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Original Paper

The Integration Design of "Course, Certificate, Post and Ability" for Software Application Courses Based on CBE

Fangfang Yin[1*] & Denghong Wang[1]

[1] Zhejiang Tongji Vocational College of Science and Technology, Hangzhou, China

[*] Fangfang Yin, Zhejiang Tongji Vocational College of Science and Technology, Hangzhou, China, E-mail: 61681034@qq.com

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Abstract

Based on the need to implement the "1+X" system, this article explored the reform and practice of the "course-post-certificate" integrated teaching system for software application courses. Drawing on the CBE competency-based education model, this article analyzed the current problems in software application courses, and proposed reform strategies based on problem-oriented teaching model innovation, curriculum-position alignment, and curriculum-certification integration. Taking the BIM technology course as an example, the implementation plan and effectiveness of the reform were demonstrated in two aspects: Modularization content design and matching learning conditions with job and certificate requirements. Practice has proved the better effect: the acquisition rate of "1+X" BIM certificate has increased from 78% to over 90%, and the passing rate has been greatly improved, which has been widely praised.

Keywords

Course and job matching, Course and certificate integration, CBE, 1+X, Software applications, BIM

1. Introduction

"CBE" (Competency-Based Education) is a competency-based vocational education theory that requires competency-centered teaching, the integration of theoretical knowledge and skill training, and focuses on student-centered learning activities for self-learning and evaluation. Ultimately, it aims to cultivate students with the professional competencies required for future job positions. As a teaching system based on competency requirements, the CBE model is worth our serious study, broadening our thinking, and drawing on its experience in the face of the current problems of "teaching being divorced from reality, majors being divorced from professions, and students being divorced from jobs" in

vocational education.

In 2019, the State Council issued the National Vocational Education Reform Implementation Plan, which focuses on launching the "diploma + several vocational skill level certificates" system, known as the "1+X" certificate system, aimed at deepening the cultivation of compound technical and skilled talents. (Qian, Zhang, & Zhuo, 2020) Under the "1+X" background, the basic condition for employers to hire workers has evolved into having the necessary basic academic qualifications and vocational skills for a certain job position. However, the phenomenon of "two skins" between academic certificate education and skill certificate training has long existed. (Liu, 2020) Against this background, based on the CBE educational philosophy, exploring the scientific architecture of the curriculum system, seamlessly connecting with job skills and vocational certificates, to achieve "course-post docking and course-certificate integration" is of great significance for implementing the "1+X" certificate system and realizing "zero-distance employment".

2. Method

2.1 Analyzing the Current Situation of the Curriculum and Exploring Teaching Reform

Computer-aided design and management have become an effective way to improve work efficiency, and the application of engineering software has also become an effective means for contemporary college students to enhance their core competitiveness. Therefore, various vocational colleges have offered software application courses, which are also widely welcomed by students.

Software application courses are different from traditional courses in that their knowledge points are scattered and require a lot of computer operation to master skills. The establishment of such courses has the following limitations: (1) The teaching method fails to be student-centered, still relying on "teacher-led lectures and student-led listening". (2) The teaching content fails to reflect the needs of job competencies, and the curriculum system is disconnected from the needs of vocational positions, and the teaching content is rigid and not adaptable to market changes. (3) The teaching process fails to integrate the assessment standards of vocational qualification certificates, and the content of the textbook deviates from the examination outline of vocational qualification certificates, resulting in a low pass rate for students' certification.

These limitations pose challenges to the integration of "course content-post competency-professional qualification" in software application courses, and require research and exploration in teaching methods.

2.2 Innovate Teaching Mode and Stimulate Learning Motivation

Change the traditional classroom model of "textbooks and teacher-led" by introducing real cases, taking the business norms and operation processes of actual work posts as the main line of teaching, and strengthening the combination of theoretical learning and work content. Flexibly use project teaching methods, task-driven methods, situational creation methods, case methods, and other methods to enhance the effectiveness of classroom teaching. Make use of information technology teaching

platforms to play the role of the "pre-class-in-class-post-class" system, and practice the "student-centered" flipped classroom model. Post tasks before class, students learn independently; answer questions in class, students digest knowledge; assist and guide after class, students sublimate knowledge. Stimulate students' learning motivation and autonomy, and improve students' professional literacy and practical ability.

Project-based teaching is adopted in the classroom, relying on 4-6 typical engineering projects as the original carrier of classroom teaching. Teachers with rich teaching experience are organized to carry out secondary processing on the original projects. According to the skills that students must master in their career positions, the original project carriers are divided into preliminary projects, advanced projects, and advanced projects, and common skill points are designed to be carried out in a hierarchical manner according to the teaching sequence. When necessary, students' skill points are repeatedly trained on different projects. In addition to common skill point training, typical skill point tasks for software application are designed. The specific teaching process is shown in Figure 1.

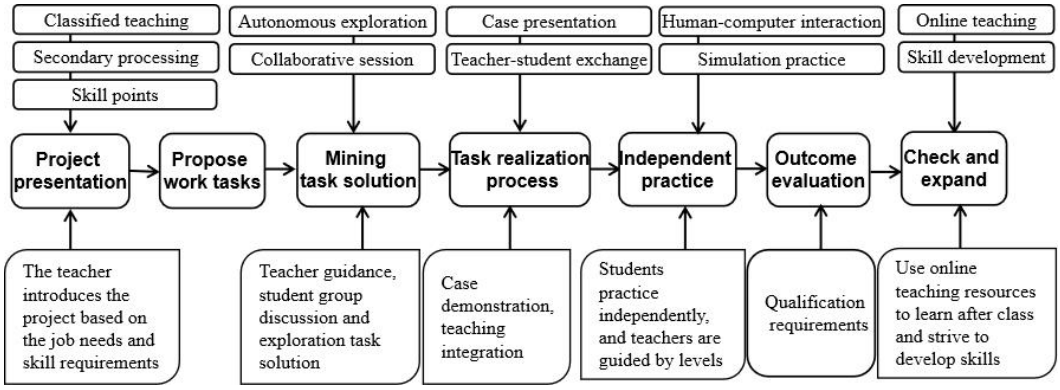

Figure 1. Teaching Implementation Based on Actual Projects

Taking the BIM (Building Information Modeling) course as an example, the task of completing a villa model can be decomposed into: In the preliminary stage, complete the creation of the building model. Create elevations, grids, walls, doors, windows, floors, roofs, steps, stairs, balcony railings, etc. according to the given drawings. The doors and windows are completed according to the dimensions of the door and window table, and those not indicated are not required. In the advanced stage: complete the creation of the structural model. The structural model must first be consistent with the building model, and the foundation, sump, column, beam, slab, post-cast strip, etc. are created according to the actual construction sequence. In the advanced stage: complete the creation of the electromechanical model. Establish models for electrical, water supply and drainage, fire protection, and air conditioning systems, perform comprehensive pipeline optimization and collision inspection, and complete the reserved holes required by the architectural discipline. The selection of typical projects covers different disciplines, including housing construction, bridges, municipal administration, etc. Design common skill points and typical skill point tasks for different technical service projects.

2.3 Deepen the Cooperation between Schools and Enterprises, and Seek for "the Connection between Courses and Posts"

The alignment of courses and jobs refers to the breakdown of job skills requirements into professional course teaching, establishing a direct link between courses and jobs (Xie, 2018).

2.3.1 Construction of Curriculum System

Enterprises are invited to participate in the formulation of talent training objectives and curriculum standards in depth, and set up curriculum systems and teaching contents according to job requirements. Enterprises subdivide job work contents and prepare corresponding skill standards and assessment requirements. After further adjustment by schools, job skill requirements are integrated into professional curriculum education. At the end of learning, students enter enterprises for internship, and enterprises feedback to schools based on students' ability performance to revise talent training programs and curriculum standards (Ke, 2020). Thus, a virtuous cycle is formed, and the curriculum system is continuously optimized.

2.3.2 Construction of Training Base

Both schools and enterprises support each other, complement each other's advantages, share resources, and jointly build training bases. Signing long-term agreements with enterprises, establishing close-knit internship bases inside and outside the school, and promoting the deep integration of school-enterprise cooperation. Both schools and enterprises jointly established a "master studio", directly stationing the project department in the school, implementing a deep cooperation model of "full participation, project stationing, resource sharing, and integration of production and education".

2.3.3 Construction of Teachers' Team

We will build a team of dual-qualified teachers who are both theoretical and practical, and who are both full-time and part-time. We will hire experts from enterprises that have cooperation with schools to teach part-time and pass on their knowledge. We will organize teachers to practice in enterprises on a regular basis to learn new technologies and processes, and improve their practical business skills. We will encourage teachers to participate in relevant teacher training such as the "1+X" certificate, to improve their operational skills and internalize vocational skill level standards.

2.4 Penetrate Professional Standards and Achieve "Integration of Course and Certificate"

Teachers should strengthen their ability to understand the deep-seated application of new technologies in the development of the industry, grasp the trend of industry change, and coordinate the professional talent training program, curriculum standards, and teaching process with it. Enhance the sensitivity to new policies and standards, and revise and improve the curriculum content in a timely manner according to policy changes. Guided by the requirements of vocational qualification certificates, infiltrate the content and requirements of qualification examinations into the curriculum content. In the course of teaching, emphasize the importance of obtaining certificates, revitalize students' motivation to obtain certificates, and enhance their enthusiasm for obtaining certificates.

The integration of courses and certificates, also known as dual-certificate teaching, refers to the

integration of professional certification and vocational education, where the content of the courses is consistent with the content of the professional certification. “Courses” are for the cultivation of talents, while “certificates” are for the needs of the profession in which one is engaged. The integration of courses and certificates refers to the combination of talent cultivation and industry requirements.

Since the country implemented the “1+X” certificate system, the “1+X” certificates corresponding to the main software application courses for the major of engineering cost - Building Information Modeling (BIM), Computer-Aided Design (CAD), and Guanglian Da Engineering Quantity Calculation Software (GTJ\GQI) are respectively Building Information Modeling (BIM), with the training and evaluation organization being Langfang Zhongke Building Industrialization Innovation Research Center; Construction Drawing Recognition, with the training and evaluation organization being Guangzhou Zhongwang Longteng Software Co., Ltd.; and Engineering Cost Digital Application, with the training and evaluation organization being Guanglian Da Technology Co., Ltd. The content and requirements of the certificate examination are integrated into the curriculum, and special certification training is conducted. The operation process is filmed into videos, which facilitate students’ self-study during and after class. The curriculum arrangement is unified with the certification, enabling students to obtain academic certificates while obtaining corresponding vocational qualifications.

3. Result

Taking the BIM course as an example, the course aims to impart relevant theories and practical skills of BIM technology, and cultivate students’ production and management abilities in BIM technology. It is a systematic and practical course.

3.1 Modular Design of Course Content

The BIM curriculum structure is shown in Table 1. The curriculum content is divided into five modules, each of which adopts a project-based teaching approach, subdivided into 2-4 projects. According to the skills that must be mastered in the professional position, several tasks are assigned to each project carrier, and the skill points are designed to be carried out in a hierarchical order according to the sequence of work and learning, integrating the job skill requirements into the teaching tasks (Gao & Wei, 2020).

Table 1. Curriculum Structure and Class Hours Allocation

	Module name	Project name	Teaching Requirements	class period
Module 1	Introduction.	1.1 Basic concept of BIM 1.2 Characteristics of BIM	1. Understand the basic concepts and development background of BIM 2. Understand the basic characteristics and value of BIM	4
Module 2	Drawing of basic components of the project	2.1 Layout of elevation grid in Revit software 2.2 Drawing beams, columns, and walls	1. Familiarize yourself with drawings and revit software operation practice 2. Create project templates and establish project engineering documents for the Qianjiang Building of the Academy of Sciences 3. Establish elevation and grid according to the drawing 4. Draw project columns, beams, floors, and walls	16
Module 3	Project deepening component drawing	3.1 Project curtain wall drawing 3.2 Drawing of stair treads for the project 3.3 Drawing of project railing ramp 3.4 Project site mapping	1. Drawing of project curtain wall, grid division, and mullion drawing 2. Drawing of project stair treads 3. Drawing of project railing ramp 4. Project site and road drawing, component placement	16
Module 4	Family and mass modeling	4.1 Drawing of fountain sculptures 4.2 Conceptual mass rendering 4.3 Family Drawing	1. Drawing of fountain sculptures 2. Understand the concept of conceptual volume, master the drawing method of conceptual volume, and establish conceptual volume 3. Understand the concept of families, master the drawing methods of families, and draw family components	16
Module 5	Detailed design of the project	5.1 View template, marking and annotation 5.2 Indoor and outdoor rendering 5.3 Printing of detailed lists and drawings	1. Set the view template file according to the view requirements and make drawing annotations for the floor plan 2. Place indoor and outdoor cameras, set the scene, and render the image 3. Create a door and window schedule and export the CAD drawing	8

3.2 Stratification of Learning Conditions, Certificate Progression and Job Matching

The "1+X" BIM certificate assessment standards are integrated throughout the entire curriculum, and students are guided to obtain corresponding BIM vocational skill level certificates based on their learning levels and stages (Liu, 2020).

In the first academic year, students are introduced to the basic content of BIM technology, and most of them can master the technology. Students are guided to obtain the "1+X" BIM primary certificate. In the second academic year, students are introduced to the intermediate content of BIM technology, and many of them can achieve intermediate and above levels. Students are guided to obtain the "1+X" BIM

intermediate certificate. In the third academic year, students are introduced to the advanced content of BIM technology, and the level of students is obviously differentiated. Excellent students are encouraged to obtain the "1+X" BIM advanced certificate. Certification training for corresponding levels of certificates is arranged every academic year to meet the needs of students at different levels. Knowledge cognition, software skills, and corresponding job positions and vocational skills certificates in each academic year are shown in Table 2.

Table 2. Teaching Contents of BIM Technology Courses at Various Stages

Academic year	Jobs available	Knowledge cognition	Software skills	Teaching Method	Vocational skill certificate
Freshman year	Junior BIM Engineer (BIM Modeler)	BIM concept, BIM application, BIM value and ROI	BIM modeling software, BIM design review tool	Project teaching method, task-driven method, situational creation method, case method, blended teaching method	BIM Vocational Skills Level Certificate (Junior)
Sophomore year	Intermediate BIM Engineer (Advanced BIM Project Manager)	National BIM guidelines, organization BIM standards, BIM implementation plan, BIM quality inspection	BIM modeling software, BIM design review tool, BIM analysis tool, BIM integration tool	Project teaching method, task-driven method, situational creation method, case method, blended teaching method	BIM Vocational Skill Level Certificate Intermediate
Junior year	Senior BIM Engineer (BIM Project Manager)	Promote BIM integration meetings, plan BIM processes, BIM contract and regulatory issues, organize import plans, BIM quality inspection	BIM modeling software, BIM design review tool, BIM analysis tool, BIM integration tool, Projectworkspace	School, enterprise professional training, internship	BIM Vocational Skill Level Certificate Advanced

3.3 Analysis of the Effect of Textual Research and Learning Ability

The BIM technology course has achieved certain results through the reform and practice of the "course-post-certificate" integrated teaching model. During the course of teaching, it significantly attracts students' attention and stimulates their interest in learning. Students are organized to participate in the "1+X" BIM vocational skill level examination (primary), and the number of applicants and the application rate have both increased compared to the previous period. The certificate acquisition rate has increased from 78% to over 90%, and the pass rate has significantly increased.

After integrating teaching practice into the one-semester course-certification-post model, the author

conducted a survey on the learning effectiveness of the experimental group (the "course-post-certification" integrated teaching model) and the control group (the traditional teaching model) using questionnaire surveys and interviews. A total of 94 valid questionnaires were distributed and 94 were returned, with a 100% response rate. The survey was mainly conducted from the perspectives of stimulating students' interest in learning and improving their learning ability. There were 10 questions in total, with 5 questions in each of the two aspects. Each question was answered using multiple choice questions, with three options for each question.

According to Table 3, after a period of teaching practice integrating course and certificate positions, the learning ability of students in the experimental group is much higher than that of the control group. The knowledge points are the same. After teaching practice through modularized knowledge arrangement, the students who can understand the classroom knowledge points and connect them with their original knowledge account for 61.1% and 56.2% of the experimental group students, respectively, which is higher than the control group's 45.2%. In terms of actual ability improvement, the experimental group students account for 70.2% and 73.1% of the total number of students in using what they have learned to connect with the real life and improve other abilities, while the control group only accounts for 56.1% and 34.7%. The use of multiple intelligences to promote learning, in terms of using language to consolidate knowledge and strengthen practice, the experimental group is also higher than the control group.

Table 3. Comparison of Learning Ability between the Two Groups

The problem	Objects.	Option A	Option B	Option C
1. Can you understand the content learned in class?	experimental group	61.1%	23.4%	15.5%
		61.1%	23.4%	15.5%
	control group	45.2%	30.4%	24.4%
		45.2%	30.4%	24.4%
2. Can the required knowledge in this task be smoothly connected with the existing knowledge?	experimental group	56.2%	29.5%	14.3%
		56.2%	29.5%	14.3%
	control group	45.2%	30.3%	24.5%
		45.2%	30.3%	24.5%
3. Can the knowledge of software application learned be connected with the real life?	experimental group	70.2%	16.7%	13.1%
		70.2%	16.7%	13.1%
	control group	56.1%	23.4%	20.5%
		56.1%	23.4%	20.5%
4. Can you express the design process and purpose of the module and project in your own words?	experimental group	80.2%	11.2%	8.6%
		80.2%	11.2%	8.6%
	control group	58.3%	26.6%	15.1%
		58.3%	26.6%	15.1%
5. Can you improve other abilities after completing this course?	experimental group	73.1%	15.5%	11.4%
		73.1%	15.5%	11.4%
	control group	34.7%	27.8%	37.5%
		34.7%	27.8%	37.5%

The analysis shows that the learning ability of the experimental group students is higher than that of the control group students, both in terms of classroom knowledge and skills operation, as well as in terms of connecting with real life and autonomous learning ability.

4. Discussion

Based on the "competency-based" approach, the three basic points of software application courses, namely "course", "post" and "certificate", complement and promote each other. The "course-post connection" course content is aligned with the job division and skill requirements, improving students' job matching and vocational skills; the "course-certificate integration" course content is closely integrated with the content of vocational qualification examinations, improving students' vocational qualification pass rate and comprehensive employability. Taking the BIM course as an example, exploring the "course-post-certificate integration" teaching reform is in line with the development requirements of the "1+X" certificate system, and is of great significance for improving the quality of software application talent training and broadening employment.

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