



Research on the Path of Advanced Skill Cultivation for the Engineering Cost Estimating Major in Vocational Undergraduate Colleges

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Abstract. Vocational undergraduate is an educational model vigorously promoted by China. That the purpose of vocational education has shifted from employment oriented to human oriented is clearly stated in the *Opinions on the Reform of Deepening Modern Vocational Education System* issued in December of 2022. engineering cost estimating major, a typical skill-based major, should integrate this new orientation in teaching to build an educational system of vocational colleges. Based on the comparison of the differences in the training of construction estimators among three ordinary colleges and three higher vocational colleges, the essay proposes the path of advanced skill cultivation for the engineering cost estimating major in vocational colleges and tries to build an advanced skill cultivation system, which will provide an effective reference for the building and development of engineering cost estimating major in vocational colleges.

Keywords: vocational undergraduate; engineering cost estimating; advanced skills; path.

1 Introduction

The personal training system mode in ordinary colleges and higher vocational colleges has gradually become unsuitable to cultivate new technical and skilled personnel for modern production process^[1]. Consequently vocational colleges come into being. Regarding to the development of vocational undergraduate, Chinese scholars have their own opinions. For example, Yu Huigang holds that the nature of vocational undergraduate education is technological adaptability^[2]. Qing Zhongquan and Yang Wenming think that the vocational undergraduate based on adherence to vocation should embody undergraduate level^[3]. Bie Dunrong believes that vocational colleges should stick to the vocational college school-running model with Chinese characteristics and pay much attention to cultivating vocational advanced skills of students^[4]. Vocational undergraduate colleges started recruiting students of engineering cost estimating major around 2021, so how to specifically develop the major is still in its

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exploratory stage. For example, Hou Lan proposes an innovative personnel training program based on in-depth cooperation between colleges and enterprises and combination of production, teaching and research, and requires construction of multidisciplinary integrated curriculum system^[5]. Setting the engineering cost estimating major as an example, Feng Xiaohong proposes that promoting the characteristic development of vocational undergraduate education is an effective way to improve the quality of vocational undergraduate personnel^[6]. engineering cost estimating major which sprouted in China in the 1980s is a typical interdisciplinary major with integration of arts, science and engineering disciplines. The major (120105) was added to general undergraduate colleges in 2012. Therefore, the engineering cost estimating has been the major in Chinese colleges and universities for 30 years. Although Chinese general undergraduate colleges have gained some experience in teaching, research and professional construction about engineering cost estimating major, its training mode of “wide-range discipline basis and less emphasis on skills” has indicated that the general undergraduate colleges is not committed to cultivating skilled workers. This cannot be satisfied to the requirement of new-type engineering cost estimating skilled personnel in modern society. Therefore, it is urgent to study the development path of advanced skill for the engineering cost estimating major in vocational undergraduate colleges.

2 Comparison and analysis of educational setting models

According to incomplete statistics of Golden Apple Ranking, a Chinese science and education evaluation platform, there are about 54 ordinary colleges offering engineering cost estimating major and 606 higher vocational colleges providing the major. As of December in 2021, there are 32 vocational undergraduate colleges in China, of which 12 have engineering cost estimating major (higher vocational college), and 7 can offer vocational undergraduate degrees about engineering cost estimating major. The essay compares and analyzes the problem of mismatch between talent training and actual demand in the two types of colleges and universities, and tries to put forward the path of advanced ability training for undergraduates with engineering cost characteristics.

2.1 Comparison of training objectives

The training objectives are mainly reflected from the aspects of ability orientation, knowledge structure, vocation positioning and others. In terms of ability orientation, general undergraduate colleges lay emphasis on individual overall abilities, such as leadership, knowledge application ability and independent thinking ability, and higher vocational colleges focus on personnel skill training. In terms of knowledge structure, general undergraduate colleges emphasize a solid theoretical foundation and wide-range disciplines, aiming at cultivating a broad engineering vision for students, and higher vocational colleges pay attention to the cultivation of basic professional abilities such as architectural map recognition, calculation and valuation. In terms of vocation positioning, general undergraduate colleges tend to cultivate the innovative

senior management people who can lead the future development of engineering cost estimating industry, such as people with the whole process cost management ability in investment control, bidding management, cost control, contract management, settlement management and others as well as the overall project management ability. Higher vocational colleges aim to train skilled people to meet the needs of technical front-line positions, such as construction cost estimator and cost estimating engineers. When the highly technological and complex skilled people are needed in the modern production process, the basic skilled people from higher vocational colleges who are unable to comprehensively apply multi-professional skills and lack complex knowledge are incapable of solving complex technical problems, and management people from undergraduate colleges are not professional enough in skills. Both training modes have certain inapplicability (See more details in Table 1).

2.2 Comparison of curriculum system

The curriculum system of general undergraduate colleges and higher vocational colleges is roughly similar, which is divided into five categories: (1) Liberal education courses + quality-oriented courses + public elective courses, the total credits are about 50. The proportion of credits of this kind for two type colleges is basically the same. (2) Basic courses of mathematics and science. The credits of general undergraduate colleges are quite different from higher vocational colleges for this course, the general undergraduate basically being about 20 credits and vocational colleges about 3 credits. The credit proportion of general undergraduate colleges is 5 times that of vocational colleges, which shows that general undergraduate colleges emphasize the foundation of mathematics, science and scientific research. (3) Major courses include basic course and core course. The total credit of major courses is about 68 for general undergraduate colleges and about 56 for higher vocational colleges. Generally, the credits of basic courses in general undergraduate colleges are higher than those of core courses, and the credits of core courses in vocational colleges are 2 to 3 times that of basic courses. The credit proportion of basic courses and core courses shows a clear contrast, reflecting that general undergraduate colleges attach importance to basic courses and higher vocational colleges skills. (4) Innovation and entrepreneurship courses are basically similar in two kind colleges. (5) The credits of intensive practical training are different for two colleges, and fluctuate within a certain range. The credit proportion of intensive practical training in higher vocational colleges is higher than that in general undergraduate colleges, which further reflects that higher vocational colleges pay more attention to skill training than ordinary colleges.

2.3 Comparison of professional courses

Professional core courses include compulsory courses and elective courses. Students should fully master contents of compulsory courses, and can select elective courses according to their personal development plans. The core skill modules of general undergraduate and higher vocational colleges are basically the same, including cost module, bidding module and management module, but there are great differences in

course depth and difficulty. general undergraduate colleges basically follow the logic that one theory course or practice course corresponds to one skill course. Higher vocational colleges divide theoretical courses according to engineering majors, measurement and pricing, let students gradually learn the basic skills of engineering cost estimating and finally gain the skill of cost estimation, which basically conforms to the logic that multiple courses (theoretical courses and practical courses) correspond to one skill.

The setting of core elective course skills bears on the ranking, positioning and characteristics of colleges. Regarding to core skills of elective courses, the elective courses in ordinary colleges are diverse, rich in content and distinctive in characteristics, while higher vocational colleges have set fewer credits in terms of elective courses. Students in vocational colleges can choose the specific major according to their own development, but they have little space for autonomy and few choices.

Some researchers use course graininess to represent the credit proportion of each course. The larger the course graininess is, the larger the credits of each course will be. Large course graininess leaves more space for students to explore deeply [7]. In this essay, the course whose graininess is more than 3 credits is called large course, and the course whose graininess is less than or equals to 3 credits is called small course. The average course graininess of general undergraduate courses is less than 3, and the graininess of specialized basic courses is greater than that of specialized core courses. The average course graininess of higher vocational colleges is mostly greater than 3, and the graininess of specialized basic courses is smaller than that of specialized core courses. In summary, general undergraduate colleges lay emphasis on foundation and wide-range knowledge to train personnel, so they focus on broadening skills and knowledge width for the setting of professional courses. Higher vocational colleges lie in “less foundation, more skills”, so they focus on course depth and highlight special skills for the setting of professional courses. (See details in table 1)

Table 1. Professional course credit statistics table

Course module category	Bachelor education			Vocational education		
	Credit	Number of courses	Course graininess	Credit	Number of courses	Course graininess
Professional basic course	44.0	16	2.75	19.5	6	3.25
Professional core course	26.0	10	2.60	36.5	11	3.32
Total	70.0	26	2.69	56.0	17	3.29

*Note:the minimum number of elective courses is used to calculate the graininess of the professional core elective courses.

3 Path of advanced skill cultivation for the characterized vocational undergraduate colleges

According to the above research, the main problems that existing education modes of general undergraduate colleges and higher vocational colleges aren't appropriate for modern technological development are as follows: (1) polarization of training objectives. There are just a few of general undergraduate colleges which offer engineering cost estimating major. They lay emphasis on the foundation and wide-range knowledge to train management personnel other than advanced technical personnel. Higher vocational colleges focus on basic skill training, and some of them offer additional skill training to train construction workers and data workers, so as to meet the need of base-work occupation in society. (2) Quite different focus of curriculum systems. general undergraduate colleges emphasize theory courses, while higher vocational colleges lay few emphasis on the foundation of mathematics and science. The people trained in higher vocational colleges are more incapable of independently solving complex technical problems. (3) Lack of advanced skills training. general undergraduate colleges ignore skill training for students and higher vocational colleges just focus on basic skill training. As for the development of engineering cost estimating major, vocational undergraduate colleges should avoid the habitual practice of drifting to general undergraduate colleges, and need to stand higher than higher vocational colleges. By comparing the training programs of construction cost estimators in general undergraduate colleges and higher vocational colleges, the author believes that the following four aspects should be mainly considered for the advanced skill cultivation path for the engineering cost estimating major in vocational undergraduate colleges

3.1 Clear positioning of educational functions

Vocational undergraduate education should serve the all-round development of people on the basis of enhancing their technical skills. As the engineering cost estimating major has distinct technical characteristics, students of the major have strong job suitability after graduation. However, vocational education streaming leads to minimum possibility of sustainable development of engineering cost estimating major. The educational function of engineering cost estimating major in vocational undergraduate colleges should put people first, eliminate discrimination of vocational education streaming, and provide sustainable career development. Emphasis should be placed on the combination of science and practice in the process of personnel training, so that students with different ability and needs have multiple choices and excel themselves after diversified training^[8].

3.2 Precise positioning of training objectives

The engineering cost estimating major featured by disciplinary crossing and integration has its particularity in personnel training. Vocational undergraduate education should focus on regional characteristics and the skill to solve career's various of complex

problems. Therefore, the major in vocational undergraduate colleges should train students to become high-level technical people who are capable of solving complex problems and develop sustainably, in accordance with the schools' characteristics and the features of professional construction.

3.3 Deepen curriculum system setting

Vocational undergraduate colleges should pay equal attention to theory and practice during curriculum setting. The course setting for the engineering cost estimating major in vocational undergraduate colleges, with socially vocational adaptability as the center, should not only improve the basic ability of cost estimation, but also lay a solid foundation of mathematics and science. What's more, professional skills with school's characteristics should be trained. This will help to establish a characteristic vocational undergraduate education. To build characteristic course systems for the major in vocational undergraduate colleges, I hold that we need to start from the following aspects:

Firstly, the ideological and political theories teaching in the curriculum leads curriculum construction. The integrated development of the ideological and political theories teaching and the professional education aims to spread proper values throughout the whole process of knowledge teaching and ability cultivation for college education. The purpose of vocational undergraduate colleges is to train craftsman-kind technical personnel. Ideological and political education is conducive to strengthening the craftsman spirit of students majoring in engineering cost estimating, deepening professional ethics education, guiding students to love technical work and consciously abide by the professional spirit and professional norms of the industry, and increasing their professional responsibility.

Secondly, basic modules of mathematics and science should be strengthened. The courses of mathematics and science play a very important role in scientific research and further study in college education. Vocational undergraduate education is followed by master's and doctor's degrees, which can meet the requirements of further study and help to make complex technological innovation to a certain extent. Therefore, the mathematics and science education should be enhanced in the phase of vocational undergraduate, the course difficulty and credits being between ordinary undergraduate education and higher vocational education.

Thirdly, curriculum system should be set in modules. This curriculum modules will help to make course setting correspond to ability training, properly work out the credit ratio of various courses, make the rational overall layout of basic ability, core ability and development ability in the entire curriculum system, discard bird courses that are superfluous, illogical and have no effect on training objectives, and sort out courses with complementary and deepening relationships. All of this will ensure that students have a complete knowledge structure.

Fourthly, practical teaching should be built by integration of theory and reality. Curriculum practice reform based on ability^[9], The essence of the difference between ordinary undergraduate college and higher vocational college is the vocation-oriented intensity. The undergraduate level for vocational colleges is embodied in the mastery of complex and composite technical skills. The engineering cost estimating major in

vocational colleges should train students to freely study either in the school or in the company and integrate theory and practice. Theories and practice courses should run in parallel in the first three years, which help students to create knowledge in 3D BIM modeling, comprehensive practical training of engineering cost estimating, structural modeling and other practical training. In the fourth year, the cost estimating skills comprehensively applied in enterprises will enable students to improve knowledge in spirals and realize transformation of accumulated ability.

3.4 Characteristic positioning of advanced skills

The training of professional construction cost estimators in vocational colleges takes the cost estimation as the core and highlights characteristic skills. Characteristic cost estimators should be trained in combination with the professional positioning, such as training students to become judicial experts with engineering and legal knowledge as the core skill, and engineering auditors with engineering and economic knowledge points as the skill point (see details in table 2).

Table 2. Analysis of characteristic ability orientation of training targets

Capability standard	Capability	Corresponding post	Training content	Necessary ability
Basic capacity	Map identification	CAD draftsman	①	*
	Modeling	Modeler	①⑤	*
Core capability	Measurement and pricing	Cost estimator, cost engineers	①③	*
	Bidding	Tenderer, tenderee	①③	*
Expanding capability	Cost estimation of complex engineering (housing, public construction)	Cost engineer	① ⁺⁺ ③ ⁺⁺	&
	Cost management	Cost management post	①②③ [*] ④ ⁺ ⑤	&
	Contract management	Contract management post	③ [*] ④ ⁺	&
	Purchasing management	Purchasing management post	④ ⁺	&
	Judicial expertise	Judicial expertise post	①② [*] ③	&
	Operation	Operation post	①④ ⁺	&
	Engineering insurance	Engineering underwriter	①②③⑥ ⁺	&
	Municipal engineering, metallurgical engineering, water conservancy engineering, etc	Cost engineer	① ⁺⁺ ③ ⁺⁺	&

Note: *is the required ability and & is the characteristic advanced skills. ① engineering knowledge, ②legal knowledge, ③economic knowledge, ④management knowledge, ⑤information knowledge, ⑥ insurance knowledge. + means the increasing difficulty of learning. The more +, the greater the difficulty coefficient.

4 Case study of advanced ability cultivation system for engineering cost estimating major in vocational undergraduate colleges under the engineering characteristics

Based on the above research path, the following part will state that how vocational colleges which are guided by the development of modern construction technology and the personnel demand build a professional curriculum system of engineering cost estimating major

4.1 Training orientation of vocational undergraduate colleges

Based on the modern development of new technology and the need of personnel in the region, colleges set the overall training goal as engineering cost estimating and complex engineering, namely training students to become high-level technical personnel who have firm ideal and belief, solid engineering knowledge, profound professional and technical level, innovative thinking in solving complex problems, comprehensive ability of “BIM digitization+skill”, and sustainably develop and lead engineering cost technology.

4.2 Curriculum system construction for vocational undergraduate

4.2.1 Course module setting.

The engineering cost estimating major in vocational undergraduate colleges is constructed to improve students' ability to solve complex problems in a post or post group on the basis of higher vocational education. Course system should be built in modules (See details in figure 1).

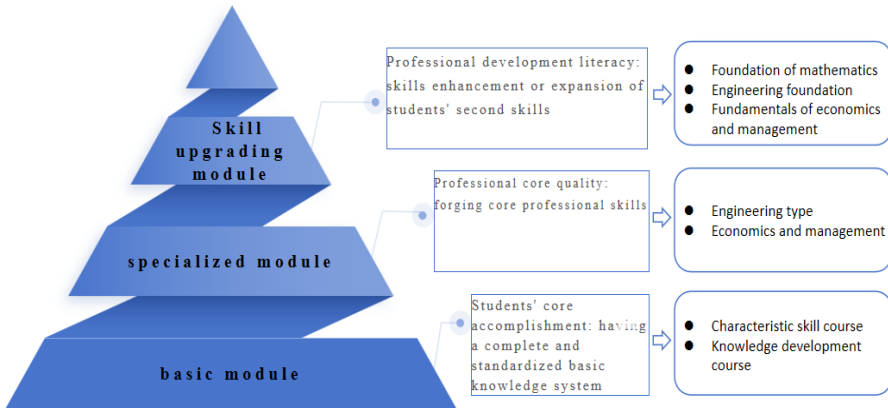


Fig. 1. Course module setting of engineering cost estimating in vocational undergraduate colleges

4.2.2 Course credit setting.

On the premise of meeting the basic requirements of credit proportion setting stated in Engineering Education Certification Standards, the credits of non-liberal education courses for the vocational undergraduate college with engineering characteristics is mainly allocated from four perspectives. Firstly, lay a solid technical theoretical foundation and add Steel Structure and Reinforced Concrete Structure in higher vocational courses. Secondly, lay the ground for students' sustainable improvement and increase the course difficulty of Building Mechanics, Advanced Mathematics and Linear Algebra. Thirdly, set up courses and strengthen the practical training around cost estimating skills, with technology as the center, such as 3D Calculation Training, BIM Training for High-rise Building, Post Practice and so on, Even increase co-op courses^[10]. Fourthly, a broad engineering knowledge and skill enables students to have transdisciplinary capability to solve complex problems. Elective courses such as landscape architecture, municipal, installation and other different cost estimating courses should be added, which enables students to study in accordance with their interests and future development.

4.2.3 Curriculum mapping.

Curriculum are set up around social occupations and have different courses in accordance with capability required for basic posts, core posts and expanding posts. Trained engineering cost estimating personnel should be comprehensive cost estimating engineers with cost estimating skill and a broad engineering knowledge. In the case, we increase the difficulty of engineering-related courses, add landscape architecture, municipal, installation cost estimation to broaden skills, which will form a characteristic engineering cost estimating personnel training system. In the end, courses are arranged according to the path of student's basic capability, professional core capability and expanding capability to form a map of non-liberal education courses for engineering cost estimating major in vocational undergraduate colleges.

5 Conclusions

The vocational undergraduate education compliments the ordinary undergraduate education which lays emphasis on foundation and ignores skills and the higher vocational education which emphasizes the foundation of technical skills. Putting people first is the basic idea for vocational undergraduate colleges to train engineering cost estimating personnel. We should avoid habitual thinking of ordinary undergraduate colleges and higher vocational colleges, stick to career orientation and sustainable education. In general, as for the construction and development of engineering cost estimating major in vocational undergraduate colleges, schools should be people-oriented and train students to become high-level technical personnel who can sustainably develop and lead engineering cost technology in line with school or regional characteristics. Only when the engineering cost estimating major in vocational undergraduate colleges is operated well, it is possible to further develop professional master's degree.

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