Application of Blended Teaching in the Instrument Analysis Experiment - Atomic Absorption Method for Measuring the Content of Calcium Ions in Water

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Abstract. In order to improve the teaching effect of instrumental analysis experiment course, teachers use es-online virtual simulation experiment platform and self-built massive open online course resources to construct a learning mode of "flipped classroom before class, offline group comparison in class , online review after class". The results show that students learn through this blended learning mode of "online and offline", and their learning initiative, enthusiasm, and comprehensive practical quality have been significantly improved.

Keywords: instrument analysis experiment, Online and offline blended teaching, Virtual simulation experimental platform, MOOC resources

1 Introduction

Instrument analysis experiment is a basic course content for science and engineering majors in universities, such as chemical engineering, environment, food, biology, medicine, etc. It is the essential basic skills and scientific research quality of students [1-3]. In order to complete theoretical and practical training，students need to understand the structure and principles of various instruments and equipment, be familiar with instrument operations [4-5]. Most universities often adopt traditional teaching methods taught and operated by teachers due to the lack of large-scale instruments, resulting in low student participation and poor teaching effectiveness, which is not conducive to the cultivation of students' comprehensive practical abilities and difficult to keep up with the rapidly developing requirements of contemporary technology [6-9]. Based on the characteristics of this course, we have constructed the Xueyin-online MOOC resources, utilized the es-online simulation virtual platform, selected experimental topics that are close to life and job needs, and designed experiments in groups with students as the main body, fully mobilizing students' initiative in learning and research[10]. The article takes the experimental chapter of atomic spectroscopy as an example to explore the construction of a blended teaching model of online learning platform and large instrument operation.

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2 Construction of a Teaching Model

2.1 Flipped classroom before class

Preview relies on the self-built Xueyin online platform. Teachers release tasks to students, including experimental videos on "Atomic Absorption Method for Measuring Calcium Ion Content in Water" and the operation video of TAS990 Atomic Absorption Spectrophotometer. After completion, students will choose the experimental direction of their group, conduct online virtual simulation experiment training, and publish the experimental results to the learning platform for discussion among classmates. The teacher conducts online Q&A simultaneously.

2.2 Implementation process of experimental teaching

2.2.1 Instrument operation guidance

Although the instrument operation process of the experiment requires student-oriented and students have conducted experimental operations on the virtual simulation platform, teachers still need to provide key guidance before each group conducts the experiment. For example, installing and adjusting hollow cathode lamps, and parameter settings, etc. Guide students to think, how are the parameters set? When do we need to reset them?

2.2.2 Operations and data processing

The team started the instrument, measured the absorbance of each standard solution and samples to test according to the design of the team, and recorded the data. In order to enable students to have a deeper understanding and mastery of the significance and processing methods of experimental data, it is required that students not only record but also independently process their own set of experimental data. For example, when there is a difference in the linear correlation coefficient of the standard curve, how to calculate and select the data in the sample results. Students also need to use drawing software such as Excel, Origin, and GraphPad Prism to re-process and analyze the experimental data in the submitted experimental report. The implementation steps of flipped classroom teaching can refer to Table 1.

Table 1. Schematic Diagram of Blended Instructional Design

Online Platform		Offline Operation
Before	Principle Module Learning	Complete Learning in the Virtual Simulation Platform
	Controls Module Learning	
	Online Discussions	Qualified in Online Assessment
In	TAS990 Simulation Operation	Experimental Explanation
	Simulation Experimental Steps	Technical Difficulties (Dilution and Injection)
		Students Operate Large Measuring Instruments under the Guidance of Teacher
		Correction of Experimental Results
After	Online data analysis and processing	Complete the Result Analysis Report and Upload
	Assessment and Evaluation	Complete online after-school tasks

3 Standard curve drawing and data collection

Select data processing software to draw standard curves. Eliminate abnormal data through residual analysis and retest if necessary. The correlation coefficient should not be less than 0.995.

Table 2. Data and Regression Equations for Each Group (C/ug ▪ml^{-1})

No.	Standard curve equation	R^2	Tap water		Mineral water		Sports drink	
			Abs	C	Abs	C	Abs	C
1	A=0.0406C+0.0029	0.9965	0.052	4.837	0.065	6.118	0.020	1.685
2	A=0.0438C+0.0077	0.9949	0.048	3.680	0.069	5.598	0.018	0.941
3	A=0.0437C+0.0073	0.9908	0.062	5.007	0.072	5.922	0.022	1.346
4	A=0.0427C+0.0110	0.9947	0.063	4.871	0.068	5.339	0.025	1.311
5	A=0.0432C+0.0038	0.9959	0.052	4.463	0.067	5.852	0.014	0.944
6	A=0.0444C+0.0018	0.9996	0.048	4.162	0.065	5.694	0.020	1.640

Table 2 shows the data obtained from six groups of experiments, and Figure 1 shows the data processing results of different software in some groups.

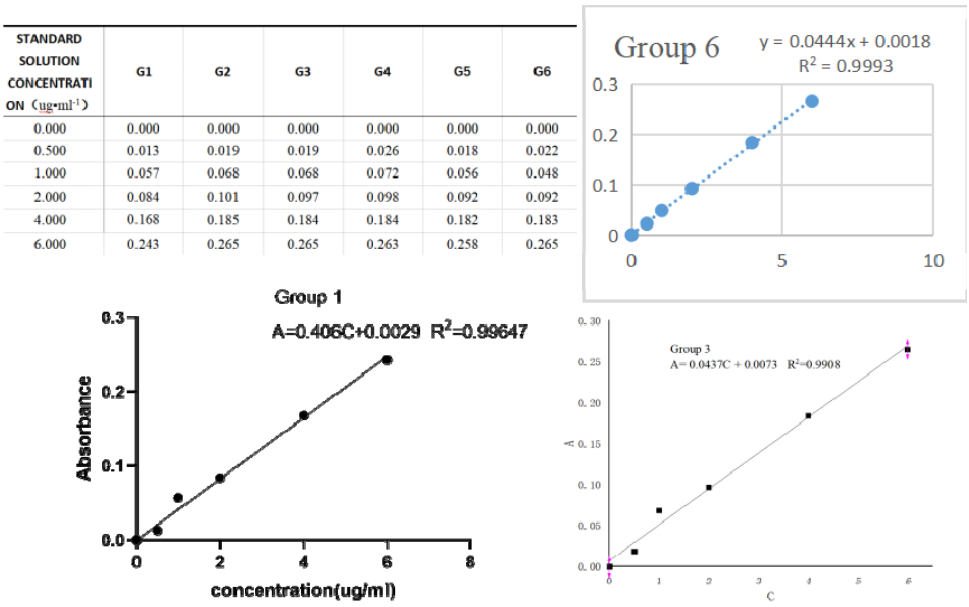

Fig. 1. Standard Curves Legends Processed by Some Groups Using Different Software

3.1 Analysis and Discussion

The teacher monitors the data uploaded on online platforms in real time and guide students to use online expansion resources for regression equation significance testing.

The teacher sets up a group task score evaluation (inter group rating/self-evaluation rating/teacher rating, 5:2:3) to guide students to use the software that each group excels in. Based on the experimental operation video, standard curve, and precision of the results uploaded to the learning platform by each group, they grade each other and select the best operation group for this experiment - the sixth group (Table 2). The teacher guides students to identify the problems and shortcomings of each group while discussing the grading, such as non-standard pipetting, failure to zero with blank solvent before each solution change measurement, and low precision of the results.

4 Teaching Effectiveness

Compared to traditional instrument analysis experimental teaching, blended teaching can fully utilize the MOOC resource platform, allowing students to have a preliminary understanding of experimental content and instrument operation before class, which is conducive to the training of experimental skills in class. From the perspective of teaching effectiveness, all students are able to complete sample pretreatment, standard solution preparation, etc. according to the experimental content, and can complete the steps of instrument startup, parameter setting, machine operation, shutdown, etc. under the guidance of the instrument operation manual. The disadvantage lies in the weak ability to process data, analyze, and describe experimental results, which requires further guidance from experimental instructors. From the implementation effect, the blended teaching mode can effectively achieve the teaching objectives of this experiment. According to the feedback of students after class, students generally believe that the blended teaching model enhances their confidence in operating large instruments and equipment, and enhances their interest in scientific research.

5 Conclusion

Compared to traditional instrument analysis experimental teaching, blended teaching can fully utilize the MOOC resource platform, allowing students to have a preliminary understanding of experimental content and instrument operation before class, which is conducive to the training of experimental skills in class. Blending learning can not only improve students' professional knowledge and skills, but also stimulate their exploration spirit and cultivate their scientific research literacy.

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