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Exploration on the Open Mode of Large-scale Instruments for Promoting Students' Innovative and Practical Ability

Guiqin Xu
Department of Safety Engineering
China University of Labor Relations,
Beijing, China

***Abstract*—Many colleges and universities are faced with the problems of the low use rate of large experimental instruments and improving the students' innovative practical ability which can be well solved by using large-scale instruments in open laboratories. Through the analysis of the common problems existing in the practice course of college students and the current situation of the large-scale instruments used in the testing experiment in our university, the necessity and significance of opening large-scale instruments in the laboratory are concluded. It is proposed that the use efficiency of large-scale instruments can be improved by three modes: students participating in teachers' scientific research projects, schools providing financial support for students to complete self-designed projects and students' graduation practice and graduation thesis with large instruments. As a result, students' practical and scientific research innovation ability can be reached.**

Keywords—large-scale instrument; laboratory; innovation ability; practical ability

In recent years, occupational health problems have become more prominent in China, and the occupational health situation has become increasingly severe so that it attract much the attention of the state, and the demand for occupational health professionals in the society is increasing. Occupational health is a highly practical discipline, and at the same time, the state's requirements for the practical innovation ability of undergraduate students in applied colleges are increasing. Occupational hazard testing is an important part of the occupational health direction. It is practical and has a wide range of applications to someone who engaged in scientific research, or enter into enterprises, or monitoring and testing institutions. However, occupational hazard testing requires a large number of large-scale instruments, which are expensive, complicated to operate, and have extremely low open utilization rates for undergraduates. How to improve the utilization efficiency of large-scale instruments and cultivate students' practical and innovative ability is a problem faced by many colleges and universities.

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I. The Requirements of Social Needs for The Cultivation of Students' Practical Ability and The Problems Existing in The Practice Teaching of Colleges and Universities

A. Requirements for the development of students' practical ability in social demand

It is stated clearly by the State Council in the "Decision on Deepening the Education Promotion and Comprehensively Promoting Quality Education": "Higher education should attach importance to cultivating the innovative, practical and entrepreneurial abilities of college students" and requires "strengthening the comprehensiveness and practicality of the curriculum. Experimental teaching, training students' practical ability." One of the missions of this century's education is to cultivate innovative talents with innovative spirit and innovative ability that can promote social development and progress. Employers are also paying more and more attention to the innovation ability and practical ability of college graduates. Strengthening experimental teaching and attaching importance to the cultivation of students' abilities have become the consensus of all universities. Experimental teaching is not only an important link between theory and practice, but more importantly, it is an important way to cultivate students' ability to solve practical problems, self-learning ability, and cultivate innovative spirit and creativity. The facts show that the laboratories of colleges and universities are the base for students to learn scientific knowledge, cite scientific ideas, improve their hands-on ability, and develop innovation.

B. Universal Problems in Practice of Colleges and Universities

Because of the scarcity of practice places and the high risk of professional nature, the practice links in engineering major can be divided into the following forms:

(1) Some students enter practice bases for further practice;

(2) Students independently contact the internship unit and complete the internship by themselves;

(3) Collective internships, mainly visits;

(4) Group in-depth internship.

The above practice forms have the following characteristics. Teachers organize students to practice collectively. In the process of practice, most of them are visits. who can't understand the production links, risk factors, safety measures and so on in the production process so that practice is easy to become a mere formality. It is difficult for teachers to control the way in which students independently contact the internship units, complete the internship by themselves, the actual effect of the internship, and even whether the students really go deep into the front-line internship site. All of them can only be judged by the presentation of the internship report. Although the existing practice bases are interesting to students while internship can only accept a small number of students in the process of graduation practice or production practice, with limited resources and uneven distribution.

Taking production practice as an example, the lack of places for in-depth production practice has resulted in a large number of professional students, but fewer counterparts, especially the traditional industrial and mining enterprises, because of the restrictions of safety and other factors which can't accept a large number of interns, plus some other factors. The production of enterprises involves a large number of inflammable and explosive dangerous substances are another factor because interns are likely to do harm to enterprises because of their lack of experience. Therefore, the attitude of enterprises to accept interns is negative. Even if some enterprises are willing to accept the study and inspection of interns, they will refuse the internship team to practice in the core area of the factory because of the problems of confidentiality of core technology and personal safety, which makes it difficult to ensure that students can learn really valuable things in the internship stage. In addition, our university's industry background is limited and undergraduate enrollment is relatively short, so the production practice of our department has always been based on the students themselves contacting the practice units, and the effect of production practice is difficult to guarantee.

II. The Current Situation and Problems of Laboratory Management Used in Colleges and Universities

A. Main modes and problems of Large-scale Instrument Experiment Teaching in Colleges and Universities

In recent years, colleges and universities have purchased a large number of large-scale instruments and equipment through the increase of funds such as World Bank loans, national and local co-construction. These instruments have greatly improved the level of teaching equipment in colleges and universities, enlarged the scope of testing, improved the accuracy of testing, and advanced means of testing. However, due to the expensive price of large-scale instruments, complex operation and limited experimental time and other factors, students in the experimental teaching of large-scale instruments and equipment has been greatly limited. At present, the main modes of large-scale instrument experiment teaching are as follows:

(1) Demonstration teaching mainly focuses on experimental demonstration, understanding of theoretical knowledge rather than the mastery of experimental skills;

(2) Virtual teaching, using virtual software as the platform for simulation operation;

(3) Open teaching mainly focuses on students' practical operation.

Generally speaking, students have limited time to practice. Because of the lack of full-time staff in the laboratory, a large number of equipment and instruments can't be maintained in time, resulting in some equipment and instruments, even large and valuable equipment long-term dust, and some even can't operate normally. Because some equipment has not been running for a long time, there are many malfunctions and parts are lost, the original experimental projects will no longer be opened resulting in less opportunities for students to enter the laboratory, lack of training in operational ability, seriously affecting the realization of the goal of training innovative talents in schools.

B. Current situation of laboratory experiment teaching in our university

Taking the laboratory of our university as an example, the laboratory invests about 7 million RMB and has large-scale international advanced detection instruments related to occupational hazards. Physical hazards detection laboratory is mainly related to the detection of noise, vibration, radiation and other factors. Chemical hazard detection laboratories are mainly aimed at some toxic and harmful chemical factors. If organic matter, heavy metals and toxic and harmful substances in dust are sampled and analyzed. Specific instruments include gas chromatography, liquid chromatography, gas chromatography-mass spectrometry, ion chromatography, inductively coupled plasma emitter. The laboratory corresponds to 32 hours, for 4 classes and another class of testing practice courses. Nearly 120 students, 32 hours, although the teacher considered the experimental effect, the experiment was divided into groups, but each instrument only less than 8 hours of time. Some instrument students can only operate the instrument according to the teacher's requirements, lack of space for thinking, students can't grasp the operation of the instrument in a short time to lack interest in class so as to affect the teaching effect and the utilization efficiency of the instrument is low. The State Council's Opinions on the Opening of National Major Scientific Research Infrastructure and Large Scientific Research Instruments to the Society pointed out that the utilization and sharing level of scientific research facilities and instruments in China is not high. On the other hand, the National Outline of Medium and Long Term Education Reform and Development (2010-2020) points out those students in our country are not strong enough to adapt to society and employment and there is a shortage of innovative, practical and compound talents. In order to solve the problem of compound talents shortage, the teaching reform in Colleges and universities urgently needs to be further deepened and using large-scale instruments for experimental teaching is an important way to cultivate students' scientific research ability and innovative spirit. Discussing how to open large-scale

instruments to undergraduates can't only revitalize some idle large-scale instruments in Colleges and universities, but also help to improve Undergraduates' practical and innovative abilities.

III. Exploration on The Application of Large-Scale Instruments in Improving Students' innovative Ability

A. The Role of Large Instruments in Cultivating Students' Innovative Ability

Although the role of large-scale instruments in the training of high-quality comprehensive talents has been recognized by more and more teachers and students, and many colleges and universities have carried out fruitful exploration and practice, but this new form of practical teaching has not been widely and thoroughly developed. At present, large-scale instrument use technology training can be carried out in undergraduate practical teaching, mainly in chemistry, environment and other minority disciplines. These disciplines rely on the original "instrumental analysis course" to carry out curriculum reform, expand the course content, so that more large-scale analysis and characterization instruments can be open to undergraduates in depth. However, this practice is rare in other science and engineering disciplines. In the actual teaching process of these subjects, demonstration experiments are often used as the main method. For the vast majority of students, it is impossible to operate independently on the computer.

In experimental teaching, the application of large-scale instruments is very important to the cultivation of students' innovative consciousness and ability which is especially related to the improvement of students' comprehensive quality. That is the task and goal of experimental teaching. Rational application of large-scale instruments and equipment is the supporting condition for effective experimental teaching. In experimental teaching, we should fully embody the students' principal position and give full play to their subjective initiative so that students can understand of the functions and applications of large-scale instruments deeply. We should not only do the past verifiable experiments, but also carry out experimental projects from the perspective of comprehensiveness, design and innovation, so as to cultivate students' innovation, ability and practical ability. In the course of experiment, we should adjust the curriculum system of validation experiment, set up large-scale instrument-related courses and practice opportunities among students, train them at different levels, and let students know the large-scale precision analysis instruments commonly used in scientific research as soon as possible, so as to lay a good foundation for future scientific research. In addition, with more and more stringent requirements on the scientific research level of employees in recruitment units, students with innovative and practical abilities are expected to be introduced. Students are not only satisfied with the previous inculcation-based teaching and acquisition of theoretical knowledge, but also hope to pass on advanced large-scale equipment and cutting-edge experimenters in related fields. students get their own perceptual knowledge, cultivate their practical operation ability, and take this opportunity to improve self-discovery and problem-solving ability and innovative consciousness through hands-on practice. Therefore, we should solve the problems such as the demand for large-scale instruments, the use of large-scale instruments in teaching, the construction and investment of large-scale instrument teachers, the operation mechanism of large-scale instrument management, the inadequacy of instrument opening and external service mechanism. So that students can understand the structure, principle, function better and use of the instrument, and master the latest modern experimental technology. Ultimately, large-scale instruments can play the effective value further, improve the efficiency of the use of instruments and cultivate high-quality talents with innovative and practical abilities.

B. In view of the characteristics and requirements of students, layered teaching in the practical application of large-scale instruments and opening laboratories to trained and qualified students

For undergraduates who have scientific research needs or related work intentions, innovative practical courses are offered for large-scale instruments and equipment. For example, by opening elective courses and other ways, increase the laboratory on-site practical teaching hours in the course, so that relevant students can master the use and operation of large-scale instruments and equipment to improve students' practical ability and scientific research experimental skills. This kind of short-term and targeted training includes application lectures and practical operation training that all the trainees need to undergo strict examination. Students can get the training certificate of large-scale instruments and equipment after passing the examination which lays a foundation for the future large-scale instruments and equipment open to scientific research and students' own computer testing. Colleges and universities are facing the task of cultivating high-quality innovative talents. The use and mastery of these valuable large-scale instruments are of great significance in the process of cultivating new and innovative talents.

C. Providing students with opportunities for scientific research projects in various ways and providing preconditions for the use of large instruments

Large-scale precision instruments and equipment have high precision, complex operation, high requirements for experimental conditions, experimental operation and high maintenance costs. It is not enough for students to learn how to operate instruments but they should use large instruments to obtain reliable data in various types of scientific research projects. Only in this way can we achieve the real goal of all-round and comprehensive exercise. In order to increase students' learning motivation and enthusiasm, improve their ability to analyze and solve problems, and understand the process of scientific research, university should provide undergraduates with opportunities to participate in scientific research projects through various ways and means. There are mainly the following ways.

1) It is to attract excellent undergraduate students to participate directly in teachers' scientific research projects. This method is the simplest because the teacher's topic is the actual research projects and students participate in the completion of research tasks within their capabilities, so that teachers do not need to spend extra energy to guide which can achieve a win-

win situation. Because of the introduction of scientific research into undergraduates' experimental practice, who participate in teachers' scientific research projects with clear experimental objectives, coherent projects, advanced technology and rich content. They not only concentrate on technical operation, but also consult relevant literature in time to find problems and solve problems and innovate. The experimental methods, comprehensive experimental skills and scientific research innovation quality have also been well trained. After the two-way choice between teachers and students so that students need to participate in the in-depth study of the topic because the number of this part of the topic will not be too much..

2) The second is that students prepare their own topics, and schools provide financial support and guidance teachers. This situation is relatively flexible and the topic can be relatively simple which needs to meet another condition that is requires schools to introduce appropriate policies and incentive mechanisms, such as evaluation of the feasibility of the project, evaluation of the workload of instructors, financial support and so on.

3) Use big instruments as part of the graduation internship and thesis. Graduation practice is an important process of cultivating students' practical ability, comprehensive practical ability and innovative consciousness in the process of current university education. Practice topics involving the use and operation of large-scale instruments and equipment can achieve the training objectives required by graduation practice. At the same time, it's convenient for students who have the need.

IV. CONCLUSION

Nowadays, many colleges and universities are confronted with the double challenges of low utilization rate of large laboratory instruments and insufficient practical and innovative ability of students in personnel training. The above two problems can be well solved by increasing the openness of large-scale instruments to undergraduates. The use of large-scale instruments can significantly improve the scientific and technological innovation ability of undergraduates. Undergraduates who have participated in large-scale instrument operation training will have certain advantages in the future employment competition because they have mastered the basic operation skills of the instrument. Increasing the opening of large-scale instruments and equipment to undergraduates is not only a requirement for the cultivation of talents' practical and innovative abilities, but also an effective way to comprehensively improve the quality of experimental teaching and students' comprehensive qualities so that teaching and scientific research can be organically integrated and the quality of teaching can be improved.

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