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Undergraduate Talent Cultivation System of Fire Engineering Innovation

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Abstract: With the emphasis on public safety in society, higher requirements are placed on fire engineering talents. Training high-quality fire engineering professionals has become one of the important topics to ensure social and economic development. In order to cultivate research-oriented fire engineering talents, this paper puts forward the problem of changing the traditional teaching mode in order to change the traditional teaching mode, and focus on inspiring student thinking. In addition, through the implementation of the teaching curriculum responsibility system, the innovation of the course content, the improvement of the experimental class teaching mode, the strengthening of internships and the implementation of targeted graduation design and other hands-on links, establish a sound undergraduate talent training system for fire engineering majors, and develop students' ability to analyze problems independently, solve problems and practical skills, and innovate.

1. Introduction

With the cross-integration of higher education disciplines and the speed of knowledge production, the traditional experimental teaching model can’t meet the needs of the development of disciplines in universities. In the age of scientific and technological knowledge, fire protection engineering, as a safety and security professional for social and economic construction, must fulfill a professional function, and must have a team of high-quality professionals who specialize in scientific and technological innovation in the field of fire engineering. In view of the demand of fire-fighting engineering professionals to cultivate application-oriented innovative talents, this paper introduces the current situation of fire engineering majors, analyzes the existing problems of fire engineering majors' innovation ability, and puts forward the idea of constructing innovative experimental teaching mode of fire engineering majors. Through the optimization of innovative experimental teaching system, open laboratory, development of innovative experimental teaching content, establishment of innovative experimental teaching evaluation system, strengthening the

construction of experimental teaching staff, and actively organizing extracurricular scientific and technological activities, it has formed an innovative experimental teaching mode for fire engineering with outstanding professional characteristics, independent and complete system, scientific management and prominent student status. Practice has proved that the innovative experimental teaching mode has significantly improved the enthusiasm, initiative, innovative thinking, scientific research ability and comprehensive quality of the students majoring in fire engineering, and the significant improvement in the rate of student entrance examinations and the quality of employment.

2. Undergraduate Talent Training Target for Fire Engineering

The overall goal of fire engineering professional education is to train engineers who can solve fire safety problems. The personnel trained in fire engineering education should meet the following requirements: the ability to apply knowledge in mathematics, science and engineering; the ability to conduct design, experimental analysis and data processing; the ability to design systems, components or production processes to meet demand; ability to play an important role in multidisciplinary collaborative research; ability to identify, articulate and solve fire engineering problems; clear understanding of professional ethics; ability to effectively communicate fire engineering problems; understanding the environmental and social impacts of fire engineering problems; recognizing the importance of lifelong learning and the ability to learn for life; understanding and familiarizing with contemporary fire engineering problems; the ability to apply advanced technologies and methods and modern engineering tools for engineering practice .

From the perspective of large engineering, modern fire engineering talents must possess engineering knowledge, engineering design, engineering implementation, value judgment, social coordination and lifelong learning. That is, fire engineering education must provide basic subject knowledge in the natural sciences and technology, and should be dedicated to providing fire engineers with the skills to use cutting-edge technology. Fire engineering education should enable people to understand and master the methods of system analysis, provide them with the ability to collect and absorb new professional knowledge, and make methodologically adequate preparations for clarifying and solving specific fire protection technologies.

With the further reform of China's higher education, the setting of the training objectives of the fire engineering major is reasonable, which has an important impact on the survival and development of the profession. Considering the requirements of large engineering and social needs for the training of fire engineering talents, the training objectives of fire engineering professionals are: able to systematically master the basic theories and methods of fire science; have a solid foundation of fire engineering technology and engineering practice; Using fire engineering principles and methods, with the ability to discover and solve practical problems of fire engineering and cooperation with people; To become a senior engineering and technical personnel in the field of fire engineering system design and implementation, fire supervision and management, fire risk assessment and control, fire accident investigation and analysis, fire command and decision-making.

3. Problems in the Innovation Ability of Fire Engineering Students

3.1. Weak Sense of Innovation

Because the traditional training mode is lacking in innovative enlightenment education, and is

restricted by traditional thinking, teachers who have been engaged in exam-oriented education focus on the explanation of professional and technical knowledge, neglecting the inspiration and guidance of innovative thinking and practical ability, resulting in the lack of personality, confidence and innovative thinking, the lack of initiative, and a weak sense of innovation.

3.2. Weak Foundation of Innovation

There is a lack of organic and unified links in the curriculum, and there are fewer settings in adjacent disciplines and interdisciplinary subjects. Teachers with rich knowledge and knowledge are busy with scientific research and pay attention to students. Students have less opportunities to contact the frontiers of relevant disciplines, and the migration of subject knowledge is slow. Students who are immersed in death knowledge do not see the value of knowledge and innovation, and do not actively explore the unknown world, which leading to a weak foundation for innovation.

3.3. Experimental Teaching Concept is Backward

Influenced by the traditional concept of education, we have a wrong understanding on the experimental teaching generally. It is considered that experimental knowledge is an auxiliary means of theoretical knowledge. It does not pay attention to the cultivation of students' experimental skills. The experimental teaching content has gradually become a vassal of theoretical teaching courses.

3.4. The experimental Teaching System is Imperfect

There is a lack of experimental teaching materials, and the experimental teaching system lacks quality and innovation. The teaching system of experimental courses is generally set up according to the "verification of traditional theories or new theories". It often refers to the theoretical teaching system, and the experimental teaching system is innovative and exploratory. It is not conducive to stimulating students' subjective initiative in experiments and future research.

4. Fire engineering Practice and Innovation Ability Training

The new program also strengthens students' practice and innovation ability through the following teaching links.

1) After the new students, through the introduction to the opening of a freshman seminar and professional, inviting famous professor, experienced expert in design and construction for the students to carry out the teaching with discussion, causes the student to the interest of the professional, make the students understand the research direction of the fire engineering, guide students to the professional study in the future.

2) The experiment of the professional course is taken out from each individual professional course. According to the semester course arrangement, the safety class is comprehensively organized, and a special person is responsible for the guidance. This overcomes the shortcomings of the previous professional courses that are independent and incoherent. The organic connection between the professional courses has been strengthened, which is conducive to the organization of comprehensive, design and research innovative experiments, and flexible scheduling in the laboratory.

In the safety class, the basic experiment accounts for about 60% of the total number of experiments. The main purpose of the experiment is to let students master the basic experimental

methods, familiarize themselves with the use of experimental devices, and deepen students' objective understanding of the theory learned in the classroom. The improvement experiment accounts for about 40% of the total number of experiments. This kind of experiment is arranged by the instructor to solve the problems or test parameters that need to be solved, so that the students can design the experimental plan, conduct experiments and solve the problem through the professional theory, experimental methods and means that have been mastered. For students who have the strength and interest, they can also combine innovative research programs with college students to arrange innovative experiments.

3) Arrange 46 weeks of concentrated extracurricular teaching. In order to improve students' learning ability, innovation ability, communication ability and social adaptability, 16 hours of academic frontier lectures and 2 weeks of research and innovation training were arranged. Scientific research and innovation training will absorb students into the research group and participate in scientific research activities as soon as possible. The course design of 6 professional courses was arranged. The topics were all part of the teacher's research project or the actual engineering design, so that students can get more practical opportunities. Train students' communication skills and social practice skills by understanding internships, production internships, and graduation internships.

4) Through the optimization of graduation design (thesis), students with higher learning level should arrange the research sub-topics of teachers as much as possible to cultivate students' ability to solve problems innovatively.

5. Innovative Undergraduate Talent Training Reform in Fire Engineering Specialty

The fire engineering content involves multiple disciplines. It has both theoretical and theoretical aspects, as well as knowledge of various legal norms and engineering practices. The content of the study is very complicated, and there are many basic knowledge items, such as architecture, mechanics, electronics and computer technology, heat transfer, and combustion. Therefore, there is a certain difficulty in teaching and learning in this profession, and teaching reform must be carried out.

5.1. The Construction of Teaching Material

Relying on the curriculum teaching team, we actively promote the teaching curriculum responsibility system, focus on the innovation of the course teaching content, and plan to construct a professional teaching material system that is compatible with the new curriculum system. In the preparation of new textbooks, pay attention to the easy teaching and learning, the depth and moderation, the theory and practice, and strengthen the "three basics and three new" (basic theory, basic concepts, basic methods, new technologies, new theories, new methods), and set in the textbook certain typical cases, discussion questions, analysis and thinking questions.

5.2. Strengthen the Construction of Professional Faculty

The professional faculty is an important support for the professional education of “Great Engineering View”. In order to realize the "Great Engineering View" education, the author puts forward two requirements for the construction of professional teachers. The first is the training of "wide" and "real" teachers. The broadening and compounding of majors and courses requires teachers with a wide knowledge base and a wide capacity structure. At the same time, due to the

strengthening of practical teaching requirements, teachers with strong engineering practice skills are needed. Therefore, higher engineering colleges must train “comprehensive” teachers who are cross-curricular and inter-professional, as well as “double-type” teachers who combine teachers and engineers. The second is the integration of counselors and business teachers.

5.3. Scientifically Constructing a New System of Experimental Teaching

The content of experimental teaching should reflect the comprehensive development trend of the subject, and introduce new knowledge, new technology and new methods into experimental teaching as much as possible, and strive to open experiments with advanced, typical and directional. In order to strengthen the cultivation of students' innovative ability, on the basis of ensuring the principle of verification, deepening the understanding of the theory and carrying out the training of basic skills, methods and abilities, the verification experiments are selected and merged to reduce the confirmatory experiment and increase the comprehensiveness and design experiments. According to the teaching objectives of different stages, the whole experimental teaching can be divided into four stages, namely, the pre-experimental phase, the confirmatory experimental phase, the comprehensive experimental phase, and the design experimental phase.

(1) the pre-experimental phase

The theoretical framework involved in the experiment, the problems to be solved, the preparation and debugging of experimental equipment and instruments, and the processing of materials constitute the first steps of the whole experiment and constitute the pre-experimental stage. At this stage, students are required to fully grasp the necessary knowledge and basic operation methods and procedures for the experiment.

(2) the confirmatory experimental phase

At this stage, we must pay attention to cultivating the scientific attitude of the students to be rigorous and realistic, and deepen the systematic understanding and mastery of the principles. The confirmatory experiment is the main content of the traditional experiment, and it has strong rationality. Repeating some classical experiments is a necessary stage for the development of comprehensive and design experiments.

(3) the comprehensive experimental phase

Through comprehensive systematic experiments, the integration of knowledge and the establishment of the essential relationship between phenomena can be achieved to achieve concrete thinking. This stage is the transition from a confirmatory experiment to a design experiment. The learner should comprehensively complete the transition from cognitive thinking to exploratory thinking on the basis of learning principles and experimental methods.

(4) the design experimental phase

This is the highest level of experimental teaching. It is the design and solution of theoretical and applied problems. It aims to guide students to think comprehensively on specific issues, train the rigor, flexibility and profoundness of the students' thinking, and help train students’ innovative spirit and practical ability.

5.4. Educational Personalized Recommendation Algorithm

The development and popularization of the Internet has made the existing fire protection engineering teaching resources digitized and networked. Undergraduates of fire engineering innovation and entrepreneurship can also use online education resources for learning. To realize the individualization and intelligence of educational resources, it is necessary to use a good educational

resource recommendation algorithm to provide college students with corresponding learning resources.

For the feature item i, there are different weight W_i spaces because of their different importance to the document. Using vector $(W_1, W_2, W_3, ..., W_n,)$ to represent documents is the basic idea of the vector model. There are many ways to calculate the weight W_i. The commonly used method on the TF-IDF formula:

$$W(t,\bar{d}) = \frac{(1+\log_2(tf(t,\bar{d})))\times\log_2(N/n)}{\sqrt{ted[1+\log_2(tf(t,\bar{d}))]\times\log\text{-}2\ (N/n)}} \quad (1)$$

$W(t,\bar{d})$ represents the weight of feature item t in document d, and $tf(t,\bar{d})$ represents the number or frequency of feature item t appearing in document d. The number of documents in which feature item t appears in the document set is represented by n_t, and N represents text The total number of documents, the naturalization factor is the denominator. Similarly, the vector represents the user's interest model (profile), and the vector $P(t_1, t_2, ...t_m)$ represents the interest model containing any m words. Compared with the vector space model, using cosine to calculate the similarity between two vectors (cosine-similarity) is the traditional method of similarity. The similarity between user v and user d can be defined as follows:

$$Sim(v,d) = \frac{\bar{v}\bullet\bar{d}}{|\bar{v}|\,|\bar{d}|} \quad (2)$$

Among them, d represents the vector of the document d, v represents the vector of the user v's interest model, and v and d are the modulus of the two vectors, representing the dot product. Recommend to the user document content that is highly similar to the user's interest model.

5.5. Current Situation of Undergraduate Talent Training for Fire Protection Engineering Innovation

(1) The orientation of undergraduate talent training for fire engineering innovation is not clear

A total of 220 questionnaires were issued in this survey, 216 questionnaires were returned, and 205 valid questionnaires, with a valid questionnaire rate of 93.18%. As shown in Table 1, it is found that less than 60% of teachers have a clear understanding of applied talents. It can be seen that colleges and universities have an unclear understanding of running a school, and the orientation of training applied talents is not clear.

Table 1. The orientation of undergraduate talent training for fire engineering innovation

	Number of people	proportion
Quite unclear	31	15.12%
Not clear	104	50.73%
Basically clear	45	21.95%
Relatively clear	14	6.83%
Quite clear	11	5.37%

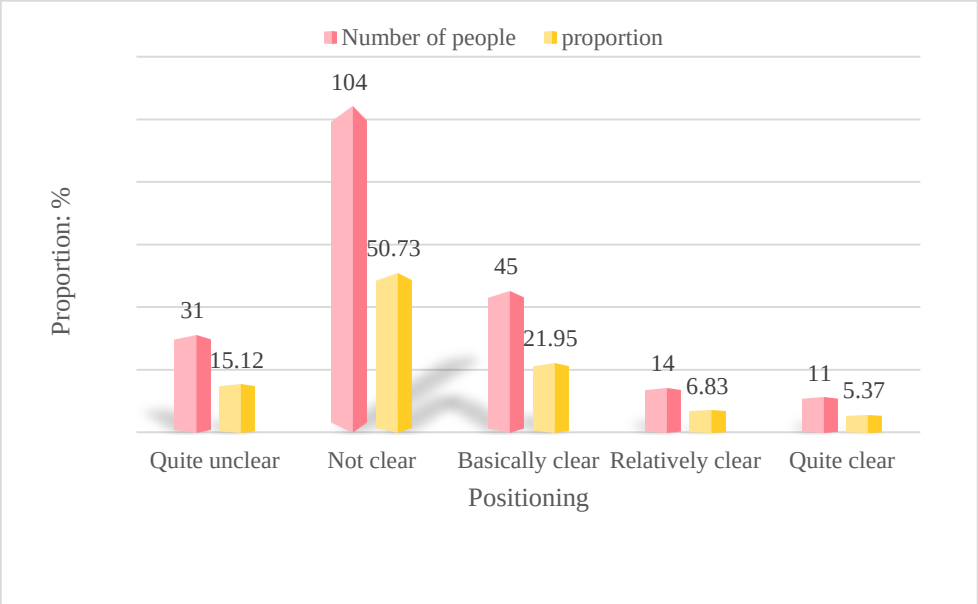

Figure 1. The orientation of undergraduate talent training for fire engineering innovation

It can be seen from Figure 1 that in the specific implementation of fire engineering innovation undergraduate talent training, there is a problem of unclear positioning. The specific manifestation is: classroom teaching is mainly used, and theoretical knowledge is only imparted, and the training of students' practical ability is ignored. The ability and quality of cultivating talents is just a formality, and it does not demonstrate the application-oriented talent training model with the characteristics of fire engineering colleges.

(2) Factors affecting the training of innovative undergraduate talents in fire engineering

Investigating the factors affecting the undergraduate talent training industry of fire engineering innovation and the results are shown in Table 2. 36 people think that the faculty is not strong, 40 people think that the talent training system is not perfect, and 45 people think that the talent training awareness is weak.

Table 2. Factors affecting the cultivation of innovative undergraduate talents in fire engineering

Influencing factors	Number of people	proportion
The faculty is not strong	36	17.56%
Talent training system	40	19.51%
Cultivate weak consciousness	45	21.95%
Lack of scientific training methods	51	24.88%
Weak innovation infrastructure	33	16.10%

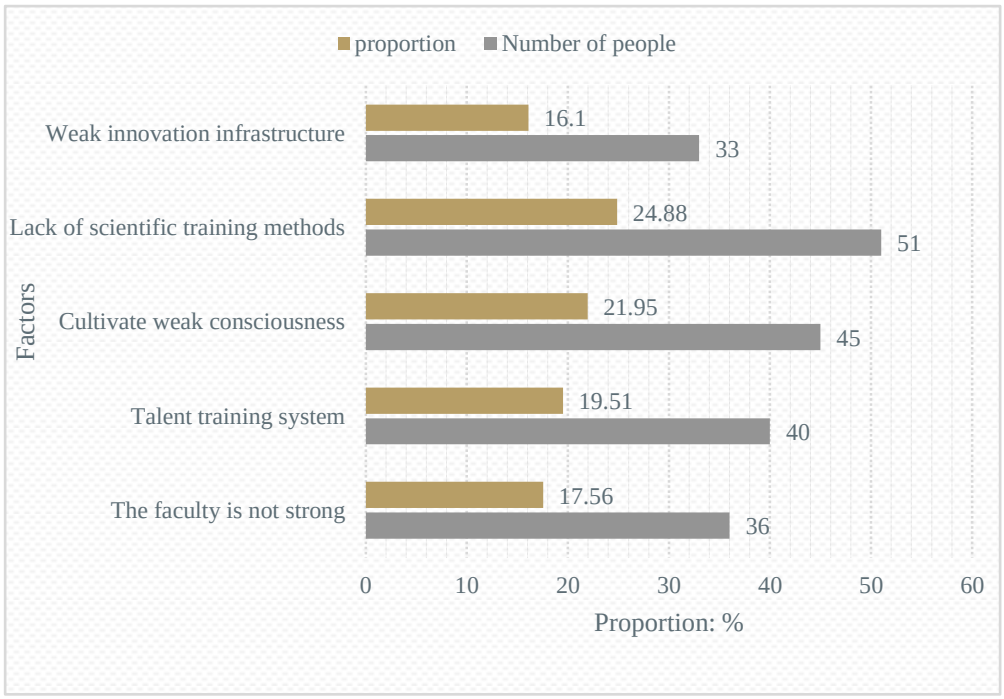

Figure 2. Factors affecting the cultivation of innovative undergraduate talents in fire engineering

It can be seen from Figure 2 that the main factors affecting the training of undergraduate talents for fire engineering innovation are the lack of scientific training methods, the lack of awareness of talent training, and the incomplete talent training system.

6. Summary

Through the research and discussion on the research-based undergraduate education system of fire engineering, combined with the actual teaching practice in China, and constantly reforming and perfecting, it is proposed that the reform of experimental teaching of fire engineering is a comprehensive system engineering. It should proceed from the reality, carry out steadily, gradually develop, realize the scientific management of the laboratory, optimize the allocation of resources, and improve the level of experimental teaching. Change the traditional teaching mode, transform the infusion teaching into heuristic and interactive teaching, transform the teacher-centered concept, regard students as the main body of teaching activities, focus on inspiring students' thinking, and develop students' ability to analyze problems independently, solve problems, and practice hands-on innovation.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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