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Exploration and research of the industry-education integration teaching model for communication principles course

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Abstract
This paper discusses the industry-education integration teaching model for the Communication Principles course. By incorporating industry needs into course design, students are exposed to real-world problems, enhancing their practical skills. It also involves the design of a multi-level assessment mechanism, allowing teachers to monitor and evaluate students' performance in a timely manner, comprehensively assessing their learning and problem-solving abilities. The paper explores project-driven experiential teaching design, where students engage in practical operations based on project requirements, thereby mastering the core concepts and technologies of data communication principles through hands-on experience. This approach fosters innovation and teamwork skills. The industry-education integration course model proposed in this study aims to develop students' practical application skills and innovative spirit, enabling them to be competitive in the information society. It provides valuable insights and inspiration for the development of higher education.

Keywords: Communication principles, industry-education integration, project-driven, teaching design

Introduction
Since February 2017, the Chinese Ministry of Education has successively issued the "Notice on Conducting Research and Practice in the New Engineering Disciplines" [1] and the "Notice on Recommending Research and Practice Projects in the New Engineering Disciplines" [2], making great efforts to explore a unique Chinese model for global engineering education. The construction of New Engineering Disciplines is a critical direction for the development of higher education, as it is of great significance in meeting the needs of social development, promoting technological innovation, improving the quality of engineering education, and enhancing the international competitiveness of engineering and technical professionals. With the continuous progress of technology and rapid societal development, traditional engineering education can no longer fully meet the demands of various industries for talent. The construction of New Engineering Disciplines will place more emphasis on cultivating students' comprehensive qualities and innovative capabilities, aiming to produce engineering and technical professionals with a global perspective and innovative spirit. This will enable them to adapt to the increasingly complex and ever-changing societal demands. In the New Engineering Disciplines education model, students will pay more attention to hands-on practice and the development of problem-solving skills [3]. University faculty will also focus more on the integration of research and industry, strengthening collaboration with businesses, and transforming research outcomes into practical productivity. This will drive the application of technological innovation in industry, promoting a virtuous cycle of technology and the economy. New Engineering Disciplines emphasize interdisciplinary and cross-disciplinary integration, enabling students to acquire knowledge from various fields while studying engineering and technology. This approach aims to cultivate students' comprehensive qualities and critical thinking abilities [4]. University faculty will also pay more attention to innovative teaching methods and content, ensuring that education is closely aligned with students' needs and societal development.
With the rapid development of information technology, data communication has become an indispensable infrastructure in modern society [5].

Whether it's businesses, government agencies, or the general public, all need to grasp the fundamental concepts and skills of data communication to facilitate better information exchange, data transmission, and network applications. The course "Communication Principles" can equip students with the ability to handle complex communication systems, meeting the societal demand for professionals. Through the study of the "Communication Principles" course, students will gain in-depth knowledge of the communication principles, protocols, and technologies of next-generation networks. They will also master methods and techniques for data transmission, laying a strong foundation for future technological innovation and applications [6]. A digitalized society relies on efficient data communication systems, which encompass various fields such as the internet, the Internet of Things (IoT), cloud computing, and more. Students, through courses related to data communication, will contribute to the development of a digitalized society, providing greater convenience and opportunities for societal advancement [7].

Currently, there are some issues in the "Communication Principles" course that require attention and improvement. First, due to the rapid development of information technology, the content of teaching materials is updated relatively slowly, resulting in some content lagging behind the latest developments [8]. Second, some "Communication Principles" courses are overly theoretical and lack practical components, making it difficult for students to apply the knowledge learned to real problem-solving. Third, data communication involves a wide range of technologies, and teachers often find it challenging to delve deeply into each area, leading to inadequate understanding of certain critical technologies by students. Of particular importance is that existing "Communication Principles" courses are seriously disconnected from the actual needs of enterprises, reducing the effectiveness of student-centered outcomes. The State Council of China has issued "Several Opinions of the State Council Office on Deepening the Integration of Production and Education," which outlines requirements for the integration of production and education in various types of education. It emphasizes that higher education should "encourage universities to consider the actual needs of frontline enterprise production as an important source of engineering and technical research topics." This paper proposes a production-education integration teaching model for the "Communication Principles" course, establishing a curriculum system with the framework of "strengthening the fundamentals, advancing knowledge, and providing practical training." This model achieves organic coordination among enterprises, students, and teachers.

Curriculum System Design and Implementation Plan

Under the concept of industry-education integration, the course system design predominantly adopts the CDIO educational model [9], which encompasses the conception, design, implementation, and operation of engineering projects. Building upon the CDIO model, this paper has designed a closed-loop teaching model suitable for the industry-education integration of the Communication Principles course, with the specific framework as shown in Figure 1.

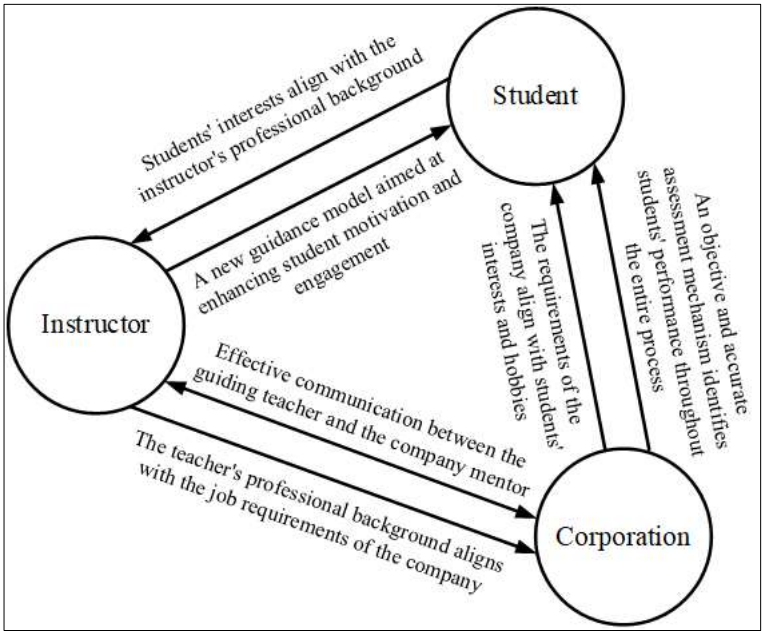

Fig 1: Closed-Loop Industry-Education Integration Teaching Model for the Communication Principles Course

The core of this framework lies in aligning students' knowledge background and interests with the practical content set by the guiding teacher. When students choose practical content, they autonomously select the type and topic of the practical work, thereby achieving a unified alignment of knowledge background, interests, and corporate requirements. The guiding teacher's professional background and practical content align with the job requirements of the company, as teachers offer students advice and opportunities that match their knowledge background and interests. The job positions and employment requirements of the company align with students' knowledge background and hobbies, giving students greater choice space. This indirectly increases the bidirectional choice space between students and the company, ultimately forming a beneficial closed-loop.

1. Top-down teaching system design

In a top-down teaching system, students begin with practical experience and work their way backward to delve into the fundamental theories related to the topic. This approach enhances their understanding and mastery of the subject matter, making the course more engaging and applicable. Four mechanisms are employed to strengthen the learning outcomes:

1. **Virtual experiments and simulation tools:** Utilizing the latest virtual experiment platforms and simulation tools, students conduct experiments and simulations on computers to observe the real-world applications of communication principles. This approach allows students to gain a more intuitive understanding of data transmission processes and communication protocols.
2. **Case studies:** Showcasing the latest advancements in technology and research findings in the field of data communication, students are presented with the most recent data communication technologies and application cases. These cases can include the application of 5G technology, practical implementations of the Internet of Things in smart cities, and more, sparking students' interest in learning.
3. **Smart device experiences:** Students engage in hands-on operations and demonstrations using modern smart devices such as smartphones and IoT devices to experience the convenience and intelligence of data communication. For example, they may conduct data transmission tests using smartphones or experiment with remote control of smart home devices.
4. **Cutting-edge lectures and academic exchanges** Industry experts or scholars are invited to give cutting-edge lectures and engage in academic exchanges, sharing the latest research findings and applications in the field of data communication. This helps students stay informed about the forefront of data communication, broaden their horizons, and stimulate their academic interests.
5. Through these methods, the Communication Principles course becomes more aligned with students' interests and needs, enhancing their motivation to learn, cultivating practical skills, and fostering innovation. Additionally, by incorporating modern educational tools such as recorded lectures [10], teachers can continuously update the teaching content, maintaining its forward-looking and practical nature, thus establishing a solid foundation for nurturing high-quality data communication professionals.

2. A multi-level, multi-modal integrated process assessment mechanism

The process assessment approach for the Communication Principles course takes into account students' practical abilities, industry-education integration awareness, and their grasp of fundamental knowledge. It includes the following components:

1. **Practical Component Design:** Setting up experiments on cutting-edge communication technologies that require students to operate data communication equipment in the laboratory, conduct data transmission, and test communication protocols. Students must complete experiment reports, detailing the process, results, and analysis of any encountered issues. Through the assessment of experiments and reports, students' practical and problem-solving abilities are evaluated.
2. **Industry-Education Integration Projects:** Collaborating with companies or aligning with actual industry demands to design industry-education integration projects related to communication principles. Students participate in project planning, design, implementation, and evaluation, gaining real-world experience in communication engineering practices. The assessment of these projects evaluates students' abilities and their awareness of industry-education integration in practical applications.
3. **Midterm and Final Examinations:** Implementing two examinations, covering basic concepts, communication protocols, transmission technologies, network architecture, and other course aspects. The midterm exam primarily assesses students' understanding of the course content, while the final exam places greater emphasis on the comprehensive application of knowledge and the ability to solve real-world problems. Additionally, application questions are included in the exams to enable students to apply their knowledge to real scenarios.
4. **Classroom Interactions and Discussions:** Organizing group discussions in the classroom to address real-world problems and encourage interaction. Through these interactions, teachers can gauge students' understanding of fundamental knowledge and encourage them to ask questions and propose solutions.
5. Homework Assignments: Assigning homework closely related to the course content, requiring students to complete tasks based on independent thinking and reference materials. Through the grading of homework, students' understanding of fundamental knowledge is assessed, and it encourages students to enhance their learning.
6. The process assessment method comprehensively considers practical experience, industry-education integration, and fundamental knowledge. It achieves a comprehensive and diversified design through a combined online/offline assessment model[11]. This approach encourages students to actively engage in practical activities, fostering their practical skills and innovation mindset. It also reinforces their mastery of fundamental knowledge, thus producing well-rounded talent in the field of communication.

3. Project-Driven Course Practical Teaching Design

The practical teaching design of the Data Communication Principles course is project-driven, emphasizing the development of students' hands-on skills and problem-solving abilities.

1. **Project Selection:** Practical projects related to communication principles are chosen, with the requirements sourced from real industry demands for communication technology. These projects may include simple data transmission systems, small-scale smart home systems constructed using sensors and IoT technology, and more. The projects are designed to be challenging to spark students' interest and motivation.
2. **Group Division:** Students are grouped into teams, with each team responsible for a specific project. Encouraging cross-disciplinary team formation fosters interdisciplinary collaboration and innovation.

3. **Project Planning:** Each team conducts project planning, including project objectives, task allocation, and time schedules. While teachers can provide guidance and suggestions, students are encouraged to think independently and make decisions.
4. **Practical Operations:** Based on project planning, students engage in practical operations, designing and building communication systems, debugging transmission technologies, and writing communication protocols. Teachers provide the necessary experimental equipment and tools, guiding students in their operations.
5. **Problem Solving:** Throughout the practical process, students may encounter various challenges and issues. Teachers encourage students to proactively solve problems, guiding them in analyzing and finding solutions.
6. **Results Presentation:** After completing the practical projects, students present and share their results. Each team showcases their project outcomes to the whole class, along with sharing their practical experiences and insights.
7. **Summation and Assessment:** Following the conclusion of the projects, teachers organize students for reflection and evaluation. Students review the project process, summarize their experiences and lessons learned. Teachers assess students' practical achievements and performances, considering aspects such as practical operations, problem-solving abilities, and teamwork.

Project-driven practical teaching design can stimulate students' interest in learning and their innovative capabilities [12]. It cultivates their ability to flexibly apply data communication knowledge in real-world applications. Students learn teamwork and communication skills, enhancing their overall qualities and professional competitiveness.

The Challenges of the Industry-Education Integration Teaching System

1. **Alignment of Industry Demands with Disciplinary Knowledge:** The core of industry-education integration teaching is to incorporate industry demands into the curriculum. However, in practice, teachers may face challenges in aligning industry demands with disciplinary knowledge. The solution is for teachers to closely collaborate with businesses to understand the latest industry requirements while optimizing the curriculum design. By integrating real-world application scenarios into the Data Communication Principles course, the teaching content can be closely aligned with industry demands.
2. **Practical Conditions and Equipment Limitations** Practical exercises in Data Communication Principles require specific experimental equipment and software/hardware resources. However, universities may face equipment limitations or delays in equipment updates. The solution is for teachers to actively seek external collaborations, utilizing resources from businesses or laboratories to expand the coverage of practical components. Additionally, teachers can introduce virtual experimentation platforms and simulation tools, allowing students to conduct experiments and simulations on computers to compensate for inadequate practical conditions.
3. **Establishing an Assessment System:** An industry-education integration teaching system requires the establishment of a corresponding assessment system to comprehensively evaluate students' practical skills, cooperation abilities, problem-solving skills, and more. The solution is for teachers to develop diverse assessment methods, taking into account actual project completion, practical reports, project presentations, classroom interactions, and other factors. This approach ensures a comprehensive evaluation of students' overall qualities.
4. **Coordination Challenges in Teacher-Business Collaboration:** Implementing industry-education integration teaching requires effective collaboration between teachers and businesses. However, during the collaboration process, challenges related to scheduling, course progression, and other aspects may arise. The solution is for teachers and businesses to jointly formulate collaboration plans, specifying responsibilities and tasks for each party, maintaining open communication and cooperation, and ensuring the smooth implementation of industry-education integration teaching.

In summary, the industry-education integration teaching system for the Data Communication Principles course faces some challenges. However, these challenges also represent an important pathway to enhance teaching quality and students' comprehensive capabilities. Teachers should be flexible in addressing difficulties during implementation and actively explore industry-education integration models that suit the characteristics of this course. This will make the curriculum align more closely with industry demands and cultivate outstanding talent with practical skills.

Conclusion

Research on the Industry-Education Integration Teaching Model of the Data Communication Principles course has shown that incorporating actual industry demands into curriculum design and emphasizing practical hands-on experience and project-driven learning effectively sparks student interest and cultivates their practical application skills. Collaboration between teachers and businesses, providing practical platforms and resources, fosters a deep integration of students with the industry, laying a solid foundation for their future employment and innovation in the field of data communication.

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