

# *Teaching Design of High School Chemistry Virtual Experiment in Blended Learning Environment*

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**Abstract:** With the development of informatization teaching, the informatization teaching method has been continuously improved to make up for the deficiencies in traditional teaching. The virtual experiment design in the blended learning environment follows the student-centered, teacher-led teaching method, breaking through the time and space constraints, and it can effectively solve the problem that high-risk and important experiments cannot be practically operated. The virtual experiment platform is used as the experimental environment, and the online interactive platform as an auxiliary tool. Blended learning and contextualized teaching are innovatively integrated and contextualized experimental teaching is carried out. The experimental urban and rural education is fair, and teaching resources are shared.

## 1. Introduction

Our country has always paid attention to cultivate students' innovative ability, information literacy and scientific literacy[1]. The 2020 edition of Chemistry Curriculum Standards for General High Schools advocates that students should have the ability of independent development and communication and cooperation, and we should cultivate students' innovative spirit and practical ability[2]. In the Core Literacy of Chinese Student Development promulgated in 2016, this outline once again emphasized the importance of students learning to learn and practice innovation [3]. In the Education Informatization 2.0 Action Plan promulgated on April 18, 2018, an implementation plan to promote "Internet + Education" was proposed. Information-based education is already a major trend in education, but how to better integrate education with the rapid development of the Internet era is more worthy of our consideration[4].

Chemistry is a natural science based on experiments, but at present, there are still the following problems in the teaching of high school chemistry experiments at the basic education stage in my country: (1) The state of demonstration experiments of "teacher doing - students watching", "teacher speaking - students listening". The experiments with a relatively high rate are mainly focused on the content of the key examinations of the college entrance examination and experiments with relatively simple experimental equipment. The laboratory is not managed by professionals, and the experimental equipment and drugs are lacking. (2) High-risk experiments

cannot be performed in practice. Students cannot obtain experimental data through experiments, and the experimental steps are recited mechanically (3) There is a large gap between urban and rural teaching resources, and urban educational resources are better than rural schools.

Based on the above problems, the use of blended learning and virtual experiments for teaching design can solve the problems of uneven urban and rural development and uneven educational resources in our country. Through the combination of online and offline teaching methods of blended learning, we can realize the fairness of urban and rural education, realizing efficient learning. Also we can make the boring study life of high school full of interest, which reflects Dewey's educational thought of "learning by doing".

## **2. Core Concepts & Learning Theories**

### **2.1 Blended Learning**

Blended learning is a teaching format and teaching strategy. Since the 20th century, various theories and technologies have given great impetus to education. Learners gradually discover that learning is a complex process during the design, implementation, and reflection of various teaching designs [5]. Blended learning originated from corporate training, but since its development, blended learning is no longer simply a combination of offline and online learning, but rather enables learners to learn through reasonable teaching design, specific teaching strategies, and effective teaching methods. A teaching method that maximizes learning effects.

### **2.2 Virtual experiment**

Virtual experiments can verify the experiments we think about in our minds. The most prominent advantage used in this article is the simulation of experiments, which breaks through the biggest limitations of "time and space" for traditional chemistry experiment classes, even if there are no schools to provide them after class. Students can also experiment and practice on their own in a specific experimental environment, and repeatedly consolidate knowledge and memory, which effectively solves the problem of teachers being unable to answer students' questions one by one during collective learning in class, which is in line with the embodiment of teaching students by their aptitude in education and teaching. Enriches students' personalized learning. It provides convenience for both teachers and students to freely and worry-free enter the virtual laboratory [6] at anytime and anywhere, operate instruments, and conduct various experiments. This is combined with the blended learning online and offline teacher-assisted guidance and the interaction between students. Collaborative learning can be used in the classroom to help improve the quality of experimental teaching.

### **2.3 Dewey 'Learning by doing' & Constructivism Learning Theory & Situated Learning Theory**

Based on Dewey's "learning by doing" idea, the hybrid learning high school chemistry virtual experiment teaching design uses multimedia equipment. Students can use the NB virtual laboratory to repeatedly conduct experiments in and out of class, fully reflecting Dewey's idea that "experiments are the main source of scientific inferences". The experimental environment and conditions of chemistry are very strict. In real scenarios, it is difficult for teachers to establish an experimental environment that meets the experimental conditions for learners, but virtual laboratories can do it easily. Learning and applying knowledge in specific situations can make learners more likely to enhance their problem-solving ability, and learning in real situations can

occur naturally and efficiently. In the hybrid learning environment, the virtual experiment teaching of high school chemistry uses the NB virtual laboratory to enable students to have a specific situation for experimental operations. "Context", "collaboration", "conversation" and "meaning construction" are the four elements of the constructivist learning environment. In the hybrid learning high school chemistry virtual experiment teaching design practice carried out under the guidance of constructivist educational thought, educators are the "organizers", "guides" and "planners" of teaching activities, and make overall plans for the content, form, environment, resources and all aspects involved in teaching. In the teaching activities before, during, and after class, they mainly focus on students' participation and learning initiative. To allow students to gain simulated experimental experience and help them construct knowledge.

### **3. Feasibility analysis of virtual experiment teaching design in blended learning**

#### **3.1 Advantages of virtual experiments**

High school students are generally faced with the pressure of college entrance examinations. Virtual laboratories can increase students' initiative and enthusiasm for chemistry experiment classes. The virtual laboratory is not limited by time and space, and the experimental operation can be repeated to prevent the waste of drug resources, avoid high-risk experiments, and ensure the personal safety of students.

Due to the use of collective learning and class teaching systems in traditional teaching, the number of students in the classroom is large, and the teachers' energy is limited. So it is difficult to answer questions in a targeted manner. Each student has equal experimental opportunities in the simulated experimental environment provided by the virtual experiment platform, which is more conducive to the individualized learning of learners.

#### **3.2 Advantages of blended learning**

The learning method in the blended learning environment breaks the teacher-led position in the traditional classroom, emphasizing the learning process of students as the main body and teachers as the auxiliary, using virtual laboratory + online interactive platform and offline teacher-assisted guidance. The teaching method gives full play to the rich online learning resources in blended learning and the powerful interactive functions of information technology. The real-time interaction between teachers and students is reflected, and teachers can more comprehensively understand the blind areas of students' knowledge and provide targeted guidance.

### **4. Instructional Design**

#### **4.1 Teaching Analysis**

##### **4.1.1 Analysis of Teaching Objects**

Taking a high school student in Jilin City as the teaching object, the high school students have certain information literacy. They are very interested in new teaching methods such as internet teaching, virtual experiments, and online interaction, and they have strong acceptability.

##### **4.1.2 Analysis of teaching content**

By summarizing the experiments of Compulsory 1 and Compulsory 2 of the chemistry textbooks, and interviewing high school chemistry teachers, it can be concluded that virtual experiments are

not suitable for all chemistry teaching experiments in high school textbooks although virtual experiments are simulated and safe. However, it cannot completely replace the real experiment. Teachers should choose the appropriate experimental method according to the nature of the experiment, as shown in Table 1 below, which is the type of experiment more suitable for virtual experiment operation.

Table 1: Experiment types suitable for virtual experiments

Classification	Description	Experimental example
1. Experiments accompanied by the generation of toxic and polluting gases during the experiment	Such experiments are generally accompanied by the presence of dangerous gases, which may be reactants or products. Such experiments are not suitable for experiments in real classrooms.	People's Education Edition (Required One) Experiment on the properties of sulfur dioxide, experiment on the laboratory method of chlorine gas
2. Microscopic experimental changes invisible to the naked eye, abstract and incomprehensible experiments	Such experiments cannot be observed in the macroscopic world, and the experimental process is complicated and difficult to understand.	People's Education Edition (Required One) Copper-zinc primary battery experiment People's Education Edition (Required 2) thermite reaction
3. In the experimental operation, the experiment with a high risk factor of severe reaction	During the experiment, the reaction is too violent and there is a potential safety hazard.	People's Education Edition (Required One) Experiments on sodium and its compounds
4. Experiments with high experimental costs and expensive drugs	Such experimental raw materials are difficult to obtain, and the success rate of the experiment is not high. The drugs and equipment are consumed, and the experimental cost is high.	People's Education Edition (Required One) Ammonia fountain experiment
5. Experiments with tiny experimental phenomena in real experiments	This type of experiment has strict requirements on the experimental environment, and changes in the experimental environment will make the experimental phenomenon less obvious.	People's Education Edition (Required One) Preparation Experiment of Ferrous Hydroxide

#### 4.1.3 Analysis of Teaching Environment

An investigation was conducted on the teaching environment of a high school chemistry experiment in Jilin City. The school was equipped with a chemistry laboratory, but there was a shortage of medicines and instruments. The multi-person experiment helped students to discuss the experimental steps, but it reduced the students' sense of participation in the classroom and made it difficult to stimulate their interest in learning. The school has sufficient computers and good network facilities. Each student can conduct independent experiments at the same time to achieve the purpose of efficient learning.

## 4.2 Analysis of Teaching Environment

### 4.2.1 Before class

Teachers publish preview materials to the interactive platform, and students preview online courses. The preview content includes virtual experiment operation methods and classroom experiment content which can avoid delays in course progress due to software operation problems in class. Teachers improve teaching plans through preview feedback.

### 4.2.2 In class

Teachers create situations to introduce learning problems, and inspiring and guiding teaching, and they also should organize students to explore independently and collaborate in groups.

Teachers use the virtual experimental platform to demonstrate and explain experiments, and students to follow-up operations. Students conduct virtual experiment operations online, and teachers provide guidance offline, giving students targeted guidance by observing the experimental situation of offline students and the interaction on the online platform, and finally display group results and evaluate each other between groups .

The teacher evaluates and summarizes the virtual experiments of each group again to help students sort out their knowledge, strengthening their memory, giving students repeated stimulation and helping students build knowledge.

### 4.2.3 After class

Teachers assign after-school homework, checking the completion of students' experiments through the online interactive platform, and using the virtual experiment platform to repeatedly practice the content of the experiments to consolidate and deepen memory. Teachers provide timely guidance as needed, improving students' initiative in learning chemical knowledge, and cultivating students' independent inquiry (Fig 1).

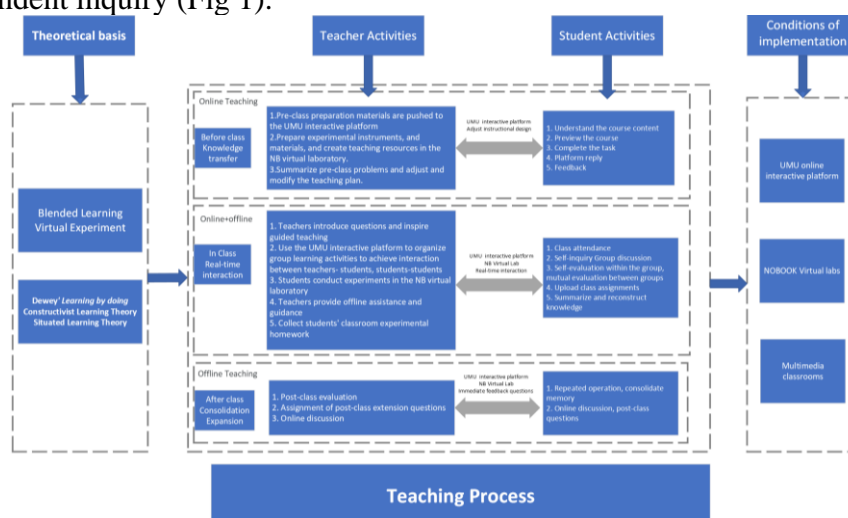


Figure 1: Teaching Process Design of High School Chemistry Virtual Experiment in Blended Learning Environment

## 5. Conclusions

The teaching design of this study focuses on the main position of learners in teaching activities, and the teaching process is convenient, concise, and easy to operate, which effectively saves

experimental time and maximizes the efficiency of teaching experiments. The NB virtual laboratory allows students to perform simulated experimental operations, and the experimental phenomena are easy to observe. The experimental device connection is automatically corrected, which saves experimental time in class, and can be repeated after class to consolidate and review. This effectively improves students' learning efficiency. A school in Jilin City is unable to carry out chemical experimental teaching activities due to time-consuming experiments, high experimental risks, and insufficient experimental drugs and instruments. The advantages of virtual experiments can effectively solve these teaching difficulties. Applying virtual experiments in the chemical experiment classroom of a high school in Jilin City has practical significance for saving educational resources. Therefore, this study has a certain practicality. The extensive application of this educational approach in high school chemistry can help bridge the gap between urban and rural teaching resources, thus promoting educational equity.

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