

## Some Thoughts on Instrumental Analytical Chemistry Experiment Teaching

Ying Liu<sup>1,2</sup>

<sup>1</sup>Wuhan Vocational College of Software and Engineering, Wuhan, Hubei, 430205, China

<sup>2</sup>Wuhan Drug Solubilization and Delivery Technology Research Center, Wuhan, Hubei, China

**Keywords:** Instrumental Analysis Experiments; Teaching; Chemistry Major

**Abstract:** Instrumental analysis experiment is an important teaching practice course for the undergraduate majors of Material Chemistry. Through teaching practice, it is found that the main existing teaching materials are relatively old, the teaching methods are relatively simple, and the teaching quality of the teaching staff needs to be further improved. Analytical chemistry is an important basic course of Pharmacy Specialty in medical colleges. Analytical chemistry experiment is an important part of the whole course. The current situation of domestic higher education experiments is not satisfactory. There are some problems such as obsolete experimental teaching instruments, lack of innovation in experimental design and weak operation of experimental training. Instrumental analysis experiment is an important way for students to understand the structure of various instruments, be familiar with the operation methods of various instruments, understand the principles of various instruments, and understand the theoretical knowledge learned in class. This paper aims at the main problems existing in the experimental teaching of instrumental analysis, and analyzes the problems existing in the experimental teaching of instrumental analysis based on the actual situation of Chinese chemistry major.

### 1. Introduction

Instrumental analysis experiment is a very practical subject, which plays an important role in cultivating students' ability to observe, think, judge and reason problems, and forming good experimental habits and rigorous scientific attitude [1]. Instrumental analysis experiment is becoming more and more important as a basic experimental course. Experimental teaching is extremely important in undergraduate education. It not only greatly improves students' observation ability and practical ability, but also helps to cultivate students' innovative consciousness and the ability of integrating theory with practice [2]. Instrumental analysis experiment is an important way for students to understand the structure of various instruments, be familiar with the operation methods of various instruments, understand the principles of various instruments, and understand the theoretical knowledge learned in class [3]. The Instrumental Analysis Experiment Course is a compulsory course for chemistry majors and an important practical teaching link. The course mainly covers common instrumental analysis methods such as chromatography, electrochemical analysis, optical analysis, and mass spectrometry. Chemistry is an experimental-based basic subject in which experimental teaching plays a vital role. In the course of the experiment, students need to analyze and think independently and solve problems independently [4].

Under the limited experimental funding conditions, the proportion of instrumental analysis experimental courses is relatively small, and many experiments are mainly based on observation and demonstration [5]. At present, the current status of domestic higher education experiments is not satisfactory. There are problems such as outdated experimental teaching instruments, lack of innovation in experimental design, and weak experimental training. Through the study of the course, students can master the basic principles of various instrument analysis methods, the basic structure of the instrument and the use of the instrument, learn to establish the basic ideas of the analysis method, and initially form the ability to apply various instrument analysis methods to solve practical problems [6]. The course mainly includes photochemical analysis, spectral analysis, chromatographic analysis, electrochemical analysis, etc. The main purpose is to enable students to

understand the structure, working principle, use method and operation technology of the specific instrument [7]. This kind of teaching mode plays an important role in cultivating students'comprehensive ability and team cooperation ability. How to make rational use of limited experimental hours and resources, maximize the significance of instrumental analysis experiment teaching, and cultivate students'practical operation ability, analysis and problem solving ability is particularly important.

## 2. Problems in Instrumental Analysis Experiment Teaching

### 2.1 The Experimental Content is Not New Enough

The instrument analysis process is complicated and has many variable factors, such as sample preparation method and experimental parameter setting. Because of the number of instruments and the experimental site, the experiment is usually carried out in a large cycle, that is, several different experiments are opened at the same time, and different groups of students do different experiments. The teacher will comment on the student's opening report, propose corresponding amendments, and let the students in the group discuss and determine the final experimental plan [8]. Students are limited by the number of laboratory sites and instruments. It is even difficult to guarantee a group of students and one instrument, and often there are more people in each experimental group, which leads to fewer mobile phones for students. If the subject does not require high analytical accuracy, the spectrophotometry is preferred. If the subject requires accurate analysis, high performance liquid chromatography is used. Classroom teaching generally focuses on the basic principles of the instrument and the basic theory of analysis. The structure of large instruments is complex and the principle is Abstract. It is often difficult for students to understand in class. Completing a pilot project on a group basis helps to improve students' sense of teamwork.

### 2.2 The Experimental Examination System is Not Perfect

The examination of many experimental courses often focuses on the results rather than the process, and the experimental report becomes the only standard to examine the students' achievements in experimental courses. In the experiment of spectrophotometric determination of substance content, we require students in each group to prepare standard solution first, and each group should conFig. it separately, and the solutions in each group should not be mixed. When students go to work, they will find that the analytical instruments used in actual work are quite different from those used in the experimental class in many aspects, such as operation level, program steps, etc. Compared with ordinary instrumental analysis experiments, advanced instrumental analysis experiments have some characteristics of their own, which determines that if the traditional experimental teaching methods are copied, there will often be many drawbacks [9]. Some students violate the basic operating rules and are not serious enough in the experimental operation process, which can not be reflected in the experimental report. In this way, the imperfect examination system has seriously affected the enthusiasm of students for experimental courses.

After completing the experiment, the students'mastery of the instrument can not reach the expected level, and the purpose of designing the experiment has not been achieved, which is not helpful to the students' experimental ability. Without the opportunity to do it by oneself, it is difficult to say how impressed students will be after a few hours of an experiment [10]. High-voltage pulse charging and discharging devices based on functional materials can be used in collision detection and other forms to advance the design problems and quality problems that may arise in the project. The performance parameters before and after optimization are shown in Table 1. The simulation comparison of topology reliability optimization is shown in Fig. 1.

Table 1 Performance parameters of the topology before and after optimization

	Before optimization	After optimization
Row number	35	42
Column number	23	32
Monitoring Points	805	1344

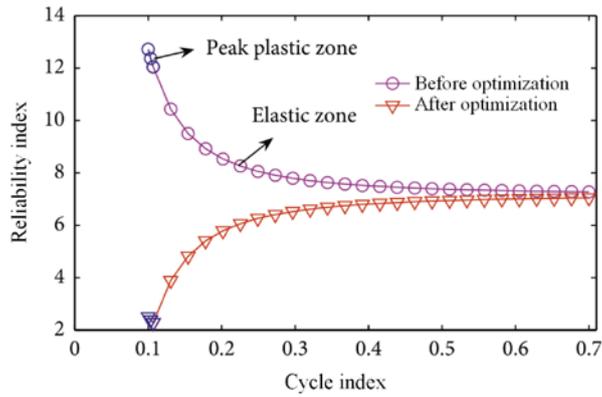


Fig. 1 Comparison of topological reliability simulation before and after optimization

### 3. Solutions to Problems in Instrumental Analysis Experiment Teaching

Traditional instrumental analysis experiments are mostly confirmatory routine experiments, which are far from modern experimental methods, techniques and practical applications, and are difficult to arouse students' enthusiasm in learning experimental courses. The teaching mode based on team cooperation has changed the traditional teaching mode which focuses on teacher instillation. Through the cooperation among the team members, the instrumental analysis experimental teaching can further enhance the students' team cooperation consciousness and the ability of international communication on the basis of imparting knowledge to the students. In order to ensure the safety of the experiment, the teachers of the laboratory will be present to guide the students to carry out the experiment during the reserved time. Generally, students will be arranged to preview the theoretical knowledge required for the experiment in advance before class, and then explain the key points of knowledge to deepen the impression during class, which can strengthen students' mastery of theory and free more time for instrument operation.

After implementing the analysis plan and obtaining the test data, it is especially important to summarize and analyze the research results. The number of instruments involved in advanced instrumental analysis experiments is relatively small, the equipment is generally relatively new, and the cost is high. The experimental and predicted values of material resistivity are shown in Table 2 and Fig. 2.

Table 2 Experimental and predicted values of material resistivity

Group number	Experimental value	Predictive value
1	175.31	174.46
2	185.85	173.81
3	220.58	220.97
4	188.33	187.73
5	206.68	206.66

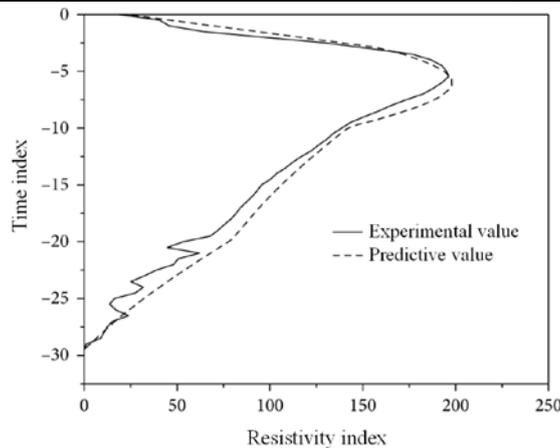


Fig. 2 Material resistivity experimental value and predicted value comparison

In teaching practice, sometimes in order to ensure that students have enough time to operate the instrument, teachers will actively coordinate to increase the experimental hours. The teaching purpose of spectral analysis experiment requires students to operate instruments and collect spectra on the basis of understanding the structure of instruments and grasping the basic principles. Most of the time, experimental courses in Colleges and universities can not be arranged with theoretical courses at the same time. Relying on theoretical teaching alone can not make students have a profound understanding of complex instruments and Abstract principles. The arrangement of the experiment must be to ensure that the students have learned the theoretical courses related to the experiment, which requires timely communication with the teachers who teach relevant theoretical knowledge. The full-time teachers have no problems in teaching skills and teaching level, but there is often a blank space for the instrument itself. Although we can understand the basic structure of the instrument and the basic principle of the experiment, we cannot operate it by ourselves, lack the subjective initiative and interest of the experiment class, and the teaching effect is not good. In the classroom, students can intuitively understand the structure and basic principles of the instrument on the computer by using software to carry out simulation experiments, thus mastering the use method of the instrument.

#### 4. Conclusion

The reform of analytical chemistry experiment course is a catalyst to promote the cultivation of students'comprehensive quality and innovative ability. We need to constantly find problems in teaching and find solutions to them. As an advanced analytical experiment course for undergraduates in Colleges and universities, advanced instrumental analysis experiment is of great significance. It is necessary to improve its practical effect and students'practical ability and innovative consciousness as far as possible. By optimizing classroom teaching, adjusting teaching content, improving experimental teaching mode and improving assessment system, the teaching quality of instrumental analysis experiment course can be effectively improved, and students'enthusiasm and initiative can be fully mobilized. In teaching practice, we need to face up to the current problems, revise teaching materials and handouts, enrich teaching contents, enrich teaching methods, establish and perfect a diversified assessment system, and carry out research-based teaching and open experiments. In the future design experiment teaching, we should make continuous improvement on the basis of summarizing experience, so that the teaching mode can be better applied to experiment teaching, in order to give full play to the advantages of team cooperation mode. Then cultivate good experimental habits, lay a good foundation for the cultivation of practice and innovation ability, and also provide new directions and ideas for the reform of other instrumental analytical chemistry experiments..

#### References

- [1] Manson R, Roy-Choudhury K, Hughes S. Polaron master equation theory of pulse driven phonon-assisted population inversion and single photon emission from quantum dot excitons[J]. *Clinical Chemistry*, 2015, 93(15):859-865.
- [2] Donohoe G C, Maleki H, Arndt J R, et al. A New Ion Mobility–Linear Ion Trap Instrument for Complex Mixture Analysis[J]. *Analytical Chemistry*, 2014, 86(16):8121-8128.
- [3] Boika A, Bard A J. Time of First Arrival in Electrochemical Collision Experiments as a Measure of Ultralow Concentrations of Analytes in Solution[J]. *Analytical Chemistry*, 2015, 87(8):4341-4346.
- [4] Katarzyna B. Application of HPTLC with Densitometry for Evaluation of the Impact of External Factors on Contents of Diphenhydramine in Its Solutions[J]. *International Journal of Analytical Chemistry*, 2017, 2017:1-6.
- [5] Yang M, Yu T, Zhang Z P, et al. A Turn-on Fluorescent Probe Based on Quantum Dots for

Detection of Trace Glutamate Dehydrogenase[J]. Chinese Journal of Analytical Chemistry, 2014, 42(3):436-440.

[6] Ponomarenko E A, Poverennaya E V, Ilgisonis E V, et al. The Size of the Human Proteome: The Width and Depth[J]. International Journal of Analytical Chemistry, 2016, 2016:1-6.

[7] Zhao B, Cao X, De L T R, et al. A green, facile, and rapid method for microextraction and Raman detection of titanium dioxide nanoparticles from milk powder[J]. RSC Adv. 2017, 7(35):21380-21388.

[8] Feist B, Mikula B. Preconcentration of heavy metals on activated carbon and their determination in fruits by inductively coupled plasma optical emission spectrometry[J]. Food Chemistry, 2014, 147:302-306.

[9] Chen H Y, Nieh H M, Yang M F, et al. Implementation of a Low-Cost Automated LED Photometer for Enzymatic Reaction Detection to Teach Basic Bioelectronics Technologies in Vocational High Schools.[J]. IEEE Transactions on Education, 2016, 59(3):194-201.

[10] Scott C E, Rap A, Spracklen D V, et al. The direct and indirect radiative effects of biogenic secondary organic aerosol[J]. Atmospheric Chemistry and Physics, 2014, 14(1):447-470.