Journal of Education and Practice
ISSN 2222-1735 (Paper) ISSN 2222-288X (Online)
Vol.13, No.9, 2022

Exploration in the Teaching Reform of Instrument Analysis in Local Applied Undergraduate Universities

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Abstract
Instrument analysis is a multi-disciplinary cross penetration and interrelated comprehensive course, which has strong theoretical, practical, developmental, and cutting-edge discipline characteristics. It is also one of the professional core courses of many specialties, such as applied chemistry, material chemistry, environmental science, environmental engineering, pharmaceutical engineering in applied undergraduate universities. The teaching reform of the instrument analysis course is significant for the training of high-quality applied talents. This paper puts forward the reform and exploration from course content, teaching method, teaching skill, and experimental training of instrument analysis to provide a reference for further improving the training quality of applied-oriented undergraduate universities.
Keywords: instrument analysis; teaching reform; applied undergraduate universities
DOI: 10.7176/JEP/13-9-02
Publication date: March 31st 2022

Applied undergraduate universities mainly serve the local economy as the starting point and aim to cultivate innovative applied talents with professional application theory and strong practical ability [1]. In recent years, with the positioning and development of local applied undergraduate universities, how to cultivate high-quality applied talents with strong social adaptability and competitive ability has become one of the focuses [2,3].
Instrument analysis is a comprehensive discipline involving of chemistry, physics, mathematics, and computer science [4]. Applied undergraduate universities aim to cultivate applied technical skilled talents as the duty mission. To cultivate related professional students' technical skills, practical ability, and innovation ability, teaching reform of instrument analysis must be explored [5,6].

1. Define the talent cultivating objective and optimize the course content

Instrument analysis methods can usually be divided into chromatography analysis, electrochemical analysis, optical analysis, NMR spectroscopy, and mass spectrometry analysis. Through the learning of the instrument analysis, students should 1) acquaintance the classification and development trend of instrument analysis methods, 2) master the basic principles, characteristics, operation precautions, and application scope of common instrument analysis methods, 3) understand the basic principles and characteristics of structural analysis methods and technologies.

Instrument analysis course is offered in the specialties of applied chemistry, material chemistry, environmental science, environmental engineering, biotechnology, biological engineering, pharmaceutical engineering in applied undergraduate universities[5-7]. The course content in other specialties is mainly taught according to the syllabus of chemistry specialty. However, the characteristic of each specialty and its corresponding talent-cultivating objectives determine the key content of the instrument analysis. Teachers should combine characteristics and the practical needs of each specialty to select the optimal course content.

For the cultivating of students majoring in environmental science and engineering, the course content of electrochemical analysis can be appropriately reduced because of its less professional application. However, more attention should be paid to expanding the detection technology and analysis methods of typical environmental pollutants [7]. For example, in the chromatographic analysis section, the content should combine with the current research progress on volatile halogen hydrocarbons, organochlorine pesticides, polycyclic aromatic hydrocarbons, fluoride, and environmental endocrine disruptors. When delivering the analysis principle of gas chromatography, liquid chromatography, and ion chromatography, the characteristics of each chromatography analysis and its application in the actual environment field should be discussed and compared in detail. The operational principle and practical application of GC-MS and LC-MS in the environmental field should also be expanded.

The theory and experimental content of instrument analysis are very important to cultivate excellent applied

talents in the field of the chemical industry. Students should acquaintance the basic principles and structure of commonly used analytical instruments, and master the basic operation methods and the influence of relevant instrument parameters on the analysis results [8]. In terms of the course content, the instrument analysis methods of raw materials, intermediates and products should be focused on. The course content about the separation, qualitative, and quantitative analysis of the typical chemical products by GC and HPLC should also be expanded. The application cases of optical analysis, NMR spectroscopy, and mass spectrometry in the structural analysis of raw materials, intermediates and products of chemical products should be listed as much as possible.

2. Breakthrough the teaching difficulties and improve the teaching methods

The instrument analysis course involves a wide range of different subject knowledge, some students have difficulties in learning this course with low interest. So, the teaching methods should be reformed to improve students' learning enthusiasm.

2.1 Reform of teaching methods

The instrument analysis course has many contents, the operational principles are usually more abstract, and the instrument structures are complex. Using traditional teaching methods can not effectively arouse students' interest. Teachers need to simplify the complex problems, specify the abstract problems, and expand students' autonomy in learning. Some teaching modes, such as guiding, heuristic, discussion, cooperative, and participatory should be gradually implemented in class to encourage students to learn consciously.

When introducing the structure of the relevant instruments, teachers can bring the old parts of the instruments and show them to students. For example, the observation of waste gas chromatography column, liquid chromatography column, deuterium lamp in the classroom can help students to vividly understand the structure and working principle of the instrument, and improve the teaching effect. When introducing the chromatography naming and principle, teachers can combine with the separation experimental of pigment from plant leaves. From that, students can intuitively understand the origin of the chromatography method. Which is helpful for students better understanding the chromatography separation principle of GC and HPLC.

By combining the abstract theory with specific examples, teachers can stimulate students' innovative thinking and stimulate their interest in learning instrument analysis. In addition, teachers should also encourage students to actively participate in the teaching process. For example, when comparing the application of atomic absorption spectroscopy and atomic emission spectroscopy, first, let students consult relevant literature, and summarize the detection methods and practical applications of different kinds of heavy metals in groups. Then, let students make PPT reports in class. The way can mobilize students' learning enthusiasm and concentration, and cultivate their ability to apply knowledge to solve practical problems.

2.2 Teaching by the case method

Course teachers should not only pay attention to the basic principle and structure of each instrument but also choose some typical cases about the course content, such as pesticide residues, cadmium rice, food additives. Through combining with the corresponding instrument analysis method in hot events, guide students to explore the course learning. Thinking about hot issues can also stimulate students to use the instrument analysis knowledge to solve practical problems interest.

Teachers can combine the detection case of heavy metal pollution in shellfish food to compare the characteristics between atomic absorption spectroscopy and atomic emission spectroscopy. Students can better understand the differences of the two heavy metal analysis methods in selectivity, detection limit, analysis speed, application scope, and actual operation and maintenance cost. Teachers can also combine the drunk driving test to introduce the principle of the exhale breathalyzer tester and inspire students to think about how to use GC to test the blood alcohol content. Students can better connect theoretical knowledge with practical application through the case teaching method.

2.3 Carry out particular discussions and integrate into the cutting-edge knowledge

Based on students mastering the basic principles and methods of instrument analysis, course teachers can arrange 2~3 class hours for the particular topic discussions according to the talent cultivating program. From that, students can comprehensively and systematically understand the practical application of different instrument analysis methods and the latest cutting-edge knowledge. For example, the environmental engineering specialty can combine the typical pollutants content level and pollution detection to carry out the special discussion. Course teachers can encourage students to consult relevant literature, summarize the pollutants analysis methods, understand the latest development of instrument analysis, learn to use instrument analysis to solve the practical problems in the environmental field. Carrying out relevant particular discussions can stimulate students' thirst for knowledge, broaden their professional horizons, and cultivate their innovation and problem-solving ability.

3. Adopt diversified teaching methods to improve the teaching quality

The content of the instrument analysis course is very complex because there are many knowledge points, abstract concepts, and complex instrument structures. It is difficult for teachers to intuitively show the teaching content through the traditional methods. Multimedia forms such as PPT, Flash, and the short video can concrete the abstract concepts, make the static images dynamic, and macroscopic the microscopic models for students effectively. These teaching methods not only stimulate students' interest in learning but also help students to understand and remember the content. In addition, teachers and students can also communicate and discuss the course content through cloud courses, QQ group, WeChat group, and other ways to stimulate students' interest in learning and exploration spirit. Therefore, diversified teaching methods can improve the efficiency of classroom teaching markedly.

4. Optimize the experimental content and reform the experimental teaching mode

To cultivate the applied talents with strong adaptability and practical ability in the applied undergraduate universities, teachers should not only teach the basic principles and methods of instrument analysis but also optimize the experimental content and teaching mode [5]. Instrument analysis course mainly includes optical analysis, chromatographic analysis, electrochemical analysis. The applied undergraduate universities should guarantee the basic experimental project of the ultraviolet-visible, infrared spectrum, atomic absorption, gas chromatography, liquid chromatography, electrochemical workstation. Through these basic projects trainning, students can further master the construction of different instruments, working principles, and basic operations. Due to the limitation of the number of experimental instruments in the applied undergraduate universities, students should be taught and guided in groups in experimental teaching. In the experimental teaching process, the interaction between teachers and students can increase the students' enthusiasm and initiative. The practical operation can effectively improve the students' ability to integrate theory with practice, using instruments to solve problems [9]. In addition, course teachers should also combine the characteristics of each specialty to open new experimental projects.

5. Conclusion

Instrument analysis courses have a very important role in cultivating the practical ability of students majoring in applied chemistry, material chemistry, environmental science, environmental engineering, biological engineering, and pharmaceutical engineering. Applied undergraduate universities should adjust the syllabus, select and expand the teaching content according to the characteristics of each specialty and talent cultivating objectives, and constantly integrate cutting-edge knowledge in the teaching process. Teachers should also actively reform the teaching methods and adopt diversified modern teaching methods. Case method teaching, particular discussion, and other ways can effectively improve students' enthusiasm to learn theoretical knowledge. Multi-level and multi-module instrument analysis experimental teaching methods are also necessary to carry out for the improvement of the student's practical ability and innovation consciousness.

Acknowledgments

The research is supported by the Project of education and teaching reform from Yancheng teachers university (2021YCTCJGZ008) and Qinglan Project of Jiangsu Province of China.

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