The Construction and Management of Experimental Teaching Platform Integrating Multidimensional Demands

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ABSTRACT

According to the cross-discipline characteristics, this article discussed the construction and management modes of the comprehensive experimental teaching platform. A three-level organization of the teaching management center, discipline teams, and backbone teachers was established to apply the top-down overall planning and bottom-up review for the construction projects in a systematic and prospective way. Meanwhile, the experimental sources were optimally distributed among the disciplines. The experimental center carried out the whole process management of the construction projects, which shortened the construction period and curbed the phenomenon of idle equipment and repeat purchase. In addition, we improved the management system at all levels and introduced running models of online booking and self-helping. The flexible management system of the teaching platform had been developed and could significantly increase the use efficiency of the platform. Through the implementation of this program, an interdisciplinary and multi-level comprehensive experimental teaching platform for biomedical engineering has been preliminarily established, providing strong support for the cultivation of innovative talents. ¹

INTRODUCTION

The experimental platform has the dual attributes of teaching and research in the higher education and is an important guarantee for comprehensively supporting

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innovative training system. At present, China has the largest engineering education in the world, and the “Double-First Class” initiative aims to ultimately build many world class universities and disciplines by the end of 2050[1]. Therefore, many universities increase capital investment to build the first-class experimental teaching platform. However, in this process, universities often focus on the construction of laboratory infrastructure and the procurement of equipment, and ignore the top-level planning of the experimental platform, which lead to phenomenon of idle equipment, repeat purchase and unequal configuration among the disciplines [2,3]. At the same time, there is a lack of systematic management during the platform construction process and use process, resulting in a lagging construction period and low operating efficiency.

In view of this, breaking through the limitations of disciplines, majors, and courses, and integrating the multi-dimensional requirements of undergraduate teaching, postgraduate teaching, and discipline construction, we develop an interdisciplinary and multi-level comprehensive experimental teaching platform of biomedical engineering. The platform can promote industry-university-research cooperation, support the construction of the practice and experiment teaching system and serve the cultivation of innovative talents.

PROBLEMS AND CHALLENGES

Biomedical engineering is a discipline that advances knowledge in engineering, biology and medicine, and improves human health through cross-disciplinary activities that integrate the engineering sciences with biomedical sciences and clinical practice. Although more than 40 years of development, the "new" is still its current state and its future trend. In present, the construction of experimental conditions that support the cultivation of excellent biomedical engineering personnel faces three challenges:

1) How to actualize the systematic and forward-looking allocation of experimental resources, not only meeting the requirements of daily teaching, student scientific and technological activities and scientific research training, but also avoiding repeated purchases, idleness and unequal allocation of instruments.

2) How to control the efficiency and standardization of the construction projects to meet the requirements for construction quality and implementation progress.

3) How to achieve the flexible management of experimental platforms to meet the teachers and students' growing rigid demand for experimental resources.
OVERALL PLANNING OF EXPERIMENTAL PLATFORM

Integrated Construction System of Experimental Resources

Focusing on experimental and practical platform system construction for BME, a three-level organization of the teaching management center, discipline teams, and backbone teachers was established. The members in the organization came from medical, biological, engineering and other subjects. Facing the demand of innovative talents and high-level scientific research in the fields of medical devices, biomedicine, aerospace, and space life sciences, they fully investigated the advanced teaching concepts at home and abroad and respectively made the construction schemes at different levels of the school, discipline, and specific courses, as shown in Figure 1. In this process, all levels of planning are implemented from top to bottom, thus ensuring the implementation of the quality education and the realization of the training programs. At the same time, a bottom-up review mechanism has been established to balance the allocation of resources among courses and disciplines, and to achieve systematic and rational allocation of experimental resources in the whole school. On the other hand, it effectively controls the types of experimental projects. The verification and demonstration experiments in courses are limited, while the comprehensive, innovative, design and research experimental/practical projects were encouraged. In nearly four years, undergraduate experimental teaching conditions for passive medical devices, active medical devices, biotechnology, rehabilitation and human factors engineering have been improved. In the same period, we actively promoted the integration of this research. The teaching management center and the experimental center are responsible for the integration the experimental resources of postgraduates and undergraduates. Based on the above four basic module experimental platforms for undergraduates, the experimental conditions for postgraduates are further
strengthened in medical biomechanics, medical information monitoring, regenerative medicine, aerospace medicine, and rehabilitation medicine. In present, an interdisciplinary and multi-level comprehensive experimental teaching platform for biomedical engineering has been preliminarily established. All sources are open and shared for all teachers and students in the school, and provide strong support for the cultivation of innovative talents.

Quality Control System of Construction Process

During the construction of the experimental platforms, there are strict time limit for using the approved government funding. The full-time teachers in the experimental center are responsible for the entire process of construction project management and put forward three measures to markedly accelerate the construction speed and improve the construction quality.

(1). Overall planning process
The procurement activity will be launched in the order of imported equipment for tendering, domestic equipment for tendering, duty-free imported equipment for self-purchase and domestic equipment for self-purchase. Through overall planning, not only sufficient time for the longest equipment procurement process is reserved, but also the difference between the bid-winning price and the budget can be used to add the accessories of the self-purchase equipment. Those strategies ensure the full use of government funding and avoid the adjustment of purchase planning.

(2) Personal responsibility system
Experimental center decomposes the construction content into a series of the personal tasks, and assigns every task to the specific teacher timely. The work mode of multi-threaded parallel processing has been formed, thus the execution efficiency of the construction project improves significantly.

(3) “Construction Project Implementation Guide” electronic handbook
According to the implementation process, the experimental center developed an electronic work guideline, “Construction Project Implementation Guide”. The guideline contains strategies and recommendations for document preparation, key steps and details, so that the teachers who perform the tasks have rules to follow in each step of implementation process and can save time and effort.

In recent years, taking the undergraduate experimental conditions construction project as an example, construction funding is increasing year by year. Through the above measures, compared to 2015, the procurement cycle of 2017 funding has been shortened from the original 8 months to less than 2 months, and the platform construction period in 2017 has been shortened from the original 14 months to less than 7 months. The construction time in the two phases has been reduced by 70% and 50%, respectively, and the construction efficiency has improved significantly. In addition, the experimental center strictly implements the three comparison processes of “database comparison, performance comparison, and price comparison” to improve the construction quality of experimental platforms. With these means, it
greatly ensures that the quality and price of the pre-purchase equipment are reliable and reasonable.

Table I. ORGANIZATIONAL STRUCTURE OF EXPERIMENTAL PLATFORM MANAGEMENT.

| Organization          | Members       | Work unites       | Tasks                                           |
|-----------------------|---------------|-------------------|------------------------------------------------|
| Level one: full-time  | Experimental  | 1/3 of all laboratories | Overall responsibility for the safety and operation of the laboratory |
|                       | teacher       |                   |                                                 |
| Level two: in turn    | One of Teachers in lab | Aspecific laboratory | Daily management of the laboratory |
| Level three: Specific duty | Equipment purchaser | Aspecific equipment | Daily use management |

OPENING AND SHARING EXPERIMENTAL PLATFORM

Based on the purpose of “mutual benefits, mutual assistance and common development”, the experiment center has constructed” 3 & 3 management mode”. That means three-level management crowds and work units, as shown in Table 1, so that there is someone responsible for the lab running. At the same time, based on the discipline characteristics of the experimental platform, the experimental center perfects institutions and consolidate standard administration. In line with the principles of openness, fairness, and democracy, the teachers and students are invited to discuss and revise the four categories of laboratory system, such as laboratory's responsibility system, equipment/material management system, site management system, and training assessment system, for a grand total of nearly 20 items. The result of system formation is rigid, and the process of formation is flexible, ensuring the identity and executability of the systems. Since the implementation of the system, there have been no major accidents, and the damage rate of equipment has been significantly reduced. At the same time, the conflicts between users in labs have been effectively resolved, and the experimental environment has been significantly improved.

In addition, with the help of information management technology, users can receive permission to use hardware and software resource within the given time. The use of resources is more flexible in lab. Through recruitment, the experimental center is staffed with highly trained students to assist the management of the important equipment or lab use, which is conductive to the time division of the resource in laboratories and can significantly enhance the efficiency of labs. The experimental center decentralizes the power to project teams to increase the flexibility of platform use, and the allocation strategies are discussed between teams based the multi-level online communication platform. At present, the laboratories are open and shared for 24 hours, and fully realizes the self-administered operation mode.
CONCLUSIONS

Experimental and practical teaching is an effective means of cultivating students' engineering awareness, developing students' creative abilities, and improving students' comprehensive quality. The experimental and practical platforms are the necessary support for putting teaching ideas into practice.

A three-level organization of the teaching management center, discipline teams, and backbone teachers was established to apply the top-down overall planning and bottom-up review for the construction projects in a systematic and prospective way. Through the top-down overall planning of the three-level organization management system, the experimental platforms clarify the direction of construction investment, and ensure the systematic and forward-looking content of the integrated platform construction. In the past two years, equipment investment for experimental and practical teaching has cumulatively increased by more than 400 sets, and the experimental conditions have been significantly improved. Meanwhile, the bottom-up review mechanism optimizes the resource allocation for disciplines and courses. The development of innovative experimental/practical projects obtain priority support, while the verification and demonstration experiment are greatly reduced. In addition, through the quality control system for experimental platform construction and the flexible management, there is uniform distribution of construction funds among disciplines, and the utilization rate of laboratories greatly increased. According to statistics, opening hours of experimental platforms have made an average 20% annual increase according to the student need. The students’ satisfaction with experimental courses and self-development have increased significantly [4,5].

REFERENCES

1. Juhong Wang, Tingting Liu, Dongyuan Ma, Long Zhang. Constricting the new engineering educational ecology of integration of government, industry, university, research under the new economy. Research in Higher Education of Engineering (03) (2017) 27-30.
2. Guangli Zhou. On academic breakthrough in the construction of “Double world-class”-on the integrative construction of discipline, specialty and course in university. Educational research (05) (2016) 72-6.
3. M.J. Prince, R.M. Felder, and R. Brent. 2007. “Does faculty research improve undergraduate teaching? An analysis of existing and potential synergies”, J Eng Educ, 96(4): 283-294.
4. X.M. Li, F. Zhao, F. Pu, H.F. Liu, X.F. Niu, G. Zhou, D.Y. Li, Y.B. Fan, Q.L. Feng, F.Z. Cui, and F. Watari. 2015. “A Multidisciplined Teaching Reform of Biomaterials Course for Undergraduate Students”, J Sci Educ Technol, 24(6): 735-746.
5. H.F. Liu, X.L. Ding, G. Zhou, X.M. Li, P. Li, X.H. Gong, X.N. Gu, F. Pu, H.J. Niu, D.Y. Li, and Y.B. Fan. 2016. “Developing Practical Abilities through a Teaching Reform of Tissue Engineering Course for Undergraduates”, Int J Eng Educ, 32(5): 2025-203.