Ideas and Approaches on "Construction of High Level Simulation Experimental Teaching Center of Virtual Chemical Laboratory"

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Abstract: With the spiritual guidance of the *Circular on the Construction of National Virtual Simulation Experimental Teaching Center* by the National Department of Education, according to the requirements of construction task and work content, and based on the reality of the simulation experimental teaching center of virtual chemical laboratory at Tianjin University, this paper mainly strengthens the understanding of virtual simulation experimental teaching center from three aspects, and on this basis, this article puts forward specific construction ideas, which refer to the "four combinations, five in one, the optimization of the resources and school-enterprise cooperation", and on this basis, this article has made effective explorations. It also shows the powerful functions of the virtual simulation experimental teaching platform in all aspects by taking the synthesis and analysis of organic compounds as an example.

1. Introduction

Chemistry, as a natural science, is mainly based on experiments, and experimental teaching has always played a vital role in it. Some experiments, including some chemical experiments which have very fast reaction speed, do not really work out for students, therefore, conventional macroscopic experiments cannot be used to obtain the mechanism of micro-structure directly. Since students can not directly perceive the chemical experiments, and the knowledge they have learned is abstract and difficult to understand, thus can have a serious impact on the quality of their teaching.

2. Important Understanding of Constructing Virtual Simulation Experimental Teaching Center

2.1 It is helpful to enhance the function and improve level of experimental teaching center

Experimental teaching, as an important place for training talents, helps to train students' creative ability. National demonstration center for chemical experiment teaching——Chemistry experiment teaching center of Tianjin University has made important achievements in the experimental teaching concept and reform. With the rapid development of social economy and the continuous progress of information technology, it is the basic characteristic of modern education, and to a certain extent, it is the most important thing to develop and promote the central construction level, construct educational information system which has Chinese characteristics, and provide adequate information and service system support for the construction of a learning society, making it an educational learning resource that everyone can enjoy. Similar to the large-scale open network courses, virtual simulation experimental teaching center is established on the basis of internet, by which students can do online learning, experiment and exploration, thus it allows different groups of people to make full use of and enjoy the quality of teaching resources at all places and time.

At the same time, virtual simulation experiments can carry out irreversible operations such as industrial scale drives and shutdowns in high-risk and extreme environments, including explosion, pollution, high temperature and high pressure, moreover, it can carry out comprehensive training with the characteristics of high flow rate and high cost, from which the experimental items offered will be more secure, reliable, economical and repeatable. Moreover, it can guarantee the quality of talent training, and can greatly improve the level of experimental teaching for undergraduate students by combining the actual situation, thus helping to maximize the radiation and exemplary function of the experimental teaching center.

2.2 Basic characteristics of virtual simulation experiment teaching

It is an important basic characteristic for virtual simulation experiment takes multimedia to take human-computer interaction, network communication, database and virtual reality as the main technical characteristics. In principle, the experimental teaching is mainly designed for undergraduate students, and therefore needs to meet the requirements of the syllabus. And we must construct the highly simulated teaching resources, the experimental object and the environment.

Openness is the biggest characteristic of virtual simulation experiment. Firstly, it refers to the opening of learning objects, that is, learners, explorers, enthusiasts, and teachers can share with each other; secondly, it refers to the opening of the form, that is, the experimental platform can be conditionally and unconditionally logged at any time and place; thirdly, it refers to the opening of resources, that is, on this platform, people can independently consult the literature, and select the corresponding experimental items to complete the scientific design of the experimental program, then input and change the operation parameters, and on this basis, people can complete self-evaluation and mutual evaluation.

2.3 Characteristics of the first-class state virtual simulation experimental teaching center

First of all, it has high-level teaching staff and efficient management system. Teacher teams with high academic and teaching level and a passion for experimental teaching are an important guarantee of the construction of the first-class virtual simulation experimental teaching center. Therefore, to a certain extent, a large number of talented people can be introduced into the experimental teaching team by relying on the guiding role of policies, and thus provide adequate talents for the healthy development of the center [1].

Secondly, the simulation experiment resources are very rich, and the system is well organized and realistic. Rich and colorful teaching resources can greatly meet the needs of different types and levels of personnel, so that the maximum social benefits can be brought into play. The so-called systematicness mainly refers to the systematization of knowledge, technology and process, and the hierarchical structure can provide an important guarantee for the gradual learning. On this basis, it is necessary to ensure relative convergence, so as to help to learn an experiment and principle, to understand a set of equipment structures, and to understand the implementation of a set of experimental techniques.

Thirdly, we should aim at the national level and set up an advanced and completed teaching system. Since advanced teaching concepts conform to the training requirements of innovative talents, and the advanced teaching system helps to promote students' creative consciousness, ability and consciousness, and it can also run through the entire teaching system, therefore, by tracking and drawing on the experience of internationally renowned universities, and by combining with all-round principles, we can maximize the characteristics of the chemical engineering, so as to help the formation of a virtual simulation experiment teaching system with great chemical function at the international level.

3. Method for Construction

Construction shall be carried out by following the guiding ideology, construction task and content of the Ministry of education, combining with the actual situation of the demonstration center, and adhering to the principles of sustainable development, emphasis, efficiency and scientific planning.

3.1 Adhere to the "four combinations"

"Four combinations" mainly include: the combination of independent research and development, introduction and sharing; the combination of experimental development projects with experimental teaching reform and scientific research; the combination of high quality training resources and teaching resources; the combination of high level virtual simulation technology and high quality experimental script.

We need to constantly optimize and integrate existing resources on the basis of independent research and development. We should always develop scientific research achievements and teaching research according to the direction of the experimental project, thus helping to realize the scientific and experimental projects of scientific research projects. By making the most of the advantage of discipline, as well as the basic chemical experimental techniques, we can realize the operation of the chemical unit and the actual control of the chemical process and industrial production, and with the help of high-level simulation technology and high quality script, we can provide important guarantee for the virtual simulation experiment which is forward-looking, advanced and active.

3.2 The implementation of the "five in one"

"Five in one" mainly refers to the fact that the main functions, including theoretical learning, self-evaluation, teacher evaluation, student interaction, simulation experiments, and typical technology (chemical synthesis technology, instrumentation, chemical technology), etc., are integrated into one, thus helping to build up a large platform of virtual simulation experiment teaching with advanced construction technology, intensive function and efficient operation.

3.3 Further optimization of resources

The optimization of resources mainly ensures that the teaching resources are more advanced and systematic through the integration and optimization of the means. It is a well-known fact that Tianjin University is one of the earliest universities to carry out simulation experiment teaching in China. The optimization and integration of various teaching resources, enhancement of functions and scientific configurations can be conductive to promoting the systematic formation of quality teaching resources. And the teaching resources involved mainly include the chemical experiment center, the national industrial crystallization and distillation center, the experimental training base and the center.

3.4 The further strengthening of school-enterprise cooperation

The so-called school enterprise cooperation is mainly to closely link and strengthen the cooperation between enterprises and centers. By giving full play to the strengths of the first-class demonstration centers, teaching teams and chemical disciplines, and combining the advanced production equipment and processes of the chemical enterprises, we can promote the strengthening of school-enterprise cooperation, and facilitate the practice of practical training. Every year the school will arrange many people to participate in the training, and the center's teachers will concentrate on the teaching and training the majority of students and teachers, and the training center will also provide students with online internship training opportunities, which helps them to receive virtual simulation training, and to be familiar with the whole process, thus facilitating the operation of various production units and effectively avoiding the risk of the enterprises. Only after the qualified training of virtual simulation can the students enter the workshop and carry out operations; and after that, the students can draw a complete picture of the large equipment and process flow on the basis of the internship results [2]; finally, the total score of the students is given with the help of joint teachers, workshop techniques and training staff.

In addition, the school will pay a high salary each year to employ senior technical staff and teachers from the training center for intensive teaching, On the basis of integrating theory with practice, the typical process, theory and technical knowledge of modernization are passed on to students, so as to achieve the goal of promoting and deepening cooperation between schools and enterprises.

4. Construction of virtual simulation platform with powerful function

It is known that virtual simulation experimental teaching platform is a system that combines software and hardware, thus the most important goal of its design is to be designed for online virtual simulation experiments and real-time or non instantaneous simulation experiments and training support platforms. Its application objects include three types, namely, learners and trainees, trainers and administrators, in the actual teaching and training, functional requirements of different roles and permissions are different. In general, the platform consists of three modules, namely, students learning, simulation experiment model, teacher teaching and acquired management statistics module. The overall functionality of the platform is shown in Figure 1 below.

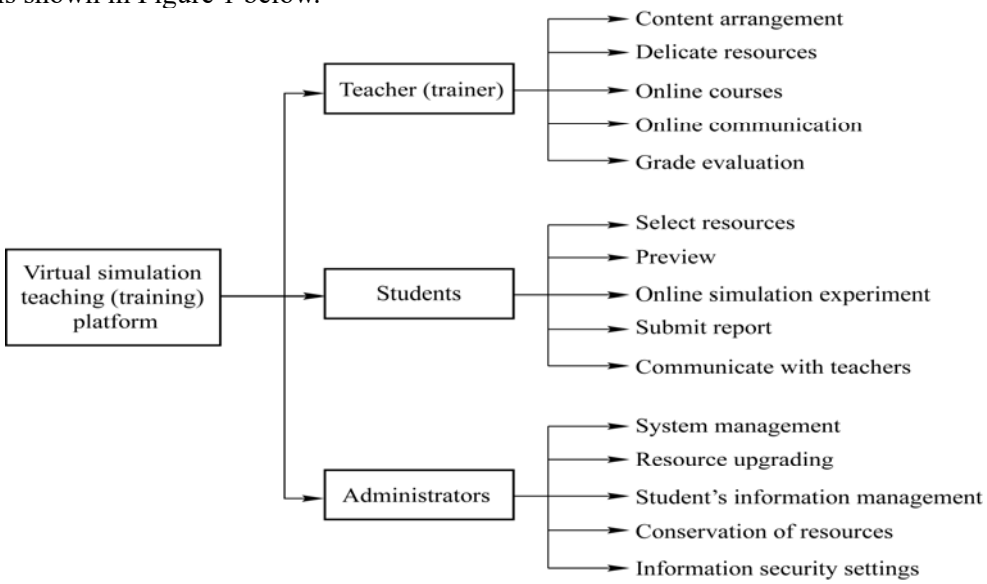

Figure 1 Virtual simulation teaching (training) platform

By using the platform, students can choose their own teachers, and carry out experiments according to their own interests, and they can also complete all kinds of virtual simulation experiments or process simulation operations within the jurisdiction of the lan,On this basis, the system can automatically evaluate the performance with specific operations.Through this process, the initiative of the students themselves can be effectively stimulated, and in the process of learning, students can also put in full enthusiasm and energy, thusdeveloping their abilities. During repeated experiments and simulations, if there is any illegal operation, such as the wrong experimental procedures, the selection of improper parameters, the system will give some hints to remind the students of the correct corrections to errors, and according to their actual conditions, students can also practice repeatedly until satisfactory results are achieved.

According to the above functions, the platform has set up special workstations and arranged for special personnel to manage it, thus it can be opened to students all day long, and the remote virtual simulation experiment and process training simulation can be realized immediately[3]. At the same time, the platform has been vigorously supported by the university campus network, and its total storage capacity exceeds 100T, ensuring that all kinds of network applications can run normally, and providing sufficient storage space to the teaching center of simulation experiment. At present, the level of information security technology used in campus network is relatively higher, thus can provide an important guarantee for the normal operation of the platform and the effective sharing of resources both inside and outside the campus.

With the increasing content of the virtual simulation experiment in the platform, the range of teaching resources and the increasing amount of interaction, it is very likely that thousands of people will log on to this platform at the same time, therefore, the "network congestion" is very easy to be caused, thus we will work with the national Supercomputer Center to ensure that our network teaching

resources can be properly run, the platform can be used more smoothly and better interactivity can be achieved.

5. Case authentication

In this study, the preparation and separation of organic compounds are taken as an example.

5.1 Synthesis technique

First of all, the concept of green synthesis needs to be established, and the routes that may be synthesized shall be determined with the help of quantitative calculations, by which the basic methods and theories of organic chemistry can be combined, and the best synthetic route can be determined.

5.2 Separation and analysis technique

Based on the physical properties of compounds, students may adopt different separation and purification techniques. The so-called "deficiency" in “deficiency and excess" in chemistry and chemical experiments mainly indicates that students can not directly contact chemical and experimental instruments, and “excess” indicates that students can make use of the virtual simulation experiment to realize the effective mastery of the principle, nature and process of chemical reaction[4]; and it is a kind of "deficiency" that students do not operate all kinds of chemical equipment and instruments personally, and use the mouse to click on the image, therefore, with the help of the virtual simulation experiment, the whole process, operation unit and condition can be controlled; and it is a kind of “excess” to optimize the production through the change of various parameter, and to observe different chemical processes and reaction results by changing reagents, restructuring various instruments, optimizing various processes and adjusting various parameters in the virtual simulation experiment.

6. Conclusions

The application of chemical virtual simulation experiment can provide more vivid, image, advanced and abundant teaching, scientific research and training means for the teachers and students, researchers and actual production workers in the field of chemical industry, and this will help to promote the students' innovative consciousness and scientific practice ability.In our future work, we will carry out scientific planning and earnest implementation according to the guidance from the Ministry of education, and promote the experimental teaching of high level chemical virtual simulation through step-by-step implementation.

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