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Blended Teaching Design and Practice of Analytical Chemistry Based on Primary Teaching Principles — Taking Indirect Iodometry as an Example

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Abstract:

With the introduction of the "first-class curriculum" construction policy of the Ministry of Education of the People's Republic of China, a large number of mixed first-class curriculums have emerged. This research aims at the problem that the traditional teaching mode is easy to be ignored in the training of applied talents. Relying on the network course teaching platform of our school and some MOOCs learning platform at home and abroad, and relying on the primary teaching principles, this research constructs the online and offline mixed teaching (guidance)-learning education mode of analytical chemistry which combines students' online self-learning, teachers' online question answering, off-line face-to-face teaching and project application design. It lays a foundation for building the first-class curriculum of analytical chemistry.

Keywords: *Blended teaching, Analytical chemistry, Primary teaching principles*

I. INTRODUCTION

With the rapid development of mobile technology, especially the large-scale popularization of "Internet + Education", blended teaching has become the new core development of future education [1-2]. The concept of blended teaching has formally evolved from "the mixture of online teaching and face-to-face teaching" to "teaching situation based on mobile communication equipment, network learning environment and classroom discussion" [3]. The teaching contents of analytical chemistry are characterized by various formulas, meticulous logic, complicated calculation, drawing various titration curves, and requiring the learners to find out the main controlling factors in the complex reaction system, and to carry out precise and accurate mathematical calculation and judgment according to the error requirements, all of which pose great challenges to the learners. At the same time, analytical chemistry has been widely used in the fields of food, clothing, shelter and transportation, ecological protection, criminal investigation and so on. In view of these characteristics, the MOOC element was led into the teaching [4], through the practical case analysis and design application in life actively guide students to carry out online open course learning, and

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through self-learning process evaluation, exercise self-test, problem exchange and interaction, innovative application practice and other teaching means extend the teaching process from classroom teaching to network teaching, from in-class teaching to off-class teaching, from telling teaching to online teaching, from passive learning to active learning, which broaden the communication and interaction channels between teachers and students without time and space constraints, and provide students with personalized teaching platform and learning experience. Iodometry is an important method in redox titration. It is widely used in the analysis and quality control of food, medicine and industrial components. Only by mastering the basic concepts can students understand the essence of iodometry and flexibly apply it to real cases. Indirect iodometry plays an important role from a connecting link between what comes before and what goes after. It can not only systematically review the principles of acid-base titration, coordination titration, oxidation-reduction titration, indicator selection, commonalities in error and result evaluation, but also distinguish differences and cultivate dialectical thinking. Moreover, the content in this section is very practical. Through case analysis, the ability to treat problems, analyze problems and solve problems can be improved, theoretical knowledge can be applied to practice, which can greatly improve learning interest, exert learning initiative, establish correct values and social responsibility. Therefore, based on the first principles of instruction, this paper designs an online and offline blended teaching module of indirect iodometry, and carries out blended teaching practice.

II. BLENDED TEACHING PRACTICE BASED ON THE PRIMARY TEACHING PRINCPLES

Under the guidance of the primary teaching principles, which is focused on problem solving, awakening the existing knowledge, showing the new knowledge, applying the new knowledge and integrating new knowledge [5], this paper designed online and offline teaching and realize the systematization of teaching process. Combining with the intelligent teaching tools of "Learning Knowledge", the blended teaching of MOOC + SPOC + flipping classroom is carried out. Teachers arrange homework, answer questions online, etc. through the online platform, students can preview, review, complete homework after class, participate in topics, and promote learning behaviors to be autonomous and personalized. By extracting big data such as learner's learning behavior, assessment and so on to analyze the learning situation and optimize the teaching design, the teaching quality can be improved obviously. It solves the problem of attaching importance to knowledge over ability and cultivates critical thinking and innovation ability.

Based on t primary teaching principles, combined with the blended teaching flow of "pre class, in class and after class", this paper designed the on-line and off-line blended teaching of "indirect iodometry", which is the common redox method in analytical chemistry. The hybrid instructional design is shown in Table I.

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Table I. The hybrid instructional design based on the primary teaching principles

Teaching procedure	Teaching content	Core question	Design intention
problem solving	Combined with the online learning situation and the description of the determination steps of copper ion content in the national standard method, the teaching tasks and objectives of this course are put forward.	Indirect Iodometric Method for Determination of Copper Content in lead copper matte	Introduce the classroom teaching contents through creating the cases around us, and stimulate the desire of new knowledge learning by task-driven
Awakening the existing knowledge	Principle of redox titration, electrode potential, principle and classification of iodometry, titration curve	Feasibility of redox titration and basis for selection of titration conditions	Review, complement old knowledge, establish knowledge link, clear knowledge structure.
showing the new knowledge,	1. $\varphi^{\theta}(Cu^{2+}/Cu^{+})=0.153V, \varphi^{\theta}(I_2/I^{+})=0..536V,$, Why can Cu^{2+} oxidize I^- to I_2 in the determination of copper content? 2. In indirect iodometry, the control of titration conditions has great influence on the accuracy of titration results, so what should be the titration conditions in this experiment? 3. What is the purpose of adding KSCN? Why add it near the finish line?	The method, principle and titration conditions of The determination of copper content; The measures to improve the accuracy of copper content determination	Answer questions and solve practical problems through reflection and thematic discussion
Application of new knowledge	Consulting the literature, combining with the knowledge learned in this section, design the experimental scheme of copper content determination in copper alloy by means of group cooperation, and carry out the implementation.	Determination of Copper Content in Alloys	Autonomous, collaborative, inquiry-based learning, learning for practical use
Well Digested Completely Understood	Online topic discussion after class: 1. Effect of Fe^{3+} on Titration Result and Elimination Method 2. What are the reasons for the blue return of the terminal point? How to avoid it? 3. Basis and Method for Solution Acidity Control	Solution of problems in practical operation	Think deeply, establish the link between old and new knowledge, strengthen the interaction between students and promote the internalization of knowledge

2.1 Activate Old Knowledge and Transfer Understanding New Knowledge

The four kinds of titration methods shared common characteristics, such as plotted against the data through experiment, with similar titration curves and some jump range. However, the four kinds of titration not only have the above commonness, but also have different degree of difference in the analysis object,

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the influencing factors of titration jump and the action principle of indicator. it is helpful for students to build up knowledge logic system and common concept system by reviewing and completing old knowledge before learning new knowledge. Before that, students have mastered the basic principles of redox titration, including titration curve drawing, determination and analysis of titration jump, selection of indicators, end point error analysis and basic principles of Iodometry, and have the basis for quantitative analysis using analytical technical principles. Before class, review the basic principles, precautions, titration conditions and error analysis of iodometry through on-line micro-lectures video. Through reading knowledge expanding materials, completing the online knowledge point test, checking the effect of self-study, discussing the difference between direct iodometry and indirect iodometry online, and putting forward the difficult points of self-study. Further activate the old knowledge by reviewing and consolidating the learned knowledge, laying a foundation for offline topic discussion, deep thinking, acquiring new knowledge and applying new knowledge.

2.2 Focus on Problems and Stimulate Interest in Learning

Problem-centered and solving practical problems as the starting point is the core of primary teaching principles and blended teaching. Chenzhou City, where the the author's university is located, is the main producing area of lead-zinc smelting in China. In the lead-zinc smelting process, matte, which is mainly formed by copper, iron and sulfur, is produced. The matte contains high copper, ranging from 20% to 70%. The copper content of pricing element is an important factor to judge the value of lead matte goods. This case is used to create situation introduction, and then ask the question: How to carry out quantitative analysis of copper content? What is the principle of the analytical method and what are the measurement steps? How are the determination conditions determined? How to improve the accuracy of analytical determination? Based on the real problems encountered in real life, it helps to improve learning interest and stimulate learning motivation. Focusing on problems, students can clearly define learning tasks, think actively with questions, and fully mobilize learners' subjective initiative.

2.3 Demonstrate New Knowledge and Improve Learning Efficiency

In the off-line teaching, after reviewing the old knowledge that the electrode potential is the basis for judging the oxidability and reducibility of electricity, and the electrode potential was calculated through Nernst equation, teacher guide students to think about the factors affecting electrode potential. A topic discussion on the factors affecting the conditional potential of the Cu^{2+}/CuI pair was presented in order to draw a conclusion on the basis of deep thinking, heated discussion and careful argumentation. Because Cu^{+} reacts with I^{-} to form CuI precipitates, the conditional potential of Cu^{2+}/CuI pair is raised to 0.87V, which is much higher than electrode potential of I^{2}/I-pair, it has the theoretical basis of oxidizing I-. After the feasibility analysis of redox titration, how to control the titration analysis conditions of copper content determination experiment? Through analyzing the electrode potential of I-, O_2, the decomposition of $Na_2S_2O_3$ and the solubility product of copper hydroxide, the students are guided to discuss the requirements and control methods of pH in solution to draw a conclusion. After defining the titration conditions, the factors affecting the accuracy of titration was analyzed and discussed. In addition to the

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factors discussed above, the change of color and state of solution during titration was also showed by animation. Students considered whether there is influence on titration result from the perspective of precipitation adsorption. After voting, peer teaching method was carried out .and vote again after discussion. After peer teaching, the accuracy rate has increased to 39% compared with the previous 31%, but the accuracy rate was still not high. The teacher explained the law of precipitation transformation again in class, analyzed from the angle of *K*sp of CuI and CuSCN and decomposition of SCN-itself. After analysis, reorganize the vote, the accuracy rate reached 92%, indicating that the students basically mastered this knowledge. In the process of demonstrating new knowledge, it is not simple information telling, but combining closely with the focus question by task-driven. Through constantly reviewing and completing the old knowledge, as well as solving problems, students can establish the knowledge system and concept system,which promoting the effective learning of the students and cultivating dialectical thinking.

2.4 Apply New Knowledge to Improve the Ability of Migration and Application

Analytical chemistry is a highly practical course, theoretical study and practical application should be carried out simultaneously. The primary teaching principles is consistent with constructivism, advocating complete task activities on the basis of problem-centered approach. On the basis of the feasibility analysis .exploration of titration conditions of determination of Cu^{2+} content by titration. The Titration accuracy of indirect iodometry was also discussed. The determination of copper content in alloy is taken as the research object. The students consult the literature by themselves, design the experiment scheme, analyze and discuss the scheme, and then carry on the concrete experiment exploration by indirect iodometry learned in class. Through the design experiment, it can promote the deep fusion of theoretical knowledge and practical application ability, cultivate students' scientific thinking and improve students' creative ability and comprehensive quality.

2.5 Well Digested Completely Understood, Cultivate the Ability of Reflection

The primary teaching principles holds that effective teaching should not terminate in learning and consolidation of new knowledge, but should give the learner the opportunity or platform, to transfer and apply the new knowledge learned to the new problem situation. On-line and off-line reflective learning, peer-to-peer collision communications and deep exploration of the learned knowledge can trigger the reflection of the learner to the new knowledge; also promote the learner to new exploration and improvement of the new knowledge. For the knowledge content of this lecture, an open discussion section is set up on the homepage of the course to carry out intra-group discussion and inter-group debate. Consult the data to discuss whether Fe^{3+}, which is often contained in actual copper samples, has influence on titration results. If so, how is it eliminated? In addition, in the actual titration process, the phenomenon that the titration end color returns to blue is often occurs, what are the possible reasons for this phenomenon? What is the effect on the titration results? How to avoid it? Through on-line topic discussion, students' reflective ability and critical thinking are effectively cultivated.

III. CONCLUSION

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This research completes the teaching design according to the primary teaching principles, adopts the online and offline hybrid teaching mode, including three teaching sessions pre class, in class and after class. After on the offline learning, students and teacher refine and summarize the topics that have the value of discussion. In class, group discussion on selected topics are carried out. This way of learning realize the learning objectives of "learning knowledge outside the class, internalizing knowledge in the class". The offline introduction through local cases improves the interest and enthusiasm of learning. The off-line classes mainly focus on solving problems. Through group collaborative learning, they increase class interaction, activate the class atmosphere, promote active thinking, and cultivate critical thinking, reflective ability and innovative consciousness. Online curriculum construction has become the premise of teaching, which fully embodies the teacher's role as organizer and provider of high quality teaching resources.

No matter teachers answer questions through network before and after class, or to interact with students in real time during class, it embodies teacher's role as an effective improver of students' learning effect and greatly improves teaching effect. Further reforming the online and offline hybrid teaching model and teaching content is still a difficult task. How to deeply integrate online and offline teaching, realize inclusive class, promote individualized learning and enhance the participation of all students, expand the time and space of interaction between students and teachers, and construct reasonable evaluation system are the important contents of the follow-up hybrid teaching research.

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