

Accurate Management for Undergraduate Teaching Laboratory of Materials

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Abstract: In view of the problems existing in the management of materials-based undergraduate teaching laboratories, the accurate management including equipments, consumables, faculty, safety and health is discussed combined with the good experiences and lessons learned from the unit. Increasing the opening laboratories and promoting the development for teaching team are the effective methods to continually strengthen management of laboratory and the subsequent cultivation of students' abilities overall.

1. Introduction

Universities should focus on cultivating innovative, practical and compound talents by broadening the knowledge of students as well as improving students' abilities to comprehensive and solve practical problems [1, 2]. To achieve the above goals for science and engineering students, the undergraduate experimental teaching in a good laboratory environment is very necessary. As well known, the laboratory is not only the base of undergraduate experimental teaching, but also the main place for scientific research and an effective platform for technological innovation [3]. Enhanced the management of undergraduate teaching laboratories in universities will significantly improve the effectiveness of experimental teaching resulted in improving of the students' practical ability and innovative ability [4]. Of course, it is also a great significance for promoting the smooth implementation of scientific research projects [5, 6]. Based on the above, this paper discussed the precise management of materials undergraduate teaching laboratory in materials science from the following aspects of laboratory equipment, consumable materials, faculty as well as environment and safety.

2. Background and the Problems of Laboratory Management Center

The Laboratory Management Center (hereafter the “ Laboratory Management Center ”abbreviated to “LMC” for convenience) of the College of Materials Science and Engineering of Jilin University was founded at 2004 composed by metal materials engineering laboratory, polymer materials and engineering laboratory, inorganic non-metallic materials engineering laboratory, material processing engineering laboratory and material physics and chemistry laboratory. The LMC implements the management mode of “deputy dean of the laboratory-director/-deputy director of the professional laboratory”. During the first years of LMC, there were mainly the following problems. First, the undergraduate teaching laboratories were scattered and distributed on seven teaching buildings in three campuses and the utilization efficiency of equipment was low.

Due to the large area of some instruments and the consistency of experimental teaching, the other small equipments, such as optical microscope and hardness tester, have to be purchased repeatedly by different majors, resulting in the low use efficiency. Second, it is hard to manage both instruments and materials during research training for undergraduates. With the development of “Innovation and Entrepreneurship Project”, many junior college students engage in scientific experiments at the laboratory. However, they often work after school or on holidays, which is also the rest time of the

technician usually. Once the equipment has anything wrong, it will not be repaired in time resulting in delaying the reparation even hindering the normal experimental teaching. Third, the people in LMC are aging because senior professional staff and experienced technicians, are accounted for 60% who are more than fifty years old, compared to the inadequate young teachers. Sometime, new recruits cannot well interlink with the technician who will be retired considering the different times between leavedate and hiredate. Thus, the teaching effect is possibly weak due to lack of experience. Fourth, safety and health in laboratory should be strengthened. It is well known that the novel experimental projects are continuing conducting with the developments of new materials and new processes, which will produce much new chemical waste. On the contrary, the laboratory construction has not kept up with the upgrading of the experimental content, some of the waste cannot be disposed of reasonably and effectively.

3. Measures for Accurate Management in Laboratory

3.1 Accurate Management of Equipments

Precision management of laboratory equipments mainly includes purchase, operating and reparation. For purchase, all equipments meeting the needs of experimental teaching will be purchased strictly follow the bidding procurement method after demonstration by the expert group including teachers and technicians. Next, it is important to overcome the low usage efficiency for some equipments as mentioned before. Therefore, some ways had been taken as following: adjusting the laboratory rooms between teaching and research rooms is an easy method to integrally managing the teaching equipments; the experimental projects in different majors employed some similar equipments are merged; the corresponding rules about equipment management system, laboratory open system and equipment purchase and maintenance system are formulated. Through these measures, more professional laboratories are open to serve undergraduate students than before. Therefore, undergraduate students after good training could anytime conduct experiments, i.e. "innovation projects", in the laboratories. For the equipments, not only the efficiency of conventional equipments is improved, but also some valuable instruments (X-ray diffraction, scanning electron microscopes, etc.) are shared. staffs are mainly in charge of the labs during working time, while two different management methods are explored during the rest time. One is department-laboratory co-management mode. The other is postgraduates management-assisted, who are engaged in scientific research training each year and are responsible for health and safety. Practice after few years shows that the former is suitable to the relative small-scale labs while the latter is fit to the labs with many people.

As for the high-risk equipment, its use should be under the guidance of technician to ensure the safety of students and equipment. At the same time, the relevant penalties rules are introduced for adverse experimental activities. The reparation is mainly by the office of laboratory and equipment management. Certainly, when the experimental teaching equipments do not serve the undergraduates, they can serve for the postgraduates after appointment and training. But the expenses occurred are managed by the corresponding research group. As a result, after the precision management, the use efficiency is obviously improved and solid hardware for cultivating innovative, practical and compound talents are built.

3.2 Accurate Management of Lab Consumable

All Consumable is an indispensable part of the experimental teaching for materials science. The LMC has established some rules for consumables, for example, the storage of consumables and the regulations for the management of hazardous chemicals. The specially-assigned person is responsible for the consumables for each professional laboratory. The LMC undertakes 264 experimental projects involving more than 600 kinds of consumables and more than 1,000 specifications. Among of them, there is flammable, explosive and easy to manufacture dangerous chemicals which are guaranteed to be purchased and stored in accordance with laws and regulations by at least two staffs that are strictly implement the warehousing system and take protective and

emergency measures in the course. The consumables for undergraduate experimental teaching directly are purchased by the LMC, while those of for scientific research training or graduate students are responsible for the instructors. For some non-disposable consumables, each user is responsible for part of the cost according to the time. So far, there are still some problems confused us. Since the consumables used in the teaching are too few to buy through the relevant sales units which sell in large quantities, such as iron alloys for cast steel and cast iron, we have to find the consumables from research projects to ensure experimental teaching. Now, to solve this question, the corresponding teaching team decided to replace the hard-to-purchase materials with relatively cheap and easy-to-purchase raw materials or to change the more operable experimental projects with the similar teaching effect compared to the original experiments.

3.3 Precision Management of Safety and Health

Throughout the earth, universities attach great importance to the health and safety in the laboratory [7, 8] because they directly affect the safety of the operators and the testing results. Also, the LMC is charge of formulating and implements the rules about the safety and health, such as the fire prevention system, the use of hazardous reagents, and emergency disposal measures. In addition, a compulsory course focusing on experimental safety and professional testing techniques was established to further improve students' safety awareness and safety skills before pursuing the experiments, to prevent or eliminate hazards. The enforced safety awareness obtained mainly from the following aspects of equipment, consumables and safety and health in order to create a good laboratory environment. Due to the particularity of the material science, its experiments inevitably involve high temperature, even "explosive" consumables and hazardous chemicals; the students should pay more attention to experimental safety and strengthen safety awareness. After training and classes, the students can follow proper safety procedures during doing experiments.

Refer to the highly dangerous experimental project, the technician instructed at least twice ensuring that the student fully mastered before the independent operation. In addition, the management center has formulated corresponding emergency measures for emergencies that may occur during the test, and prepared certain emergency drugs and fire-fighting equipment for emergency use. The above laboratory safety systems and measures can effectively ensure that students complete the experiment far away danger.

3.4 Staff

The quality of the teaching team of universities determines the management level of modern laboratories and further influences the teaching efficiency [9]. Precision management of team is more beneficent to improve the effectiveness of experimental teaching and promote the research projects for teachers and students. LMC has established primarily relevant systems for the induction and evaluation of staffs. The technicians are charge of the purchase, use, modification and maintenance of teaching equipment except for undertaking some experimental courses as well as assisting in the management of large scientific instruments. Importantly, LMC arranges its experimental teaching tasks according to the specialty of each staff. For example, if one is good at machinery and is responsible for the equipment courses and the maintenance of some equipment. At the same time, the center arranges teachers to conduct business training once a year to learn from advanced management and teaching experiences aiming to manage teaching laboratories scientifically and impart the forefront knowledge. Recently, six doctors joined the team in response to the aging, which brought new teaching methods, enriched the teaching mode and improved the teaching effect. The staffs make full use of their spare time to engage in certain scientific research activities, which is conducive to personal growth, but also promotes the development of the research group, and accelerates the transformation of scientific research results into experimental teaching content to further improve the teaching effect.

4. Conclusion

Materials are the foundation and driving force for the rapid development of contemporary science and technology and material civilization, and are of great significance for achieving the strategic goals of sustainable development. The development of the material discipline is inseparable from the work of the laboratory. University laboratories are indispensable basic conditions for cultivating talents and scientific research. Strengthening laboratory management, including equipment, consumables, staffs, safety and health is very beneficial to promote the cultivation of innovative and applied applications and furthermore show an important significance in achieving educational strategic goals.

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