Research on the Integration of Theory and Practice Teaching Mode in Optical Cable Line Engineering

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Abstract. With the rapid development of emerging technologies, the market has put forward higher requirements for positions related to communication lines, especially optical cable lines engineering. Therefore, in order to improve the students' basic knowledge of optical cable lines, and further improve the students' future job ability. This paper analyzes the characteristics of students in the teaching of optical fiber communication in recent years, as well as the curriculum characteristics of courses related to optical fiber lines, and combs out the practical problems of poor teaching effect in the past teaching process. In the course teaching, the teaching mode combining "theory and practice" is adopted to achieve a smooth transition from the teaching starting point to the teaching goal, improve the degree of achievement of the teaching goal, and eventually, form a virtuous cycle.

Keywords: Integration of Theory and Practice, Optical Cable Lines Engineering, Teaching Goal, Teaching Effect

1 Introduction

In recent years, the development of China's information communication industry is very rapid, and the high-quality development of information communication industry has achieved remarkable results. Focus on humanoid robots, brain-computer interface, 6G, AR and other fields of scientific research public relations[1]. Under the new information and communication industry system structure and the impact of the rapid development of new technologies, the information and communication industry related posts and positions, reflecting the very distinct characteristics of one post and multiple capabilities, in urgent need of comprehensive professionals covering from theoretical principles to engineering practice. This puts forward higher requirements for higher education and vocational education in colleges and universities, and the personnel training system in colleges and universities must be more targeted and directional.

At present, in the actual teaching and research work, the theoretical research and practical application are often in a disjointed state. Those who are engaged in theoretical research often neglect practical application problems. Although the practical engineers

C. Lin et al. (eds.), *Proceedings of the 2024 9th International Conference on Modern Management, Education and Social Sciences (MMET 2024)*, Advances in Social Science, Education and Humanities Research 880,
https://doi.org/10.2991/978-2-38476-309-2_63

have enough engineering experience, they often lack the relevant theoretical knowledge system. Take the specific cultivation object as an example. For higher education, we pay more attention to the depth of its content, the degree of challenge, and the shaping and training of students' innovative ability. Practical application is only a part of auxiliary knowledge ability. Correspondingly, for vocational education, we pay more attention to the operation and use of specific equipment and process specifications, and ignore the construction of their theoretical knowledge system, which leads to students' emphasis on practice over principle, and lack of ability to draw inferentially in actual work.

In fact, whether it is higher education or vocational education[2], we must see the attributes of the post behind it, the post is market-oriented, and the demand of the market is constantly iterating and changing, back to the college talent training and course teaching, theory and practice are inseparable, but also complement each other, step by step. Therefore, this paper takes the fiber optic line engineering course for fiber optic communication major as an example, first analyzes the starting point of teaching, including the basic situation of students, the main characteristics of the course and the teaching status quo, and puts forward the teaching mode combining "theory and practice" to be applied in the actual teaching process, and further matches the corresponding teaching methods for different teaching contents. The result shows that this method has a very good teaching effect on the teaching practice of engineering courses.

2 Teaching Starting Point Analysis

2.1 Analysis of Student Situation

In the process of teaching, it has been observed that students majoring in optical communication generally exhibit several typical characteristics. Firstly, they often lack a thorough understanding of the theoretical framework of optical communication. Whether at the higher education or vocational education level, when exposed to courses related to optical communication, students typically demonstrate limited comprehension of the principles underlying optical communication. Additionally, in terms of practical tasks, higher education students often lack clarity regarding basic optical communication equipment due to their limited real-world work experience. On the other hand, vocational education students may be familiar with basic equipment types but tend to lack sufficient ability for extrapolation and systematization. Consequently, when faced with more complex and comprehensive problems, they struggle to find effective solutions.

Furthermore, students who have grown up in the digital age commonly report difficulties in sustaining prolonged attention spans and display heightened sensitivity towards fragmented knowledge. Simultaneously, they excel in resource retrieval and knowledge association while exhibiting strong cognitive leaps.

2.2 Curriculum Characteristics

The field of optical cable route engineering is characterized by a strong blend of theoretical and practical components. This is particularly evident for students in vocational education, as the curriculum encompasses fundamental principles of fiber optic communication, relevant laws and regulations governing communication line construction, as well as the common instruments used in optical cable route engineering construction and methods for troubleshooting. These instruments include commonly used tools such as optical sources, optical power meters, OTDR (Optical Time Domain Reflectometer), cable detectors, and megohmmeters. Additionally, comprehensive subjects related to real-world engineering issues are covered, including daily maintenance of optical cable routes and emergency fault repairs. As a result, students are required to possess high-level comprehensive abilities to succeed in this field.

2.3 Current Teaching Situation

Given the students' foundational profile and the unique characteristics of the course, the current teaching practices have yet to undergo tailored modifications. In an effort to uphold the systematicity and completeness of the curriculum, the traditional approach of initiating with theoretical instruction followed by corresponding practical training remains prevalent. This sequential methodology, though intended to preserve the coherence of knowledge acquisition, encounters several significant challenges in its implementation.

Firstly, students often encounter difficulties in grasping abstract theoretical concepts and knowledge points during theoretical learning due to a lack of intuitive or perceptual understanding. As a result, they resort to rote memorization, which can be ineffective in fostering a deep comprehension. Moreover, the monotony of prolonged theoretical sessions often leads to diminished student attention and engagement.

Consequently, when transitioning to practical training, students struggle to seamlessly integrate their theoretical knowledge into practical applications. This limitation frequently results in practical exercises being reduced to mere operational tasks, neglecting the underlying theoretical foundations and systemic perspectives. As a result, students fail to develop a holistic understanding of each subject, hindering their ability to address complex issues in future professional settings.

Furthermore, the segregation of theoretical and practical teaching in terms of evaluation exacerbates the problem. The reliance on traditional assessment methods, such as summative exams for theory and formative assessments for practice, falls short in evaluating the interplay between theory and practice. The absence of assessments that examine how theory informs practice and vice versa undermines the authenticity of the evaluation process. This, in turn, may inadvertently steer educators towards a bias towards theoretical instruction, thereby compromising the development of students' practical problem-solving skills.

To address these issues, a more integrated and holistic approach to teaching and evaluation is warranted. This includes incorporating hands-on learning opportunities within theoretical sessions to enhance students' understanding and fostering a bidirectional feedback loop between theory and practice in assessment mechanisms. Such reforms aim to foster a deeper and more interconnected learning experience that better prepares students for the complexities of their future professional endeavors.

3 Model of Teaching

3.1 Introduction of the Intergration of Theory and Practice

The Integration of Theory and Practice (ITP) teaching model represents an innovative approach that builds upon existing educational methodologies, integrating knowledge, competence, and quality into a cohesive whole. As shown in the figure 1, this model meticulously attends to the specific characteristics of occupational roles and the evolving needs of the contemporary era, meticulously mapping out job tasks within prototypical scenarios[3]. Driven by these tasks and guided by the BOPPPS (Bridge-in, Objective, Pre-assessment, Participatory Learning, Post-assessment, Summary) framework[4], it leverages the construction of virtual simulation resources to bolster the learning experiences of procedural and competitive tasks. The seamless integration of online and offline instructional activities facilitates the realization of this teaching model, where theory and practice are inextricably linked. The practical execution revolves around four core components: refining teaching content, innovating teaching methodologies, optimizing resource conditions, and reforming evaluation and assessment systems. This approach tackles head-on the pervasive issue of disjunction between theoretical knowledge and practical application in traditional education, rendering academic programs more purposeful and fostering a heightened level of achievement in relation to educational objectives.

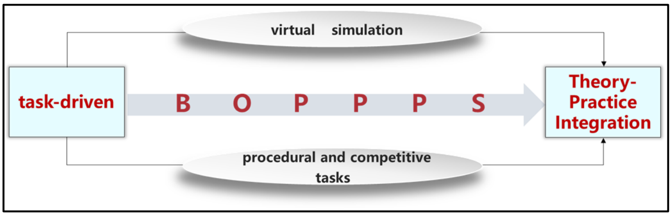

Fig. 1. The Integration of Theory and Practice (ITP) teaching model frame diagram.

3.2 Content of Courses

Considering current technological advancements and industry demands, along with other external factors, we have undertaken a comprehensive approach involving research projects, surveys, and training follow-ups tailored specifically to the requirements of optical fiber cable line positions. Building upon the existing curricular content, we leverage both online and offline platforms, as well as pre- and post-class hours, to enrich and expand our teaching materials under the guidance of an innovative teaching model. Our strategy focuses on job tasks as entry points, while simultaneously breaking down knowledge into manageable units, aiming to enhance students' learning efficiency.

As depicted in the following illustration, taking the Optical Fiber Cable Line Fault Repair task as an example, we orient our instruction towards job tasks and student competency development. We seamlessly integrate the fundamental principles of OTDR (Optical Time Domain Reflectometer), Fault Location in Optical Fiber Cable Lines, and Fault Repair Procedures, thereby rendering our course content more targeted and systematic. This approach ensures that students not only acquire the necessary theoretical knowledge but also develop practical skills relevant to their future careers.

3.3 Teaching Method

The teaching implementation is structured into three phases: pre-class, in-class, and post-class. Based on the BOPPPS model, instructional design is conducted to execute the crucial steps of task-driven teaching. This teaching model incorporates three modifications: Firstly, to thoroughly grasp students' learning situations before the course commences, the "pre-assessment" phase is shifted to pre-class, leveraging software and hardware platform resources. Secondly, to address the challenge of limited equipment in relation to student numbers, which hinders effective full-coverage post-assessment, a portion of the post-assessment is conducted through the platform after class to ensure comprehensive participation. Thirdly, to better implement the educational philosophy of integrating theory with practice, the in-class post-assessment is further integrated with participatory learning, utilizing various forms such as lectures, exercises, comparisons, and evaluations. As depicted in Figure 2.

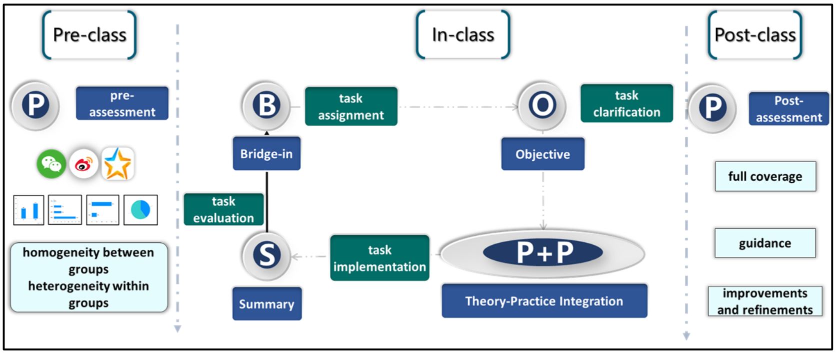

Fig. 2. The Integration of Theory and Practice (ITP) teaching model implementation diagram.

Pre-Class. On platforms like Weizhujiao and Yuketang, relevant learning materials tailored to the specific task are uploaded. The task worksheet for the upcoming class is finalized, followed by a thorough assessment of students' prior knowledge using social media software to facilitate targeted grouping, aiming for "homogeneity between groups and heterogeneity within groups."

In-Class:

- **Bridge-in (B)**: Depending on the content, methods like scenario, task, or story introductions are employed to deliver "task assignments." For practical subjects, task assignments are designed to closely align with job requirements. For instance, when introducing the "OTDR Curve Analysis" module, the task assignment commences with a "task introduction" outlining the broader context of obstacle repair, complemented by demonstrations using actual instruments to enhance students' understanding of the significance of OTDR curve analysis.
- **Objective (O)**: Task assignments are formulated to be achievable, quantifiable, and actionable. For practical subjects, the process is further refined through four aspects: "assignment purpose, method, role, and requirements."
- **Participatory Learning + Post-assessment (PP)**: This phase incorporates hands-on activities, classroom discussions, demonstrations, and other teaching methodologies to execute "task implementation," reinforcing the integration of theory and practice. To accentuate the "two natures and one degree" requirements of vocational education, scenario-based learning and group competitions with assigned roles are organized, enhancing the achievement of instructional objectives. For example, in teaching optical fiber cable fault location, practical exercises are prioritized, with students engaging in group discussions, lectures, exercises, comparisons, and evaluations to grasp the scientific approach to pinpointing faults swiftly and accurately in engineering tasks. Additionally, group competitions encompassing the entire fault location process reinforce fault-locating skills.
- **Summary (S)**: The content is condensed and presented in a framework, with student sharing and instructor supplementation, to conduct an effective "task evaluation." This feedback loop informs teaching effectiveness, ensuring a closed-loop instructional process.

Post-Class. Students are required to independently complete the assigned task worksheet through the software platform, ensuring full coverage. Instructors further leverage platform resources to provide diverse and individualized answers and guidance, serving as data for subsequent improvements and refinements.

3.4 Condition Construction

To better support the aforementioned teaching processes, we have fully integrated online and offline resources during the course delivery and completed the construction of software and hardware resources. Additionally, to comprehensively recreate various scenarios that may be encountered in actual work, we innovatively designed and implemented a virtual training platform for optical cable lines, further bolstering the teaching framework. This approach yields two major benefits: Firstly, the utilization of the platform effectively addresses issues such as inadequate equipment, limited usage scenarios, and safety concerns stemming from irregular equipment operations[5]. Secondly, by incorporating the virtual training platform, the focus of practical operations shifts, to a certain extent, from mere device operation steps and maintenance mechanisms to the theoretical framework. This allows students to allocate more time and energy towards integrating theoretical knowledge into practical operations, thereby laying a solid foundation for subsequent equipment manipulations. Consequently, the essence of "integration of theory and practice" is gradually enriched into a teaching model encompassing "theory, virtualization, and practice."[6]

3.5 Appraise and Examine

Based on the existing talent cultivation system and teaching plan, in order to further address the inadequate integration between theoretical knowledge and practical operation, adjusting the methods and contents of evaluation and assessment is one of the most effective means. On the one hand, it is necessary to promptly adjust the setting of job tasks during the teaching process and the entry point for the iterative integration of theory and practice according to the students' process data, and even further consider the teaching evaluation methods oriented to the virtual environment[7]. On the other hand, in setting up assessment subjects for practical operations, we should, on the current basis, explore open-ended, real-world job problems, consider comprehensive subjects and teamwork abilities, and further examine students' ability to flexibly apply theoretical knowledge to solve practical problems through the assessment of practical subjects.

4 Analysis of teaching application effect

The application of the integrated teaching model combining theory and practice in the recently concluded academic cohort has led to an overall improvement in teaching effectiveness compared to previous cohorts, manifested primarily in the following aspects:

Enhanced Systematicity and Coherence in Practical Responses: Students demonstrated a more systematic and structured approach when answering questions during practical sessions, indicating a better grasp of the interconnections within the subject matter.

Increased Frequency of Question-and-Answer Interactions Driven by Practical Encounters: During theoretical lectures, students engaged in more frequent question-and-answer interactions, often sparked by issues encountered during equipment operation, highlighting a more active and problem-oriented learning attitude.

Improved Accuracy in Discriminating Similar Concepts in Theoretical Examinations: Students showed greater accuracy in differentiating between conceptually similar knowledge points in theoretical written tests, evidenced by higher scores on objective questions such as multiple-choice items.

Elevated Interest in Extracurricular Content Exploration Before and After Class: There was a notable surge in students' interest in exploring supplementary learning materials both before and after class sessions, reflecting a heightened enthusiasm for deepening their understanding beyond the core curriculum.

5 Summary

With the application of the "Integration of Theory and Practice" teaching model in courses related to optical fiber cable line engineering, students majoring in fiber optic communication have generally reported that this model effectively facilitates their understanding of the knowledge framework and enhances their ability to complete practical subjects. In terms of teaching content, the model is driven by job tasks, integrating online and offline resources. During the implementation of teaching, the application and refinement of the BOPPPS (Bridge-in, Objective, Pre-assessment, Participatory Learning, Post-assessment, Summary) teaching model have better embodied the "integration of theory and practice" approach, achieving the goal of learning for practical application. Regarding resource and condition development, innovative measures have been taken to introduce the construction of virtual platforms into both "theory" and "practice" segments, addressing the issue of teaching and learning in practical scenarios. This enables both theoretical and practical instruction to revolve more closely around job-specific tasks. In terms of evaluation and assessment, comprehensive subjects and open-ended questions are employed to further examine students' abilities to integrate knowledge and skills to solve real-world problems.

Undoubtedly, there are still issues that require continuous improvement in the process of teaching and practice, such as the formulation of teaching plans, the refinement of syllabuses, and the training of teachers' engineering capabilities[8]. In future teaching endeavors, the teaching team will strive to continually enhance the school-specific "integration of theory and practice" teaching model based on the actual market demand for numerical control technology talents, coupled with the school's unique circumstances. This approach aims to further elevate the quality of talent cultivation, ensuring that graduates are well-equipped to meet the evolving needs of the industry.

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