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Reform and Practice of Project-based Teaching for "Installation Engineering Quantities Calculation and Pricing Software Training" under the Background of Industry-Education Integration

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Abstract: At present, the main problems in the teaching of the "Installation Engineering Measurement and Pricing Software Training" course on campus include that the teaching outline is mainly classified by knowledge modules. At the same time, the limitation of class hours in this course has resulted in insufficient completeness of the projects that students participate in, and the skills they learn do not match the requirements of the enterprise after graduation. This article uses the concept of industry education integration to link the "school-enterprise-cooperation" together. In teaching, the course team used the electrical engineering and plumbing engineering drawings of Building No.4 in a university as a case study to create a complete process task chain for students. The task chain process includes graphic recognition, modeling, quantity calculation, summary of engineering quantity list, and pricing list items. The teaching reform deeply integrates digital teaching tools such as Guanglianda GQI installation measurement software, GCCP cloud pricing platform, Xuexitong knowledge graph, and AI teaching assistants. During the two cycles of operation, a teaching model of "project oriented, task driven, and industry education integration" was formed. This kind of teaching effectively enhances students' ability to recognize graphics, model, calculate quantities, understand pricing, and collaborate in enterprise adaptation.

Keywords: Industry-Education Integration; Installation Engineering; Quantities Calculation and Pricing Software Training; Project-Based Teaching; Teaching Building

1. Introduction

In January 2025, China issued the "Outline of the Plan for Building an Education Strong Country (2024-2035)". The outline requires that the "vocational education system integrating industry and education" be regarded as an important component of the construction of the "eight major systems" for building an educational powerhouse. Chongqing is also continuously promoting the deep integration of industry and education, with a total of 36 municipal industry education consortia recognized and 52 cross regional industry-education integration communities registered [1]. "Installation Engineering Quantities Calculation and Engineering Pricing Software Training "is a core professional training course for third year students majoring in engineering cost. Under the traditional teaching mode, the following prominent problems are faced. Firstly, the teaching syllabus is developed based on knowledge modules. Installation engineering involves two majors, electrical engineering and water supply and drainage engineering, with detailed and diverse knowledge points. The teaching content urgently needs to be updated and upgraded [2]. Secondly, the current practical training courses only have 24 hours, which limits the authenticity and completeness of the projects. Incomplete project results in weaker ability of students to connect with enterprises after graduation. Thirdly, there is a lack of practical training platforms and other software in terms of teaching conditions, which makes it difficult to support the operation of the cost model throughout the entire process [3]. Fourthly, the mode of school enterprise cooperation is single. It is difficult to effectively integrate real engineering cases, industry standards, and job requirements into the teaching process [4].

The integration of industry and education is a new direction required by the country in recent years.

The integration of industry and education emphasizes industry demand as the guide and capacity cultivation as the core [5]. The "university-enterprise-association" multi-stakeholder collaborative education model, by engaging enterprises and industry associations, establishes a collaborative education ecosystem characterized by university leadership, enterprise participation, and association support [6]. This study integrates the principles of industry-education integration with the "university-enterprise-association" multistakeholder collaborative framework, employing authentic engineering projects as the instructional vehicle to implement project-based teaching reform and exploration for this course [7].

2. Analysis of the Current Teaching Status and Existing Problems

2.1 Current Status of Course Instruction

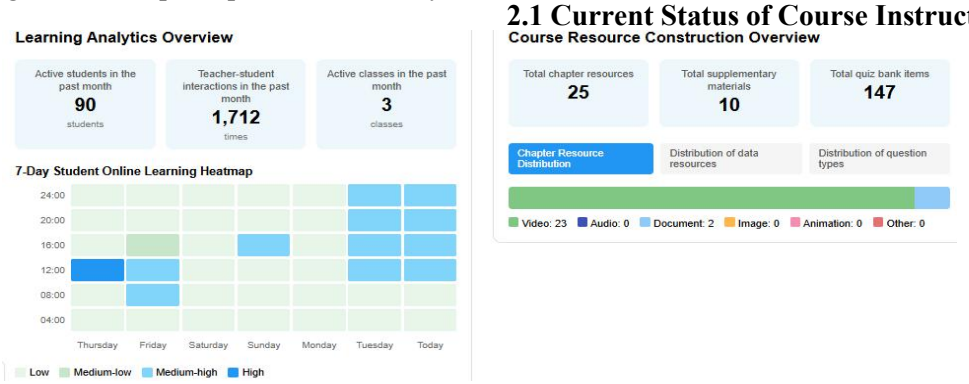


Figure 1. The Operation Status of this Course on the Xuexitong Learning Platform

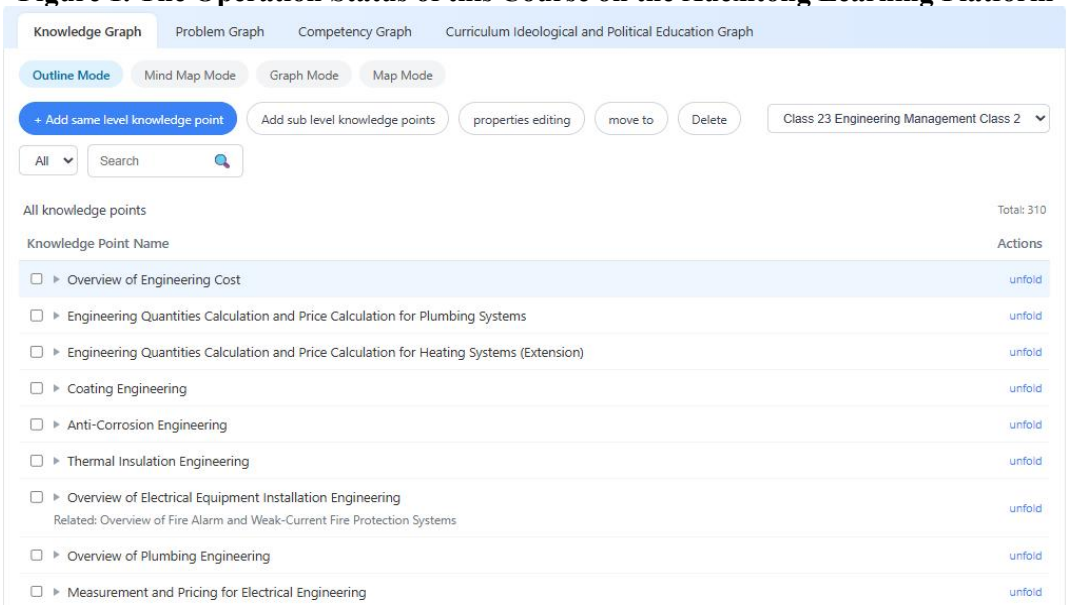


Figure 2. Knowledge Graph of this Course on the Xuexitong Learning Platform

"Installation Engineering Quantities Calculation and Pricing Software Training" is a core practical course for construction cost engineering majors, offered to third-year undergraduate students with 1 credit and 24 class hours. The course content encompasses core competencies including BIM modeling, quantity takeoff, bill of quantities compilation, and pricing and rate application. At present, the course has preliminarily established a digital instructional resource system, having been delivered for two semesters via the Xuexitong online learning platform. Recent data indicate 90 active student enrollments, 1,712 student-instructor interactions over the past month, 25 chapter-based resources, 10 supplementary materials, 147 test bank items, 446 submitted assignments, 6 online examinations, and 521 discussion posts. The course knowledge graph has been fully constructed, comprising 9 first-level knowledge nodes, 25 second-level nodes, and 310 third-level nodes. As shown in the Figure 1 and Figure 2 below.

2.2 Problems in Teaching

First, the syllabus is predominantly organized by modular knowledge units. Such as "Quantity

Takeoff for Plumbing Engineering," "Quantity Takeoff for Electrical Engineering," and "Quantity Takeoff for Fire Protection Engineering". The modular knowledge units relatively independent content and insufficient interconnection among modules. Although the course knowledge graph systematically sorts out the logical relationships between knowledge points, it lacks a complete real-world engineering to organically connect various knowledge points [8]. Students only complete individual tasks within the module, making it difficult to understand the measurement and pricing process as a whole.

Secondly, the lack of class hours results in insufficient authenticity and completeness of the project. At present, the course only has 24 hours, 4 classes per week, for a total of 6 weeks. Within the limited teaching time, the teaching content can only be limited to the core modeling and pricing steps. The classroom teaching content is mainly focused on core key points, and modeling is only limited to a small part of the project. For example, the water supply system only teaches one water supply riser and its branch pipes in the project. The electrical power system only teaches the cable wiring method in one of the distribution boxes and the connection method of the end devices. The teaching content did not fully reflect the complex interdisciplinary and pipeline integration situations in real engineering. And due to class hour limitations, students can only complete the ceiling price document, and cannot involve the changes, variations, and monetary claims that may occur in the subsequent construction process during the actual implementation of the project. The incompleteness of the teaching process leads to a significant lack of adaptability for students entering the enterprise to face practical engineering.

Thirdly, there is a lack of equipment for the full process cost training platform and training courses in terms of teaching conditions. The current teaching conditions mainly include the Guanglianda GQI2021 installation measurement software, GCCP5.0 cloud pricing platform in the computer room. However, at present, there are new versions of software available and what enterprises need are students who are involved in both cost concepts and software operations. The school lacks a comprehensive cost management platform that can cover the entire process of a construction project [9]. Students are unable to experience the complete data transmission process and dynamic management process from the preliminary estimate stage to the final account stage of a project.

Fourthly, the mode of school enterprise cooperation is single and the depth of cooperation is insufficient. At present, school enterprise cooperation in curriculum construction mainly remains at the level of software procurement and technical support. That is to say, schools purchase software and companies provide basic software operation training. Employers have not been deeply involved in core aspects such as curriculum goal setting, teaching content design, teaching process implementation, and teaching quality evaluation. This superficial collaboration results in graduates who are unable to rapidly adapt to authentic engineering contexts upon entering the workforce [10].

3. Course Reform Design Based on the Concept of Industry-Education Integration

3.1 Selection of the Project

This course selects a university's Teaching Building No. 4 as the real architectural project that runs through the entire course. Teaching Building No. 4 is a multi-story public building. It encompasses the drainage system, wastewater system, rainwater system, and fire protection water system. It also encompass the power main system, lighting system, lightning protection and grounding system, fire alarm and weak-current fire protection system, and weak-current communication system within the electrical engineering category. The project features complete engineering content and broad professional coverage, making it well-suited as an architectural project for installation engineering cost estimation training.

There are four advantages to choosing Building 4 as the course building project: (1) The drawings are authentic and complete with reliable provenance, capable of providing a realistic engineering context; (2) The two major disciplines of plumbing and electrical engineering run in parallel within the same building. The plumbing and electrical drawings for this project are for the same building and can be calculated and priced in the same file using GQI and GCCP software. The final output of the bill of quantities is more comprehensive and the model is clearer. Ultimately, the installation project output results can also be merged into one

project when pricing in the GCCP software. The collaborative modeling and pricing of the two interdisciplinary fields reflect the complex multi-disciplinary intersections and pipe integration challenges inherent in real engineering projects. (3) As a public building with a floor area of 9,947.8 m², the complexity is moderate. It is sufficient to meet skill training requirements without exceeding students' capabilities due to excessive intricacy. (4) As a campus building, students have a natural sense of familiarity and can establish an intuitive connection between theoretical learning and practical construction.

3.2 Conceptual Framework and Objectives of the Teaching Reform

This course reform is grounded in the core concept of industry-education integration, with the "university-enterprise-association" multi-stakeholder collaboration serving as the implementation mechanism. The core concept of the reform can be summarized as "threefold integration."

3.2.1 Industry-education integration

The course objectives, instructional content, and assessment criteria are designed based on the talent demands of the construction cost engineering industry, with "whether students are competent for job positions" serving as the ultimate criterion.

3.2.2 University-enterprise integration

The course introduces the real engineering project and actual workflow of Teaching No.4 Building. Students learn knowledge, train skills, and accumulate experience while completing the real projects. In the future, schools can also directly seek cooperation with enterprises, allowing students to directly participate in the quantities calculation and pricing process of enterprises.

3.2.3 Cultivates students with architectural association

At present, there are many college students participating in student competitions organized by industries and associations. Students can learn about the entire process of cost estimation during the competition and award process. Industries and associations can also leverage their advantages in standard setting, resource integration, and quality evaluation. A diverse collaborative education ecosystem led by schools, deeply participated by enterprises, and supported by association competitions will be established.

3.2.4 Overall course objectives

Through constructure project learning, students can complete the entire cost work task of the installation project of No.4 building in a team collaboration mode [10]. Students need to complete software model building, bill of quantities compilation, ceiling price document compilation, and final account document compilation during the learning process. Finally, students achieve the job competency goals of "being able to recognize graphics, model, calculate quantities, calculate prices, excel in analysis, and collaborate with others".

3.3 Course Objective System

Based on the concept of integrating production and education, the teaching objectives of this course can be divided into three goals: knowledge objectives, ability objectives, and quality objectives. Please refer to Table 1 for specific details.

Table 1. Course Objective System

Objectives	Teaching Requirements
Knowledge Objectives	Students can proficiently master the reading methods of installation engineering construction drawings, modeling steps in GQI, quantity statistics rules, pricing principles in GCCP. And students have a certain understanding of relevant standards, including water supply and drainage, electrical system composition and construction technics.
Competency Objectives	(1) Students are able to proficiently interpret drawings and grasp the designer’s intent. (2) Ability to apply digital tools. Students can skillfully operate the Glodon GQI engineering quantities calculation software and the GCCP cloud-based pricing platform. They can correctly set layers and component properties during the modeling process. (3) Ability to analyze and solve engineering problems. Students can identify errors, collisions, omissions, and conflicts in pipelines across different disciplinary construction drawings.
Quality Objectives	Through the course, students identify with the construction cost engineering profession and develop sound ideals and beliefs. The course cultivates a professional ethos of "diligence, responsibility, and truth-seeking," and equips students with a sense of national identity, social responsibility, and fundamental awareness of engineering ethics and legal compliance.

3.4 Project-Based Teaching Content System

The course employs the authentic construction drawings of Teaching Building No.4 as the instructional project. In accordance with the actual workflow of construction cost estimation

positions, establishes a progressively structured project-based teaching content system comprising 7 projects with a total of 36 class hours.

3.4.1 Project 1: project orientation and drawing interpretation

Students first familiarize themselves with the general project information of Teaching Building No. 4 and the course objectives. Subsequently, they interpret the plumbing and electrical construction drawings, developing the ability to understand the relationships among the design specifications, system diagrams, and plan views.

3.4.2 Project 2: plumbing engineering BIM modeling

Students comprehend the graphic language of the drawings and complete three-dimensional modeling of the water supply system, drainage system, and fire protection system within the GQI software drawings. During the modeling process, they configure pipe types, diameters, and elevations in the property settings panel. Pipe valves, accessories, and equipment indicated in the drawings must also be fully incorporated without omission.

3.4.3 Project 3: electrical engineering BIM modeling

Students are required to complete three-dimensional modeling of the electrical power system, lighting system, and fire alarm and weak-current fire protection system within the GQI software. Cable trays, conduits, and wiring are arranged in the model, while electrical system configurations and cable laying methods are specified in the property settings. Circuit information must be assigned to all electrical equipment indicated in the drawings, including distribution boards, luminaires, switches, sockets, and detectors.

3.4.4 Project 4: bill of quantities verification

Students aggregate the plumbing and electrical engineering quantities from the completed model and export the data files. Selected systems are manually calculated for cross-verification, with deviation causes analyzed and recorded.

3.4.5 Project 5: bill of quantities compilation

Based on the verified engineering quantity, students compilate the quantities bill of sub-parts according to national standards, filling in item codes, item names, item characteristics, measurement units, and engineering quantities.

3.4.6 Project 6: pricing and pricing document compilation

According to the principle of applying the list items, students choose the latest quota in Chongqing for comprehensive unit price analysis. After analysis, students enter the material information price and market price into the software, and compilate the ceiling price document.

3.4.7 Project 7: engineering settlement document compilation

This section serves as additional content for students. This project provides some design variations and engineering visa documents. Based on these materials, students adjusted their measurement models and quantities, and recompiled the pricing documents to complete the final account document.

4. Implementation Pathways for the Teaching Reform

4.1 The "University-Enterprise-Association" Multi-Stakeholder Collaborative Mechanism

This teaching reform adopts the model of "school led-enterprise participation-association support". Three parties work together to implement undergraduate teaching. The school is mainly responsible for the overall design of the curriculum, the teaching and monitoring of teaching outcomes. The entire process of enterprise participation in curriculum construction, such as providing real engineering projects as teaching cases, selecting engineers with rich practical experience to participate in classroom teaching every semester, for at least 2-4 class hours. The association is responsible for providing the latest industry standards and organizing software skills competitions for college students.

At present, the course team has contacted a cost consulting company in Chongqing, which can provide real project drawings and negotiate to send front-line cost engineers to participate in the final evaluation of students' achievements. At the same time, invite experts from the Architectural Association to participate in the revision of the course outline. Revising together can ensure precise alignment between course objectives and current societal needs.

4.2 Development of a Full-Cycle Cost Estimation Practical Training Platform

Firstly, upgrade the pricing software on the college computer. I have applied to the college this year to purchase Guanglianda GQI2026

installation measurement software, GCCP cloud pricing platform GCCP7.0. This software is currently the most widely used pricing software in the industry. Every computer in the computer room is installed with genuine software, meeting the needs of every student who can operate the computer.

The development of digital instructional resources has been advanced. The course has already established digital resources including a knowledge graph and AI teaching assistant. In subsequent phases, continued digital resource development will include the recording of more than operation videos of key steps, each approximately 10–20 minutes in duration, covering core skills such as modeling, quantity extraction, bill compilation, and pricing.

4.3 Expansion of Class Hours and Transformation of the Traditional Teaching Model

The authentic project of Teaching Building No. 4 is integrated throughout the entire teaching process, accompanied by an expansion of class hours. The teaching process divides water supply and drainage engineering and electrical engineering into multiple progressive subtasks for modeling. The modeling process can invite enterprise mentors for on-site guidance. At the same time, junior students can also participate in software competitions held by the association, keeping them in a software training environment. Try to approach real cost work as closely as possible in learning.

4.4 Student Team Organization and Role Rotation

Students are grouped in groups of three, and it is ensured that each group has one student with strong learning ability. The team has established three positions: Engineering Modeling, Engineering Measurement, and Engineering Pricing. The Engineering Modeling Specialist is primarily responsible for BIM model creation and modification. The Engineering Quantities Calculation Specialist is primarily responsible for extracting quantities from the model and compiling bills of quantities. The Engineering Pricing Specialist is primarily responsible for rate application, price adjustment, and pricing document compilation. Upon the completion of each subsystem, role rotation is implemented to ensure that every student experience different positions. Prior to the submission of each project deliverable, cross-verification is conducted by another team member, who then submits the results.

5. Reform Outcomes and Practical Reflections

Through the teaching reform practice, the course has achieved notable outcomes in the following aspects.

Students' software operational proficiency has been significantly enhanced, accompanied by increased completeness of task execution. With Teaching Building No.4 as the authentic project vehicle, students are able to skillfully employ Guanglianda GQI to complete modeling for all systems in the engineering drawings. Students are able to utilize GCCP to perform pricing and generate reports. The completeness and standardization of software operations have markedly improved.

Meanwhile, students' capacity to address complex engineering problems has been strengthened. By integrating plumbing engineering and electrical engineering into a unified framework, students are required to simultaneously consider errors, omissions, collisions, and deficiencies across different disciplines, during the processes of drawing interpretation, modeling, quantity calculation, and pricing. This process enables students to better understand the meaning of the drawings, become more familiar with software operations, and gradually adapt to real cost engineer work scenarios. Ultimately, the bill of quantities and pricing results output by students are also more accurate.

This course is more closely aligned with industry demands. The revised course outline combines the software operation requirements of enterprises for graduates, enabling them to quickly adapt to their job positions after graduation.

The depth of integration between industry and education has significantly increased. Cost enterprises and construction associations have been deeply involved in the course construction. Excellent engineers from the company entered the classroom to give lectures, fully mobilizing students' enthusiasm and initiative in class. The association's competitions make students more proficient in software applications. Three parties work together to cultivate excellent engineering cost talents.

6. Conclusion

This article is based on the concept of the

"University-Enterprise-Association" multi-Stakeholder collaborative mechanism, using a real teaching building project as an example to reform the project-based teaching in the course of "Installation Engineering Quantities Calculation and Pricing Software Training". In response to existing teaching bottlenecks, the course has taken multiple measures such as increasing class hours, building a full process cost training system, and strengthening the integration of industry and education, achieving systematic governance of the problem. By deeply integrating GQI installation measurement software, GCCP cloud pricing platform, Learning Knowledge Graph, AI teaching assistants and other digital teaching tools, we aim to create a new model of AI digital teaching. The joint action of multiple platforms can effectively help students improve their professional knowledge and practical abilities.

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