knowledge points. Before class, the platform pushes micro-lectures, foundational exercises, and intelligent cases; the AI learning analytics system automatically collects students' preparation data, precisely diagnoses their knowledge weaknesses and differences in prior foundations, and stratifies students into foundational, advanced, and innovative tiers, providing the data support for tiered classroom instruction and realizing “instruction informed by learning.”

4.2.2 In class: AI-interactive teaching strengthening thinking and hands-on practice

The single-lecture model is replaced by a classroom model of “focused theoretical exposition + AI demonstration + interactive hands-on practice.” Teachers streamline theoretical explanations and concentrate on deconstructing the logic of model application; intelligent simulation platforms demonstrate the digital solution process of OR models in real time, and tools such as Python and MATLAB are used to live-demonstrate intelligent optimization methods for complex problems. Meanwhile, intelligent teaching assistants enable real-time question answering, in-class quizzes, and interactive polling, allowing teachers to monitor students' engagement in real time, adjust the instructional pace accordingly, and improve classroom efficiency [9-10]. For difficult knowledge points, knowledge graphs visually display the connections among concepts, rendering abstract OR logic concrete and lowering learning difficulty.

4.2.3 After class: AI-precision push and tiered extension

Based on big data from classroom learning analytics, the AI system pushes differentiated after-class tasks to students at different tiers: foundational-tier students focus on digital hands-on training with basic models to consolidate core knowledge; advanced-tier students focus on comprehensive case modeling and solving to strengthen application capability; innovative-tier students focus on intelligent optimization algorithm innovation and inquiry projects in complex digital scenarios to cultivate innovative literacy. In addition, the intelligent question-answering system resolves students' doubts around the clock and records their learning trajectories, forming a closed-loop learning system.

4.3 Constructing a Multi-Dimensional Dynamic Evaluation System

Oriented by OBE, evaluation is expanded from a “single written examination” to whole-process, multi-dimensional assessment. Formative evaluation (modeling assignments, code implementation, laboratory reports, and classroom contributions) carries substantial weight; project evaluation combines “student defense + peer review + enterprise mentor assessment”; and the final examination focuses on comprehensive modeling and solution design rather than mechanical computation. The evaluation dimensions cover modeling capability, algorithm implementation, data analysis, teamwork, oral and written communication, and the appropriate use of AI tools—where “appropriate use” assesses both the ability to leverage AI to enhance efficiency and the ability to critically discern and responsibly use AI-generated content. All scores are recorded in a structured manner, forming a traceable competency profile that provides the evidence base for personalized learning guidance and continuous improvement (Plan-Do-Check-Act).

4.4 Faculty and Resource Support

The implementation of the reform hinges on faculty and resources. On the one hand, teachers are organized to participate in AI teaching-capability training, and cross-appointment of dual mentors between universities and enterprises is established to enhance faculty expertise in intelligent optimization and data-driven directions; teachers are also encouraged to transform their research projects into teaching cases, thereby promoting teaching through research. On the other hand, universities and enterprises jointly build open case repositories and question banks and co-develop new-form textbooks and digital resources that incorporate authentic scenarios, implementing the four-in-one construction of “core courses, core textbooks, core faculty, and core practical projects.” Case repositories and training environments should be openly shared among universities to reduce redundant construction costs, forming a replicable and transferable teaching resource system that is dynamically updated as industrial technologies evolve.

5 CONCLUSION

AI empowerment and digital talent goals constitute the defining proposition that OR teaching reform must answer in the era of the digital economy. This paper proposes a systematic framework organized around six main lines: reconstructing the integrated curriculum system, updating intelligent optimization content, innovating project- and AI-assisted methods, building blended virtual-physical practice platforms, constructing multi-dimensional dynamic evaluation, and strengthening faculty and resource support. The aim is to reshape OR from a technical course centered on “solving textbook problems” into a hub course that underpins the quantitative decision-making capability of digital talent. It must

be emphasized that the reform does not substitute AI for teachers' professional guidance; rather, AI relieves teachers and students of repetitive training so that they can concentrate on capabilities that machines can hardly replicate—modeling intuition, critical thinking, and value judgment. Looking ahead, the impact of generative AI on teaching ethics, academic integrity, and evaluation methods should be continuously monitored, and course content and resources should be dynamically iterated, ultimately fostering a new OR education ecosystem commensurate with the high-quality development of the digital economy.

COMPETING INTERESTS

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