Adult and Higher Education (2025)
Clausius Scientific Press, Canada

DOI: 10.23977/aduhe.2025.070420
ISSN 2523-5826 Vol. 7 Num. 4

Exploration and Practice of Industry-Education Integration Talent Cultivation Models for Network Engineering Majors in the Context of New Engineering Education

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Keywords: New Engineering Education, Industry-Education Integration, Talent Development, Curriculum System

Abstract: In response to the talent development objectives for network engineering majors under the new engineering education paradigm, this paper explores how to establish a talent cultivation model aligned with contemporary demands, using industry-education integration as its entry point. First, it analyses the new challenges posed by new engineering education to network engineering programs and the pivotal role of industry-education integration in bridging the gap between theory and practice. Second, integrating constructivist learning theory and the CDIO engineering education philosophy, it proposes four core reform strategies: restructuring the curriculum system, innovating teaching methods, enhancing practical platforms, and deepening university-industry collaboration. Finally, through practical case studies, it demonstrates the significant effectiveness of the industry-education integration model in enhancing students' engineering practice capabilities, innovation abilities, and professional competence. The paper concludes by outlining future development directions, emphasizing the importance of establishing a multi-dimensional collaborative education mechanism.

1. Introduction

With the rapid advancement of information technology, the field of network engineering faces unprecedented opportunities and challenges. The development of new engineering disciplines emphasizes interdisciplinary integration and the cultivation of practical engineering skills, placing higher demands on traditional talent development models in network engineering. Conventional teaching approaches often prioritize theoretical knowledge transmission, creating a disconnect with corporate needs. This results in graduates lacking practical capabilities and struggling to adapt swiftly to industry developments. Industry-education integration, as a vital educational model, bridges this gap through university-enterprise collaboration. By incorporating real-world industry demands into the curriculum, it effectively bridges the theory-practice divide and cultivates high-caliber, application-oriented talent aligned with corporate needs[1].

Under the new engineering paradigm, network engineering faces multifaceted challenges: pressure from rapid technological iteration and the imperative for profound transformation in talent development models. First, the rapid advancement of network technologies has widened the gap between traditional curricula and real-world applications. Emerging technologies like cloud computing, big data, artificial intelligence, the Internet of Things, edge computing, and 5G/6G communications are proliferating and often converge to form complex application scenarios. If traditional network engineering curricula remain focused solely on foundational topics like TCP/IP protocols, routing and switching, and cybersecurity—while neglecting the principles, applications, and trends of these emerging technologies—graduates will struggle to meet corporate demands for roles such as network architects, cloud platform engineers, and cybersecurity specialists. Secondly, enterprises increasingly prioritize practical skills in network engineering graduates. Merely mastering theoretical knowledge is no longer sufficient; companies increasingly expect graduates to possess the ability to independently complete practical tasks like network planning, design, deployment, operations and maintenance, and security protection. However, traditional teaching models often emphasize theoretical knowledge transmission while lacking sufficient practical components, resulting in significant deficiencies in students' hands-on capabilities. Concurrently, interdisciplinary convergence imposes new demands on network engineering programs. The advancement of modern network technologies increasingly relies on knowledge and techniques from other disciplines. Examples include the application of artificial intelligence in cybersecurity, big data in network traffic analysis, and cloud computing in network resource management[2]. Students in network engineering programs must possess foundational knowledge in mathematics, computer science, and electronic engineering to effectively comprehend and apply these emerging technologies. Consequently, under the new engineering paradigm, network engineering faces multifaceted challenges encompassing technological evolution, practical competency, comprehensive skill development, and interdisciplinary integration, necessitating comprehensive reform and innovation.

In addressing the numerous challenges facing network engineering programs under the new engineering education paradigm, the importance of industry-education integration has become increasingly prominent. It represents not merely an innovation in teaching models, but a crucial bridge bridging the gap between educational supply and industrial demand. By deeply integrating the practical needs of the industry with the educational resources of universities, industry-education integration can effectively tackle issues such as rapid technological updates, high demands for practical skills, diverse requirements for comprehensive competencies, and increasingly severe cybersecurity threats. First, industry-education integration enables real-time curriculum updates, ensuring teaching content remains aligned with cutting-edge industry developments. By collaborating with enterprises, the latest technologies, case studies, and industry standards are introduced into the classroom. This equips students with up-to-date knowledge and skills, preventing post-graduation knowledge gaps and skill mismatches. For instance, corporate engineers can participate in curriculum development, incorporating real-world project challenges and solutions into teaching cases, exposing students to authentic engineering scenarios during their studies. Second, industry-education integration strengthens practical training components, significantly enhancing students' hands-on capabilities. Enterprises provide internship and training opportunities, allowing students to gain practical skills and problem-solving abilities through real-world project environments. This hands-on experience, irreplaceable by classroom instruction alone, helps students better comprehend and apply theoretical knowledge to practical work[3].

2. Theoretical Foundations of Industry-Education Integration

2.1 A Constructivist Theory of Industry-Education Integration

Constructivist learning theory emphasizes that learners do not passively receive information but actively construct the meaning of knowledge. In educational practice, constructivism highlights elements such as context, collaboration, and dialogue, asserting that learning should occur within real or simulated practical settings[4]. Learners achieve deeper understanding through collaborative discussion and joint inquiry. In constructing knowledge, learners must engage in critical thinking, independently solve problems, and apply acquired knowledge to real-world contexts. The teacher's role shifts from traditional knowledge transmitter to learning facilitator and guide, providing essential resources and support to help students build their own knowledge systems. Within the framework of industry-education integration, constructivist learning theory holds significant guiding value. Real-world projects and practical environments provided by enterprises create ideal learning contexts for students. By participating in actual projects, students can proactively explore knowledge, solve practical problems, and integrate theoretical knowledge with practice, thereby gaining a deeper understanding of knowledge's essence. In summary, constructivist learning theory provides crucial theoretical support for industry-education integration talent development models. It emphasizes learner initiative and interactivity, offering guidance for constructing more effective teaching methods and learning environments.

2.2 The Theory of Industry-Education Integration Based on CDIO Engineering Education

CDIO stands for Conceive, Design, Implement, and Operate. It emphasizes that students fully engage in the entire project lifecycle—from the initial conception phase to the final operational stage—within authentic engineering environments, thereby comprehensively mastering engineering knowledge and skills[5]. The core of the CDIO engineering education philosophy lies in integrating engineering practice into teaching. This ensures students continually engage with real-world engineering problems during their studies and apply acquired knowledge to solve them. This model emphasizes the integration of theory and practice, fostering students' engineering thinking and innovation capabilities. Under the CDIO model, course design typically revolves around actual engineering projects, requiring students to complete the entire process from project conception to final operation. Throughout this journey, students apply diverse engineering knowledge and skills—including design, modeling, simulation, and testing. They also collaborate with team members to solve problems collectively and communicate with clients to understand requirements. By completing these real-world projects, students comprehensively enhance their engineering capabilities, preparing them for future career development.

3. Innovative Approaches to Industry-Education Integration in Talent Development Models

3.1 Curriculum System Design

The curriculum system serves as the core vehicle for talent cultivation. Under the new engineering education paradigm, the traditional network engineering curriculum framework no longer adequately meets industry demands. Therefore, restructuring the curriculum system is a critical component of the industry-education integration talent development model.

First, conduct in-depth industry needs research to understand development trends, corporate staffing requirements, and competency models for specific roles. Some viable approaches include collecting primary data through methods such as company interviews, questionnaires, and industry seminars to analyze corporate expectations regarding the knowledge, skills, and qualities required of network engineers. Research should cover emerging technology fields like cybersecurity, cloud computing, big data, and artificial intelligence, as well as traditional domains such as network planning, network management, and network optimization. The grassroots teaching organization will clarify the reform direction of the curriculum system and determine which courses need to be added, revised, or discontinued based on the research findings.

Second, implement modular course design by decomposing traditional linear curricula into independent, combinable modules. Each module should correspond to one or more real-world enterprise projects, enabling students to learn and master relevant theoretical knowledge and practical skills within a relatively complete knowledge unit. Modules should maintain logical interconnectivity, forming a progressive knowledge framework that advances from foundational to advanced concepts. For instance, cybersecurity curricula could be structured into modules such as Security Fundamentals, Penetration Testing, Vulnerability Analysis, and Security Defense, each aligned with one or more real-world security attack-defense projects. At the same time, educators should prioritize the timely updating of course content, collaborating with industry partners to develop curricula that integrate the latest technologies, standards, and real-world case studies into the classroom. The most effective approach involves inviting corporate engineers to participate in course design and instruction, enabling them to share practical experience and industry insights.

Furthermore, project-based teaching methods should be adopted, using projects as drivers to integrate theoretical knowledge into practical application. Students learn and master concepts while completing projects, thereby enhancing their interest and engagement. Projects should be challenging and practical, simulating real-world corporate scenarios. For example, a cloud-based network architecture design project could require students to apply cloud computing knowledge to design a scalable, highly available network architecture. Project-based learning cultivates students' engineering practice skills, problem-solving abilities, and innovation capabilities. Finally, a flexible course evaluation mechanism must be established to continuously refine and improve the curriculum based on industry developments and student feedback.

3.2 Innovation in Teaching Methods

Under traditional teaching models, teachers serve as knowledge transmitters while students remain passive recipients. This approach struggles to cultivate students' proactive learning abilities, practical skills, and innovative capabilities. Therefore, innovative teaching methods are essential to stimulate students' interest in learning, enhance their engagement, and foster their self-directed learning and problem-solving skills.

First, adopt case-based teaching methods by introducing real-world business cases that challenge students to analyze and resolve practical problems. These cases should be representative, typical, and practical, reflecting the latest industry trends and challenges. Instructors can guide students in analyzing the case's context, issues, solutions, and lessons learned, thereby developing their analytical, judgmental, and decision-making skills. For instance, a case study of a company suffering a cyberattack could be used, prompting students to analyze the attack's causes, process, and impacts while proposing corresponding defensive measures.

Second, project-driven teaching should be adopted, where students learn and master knowledge through completing projects. Projects should be challenging and practical, simulating real-world corporate scenarios. Instructors can guide students in developing project plans, assigning tasks, resolving issues, and evaluating outcomes, thereby cultivating project management, teamwork, and communication skills. For instance, a SDN-based network optimization project could be designed, requiring students to apply SDN knowledge to enhance network performance.

Additionally, adopt the flipped classroom approach where students engage in self-directed learning before class and participate in discussions and Q&A during class time. Instructors can provide learning materials, video lectures, and online quizzes for pre-class study and review. In class, facilitate discussions, address questions, and conduct case studies to enhance learning efficiency and student engagement. For instance, students could watch video lectures on network protocols before class and then discuss and clarify concepts during class to deepen their understanding. Simultaneously, modern teaching tools should be leveraged, such as online education platforms and virtual simulation laboratories, to enhance instructional outcomes. For instance, online platforms can distribute course materials, assignments, and assessments, enabling students to learn and collaborate digitally. Virtual simulation labs can replicate network environments, allowing students to conduct experiments and practice in simulated settings. By innovating teaching methods, we can stimulate student interest, boost engagement, and cultivate independent learning, practical skills, and innovative thinking.

3.3 Deepening School-Enterprise Collaboration

Industry-academia collaboration is the core of integrating industry and education, serving as a vital safeguard for achieving talent development objectives. By deepening such partnerships, the practical demands of the industrial sector can be integrated into the teaching process, cultivating high-caliber applied talents who meet corporate needs.

First, joint curriculum development is essential. Enterprises should participate in course design, introducing the latest technologies and real-world case studies into the classroom. Corporate engineers can be invited to collaborate on designing course objectives, content, and assessment criteria. Corporate engineers can infuse real-world experience into courses, helping students grasp industry trends and corporate hiring requirements. Simultaneously, enterprises can provide course case studies and practical projects, enabling students to learn and master knowledge through hands-on application. For instance, collaborating with cybersecurity firms to co-develop cybersecurity courses can introduce cutting-edge security technologies and attack-defense case studies into the classroom.

Second, jointly build faculty teams by having corporate engineers teach at universities and university faculty gain practical experience at enterprises. Corporate engineers can bring real-world expertise to the classroom, enhancing teaching practicality and applicability. School faculty can gain insights into industry trends and corporate hiring needs through corporate placements, improving teaching relevance and effectiveness. The college should establish a system for hiring corporate engineers as adjunct faculty members to teach at the institution. Concurrently, it should organize faculty members to participate in short-term or long-term practical activities at enterprises to enhance their practical skills and teaching proficiency.

Additionally, collaborative research platforms should be established, with schools and enterprises jointly undertaking research projects to address industry challenges. Such partnerships leverage complementary strengths to tackle complex issues. Enterprises can provide funding, equipment, and data, while schools contribute researchers and technical support. Research outcomes can be applied to industrial production and teaching practices, facilitating technology transfer. For instance, collaborating with internet companies on cybersecurity research projects could address vulnerabilities and attack defense mechanisms. Simultaneously, emphasis should be placed on establishing robust mechanisms for university-industry collaboration to foster long-term, stable partnerships. Formal agreements should be signed to clearly define the rights and obligations of both parties. A dedicated university-industry cooperation committee can be established to hold regular meetings and coordinate solutions to collaborative challenges. By deepening these partnerships, the practical demands of the industry can be integrated into the teaching process, cultivating high-caliber applied talents who meet corporate needs.

4. Innovative Cases of Industry-Education Integration

4.1 Enhancing Practical Capabilities through Cybersecurity Attack and Defense Exercises

Jointly conducted by the Network Engineering program and cybersecurity companies, this initiative aims to enhance students' practical skills in cybersecurity by simulating real-world hacking scenarios. Students are divided into Red Teams (attackers) and Blue Teams (defenders). The Red Team's mission is to attempt penetration into the Blue Team's network systems to obtain sensitive information or disrupt system services. The Blue Team's task is to build a secure network environment and detect and block the Red Team's attacks. Red Team students must learn and master various common attack techniques, such as SQL injection, cross-site scripting, and denial-of-service attacks, and use these techniques to conduct penetration testing on the Blue Team's servers, websites, and applications. Blue Team students, in turn, must learn and master various defensive techniques, such as firewall configuration, intrusion detection system deployment, and security vulnerability remediation, and use these techniques to build a secure network environment.

Throughout the exercise, both teams continuously analyze and learn from each other's offensive and defensive strategies to enhance their skills. After the simulation concludes, both sides conduct a debriefing to review the entire process and summarize lessons learned. By participating in this project, students not only master core cybersecurity technologies but also cultivate risk awareness, emergency response capabilities, and teamwork skills. Additionally, the project helps students understand the latest trends and challenges in the cybersecurity industry, preparing them for future career development.

4.2 Case Study on Optimizing Wireless Sensor Network Data Transmission Based on Channel Coding

Project on Optimizing Wireless Sensor Network Data Transmission Based on Channel Coding aims to enhance data transmission reliability and extend network lifetime in harsh environments by applying channel coding techniques. Students participate in all project phases, from channel modeling, coding scheme selection, and codec design to performance simulation and hardware implementation. During channel modeling, students study wireless channel characteristics—such as fading, multipath effects, and interference—and establish appropriate channel models to simulate real-world wireless transmission environments. During the coding scheme selection phase, students studied various channel coding techniques—including convolutional codes, Turbo codes, and LDPC codes—and selected appropriate schemes based on application scenarios and channel conditions. Factors such as error correction capability, complexity, and power consumption were considered. To implement low-power codecs on resource-constrained sensor nodes, algorithmic optimizations were required, such as employing lookup tables and parallel processing techniques. During the performance simulation phase, students must use specialized simulation software to evaluate the performance of their designed channel coding schemes, analyzing bit error rates and throughput under varying signal-to-noise ratios. Through participation in this project, students will not only gain a deep understanding of data communication principles and master channel coding techniques but also develop the ability to solve real-world engineering problems.

5. Conclusion

This paper delves into how to effectively apply the concept of industry-education integration to establish an innovative talent cultivation model for network engineering that meets contemporary demands within the context of new engineering disciplines. Research findings indicate that the industry-education integration model effectively bridges the gap between theory and practice, thereby comprehensively enhancing students' engineering practical skills, innovative capabilities, and professional competence. Through restructuring the curriculum to closely align with industry demands; innovating teaching methods by adopting case-based instruction and project-driven learning; improving practical platforms by establishing on-campus training bases and off-campus internship sites; and deepening university-enterprise collaboration to jointly develop courses and faculty teams, the quality of talent cultivation in the Network Engineering program has been significantly elevated. Practical cases also demonstrate that implementing industry-education integration substantially enhances students' hands-on skills, problem-solving abilities, and teamwork capabilities. Simultaneously, graduates' competitiveness in the job market has markedly increased, with not only higher employment rates but also improved job quality. More graduates secure positions in renowned enterprises within the industry, engaging in more challenging and promising roles.

Acknowledgements

This work is supported by the Higher Education Research Project of Heilongjiang Higher Education Society (Exploration and Practice of Industry-Teaching Integration Curriculum System of Network Engineering Major in the Context of Emerging Engineering Education, No. 23GJYBF036), Heilongjiang Higher Education Teaching Reform Program (Exploration and Practice of "3+1" Enterprise Comprehensive Internship Industry-Teaching Integration Cultivation Mode in the Context of Emerging Engineering Education, No. SJGY20220703), Heilongjiang Postgraduate Course Ideological and Political Teaching Case Construction Project (Intelligent Information Retrieval, No. HLJYJSZLTSGC-KCSZAL-2023-020), Higher Education Teaching Reform Project of Heilongjiang Province-Cultivation Project (Research and Practice on Industry-Education Integration Talent Cultivation Models for Network Engineering Majors in the Context of New Engineering Education, No. SJGPYXM2024014).

References

[1] Yuan, P., & Yang, X. (2024). Exploration of the model of deepen industry–education integration in the digital economy era. Journal of Internet and Digital Economics, 4(3), 179-186.

[2] Abbas, N. N., Ahmed, T., Shah, S. H. U., Omar, M., & Park, H. W. (2019). Investigating the applications of artificial intelligence in cyber security. Scientometrics, 121(2), 1189-1211.

[3] Wang, Y., Jiang, Y., Tian, S., Zheng, Y., Zhou, S., & Huang, H. (2023). Research on the four collaborative innovation mechanisms of industry-education integration based on the concept of community. Journal of Educational Technology and Innovation, 5(4), 20-33.

[4] Wibowo, S., Wangid, M. N., & Firdaus, F. M. (2025). The Relevance of Vygotsky's Constructivism Learning Theory with the Differentiated Learning Primary Schools. Journal of education and learning (EduLearn), 19(1), 431-440.

[5] Yuan, X., Wan, J., An, D., Lu, J., & Yuan, P. (2024). Multi-method integrated experimental teaching reform of a programming course based on the OBE-CDIO model under the background of engineering education. Scientific Reports, 14(1), 16623.