

Empirical Study on Online Experimental Teaching Design of Physics at Harbin University under the Background of Epidemic Prevention and Control

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ABSTRACT

At the beginning of the New Year 2020, a sudden epidemic broke the original order of life. Colleges and universities in China have had to postpone the start of classes to prevent the epidemic from spreading to schools. According to the decision and deployment of the central government and the requirements of the Ministry of Education and the Provincial Department of Education, it is imperative to improve the innovative ability of college students in online teaching of college physics experiment. Relying on the virtual simulation experiment teaching cloud platform of Aorui Company during the anti-epidemic period, the physics experiment teaching center of Harbin University develops the teaching design with students as the main body through detailing the online teaching steps, refining resources and optimizing the teaching structure, and achieves good teaching effect. This study provides reference for the offline experimental teaching and the cultivation of students' practical ability under the background of epidemic prevention.

Keywords: *Physics experiment; Online experiment teaching; Practice ability training; Teaching design of "detailing, refining, optimizing and one body"*

1. INTRODUCTION

In order to win the battle against the outbreak of the Novel Coronavirus Pneumonia and respond to the policy of "stop classes but continue teaching", all the teachers of the physics experiment center of Harbin University concentrate their wisdom and overcome many difficulties to construct the cloud teaching of "university physics experiment" and "modern physics experiment" with many resources and platforms [1-2].

Harbin University is an application-oriented university, which is committed to cultivating high-quality and high-skilled application-oriented talents [2]. The experimental link is the premise of improving students' practical ability, carrying out quality education and cultivating applied talents. In this semester, the Physics Experiment Center not only undertakes modern physics experiment, general physics experiment, photoelectric experiment and other teaching tasks for students majored in physics, but also undertakes the teaching tasks of university physics experiment for more than 800 students from more than 20 classes of science and engineering majors. Whether from the perspective of teachers or students, the task is relatively heavy. For example, if experiments cannot be opened online, the laboratory will face the pressure of personnel, time and place conflict after the semester starts, which makes it difficult to guarantee the teaching task of this semester. Under this background,

after multiple investigations and discussions, the teachers of the center finally decide to focus on the virtual simulation experiment teaching cloud platform of Aorui Company during the anti-epidemic period, and complete the online teaching task together with personalized design and guidance. Specifically, by detailing online teaching steps, refining online resources, and optimizing teaching structure, the student-centered teaching design of "detailing, refining, optimizing and one body" can be developed [1-4].

2. TEACHING RESOURCES AND ADVANTAGES

2.1. Teaching platform

The cloud platform for virtual simulation experiment teaching of Aorui Company is rich in teaching resources during anti-epidemic period. It contains many simulation experiments corresponding to physical experiments, and all of them are equipped with detailed teaching auxiliary resources, which can meet the needs of students' preview, learning and autonomous thinking. At the same time, the sharing platform of national virtual simulation experiment teaching project and the Heilongjiang Province virtual simulation experiment teaching project in 2017 and 2019 jointly developed by enterprises are utilized, and it is

supplemented by more than 40 virtual simulation experiment projects in the physics experiment teaching center. Besides, the teaching teachers set up "College Physics Experiment II" to complete individualized teaching on the platform of superstar fanya. Figure 1 is a

schematic diagram of virtual simulation experimental platform system of physical experiment center of Harbin University. At present, this platform only has Chinese web pages, no English web pages. Specifically, the simulation platform has the following.



Figure 1. Virtual simulation experiment platform of physics experimental teaching center of Harbin University

2.1.1. Abundant resources

Since 2006, the teaching team of physics teachers has tried to carry out virtual simulation experiment teaching, including experimental video recording and online experimental resource construction. In 2013, more than 40" basic physics"simulation experiments and some"modern physics"simulation experiments can be opened.

2.1.2. Serve teaching

Through the combination of virtual and real teaching mode and the combination of online and offline teaching mode, it makes up for the deficiency of real experimental teaching to a certain extent, and teachers and students have good feedback effect and great harvest.

2.1.3. Friendly interface

Virtual simulation experiment provides a platform for students to learn independently on the network. The instrument is designed by component technology, the virtual instrument is designed by software 3D modeling,

and the virtual experimental environment is established. In this environment, students design their own experimental scheme, draw up experimental parameters, and simulate the real experimental process. In this process, it not only deepens students' understanding of physics knowledge, but also cultivates their innovative ability. In recent years, physics students have achieved good results in the national college students and graduate students' physics self-made teaching aids, design experimental exhibition evaluation and Heilongjiang university students' photoelectric design competition.

2.1.4. Base support

The virtual simulation experiment system of modern physics experiment of Harbin University is formed on the basis of Heilongjiang experimental teaching demonstration center, that is, "physics experiment center" of physics majorand "physics demonstration laboratory" of Heilongjiang provincial science popularization education base.

2.2. Teachers create their curriculum

In order to better grasp the learning status of students, each

teacher should carry out personalized curriculum resources construction according to the characteristics of teaching majors. Each link can be effectively monitored through the corresponding platform and maintain good interaction with students, so as to timely understand students' difficulties and sticking points according to their learning trajectory.

2.2.1. Detailing the online teaching steps

In addition to uploading basic teaching documents, teachers will upload videos of preview points before class, so that students can complete the preview with a specific aim. The preview effect can be tested through the system small test module, so that teachers can adjust the teaching focus. After class, students are required to write a detailed experimental report and hand it in. According to the experimental report submitted by students and the feedback from the students' learning channel, teachers can answer questions and discuss with the students, and students can improve and sort out the experimental report, and finally submit the complete experimental report.

2.2.2. Refining online resources

There are many online resources, and teachers should select some experiments that are easy to operate and interactive in the special period. The content of the experiment is not confined to the syllabus, but mainly aims at cultivating students' ability, so as to expand and enrich the content of the experiment project as far as possible. In order to enhance students' interest in experiments, some independent experiments are also carried out to fully stimulate students' innovative ability, such as "the exploration of the parameters affecting smooth landing success rate of the overturned water bottle" and "the inelastic collision of the elastic ball based on the phyphox software". In addition, some exploratory experiments are introduced to further improve the difficulty of the experiments so as to cultivate students' ability to solve problems with scientific knowledge.

2.2.3. Optimizing the teaching structure

Starting from cultivating application-oriented talents [3], teachers have optimized the structure of online physics experimental teaching in universities for many times in combination with the current situation, characteristics of different majors and disciplines, and the current situation of physics experimental teaching in colleges and universities. In addition to setting up some basic experimental projects, some autonomous experiments and inquiry experiments are also added to provide targeted training for cultivating students' practical ability to solve practical problems, so as to achieve the cultivation of innovative ability.

2.2.4. Students-oriented

In order to facilitate students to complete the experiment at home, teachers should try to focus on the existing materials and let students complete different experiments at home. In terms of teaching design and organization, teachers and students should learn together instead of teachers talking to students. Through the teacher's online guidance, the interactive discussion between teachers and students is helpful to the completion of the experiment and the cultivation of students' ability.

3. EXISTING PROBLEMS AND SOLUTIONS

In order to ensure the orderly conduct of the course, professional teachers should timely sort out the problems and carefully listen to students' suggestions and put forward solutions.

3.1. Platform issues

For the platform problems in the course of the experiment, the leaders of each class will feedback to the WeChat group of college physics experiment, and there will be special teachers responsible for guiding and solving the problems. In addition, special platform staff will be contacted in case of extreme cases.

3.2. Attendance issues

In order to grasp the attendance status of students in time and make use of the check-in function, teachers should issue a sign-in notice 15 minutes in advance for each class, and students should complete the sign-in before class.

3.3. Insufficient attention

Building an interactive mechanism for online open courses [2] is the best way to teach physics experiment course online. In order to enhance students' interest in college physics experiments, each teacher is constantly enriching teaching methods, changing teaching strategies and improving teaching quality.

3.4. Lack of practical operation

Experimental course, as the name implies, is not just an armchair theory but a hands-on operation. Experimental projects [5-6] should be innovative and inquiry-based, while online MOOC and virtual simulation resources cannot achieve all teaching objectives. In order to enable students to do experiments at home, teachers should concentrate their wisdom to expand the space and have the

courage to practice. Smartphones and household items (such as mineral water bottles, plastic measuring cups and plastic medicine bottles) can be used to create interesting and close-to-life experiments, such as the "impact on the success rate of the smooth landing of water bottles" and "phyphox software based on the study of elastic ball inelastic collision". In order to achieve better teaching results, teachers can also record a few small videos in advance to help students do better experiments at home. In order to achieve the goal of experimental teaching, it is necessary to cultivate students' practical ability and their innovation consciousness step by step.

4. TEACHING FEEDBACK - TAKING THE "VIRTUAL SIMULATION EXPERIMENT OF MEASURING LOW RESISTANCE OF DOUBLE ARMS BRIDGE" AS AN EXAMPLE

According to the needs of students of different majors [2], in addition to the theoretical part of university physics experiment in week 1, week 2-9 respectively open the error matching virtual simulation experiment, virtual simulation experiment of hall effect, virtual simulation experiment of measuring low resistance of double arm bridge, relativistic experiment on the relationship between momentum and kinetic energy of a fast electron, determination of focal length of convex lens, "research on the parameters influencing the smooth landing success rate of inverted water bottle" and "phyphox software based on the study of elastic ball inelastic collision" experiment. This work takes the virtual simulation experiment of measuring low resistance of the double-arm bridge as an example.

4.1. Course process

Preparation before class. In addition to using WeChat group to conduct platform login, software download, installation, debugging training and guidance for class monitor and student committee, each teacher should make careful preparations for their own experiments. For example, they should establish SPOC in super star Fanya platform, get familiar with the use of instruments and experimental procedures in advance, write virtual simulation experiment lecture notes and indoor + experiment lecture notes, make PPT, experiment report template and supplement experimental resources. Besides, teachers should distribute the prepared experimental handouts and experimental report templates to students in

advance in PDF form to help students prepare.

Interaction in class. The live broadcast of "Tencent Meeting" can be used to explain the problems encountered in students' preview, such as the particularity of measuring low resistance and the necessity of using four-terminal wiring method, so as to realize classroom flip. Students come with questions, and teachers can teach with targets. In addition, the content of the experiment should be simply introduced, with emphasis on the experimental principle and how to balance the bridge by adjusting the resistance of the double-arm bridge. Finally, it is emphasized how to correctly read the resistance value and how to obtain the resistivity of the two metal materials and the uncertainty of the two resistivities when the bridge is balanced.

In addition, it is necessary to pay attention to the error-prone areas in the experiment. If the circuit instrument in this experiment is not allowed to be removed by pressing DEL key, the starting position of the resistance frame slider to be measured is 10cm, and the length of the metal to be measured is required to be 40cm, then the position of the other side slider should be placed at 50cm instead of 40cm. Moreover, before the experiment starts, it is necessary to check whether the voltage source pointer is 10 V, if not, set it to 10 V.

In addition, the experimental process, instrument use and how to balance the bridge by adjusting the resistance value of the double-arm bridge can be used to demonstrate online through the "Tencent Conference", while students share the screen feedback discussion through the Tencent conference.

After-school tutoring. Teachers in charge of each experimental project will answer questions for students through WeChat group, QQ group and learning channel in real time. At the end of the experiment, each student is required to hand in the electronic version of the experiment report, and record the experiment process and experience. According to the feedback of students, teachers comb and improve the quality of teaching.

4.2. Course effectiveness

From the frequent interaction of students in the online classroom, the completion of experiments, and the fact that most students actively speak and discuss the problems encountered in class in the discussion area, and ask for advice from teachers, it is clear that students are very interested in learning virtual simulation experiment, and the teaching effect is good. Figure 3 shows the experimental opening rate, completion rate and satisfaction rate.

Table 1. Experimental opening rate, completion rate and satisfaction rate

Number	Professional class	Number of students	Number of computers available	The number of successful login	Number of cloud desktop applications	Percentage of Experimental, completion and satisfaction								
						Number of cloud computing applications	Percentage of the first submission by PC	Percentage of the second submission by the cloud computer	Percentage of rework	Percentage of problems	Number of experiments	Percentage of experimental	Percentage of experimental completion	Percentage of satisfaction
1	Chemistry	33	9	4	5	24	27%	73%	6%	11%	5	100%	100%	100%
2	Chemistry	33	9	9	0	24	27%	72%	13%	19%	5	100%	99%	99%
3	Chemistry	34	10	5	5	24	29%	71%	9%	15%	5	100%	100%	100%
4	Building Electrical and Intelligent	28	25	7	18	3	89%	8%	7%	10%	5	100%	97%	97%
5	Building Electrical and Intelligent	29	19	19	0	10	66%	34%	0%	0%	5	100%	100%	100%
6	Building Electrical and Intelligent	27	23	15	8	4	85%	15%	15%	19%	5	100%	100%	100%
7	Electronic Information Engineering	30	15	6	9	15	50%	48%	7%	10%	10	100%	98%	98%
8	Electronic Information Engineering	30	9	6	3	21	30%	69%	0%	0%	10	100%	99%	99%
9	Electronic Information Engineering	30	14	3	11	16	47%	53%	7%	10%	10	100%	100%	100%
10	Software Engineering	33	30	26	4	3	91%	7%	10%	15%	10	100%	98%	98%
11	Software Engineering	33	29	26	3	4	88%	12%	12%	19%	10	100%	100%	100%
12	Software Engineering	35	35	31	4	0	100%	0%	0%	0%	10	100%	99%	99%
13	Software Engineering	33	30	30	0	3	91%	9%	15%	23%	10	100%	100%	100%
14	Software Engineering	32	27	16	11	5	84%	12%	3%	6%	10	100%	96%	96%
15	Software Engineering	32	28	5	23	4	88%	13%	0%	0%	10	100%	100%	100%
16	Software Engineering	31	30	25	5	1	7%	3%	6%	10%	10	100%	100%	100%
17	Civil Engineering	37	21	20	1	16	57%	43%	8%	15%	10	100%	100%	100%
18	Civil Engineering	40	23	14	9	17	58%	40%	10%	19%	10	100%	97%	97%
19	Civil Engineering	30	5	2	3	25	17%	83%	3%	6%	10	100%	100%	100%
Total		610	391	269	122	219	64%	35%	7%	11%	10	100%	99%	99%

4.3. Teaching promotion

In order to better carry out online experimental teaching and improve the quality of online experimental teaching, teachers of the experimental center use Tencent meeting to carry out teaching and research activities every Wednesday afternoon. The meeting mainly exchanges the online activity experience, and carries on the discussion to the recent common question. In order to enhance students' practical ability and stimulate students' interest in experiments, teachers of the center also set up a number of home + experiments using smartphones and common items at home according to the students' existing conditions, so as to let students experience the fun of the experiment at home, and also make their life at home become more colorful.

4.4. Achievement determination

Student achievement evaluation also plays an important role in teaching. Scientific and reasonable assessment methods can guide students to achieve predetermined educational goals, and teachers can also improve their teaching methods and teaching design through their degree of achievement.

After the completion of the experiment, students are required to hand in the electronic version of the experiment report. In the report, students are required to fill in the experimental purpose, content, principle, procedure, result and conclusion. Students are also required to paste the experimental results and photos of themselves when experimenting with the experimental report. The full score of the experiment is 10 and the highest score of the report is 6. Students can get up to 4 points by completing the study preview, test and uploading the operation process to the designated position on time.

5. SUMMARY

During the epidemic period, "university physics experiment" and "modern physics experiment" not only alleviate the great pressure of the experiment after the epidemic situation through "multi-platform cloud teaching", but also effectively increase students' interest in studying big object experiments through indoor + experiments and self-built courses by teachers, thus improving the teaching quality of physics experiments. In addition, this online teaching is more helpful to cultivate students' independent thinking, innovation, and scientific quality. But considering the principle of "being real" in experimental teaching, the virtual simulation experimental projects set up in the first few weeks are all original in the experimental syllabus, and there is real experimental equipment in the laboratory. After returning to school, students can properly make up for the real experiment according to their situation, and combine the virtual and the real organically to strengthen the cultivation of students' practical ability.

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