

Original Paper

Theory and Practice Integrated Research on Engineering Project Management Course Based on Multi-Role-Playing Method

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Abstract

The goal of cultivating applied talents in colleges and universities is that students not only need to have sufficient theoretical knowledge and professional qualities, but also be able to comprehensively use professional skills to solve practical problems and create economic and social benefits for society. Therefore, in view of the current disconnect between theory and practice in construction engineering education. We should promote innovation in teaching systems and reform of internal operating mechanisms of courses. In the engineering project management course, we designed a real engineering project background, where students play the roles of seven types of participating parties and manage them independently to complete the main engineering activities from the project decision-making stage to the implementation stage. The result is that we have fundamentally subverted the previous pure case-based teaching with unclear goals.

Keywords

Multi-Role-Playing Method, Combination of Theory and Practice, Teaching reform, Student-centered education

1. Introduction

Due to the problems of insufficient supply of high-level innovative talents, lack of precision in serving the national strategic needs and urgent optimization of resource allocation that still exist in China's higher education, the Ministry of Education of the People's Republic of China has put forward the guiding ideology of creating first-class self-reliant and self-improving talents with the cultivation path of "Interest + Ability + Mission". In civil engineering education, there has long been a disconnect between theory and practice (Forster, Pilcher, Tennant et al., 2017), resulting in students not being able

to fully understand the logic of work (Paul & Elder, 1999), and it is difficult to use professional knowledge to solve practical problems.

Nowadays, project management work has fully entered into the information era (Lin & Huang, 2020), and is closely integrated with the strategic goals and macro objectives of enterprises (Kerzner, 2017). Almost all construction enterprises need to carry out rational planning under the conditions of limited resources and create maximum value through project portfolio. In this context, the training of engineering project management personnel need to master the comprehensive knowledge system constructed by multiple theoretical courses in the learning process, and “problem-oriented” combined with the actual project training to truly achieve the cultivation of “innovative, application-oriented, composite” talents (Acton, 2019).

We have adopted innovative teaching methods (Sivarajah, Curci, Johnson et al., 2016) such as lecture method, flipped classroom, group discussion, case-based teaching, etc. However, in the teaching scenarios, we found that students are easy to produce the stereotype that this is a memorized learning subject after contacting the teaching materials, and their learning is limited to knowledge-related memory and understanding of words, and they are almost unable to transform their way of thinking from technicians to managers, and thus fail to complete the teaching and training objectives in the limited number of class hours. In recent years, the immersive role-playing game has become a popular type of offline entertainment. Participants in the game are guided by the host to follow the storyline and experience the fun of role-playing through communication and discussion. In some areas of expertise, role-playing has also become a new form of educational activity (Moreno-Guerrero, Rodríguez-Jiménez, Gómez-García et al., 2020; Prager, 2019; Winardy & Septiana, 2023). This method is very suitable for the teaching of engineering project management, on the basis of which we have carried out teaching reforms. We designed a real project background, rich alternative participant roles, maximize the mobilization of the students’ thinking level on the basis of theoretical teaching, and flexibly construct a project scenario that can be experienced, interacted and cooperated with, and independently defined, so that students can become the protagonists, and greatly enhance the personal sense of existence and sense of belonging. In the process of immersive experience, students can complete the metamorphosis to project management engineers, and achieve the teaching goal of combining theoretical knowledge and engineering practice to cultivate talents (Sami Ur Rehman, Abouelkhier, & Shafiq, 2023; ElGawely & Nadim, 2020).

2. Teaching Reform Concept

Our research aims is to achieve the following objectives “Enhancing the level of understanding, Elevating the level of thinking, Cultivating teamwork spirit, Career sustainable development”, which linked to the core of the curriculum, to design the continuity and extensibility of the actual work process of the enterprise, and the real scene of the work task. In order to build the integrity of the project with professional characteristics of the teaching system, the teaching reform concepts are

mainly embodied in the following aspects.

2.1 Constructing a Knowledge Network System with Vertical and Horizontal Associations

The project team found it difficult for students to understand the basic theories and methods of Engineering Project Management in teaching. The fundamental reason is this project management is a complex body of knowledge consisting of multidisciplinary and interdisciplinary. Therefore, the project team reorganized the sequence of previous courses, and built a comprehensive knowledge system for students with several categories of courses, including basic professional courses, ideology courses, basic management courses, cost engineering core courses and information technology courses, which are vertically interconnected with each other and horizontally advancing the level of knowledge, so as to promote the formation of a reasonable cognitive structure for students. Supported by the vertical and horizontal knowledge network, students can transfer the knowledge, methods and experience gained in the learning process to the real work situation of project management, break through the stereotyped thinking and solve the comprehensive problems, so as to achieve the purpose of cultivating “innovative, application-oriented and compound” talents. The vertical and horizontal knowledge network is shown in Figure 1.

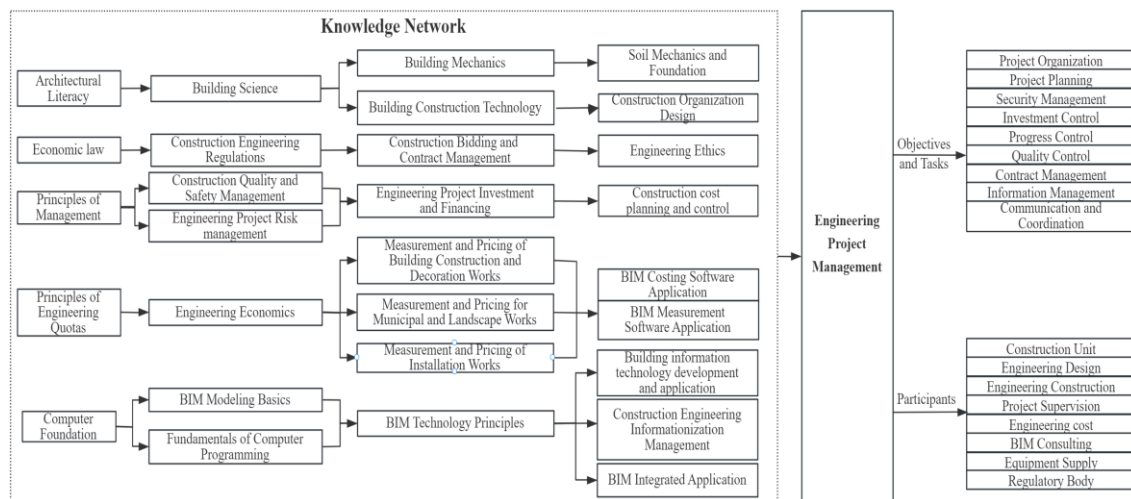


Figure 1. The Vertical and Horizontal Knowledge Network

2.2 Project-Focused Community Classroom Structure

The classroom structure was rearranged according to the number of participants and the specific content of the practice, with a separate “office” for each participant and company signage placed on the desk so that students could quickly get into the role, as shown in Figure 2. Under the guidance of teachers, each company will focus on the project, moving the project forward in an orderly and coordinated manner following the project calendar, based on their respective organizational structures and management.

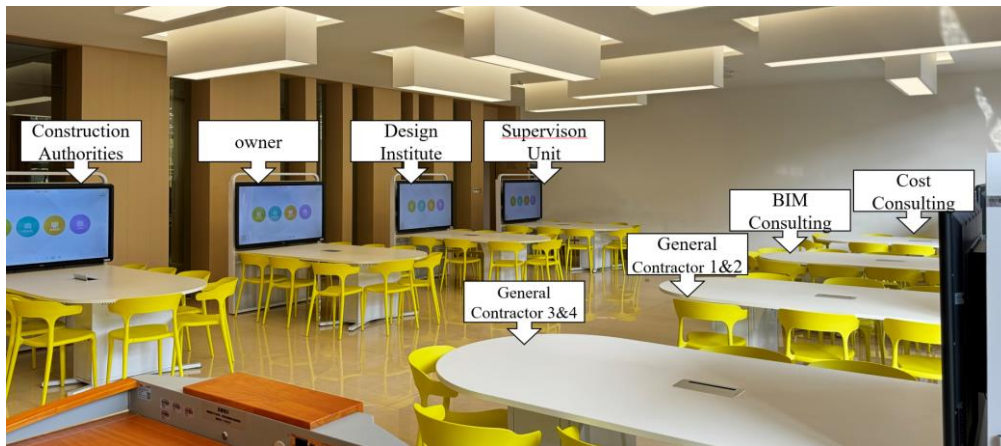


Figure 2. Community Classroom Structure

2.3 Student-Centered Whole Process Education Model

With the concept of “student as the main body, whole process participation”, this research breaks the traditional teaching system. We restructured the teaching program with an engineering problem orientation through universities joining forces with companies, and the design of the course content has been repeatedly demonstrated and revised. On this basis, we have established the evaluation and feedback mechanism of teaching effect with the participation of multiple subjects, constructed the participation of the whole industrial chain of the construction industry, built the practice of the whole process of work and business process, and finally created a new system of teaching activities for comprehensive education.

2.4 Create an Innovative Classroom that Keeps up with the Frontier of the Industry

The course content reflects the industry’s foresight and timeliness. For example, information management, smart construction management and other contents are added to theoretical knowledge teaching, focusing on the application of cutting-edge technologies such as digital twins, 5G, building information technology, big data, and the Internet of Things in engineering project management. The role of BIM consulting participant is introduced in the practice session to explore the management mode in the context of the digital and intelligent era.

In addition, our teaching format need to reflect the progressiveness and interactivity. For example, we have adopted the concept of interactive online teaching in the practical session, allowing students to set up the company’s organizational structure, conduct online meetings, edit collaborative documents online, manage human resources, and submit weekly and monthly reports, manage employee wages, and approve documents on the project management platform software.

2.5 Learning Community of Mutual Delight of Teachers and Students

In the process of project implementation, students are immersed in the working atmosphere under the guidance of teachers, and their comprehensive professional ability grows rapidly. Besides, in order to successfully conduct multi-role-play engineering project management teaching activities, teachers are

required to have profound specialized knowledge, to cope with complex and changing learning scenarios, and to have a global perspective, which in turn urges teachers to go to the enterprise to learn more advanced management techniques and to continuously strengthen their understanding of theory and practice. The learning atmosphere established on this basis allows teachers and students to fully recognize their own strengths and weaknesses, and to motivate and grow with each other on the road to solving problems, constantly affirming their own value, and filling the learning process with a sense of enjoyment and satisfaction.

3. Curriculum Design

3.1 Pedagogical Mapping

This course takes “comprehensive application of knowledge, construct project management thinking, analyze and solve practical problems, cultivate the spirit of teamwork, and achieve sustainable development of the career” as the goal of the course.

We designed the theoretical teaching content according to the course objectives and the engineering project management knowledge system, and made a lot of modifications to the original lesson plan, as shown in Table 1.

The length of theoretical teaching is controlled at half of the weekly class time, focusing on guiding students to understand and apply the tools, methods and measures of engineering project management. Role-playing practice is arranged after the weekly theoretical teaching. The course practice takes a multi-storey civil building to be constructed as the background of the project, students are free to choose the role of construction participants they want to play. Then different participants work collaboratively to complete the project from the project decision-making stage to the implementation stage. During this period, a number of enterprise experts are invited to participate in the whole process of project management, such as: online guidance for students, participation in bid evaluation, etc., so the theory and practice are continuously supplemented to promote students to achieve the competency level required by the course objectives. The teaching map of the course is shown in Figure 3.

3.2 Immersive Participant Roles Designed with Student-Centered Status

A total of seven participant roles are designed in this study, including Construction Authorities, Owner, Design Institutes, Cost Consulting Company, BIM Consulting Company, General Contractor for Construction (no less than 3 companies which determined by class size, and the unsuccessful bidders disbanded after the 13-week bid opening and members reorganized into other companies), and Supervision Unit. The company name and organizational structure were built by the students, and each unit sets its own job positions and arranges the division of work tasks and work functions. Fig. 4 shows the organizational structure of a owner built by students.

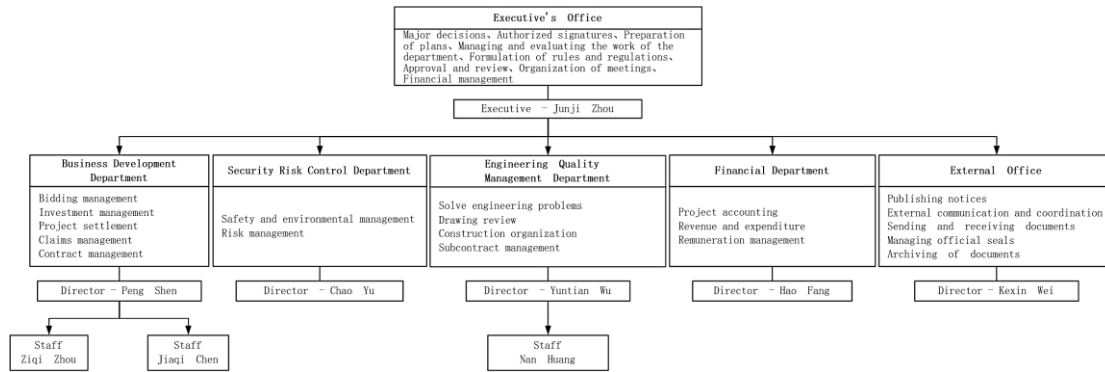


Figure 4. Organizational Structure of a Owner and Division of Tasks

Table 1. Comparison of the Old and New Lesson Plans

| Lesson Plan | Older version | New version |
|---|--|---|
| Chapter name | Organizational Theory of Project Management | |
| Teaching goal | Understand the major engineering project management participants and their responsibilities, Master the organizational theories and tools of project management. | Understand the major engineering project management participants and their responsibilities, key departments and staffing. Recognize the major tasks of each unit throughout the life cycle of the project. |
| Teaching Focus | The basic form and characteristics of the organizational structure of construction project management. | Mastering organizational structure building and workflow mapping. Understand the importance of engineering project organization for subsequent work to be carried out. |
| Teaching Difficulty | Scope of application of various organizational structure models for construction project management. | Build an efficient company organizational structure and workflow. |
| Teaching methods | Lecture method, Case Study | Lecture method, Case Study, Task-Driven method, Role-playing |
| Teaching content and time allocation | 1. Overview of organization theory (5 minutes) 2. Models of organizational | 1. Teaching of theoretical knowledge (35 minutes) 1) Project organizational structure (5 minutes) 2) Division of work tasks and division of functions (5 minutes) |

| | | |
|-----------------|--|--|
| | structure (10 minutes) | 3) Workflow organization (5 minutes) |
| | 3. Organizational division of labor (10 minutes) | 4) Case: Hong Kong Convention and Exhibition Center project management planning (20 minutes) |
| | 4. Workflow organization (10 minutes) | 2. Practical content teaching (35 minutes) |
| | 5. Work project structure (10 minutes) | 1) Naming the company, which was completed last week, with a name that reflects the nature of the company's work. |
| | 6. Case study: Analysis of the organizational structure of a land development project (25 minutes) | 2) Set up the company's functional departments and clarify their responsibilities. |
| | 7. Case: Project management planning for the Hong Kong Convention and Exhibition Center project (20 minutes) | 3) Complete the staffing of each department and the detailed division of tasks. |
| | | 3. Summary (20 minutes) |
| | | 1) Choose 1-2 companies to show and analyze their organization charts. |
| | | 2) Summarize the significance of project organization structure to project management. |
| | | 1. Each unit sorts out the work tasks in the whole process of the project according to the work calendar, draws the work flow chart according to any one of the following ways according to the characteristics of the company, and assigns each work task to the functional departments of the company: |
| | | 1) Develop a flow chart for each task individually (applicable to work tasks with complex processes) |
| | | 2) Comprehensive consideration of project phases, functional departments, work tasks to draw a workflow diagram (applicable to the overall arrangement) |
| Homework | 1. Please draw a project structure diagram | |
| | 2. Please draw an investment control workflow diagram | |

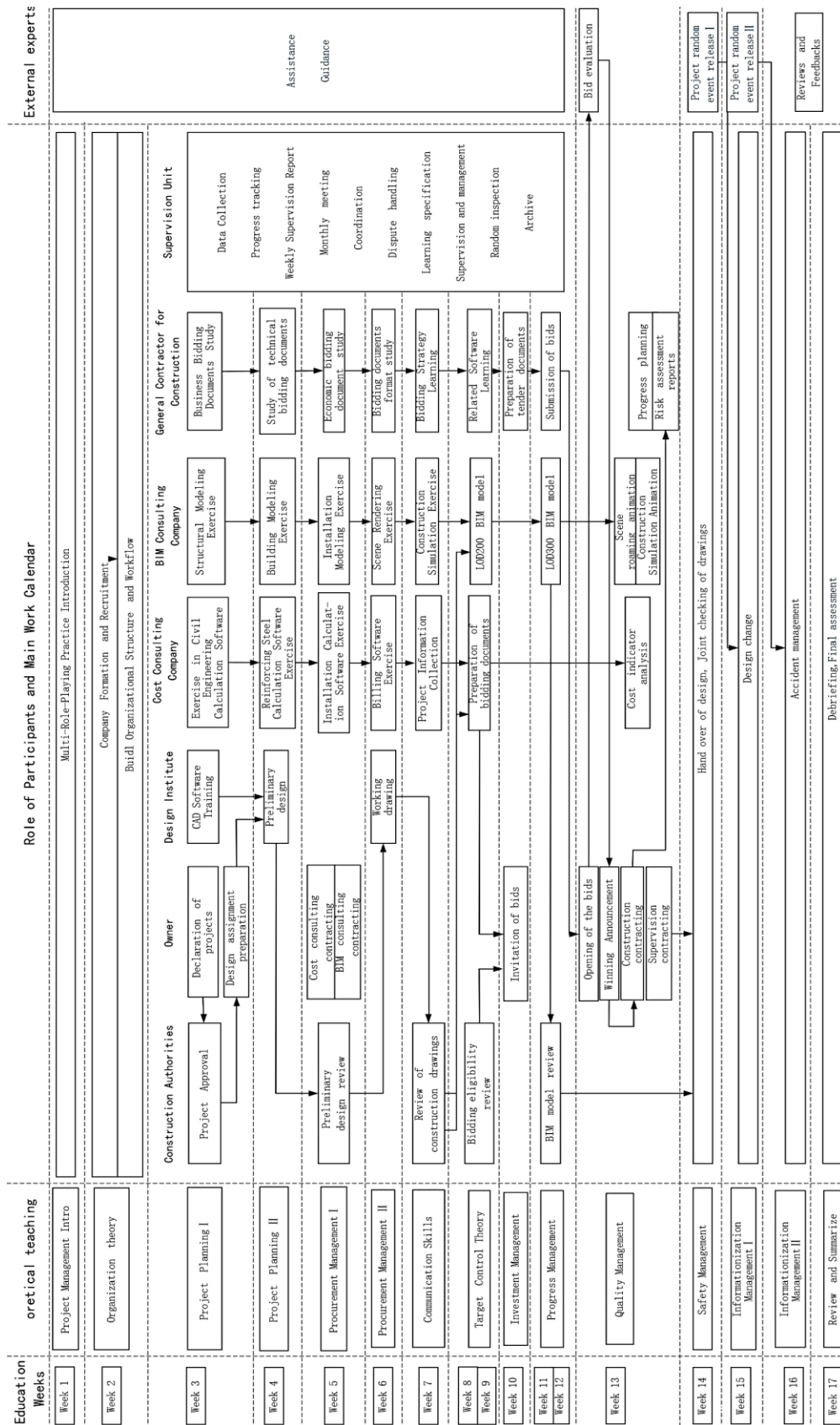


Figure 3. Teaching Mapping of the Curriculum

3.3 Whole Process Engineering Project Experience

Weekly role-playing practice is carried out according to the following process: Teacher guidance → Distribute cards on what each unit is doing this week → Completion of the week's work by all student units → Communication between companies → Teacher summarizes and guides the work of the week and arranges after-school tasks. In order to allow students to experience the immersion of real work scenarios, we try our best to restore real work details throughout the semester, such as: place unit desk cards, address each other by position, workflow is strictly in accordance with industry regulations, all process documents are executed in accordance with national, industry or local standards, documents are stamped with official seals (seals for teaching), and all fund exchanges are issued with "bank receipts", etc., as shown in Figure 5, Figure 6, Figure 7.



Figure 5. Students at Work (the Table Sign Says Design Institute in Chinese)

| 四川油海建设 有限责任公司 | | | | 电子回单 (付款) | | | | 流水号: 2022 00001 | | | |
|------------------------|--|------------------------|--|------------------------|--|------------------------|--|------------------------|--|------------------------|--|
| 付款单位 | | 收款单位 | | 付款单位 | | 收款单位 | | 付款单位 | | 收款单位 | |
| 名称: 四川油海建设有限责任公司 | | 名称: 万好设计咨询有限公司 | | 名称: 四川油海建设有限责任公司 | | 名称: 万好设计咨询有限公司 | | 名称: 四川油海建设有限责任公司 | | 名称: 万好设计咨询有限公司 | |
| 账号或地址: 622901273829127 | | 账号或地址: 622901273829127 | | 账号或地址: 622901273829127 | | 账号或地址: 622901273829127 | | 账号或地址: 622901273829127 | | 账号或地址: 622901273829127 | |
| 开户银行: 中国建设银行 | | 开户银行: 中国建设银行 | | 开户银行: 中国建设银行 | | 开户银行: 中国建设银行 | | 开户银行: 中国建设银行 | | 开户银行: 中国建设银行 | |
| 金额: 人民币 (大写) 6,000.00 | | 金额: 人民币 (大写) 6,000.00 | | 金额: 人民币 (大写) 6,000.00 | | 金额: 人民币 (大写) 6,000.00 | | 金额: 人民币 (大写) 6,000.00 | | 金额: 人民币 (大写) 6,000.00 | |
| 用途: 定金 (20%) | | 用途: 定金 (20%) | | 用途: 定金 (20%) | | 用途: 定金 (20%) | | 用途: 定金 (20%) | | 用途: 定金 (20%) | |
| ERP NO: | | ERP NO: | | ERP NO: | | ERP NO: | | ERP NO: | | ERP NO: | |
| 公司 (盖章): | | 公司 (盖章): | | 公司 (盖章): | | 公司 (盖章): | | 公司 (盖章): | | 公司 (盖章): | |

Figure 6. Owner's Bank Transfer Receipt (in Chinese)



Figure 7. Sealed Bidding Documents Submitted by Students (in Chinese)

3.4 In-depth Integration of Schools and Enterprises to Jointly Build Curriculum Content

Traditional school-enterprise cooperation usually adopts the mode of “on-campus learning + off-campus internship”, which lacks effective integration of teaching and practice to a certain extent. This model pays more attention to skill enhancement, students need to go through a long period of internship training under the guidance of enterprise instructors before they can gradually develop the ability to solve practical problems, students generally lack a comprehensive understanding of the construction engineering system, and it is even more difficult to cultivate their professional sentiments. Therefore, our teaching team and industry experts discussed the teaching reform methods and contents with the characteristics of the courses, jointly formulated reform programs, and participated in classroom guidance and student evaluation. The result is that we have fundamentally subverted the previous pure case-based teaching with unclear goals or the very superficial task-based teaching model. From the previous focus on cultivating students’ professional and technical abilities in a single stage of engineering construction or a single position, it has changed to expanding the service stage of engineering management forward and backward. Enhance the cultivation of students’ comprehensive qualities such as contract management capabilities, cost control capabilities, information management capabilities, organization and coordination levels required in the entire project management process.

3.5 Establish a Multi-Dimensional Quality Evaluation Model with Multi-Subject Participation

The basic feature of the traditional evaluation of higher education is a single subject and a single way of evaluation, relying on the subject of education to evaluate each student according to nearly the same method, or to replace the evaluation with an examination. This approach is contrary to the diversity of educational facts, the diversity of individual character, the diversity of the industry’s demand for talents, and the diversity of personal growth and development. Therefore, this course is not limited to a single

evaluation standard and evaluation method, but takes full account of the dynamic changes in educational scenarios and working time and space, and relies on multiple evaluation subjects to assess the comprehensive quality of students in the whole process according to different evaluation mechanisms. The evaluation method of the course is shown in Figure 8.

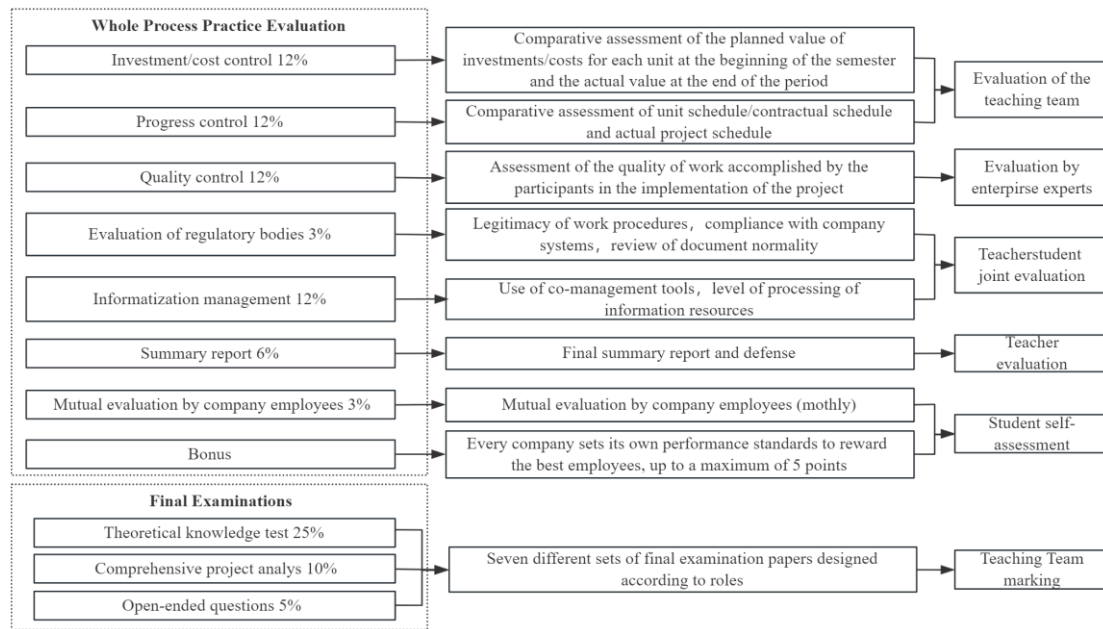


Figure 8. Multi-Dimensional Quality Evaluation Model with Multi-Subject Participation

4. Conclusion

Due to the complex knowledge system of the “Engineering Project Management” course, there is a lot of theoretical knowledge, many of which are difficult to understand. The lack of interaction in traditional classrooms leads to low student participation, so it is difficult for students to comprehensively apply management methods and measures to solve practical engineering problems. In order to meet the demand for the ability and comprehensive quality of practitioners in construction engineering projects under the background of informationization, this study introduces the actual work process of enterprises and real work scenarios with continuity and extension, and builds a complete project teaching system with professional characteristics. Fundamentally changed the previous project-based teaching model with unclear goals.

We are outcome-oriented in our curriculum reform and reverse-design a role-playing teaching model that integrates multi-disciplinary backgrounds. This model assigns students to various participant roles in the engineering project management process, allowing students to practice in simulated scenarios. Through collaborative work among different participating parties to complete various key tasks in the entire project management process, students are trained to establish a complete engineering project management thinking, and develop good professional behaviors and high levels of interpersonal

communication skills. During the practice of multi-role play, the students' enthusiasm for learning was fully mobilized, and they integrated and comprehensively applied the professional knowledge from multiple courses. The result is that we have fundamentally subverted the previous pure case-based teaching with unclear goals or the very superficial task-based teaching model. From the previous focus on cultivating students' professional and technical abilities in a single stage of engineering construction or a single position, it has changed to expanding the service stage of engineering management forward and backward. Enhance the cultivation of students' comprehensive qualities such as contract management capabilities, cost control capabilities, information management capabilities, organization and coordination levels required in the entire project management process.

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