

# *Study on Cultivating Students' ability of Practical Innovation*

—Illustrated by the Example of the Teaching Reform of Detection Courses<sup>1</sup>

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**Abstract**—The ability of practical innovation is an important index to measure the comprehensive quality of college graduates. With the aim of cultivating students' practical innovation and solving the contradiction between the system of routine detection courses and the existing demands for relevant talents, a teaching reform of the series of detection courses is carried out and the series is established in the integration of the three modules of theoretical teaching-integrated design experiment-onsite practice. The starting point of the design of every link of the course is to cultivate students' ability of practical application and innovation in order to meet the needs of students' employment and postgraduate's entrance examination. It's also supplemented with the experts in enterprise service institutions to participate in the practice link. At the same time, to strengthen the training of double-qualified teachers to enhance the practical ability of teachers. Outstanding undergraduate are encouraged to participate in the research projects of the teachers. Distinctive and featured supporting experimental materials should be developed. This paper is innovative in teaching content and practice. The result shows that the students' comprehensive practical ability has been greatly improved through the teaching reform of the series of detection courses.

**Keywords**—Practice; Innovation; Detection course; Teaching Reform

## I. INTRODUCTION

In the process of the cultivation of college students, it's an essential link to cultivate the ability of practical innovation. Students can enhance their ability through various practical training, but the role of the traditional way of teaching is limited[3],[4]. The article takes the teaching reform of detection courses as an example to illustrate how the college cultivates students' ability of practical innovation in the process of the curriculum provision and implementation.

Detection courses are a core curriculum in the Occupational Safety and Health (OSH) related professional direction, with wide range of applications[5]. For the graduates, whether they further their study as a postgraduate, engage in scientific research, or enter an enterprise, a supervisory or detection institution, its application is direct and relatively of broad range. However, due to the fact that the content of the courses is large, and that it involves a great many instruments and methods, it's relatively difficult for the students to master not majoring in detection or analysis. With a variety of teaching modes, we can

cultivate students' ability of practical innovation to the greatest degree in the limited teaching hours.

## II. SOCIAL DEMAND FOR THE TALENTS OF DETECTION

In China, the problems about OSH highlight and the situation of it is increasingly severe, which has caused the country's attention.[1,2]According to Notice on the Division of Responsibilities of Occupational Health Supervision Departments compiled and issued by the central authority in Oct., 2010, the duties and responsibilities on OSH of Ministry of Health, State Administration of Work Safety, Ministry of Human Resources and Social Security and All-China Federation of Trade Unions are prescribed. Since then, State Administration of Work Safety has been comprehensively responsible for OSH inspection, supervision and management work, gradually increased the coverage of OSH inspection and evaluation, and fully supervised the problems about OSH in all link from project design, construction to putting into use. According to Interim Provisions on Occupational Health Supervision and Management of Workplaces, it's required that for production and operation units with occupational hazards, there should be equipped with a person responsible for the routine monitoring of the occupational hazards at workplace to ensure the monitoring system is in normal working condition; production and operation units with occupational hazards should entrust the intermediary technical service agency with appropriate qualification to carry out the occupational hazards detection at least once a year and the status evaluation at least once for three years. Consequently, the demand for OSH technical service is increasing rapidly. And these conditions also determine the growing demand for talents of OSH.

## III. ADJUSTMENT OF PROFESSIONAL DIRECTION'S SETTING

Originally, the Ministry of Health was responsible for the duties of OSH supervision, thus the technical service agencies for OSH detection were mostly owned by various Centers for Disease Control (CDC), which are subordinated to the Ministry of Health, and the professional background of the staff is almost always medical background. Nowadays, however, the principle of Three-simultaneity has been implemented on OSH protection facilities in construction projects, and the prevention is placed the first, and the nation advocates the prevention port should be moved forward, which requires the engineering and

technical personnel not only to understand the knowledge of safety, but also master that of occupational health. In view of the situation, the college established the professional direction of OSH in Safety Engineering, and set the main courses of hygiene and medicine, such as Medical Foundation, Toxicology, Occupational Health, Epidemiology and Health Statistics and so on, and increased the practical time of detection courses. The students who work for occupational hazards detection and evaluation or related jobs after graduation will have unique advantages owing to the integration of their professional knowledge background. The jobs related to occupational hazards detection and evaluation mentioned above include the OSH management in first-tier enterprises, occupational hazards detection and evaluation in technical service agencies and the supervision and management on OSH of Regulatory authorities. Graduates from this professional direction will have the advantages of interdisciplinary whatever kind of job among the three above they will engage in, and the advantages will play a huge role.

By adjusting the professional direction, increasing the practical hours in the training program and optimizing the content and forms of practical courses, we laid a good foundation for the further cultivation of students' ability of practical innovation.

#### IV. GENERAL SETTING OF DETECTION COURSES

The shortcomings of the former course's setting are as follows. The theoretical part of the teaching was mainly taught by the teachers, and the content was basic theory and concept. For instance, the basic theory of the sampling, the working principles of the instruments' basic components and the principle parts of the detection, etc. Generally speaking, the theoretical knowledge was taught comprehensively and thoroughly, but combined less with the reality. Students' theoretical basis is relatively solid, but the ability of practice is weak, and their work started slowly. It is difficult for them to apply the theoretical knowledge to practice when they step into the actual work, and they usually feel unsure and unconfident about their work, for it seems that they've learnt about the knowledge points, but they have many differences compared with the actual needs, which is the common problem of lots of courses related closely to practice as well. The experimental courses are set to emphasize the actual application of the content of classroom teaching, so they are just partially theoretical verification and demonstration. They don't stress the application of the standard or specification, contact the actual detection site, and nor do they underline the study of research and experimental methods. What the students need to do is to simply do experiments and verify it in view of the specific given situation.

#### V. TEACHING REFORM OF DETECTION COURSES OF EMPHASIZING THE CULTIVATION OF ABILITY OF PRACTICAL INNOVATION

Considering the basic demands for the talents related to detection of the society, setting the core of enhancing students' ability of practical innovation and aiming to cultivate the compound talents for application, a series of detection courses

is established, which is theoretical teaching-integrated design experiment-onsite practice. Simultaneously, develop the distinctive and featured experimental materials for detection, invite the first-tier detection experts for a lecture or to participate in the practical link for guidance on site, encourage some students to join in the teachers' research projects, etc. And the series consists of six parts.

##### A. Link of Theoretical Course

The content of the theoretical course is based on the outline of detection practice qualification examination. That is to say, the syllabus is comprised of the main content of the exam, and supplemented with some knowledge beyond the outline, but is basic theory and concept the students' lack. It guides them to attach importance to the master of the common standard or specification for sampling detection, to the explanation of theoretical knowledge and to the convergence in actual application, which greatly enriches the content of the original outline.

The teaching form is changed from teacher-based teaching to the form of mainly teachers' guiding, and students' extensive reading after class is combined with the discussion teaching in lesson. Not only does it enhance students' ability of self-learning, but also it improves the effectiveness of the lesson. For example, about the instrument analysis part, teachers illustrate the composition, principles, applicable conditions, operating etc. of gas chromatography and UV - visible spectrophotometer in detail. But for liquid chromatography and atomic absorption spectrometer, which are similar in structure principle, students should read about it after class firstly, and in class, they are required to compare the similarities and difference between them under the guidance.

##### B. Link of Experiment

Except for part of the necessary experiment for verification and demonstration, there primarily adds the content of integrated design experiment, and that is tightly combined with specifications according to the needs of actual work. Teachers' requirements for the experiment are open, and only several of them necessary are put forward to be met, such as a complete plan for sampling, the design of the experiment link meeting the requirements for an small but integral research program, the reasons for the choice of experiment object and the experiment time, the determination of the influencing factors, the experiment objective to be achieved, the problems to be demonstrated by designing a couple of influencing factors, etc. The composing of the experimental report is required to focus on the integrity of the process, including the experiment design, the processing and analyzing of the experiment data, the conclusion, the suggestion and so on. The design of the experiment link enables the students to have an understanding of not only the instruments' operation, but also the solution ideas and methods of experimental scientific research projects. At the same time, as for the specific detection operation, students are required to be familiar with the corresponding standard and specification and operation according to them, which has good foundation for the actual work in the future.

Reform the modes of evaluation. The assessing principles of practical courses are to encourage the students to think and

practice more, and avoid the mechanically copied and monotonous experiment report. So that the requirements of the experiment plan are to design the integrated designed and somewhat scientific research experiments, the experiment reports submitted by anyone must be unique. Errors or mistakes are allowed in the experiment, but whether the experiment data is reasonable, the processing of data, the analysis of the causes of errors and the shortcomings of the experiment plan and other issues are required to illustrate in the experiment report. The report with a high score is not always the one with a reasonable plan and correct data. Even not with a thorough consideration and reasonable data during experiment, there can be an excellent experiment report as long as one could find the problems, analyze them and be capable to solve them in the report. Consequently, it avoids the students to fabricate the data or mechanically copy it, and instead, they could analyze and solve the problems in a more practical way.

### C. Practice link

With respect to experiments mentioned above, students were required to set the theme and work out sampling and detection schemes on their own, while they were required to carry out practice in actual conditions in the practice link. Students were guided to carry out the detection practice in a practice-training base outside the school. After one week of practice work, students completed the whole detection work, including field survey, scheme making, pre-detection preparation, on-site sampling, on-site detection, laboratory detection, data processing, and detection report preparation. Based on the detection theory course and experiment course, students carried out practice in actual conditions, making theory combined with practice, so as to improve their ability.

### D. Other practical link

Besides internal laboratories and external practice bases, detection practice bases outside the school were actively expanded. In addition, extensive cooperation with enterprises, administrative institutions, and social service organizations was carried out to provide students with more relevant opportunities. In recent years, a certain number of students are arranged to have internship at detection and evaluation organizations annually.

In addition, students are encouraged to take part in teachers' scientific research projects. Through two-way selection, some excellent senior college students are selected to participate in teachers' scientific research projects at laboratories. This provides students with a lot of benefits, including cultivation of their scientific research consciousness and ability, improvement of their scientific research expertise, and advantages in their postgraduate entrance exam and application for overseas study. In addition, this can also laid a firm foundation for them to be engaged in scientific research works and successfully complete their postgraduate courses in the future.

### E. Teaching materials link

As the market is short of experiment tutorials for regular college students and staff with insufficient experience at detection organizations, featured experiment teaching textbook

was compiled. This textbook covers the most common basic theories related to occupational hazard factor detection experiments, all kinds of sampling methods, notes on operation procedures for major instruments, and basic knowledge related to laboratory. In order to solve problems that beginners are faced with in the process of sampling and sample processing, storage and detection in experiment projects that are typical in occupational hazard detection technology service organizations, experiment reports are contained in the textbooks. In addition, contents related to common projects and frequently asked questions are comprehensive and specific. This provides convenience not only for teachers to carry out teaching, but also for students to solve their problems in self-directed experiments.

### F. Teacher guidance module

Given training requirements to enhance students' practice training, improve their practical work ability and guide them to learn scientific experiment methods, a teaching team that features "combination of teaching talent introduction and output" was adopted to enhance training double-position teachers (i.e. teachers who play two roles such as the roles of engineer and teacher), so as to provide students with guidance that is closer to actual works. The phrase "teaching talent introduction" means introduction of teachers from detection organizations and foreign countries. In recent years, the school successively introduced experts in relevant fields from National Kaohsiung First University of Science and Technology, Beijing Municipal Institute of Labor Protection, and other occupational hygiene detection and evaluation institutions to act as part-time instructors to teach students or give lectures on practice of occupational hygiene detection. This allows students to expand their vision and learn more knowledge. In addition, teachers were organized to participate in trainings for qualification examination of occupational hygiene detection and evaluation to enhance exchange between teachers and detection and evaluation institutions, so as to further improve teachers' practical ability.

## VI. REFORM EFFECTS

Through establishment of occupational hygiene monitoring curriculum group, outstanding achievements have been reached. This enhances students' motivated learning consciousness and cultivates their operational ability and the ability to solve practical problems, so as to significantly improve their expertise and employability, allowing them to meet the society's requirements on practical talents.

## VII. CONCLUSIONS

In order to cultivate students' practical innovation ability and meet the society's requirements on detection talents, given that conventional detection courses cannot sufficiently cultivate students' practical ability, the course settings were comprehensively optimized, so as to establish a monitoring practice curriculum series that integrates three links: theoretical teaching-integrated design experiment-onsite practice. Meanwhile, an all-round practice teaching system that invites first line detection experts to participate in teaching and allows students to participate in teachers' scientific research projects

was implemented as supplement. This system highlights the experiment link that cultivates students' scientific research ability, motivates students' subjective initiative, and arouses students' creativity, so as to improve their ability to analyze and solve problems, meeting the requirements on training comprehensive practical talents.

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