Construction of Refined Assessment System for Practical Education of Engineering Majors under the Perspective of Craftsmanship

-- A Case for Fire Engineering

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Abstract. With the advent of a new era in Chinese socialism, the role and significance of human resources as the primary resource for economic and social development has become increasingly evident. From the perspective of practical education, the cultivation of applied talents with the spirit of craftsmanship has become a new demand in the new era, in conjunction with a refined assessment system for practical education that incorporates this spirit. Taking the Fire Engineering program at Southwest Forestry University as the research object, a questionnaire survey was used to evaluate the satisfaction of students with the training and assessment system, with a total score of 72.25 points. The satisfaction with the assessment system was at an above-average level, with scores of 82 for teaching methods evaluation, 75 for teacher evaluation, 67.5 for student evaluation, and 62.75 for learning methods evaluation. Using the expert scoring method, four refined assessment indicators of practical education were evaluated as "very important," including teacher and student dimensions, individual development of students, basic knowledge application ability, and comprehensive quality. The results of this study supplement the theoretical basis of the refined assessment system for practical education and provide reference opinions.

Keywords: Fire engineering; Practice education; Fine assessment system; Craftsmanship spirit; Engineering program.

1. Introduction

Education is a long-term undertaking, and the comprehensive development of college students is related to the deepening of their self-worth and the development of the country and society. In the new era and under new circumstances, reform and opening up, as well as the modernization of socialist construction, promote the comprehensive development of individuals and society, while also placing new and higher demands on education and learning [1]. Under the new development background, it is necessary to continuously improve the construction of a refined assessment system for practical education, cultivate applied talents with the spirit of craftsmanship, and take moral and artisanal education as the fundamental tasks. It is important to clarify the direction and goals of socialist higher education institutions, and to study the construction of a refined assessment system for practical education in engineering majors from the perspective of the spirit of craftsmanship.

There are many problems in the management of university teaching, and some universities have low efficiency in teaching management[2]. Refined assessment management and goal assessment management can be integrated into the system. However, compared with the goal management mode, the refined management system pays more attention to workflow management. Overall, research on this topic covers a wide range of disciplines[3] and is currently a hot topic. Research on practical education in Chinese universities can be traced back to the 1980s [4-6]. Practical education is an important way to innovate talent cultivation, and it plays an important role in cultivating innovative talents[7-8]. The development of the spirit of craftsmanship cannot be separated from the construction of a practical education system. Currently, domestic scholars mainly focus on four aspects of the research on the spirit of craftsmanship: the reasons for the lack of the spirit of craftsmanship[9], the basic connotation of the spirit of craftsmanship[10], the social value of the spirit of craftsmanship[11-12], and the cultivation system of the spirit of craftsmanship[13]. As an indispensable step in talent

cultivation, the construction of a refined assessment management system has gradually begun to be studied by domestic experts and scholars[14-17].

This study takes the construction of a practical education system and a refined assessment management system as the starting point, implements the fundamental task of cultivating applied talents with the spirit of craftsmanship, and focuses on the fundamental issues of what practical education is, what a refined assessment management system is, how to do practical education well, and how to construct a refined assessment management system. This study will use the Fire Engineering major in engineering as an example and combine the spirit of craftsmanship with practical education and a refined assessment management system to deeply explore the significance of the assessment system for talent cultivation, laying a foundation for further enhancing the comprehensive quality of Fire Engineering students. At the same time, a questionnaire survey method[18] and an expert scoring method[19-20] will be used to jointly construct the assessment system, explore the new opportunities and challenges faced by Fire Engineering students, and focus on building and improving the mechanism of practical education and a refined assessment management system.

2. Research Methods

2.1 Questionnaire Survey Method

To understand the professional satisfaction of Fire Engineering students in a certain school and the current situation of practical education and refined assessment management system construction in the major, a questionnaire was designed and randomly distributed to all four-year and two-year students in the Fire Engineering major. Excel was used to analyze the survey results and summarize the current status and existing problems of practical education and refined assessment management system construction.

2.2 Expert Scoring Method

The expert scoring method is a qualitative description and quantitative method. It first selects evaluation items based on the specific requirements of the evaluation object, formulates standards based on the evaluation items, and then invites experts to give scores based on their experience and analysis. In this study, the expert scoring method was used to improve the construction of the assessment system. The practical education assessment system was jointly studied to strengthen the system construction. The scoring mode was used for objective and scientific comprehensive evaluation analysis based on the subjective judgments of experts from various fields, in order to make the final reasonable analysis and evaluation results. The main steps are shown in Fig.1.

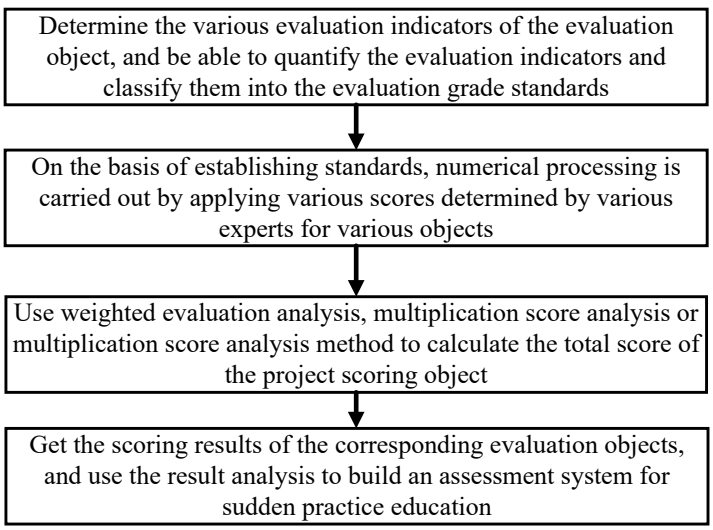


Fig. 1 Flow chart of expert scoring method

The calculation method for the addition-type evaluation is to sum up the scores of each evaluation indicator, and represent the evaluation result based on the total score. This method is suitable for situations where the relationship between indicators is simple. The formula for calculating the total score is:

$$M = \sum_{i=1}^{n} M_i \tag{1}$$

M-Total score of the evaluation object, M1-Score value of the first indicator, n-Number of indicators.

The weighted evaluation type gives different weights to each index item in the evaluation object according to the importance of the evaluation index, that is, the importance of each factor is treated differently.

$$W = \sum_{i=1}^{n} A_i W_i \tag{2}$$

W-Total score of the evaluation object; Wi-The i index item score of the evaluation object; Ai-The weight of the index item.

3. Research Results

3.1 Satisfaction Analysis of the Cultivation and Assessment System

3.1.1 Questionnaire Design for Satisfaction Analysis of the Cultivation and Assessment System

The questionnaire for the satisfaction analysis of the cultivation and assessment system will consist of 20 multiple-choice questions (see Appendix 1) from dimensions such as teaching method assessment, learning method assessment, teacher assessment, and student assessment. The answer options will use a three-level scale, including "strongly agree", "agree", and "disagree", with scores of 5, 3, and 1 respectively.

3.1.2 Implementation of the Satisfaction Analysis Questionnaire for the Cultivation and Assessment System

Tab. 1 Student satisfaction variables and models

I-Dimensional Variables	II-Dimensional Variables
Teaching Method Assessment A	A1 Diversified teaching methods
	A2 Integration of craftsmanship into teaching activities
	A3 Improved learning interest and participation
	A4 Combination of teaching methods and practice
	A5 Active participation in extracurricular competitions
Learning Method Assessment B	B1 Combination of various learning methods
	B2 Ability to stimulate learning interest
	B3 Integration of online and offline learning into daily life
	B4 Reflection of practice in daily learning
	B5 Active participation in classroom discussions
Teacher Assessment C	C1 Reliable and complete teaching plan
	C2 Adherence to basic etiquette for teachers
	C3 Completion rate of assessment according to grading criteria
	C4 Clear teaching objectives and complete classroom activities
	C5 Diversified teaching methods
Student Assessment D	D1 Attendance and course status meet basic requirements
	D2 Assessment of final grades and regular grades in line with practical education concepts
	D3 Adequate time for practical activities
	D4 Student internship status and group learning status meet basic learning requirements
	D5 Positive learning attitude of students

The questionnaire survey was conducted among students of the Fire Engineering Department of the School of Civil Engineering at Southwest Forestry University, using a QR code to scan and fill out the questionnaire through a mini-program. The satisfaction level of the current cultivation and assessment system for fire engineering students at Southwest Forestry University was obtained.

A total of 60 questionnaires were collected, and all of them were valid for analysis. The statistical results were analyzed using Excel software, and the satisfaction levels of students with respect to teaching method assessment, learning method assessment, teacher assessment, and student assessment were obtained. Based on the analysis of the mean, variance, and other statistical indicators, and the overall measurement of the univariate variable distribution that affects student satisfaction, a model was established with four I-dimensional variables, 20 II-dimensional variables, and a total satisfaction variable. The student satisfaction model with two-level dimensions is presented in Tab.1, considering the factors influencing student satisfaction with the cultivation and assessment system and the problems in the management process of the system.

3.1.3 Student Satisfaction Analysis

The mean score of the overall satisfaction question (X0) in the survey questionnaire was calculated, and the student satisfaction score was found to be 2.86, equivalent to a score of 72.25.

Based on the mean score of the four I-dimensional variables, the student satisfaction score was found to be 2.8, equivalent to a score of 70. This score is consistent with the X0 mean score, which indicates the stability, consistency, and effectiveness of the survey questionnaire.

Tab. 2 Statistics of student satisfaction for dimension I variables

NO.	Index I-Dimensional Variable	Average score	Equivalent Score
1	Teaching Method Assessment	3.28	82
2	Learning Method Assessment	2.51	62.75
3	Teacher Assessment	3	75
4	Student Assessment	2.7	67.5

Student satisfaction with teaching method assessment was the highest, while satisfaction with learning method assessment and student assessment was below average. In other words, the satisfaction level of fire engineering students with the assessment system is above average.

3.2 Construction of a Fine-Grained Assessment System for Practical Education Based on Expert Scoring

3.2.1 Establishment of Assessment System Indicators

Based on a comprehensive consideration of various influencing factors, four indicators were identified for the fine-grained assessment system for practical education, including teacher and student dimension A, individual student development dimension B, basic knowledge application ability dimension C, and comprehensive quality dimension D.

3.2.2 Determination of Assessment Evaluation Indicator Weights

Several methods can be used to determine the weights of the evaluation indicators for the fine-grained assessment system for practical education, such as expert scoring method, weighted average method, analytic hierarchy process, and Delphi method. In this paper, the evaluation weights were determined by 10 expert teachers responsible for teaching management or teaching in the Fire Engineering Department of Southwest Forestry University.

The survey table for constructing the fine-grained assessment system for practical education consists of 4 primary indicators and 20 secondary indicators, with each secondary indicator corresponding to different weight-bearing factors. Ten experts scored the indicators based on their personal experience, and provided feedback and suggestions for improvement. The scores were then analyzed and summarized, and minor indicators were excluded. The indicator weights were determined based on the summary table, as shown in Appendix 2.

3.2.3 Application of Indicator Weights in the Assessment System

The construction of a fine-grained assessment system for practical education within a university can improve its assessment system. The evaluation of the practical education execution level is also applicable to the indicator evaluation of the fine-grained assessment system. Following the above method, the expert scores for each primary and secondary indicator can be determined in order, and the weight distribution for each level of the indicators can be determined. Finally, the fine-grained assessment system for practical education indicator table can be constructed, as shown in Tab. 3.

Tab.3 Table of practical education and refinement assessment index system

Primary Indicators	Secondary Indicators
Teacher and Student Dimension A (0.4)	Attitude towards teaching A1 (0.2) Teaching effectiveness A2 (0.1) Teaching content A3 (0.2) Teaching methods A4 (0.3) Student's regular grades A5 (0.2)
Individual Student Development Dimension B (0.2)	Self-learning ability B1 (0.2) Evaluation and reflection ability B2 (0.3) Analysis and synthesis ability B3 (0.2) Logical thinking ability B4 (0.15) Student innovation ability B5 (0.15)
Basic Knowledge Application Ability C (0.3)	Student's professional skills C1 (0.4) Hands-on practice C2 (0.2) Artistic and athletic talents C3 (0.1) Communication skills C4 (0.2) Volunteer activities C5 (0.1)
Comprehensive Quality D (0.2)	Political quality D1 (0.4) Moral quality D2 (0.2) Intellectual quality D3 (0.2) Physical quality D4 (0.1) Psychological quality D5 (0.1)

The indicators include both qualitative indicators such as teaching attitude and teaching methods, and quantitative indicators such as students' regular grades and the number of hands-on practices. This paper applied the expert scoring method and analyzed the application results based on the scoring of the importance of assessment indicators by 10 assessment experts.

Determination of weights. This paper first considered the degree of influence of the influencing factor indicators on the secondary indicators, and then analyzed the relationship between the secondary indicators and the primary indicators in order to construct the entire indicator system. Therefore, the assessment experts need to determine the weights that add up to 1 for the relative importance of the influencing factor indicators within each indicator.

Classification of levels. The experts will use classification to determine the level of each indicator in the fine-grained assessment system for practical education and assign a quantitative value. The classification includes four levels: most important (Level I), very important (Level II), general (Level III), and not important (Level IV). The values are scored as 1, 0.8, 0.6, and 0.2 respectively.

Calculation of scores for each level. The weights of the influencing factor indicators and the corresponding level scores are multiplied to obtain the scores for each secondary indicator. The sum of the scores for each secondary indicator is the score for its corresponding primary indicator, as shown in Tab.4. Similarly, the scores for other scoring situations can be obtained, as shown in Tab.4.

This paper conducts an analysis of the results of the application of a fine-grained assessment index system for practical education based on expert ratings. It can be summarized that the scores of the teacher and student dimension indicators are 0.78, the score for individual student development indicators is 0.7, the score for comprehensive quality indicators is 0.77, and the score for basic knowledge application ability indicators is 0.84. According to the maximum membership principle, the assessment of the fine-grained assessment system for practical education can be evaluated as "very

important". Under current requirements, the fine-grained assessment system for practical education in the field of fire engineering has basically met the standards. This paper conducts a preliminary analysis of the assessment indicators for students majoring in fire engineering, and builds a comprehensive evaluation indicator system for cultivating applied talents in fire engineering, consisting of four primary indicators and 20 secondary indicators. This provides a reference for the establishment of a comprehensive, accurate, and scientific evaluation indicator system.

Overall, the fine-grained assessment index system for practical education is of great significance for cultivating students majoring in fire engineering. By evaluating their individual development, comprehensive quality, basic knowledge application ability, and other aspects, we can better understand their strengths and weaknesses, and provide targeted training and improvement, thereby cultivating more excellent applied talents in fire engineering.

Tab.4 Teacher and student dimension indicators scores

Primary Indicators	Secondary Indicators	weight factor	level	Weights	Score	Total
	A_1	0.2	II	0.8	0.16	
	A_2	0.1	I	1	0.1	
A	A_3	0.2	III	0.6	0.16	0.78
	A_4	0.3	II	0.8	0.24	
	A_5	0.2	III	0.6	0.12	
	B_1	0.3	II	0.8	0.24	
	B_2	0.1	II	0.8	0.08	
B	B_3	0.25	III	0.6	0.15	0.70
	B_4	0.1	II	0.8	0.08	
	B_5	0.25	III	0.6	0.15	
	C_1	0.3	II	0.8	0.16	
	C_2	0.2	III	0.6	0.18	
C	C_3	0.2	I	1	0.25	0.77
	C_4	0.2	II	0.8	0.12	
	C_5	0.1	III	0.6	0.06	
	D_1	0.2	II	0.8	0.16	
	D_2	0.3	I	1	0.3	
D	D_3	0.25	II	0.8	0.2	0.84
	D_4	0.15	II	0.8	0.12	
	D_5	0.1	III	0.6	0.06	

3.2.4 Curriculum Construction of Fine-grained Assessment System for Practical Education

According to the results of the investigation and statistical analysis, the public basic courses are relatively reasonable, with 52 credits for theoretical teaching, 6 credits for experimental teaching, and a total of 58 credits, accounting for about 30% of the total teaching credits. Thirteen courses are offered, such as "Linear Algebra A", "Advanced Mathematics A", "Probability and Statistics B", "Applied Writing Style", "Fluid Mechanics", etc. Based on satisfaction data, no additional courses are needed for the professional basic courses, with 24.5 credits for theoretical teaching and 5.5 credits for experimental teaching, a total of 30 credits, accounting for 14.5% of the total teaching credits. Ten courses are offered, including "Architectural Drawing", "Electrical and Electronic Technology", "Fire Combustion Science", "Safety System Engineering", etc. Five courses are set for the professional core courses, with a total of 15 credits. Nine courses are offered for the professional characteristic courses, such as "Fire Drawing", "Fire Investigation Science", "Fire Management Science", "Fire and Emergency Rescue Technology and Equipment", etc., with a total of 17 credits. In the course assessment, traditional closed-book exams can be used, or reformed comprehensive assessments can be conducted to evaluate students' knowledge mastery and application abilities.

Practical education should be integrated into daily practice teaching. Practical assessment mainly focuses on course experiments, with 13 experimental courses offered, totaling 42 (30.5+11.5) credits. Among them, the graduation thesis (design) is one of the important components of the assessment

system, and is also an important indicator for testing students' comprehensive abilities. The process of students choosing, designing, and completing experiments independently is one of the important ways to improve the innovative design awareness of students majoring in fire engineering.

3.3 Problems and Countermeasures in the Construction of the Training and Assessment System

3.3.1 The cultivation of craftsmanship spirit is not perfect in the assessment system

In the process of cultivating craftsmanship spirit, an imperfect training and assessment system directly affects the quality of college students' craftsmanship spirit. Therefore, universities should establish a sound mechanism that is compatible with the cultivation of craftsmanship spirit under the existing system, form standardized regulations, and promote the long-term development of craftsmanship spirit cultivation. For example, universities can strengthen the publicity of craftsmanship spirit, establish regulations that meet the needs of craftsmanship spirit cultivation, build a "dual-teacher" teacher team, improve the mechanism for cultivating craftsmanship spirit, and achieve standardized and integrated development of college students' craftsmanship spirit cultivation.

3.3.2 Insufficient implementation of practical education in training

In some majors in some universities, the concept of practical education has not been deeply integrated into teaching in the training and assessment system. Assessment is limited to written standard exams, leading to students having an exam-oriented mentality, and only requiring themselves to pass the exams. Therefore, universities should grasp the basic connotation of practical education and implement it in the training and assessment system, which requires courage to innovate and practice. Professional learning should be supplemented by serving society as the main goal, and part-time jobs should be the main focus, with innovation and entrepreneurship as the supplement.

3.3.3 The refinement management is not significant in the assessment system

There are shortcomings in the construction of the training and assessment system in universities, mainly manifested in the fact that refinement management is not significant in the assessment system. Under the education background of the new era, it is necessary to formulate regulations that conform to students' growth, so that students can grow up in a personalized way, and provide a good teaching environment to lay a stable foundation for future development. As an important carrier of providing talents to society, universities should not only pay attention to the surface work in applied talents training but also attach importance to students' comprehensive development. While establishing a system for practical education and refined assessment, it is necessary to conduct stage evaluations of professional students according to the teaching process, so that the evaluation results are more accurate. By making up for the defects of the traditional teaching management and assessment system, setting the most suitable assessment and evaluation index system for each student, and diversifying the assessment and evaluation index system, universities can cultivate professional talents with a purpose and plan, with students as the core.

4. Conclusion

Under the background of the new era, aiming to cultivate applied talents with craftsmanship spirit, this paper provides guidance standards for the construction of the assessment system for practical education and refinement by grasping the relationship between practical education and refinement from the perspective of craftsmanship spirit. By analyzing various indicators and the feasibility of applying them to the refined assessment system for practical education through questionnaire survey and expert scoring, this paper constructs a refined assessment system for practical education from the perspective of craftsmanship spirit.

Taking the Fire Protection Engineering major of Southwest Forestry University as the research object, the questionnaire survey results of the satisfaction of students with the current training status of this major show that the total satisfaction score of students is 72.25 points, with teaching method

assessment at 82 points and teacher assessment at 75 points. However, the student assessment score and learning method assessment score are 67.5 and 62.75 points, respectively, lower than the average value. By redesigning the indicators from the dimensions of teachers, students, student individual development, basic knowledge application ability, and comprehensive quality, and setting the weight of the first-level indicators as 0.4, 0.2, 0.3, and 0.2, the first-level indicator scores are 0.78, 0.7, 0.77, and 0.84. Therefore, the assessment of the refined indicators for practical education is "very important."

Under the current conditions, the refined assessment system for practical education has basically met the standards. However, the construction of a sound refined assessment system for practical education is a long-term process. From the perspective of craftsmanship spirit, it is necessary to adhere to practical education and refinement as the core and strive to build a refined assessment system for practical education that fits the development of their own universities' majors.

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