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Experience and Discussion on Introducing the "Internet Plus" Classroom Into Teaching Physiological Experimentation

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The "Internet Plus" education model, enabled by the internet, is a type of "Distance learning" education models. To explore the application of "Internet Plus" education in teaching physiological experimentation at Guilin Medical University, undergraduate clinical medicine students from the 2011 to 2013 classes were used as the historical control group for teaching an experimentation class using the traditional teaching model: "teacher-teaching + student-operation." Undergraduate clinical medicine students from the 2014 to 2018 classes were used as the teaching reform group and were taught using an "Internet Plus" educational model: "microlectures-previewing + test + feedback + student-operation." The experimentation operating examination results for the two groups of students were analyzed, questionnaire surveys were administered to students in the experimental group and the relevant teachers, and the survey results were counted. The experimentation operating examination results were significantly higher for the students in the teaching reform group (89.3 points) than for the control group students (84.4 points). The excellent rate was higher (69.8% for the reform group and 54.5% for the control group), whereas the failure rate was lower (1.9% for the teaching reform group and 4.3% for the control group). Additionally,90.1% of the students identified with this reform method, and more than 90% believed that the method improved their interest and confidence in surgical operations during pharmacological and pathophysiological experimentation classes in subsequent courses. All teachers in the physiological experimentation course identified with this teaching method, and 81.8% of the teachers of relevant disciplines in a later stage believed that this learning method was more conducive than traditional teaching to cultivating student interest in learning, proactivity, and other factors. Application of an "Internet Plus" educational model for physiological experimentation teaching can help cultivate hands-on operating abilities and improve the learning interest of students.

Keywords: video-based learning, physiology, "Internet Plus" education, laboratory course, hands-on operating abilities

FOREWORD

Human physiology is a basic discipline in schools and colleges of medicine. Proficient knowledge of this basic discipline is very important, as this proficiency is considered a key distinction between a practitioner and a technician in the treatment and care of patients (Pangaro, 2010). However, in these disciplines, theoretical knowledge of physiology is very complicated, strongly inferential, and difficult for undergraduates to master, and schools and colleges of medicine in China generally set up corresponding experimentation classes to help students understand and grasp physiological knowledge. The objects of research in physiology are living cells, tissues, organs, and organisms. Therefore, live animals are traditionally used as experimental objects in physiological experimentation. To guide student experimentation and improve the success rate, some schools and colleges first arrange for a demonstration class in the curriculum in which the teacher performs the experiments step by step for the students to observe. However, this teaching method places restrictions on the place and time at which students can learn, and students cannot watch the demonstration repeatedly. As a result, few students feel confident in experimentation classes.

Technological developments have urged the rethinking of learning spaces (Velez Rueda et al., 2019). "Internet Plus," a deep integration of the internet and traditional industries by using information and communication technology (ICT) and Internet platforms, was started from 2015 in China. The "Internet Plus" education, one type of "Internet Plus," is a cross-border integration of internet and education, which gradually entered student learning. An increasing number of internet-based platforms have been introduced into education, and medical education is no exception (Muttappallymyalil et al., 2016; Dhir et al., 2017; Popovic et al., 2018). The "Internet Plus" education model promotes the transformation and upgrading of teaching modes, and creates a new form of design, development, utilization, management, and evaluation for education. Realizing the "Five Anys" of education, that is, anyone can start from any content and learn any course at anytime from anywhere (Jianyang et al., 2021). In addition, learners can control their own learning progress, which facilitates students' independent learning and solves the problem of teaching time and teaching space limitations. Introducing "Internet Plus" education into the classroom "invites" the smartphone into the classroom, making it the main tool of classroom learning for the student. Finding data, viewing microvideos, and taking tests can be achieved through the Internet on a mobile phone (Koohestani et al., 2018). As we know, "Distance learning" education models are mainly used in the theoretical teaching but not experimental teaching. Thus, we here attempted to implement this model in our physiological experimentation in 2015 by formulating a series of microlectures.

The remarkable characteristic of the microlecture that differs from traditional online instructional videos is the "micro" aspect. Generally, the microlectures that we produced were approximately 10 min long. The capacity is comparatively small and is convenient for students to download. The students can use fragmented time to watch the videos via mobile phones, which can satisfy the needs of the students to learn anytime and anywhere and advantageously solve the issues of student individualization and differentiation (Salter et al., 2014; Wu et al., 2018). In addition, to supervise the students' autonomous learning and test their learning outcomes, we shaped the contents related to each experimentation class into multiple-choice or judgment questions in a test administered to the students prior to the experimentation class through the school's online testing system. The purpose of this study is to reduce classroom lecture time, increase the operating time of students, stimulate the interest and confidence of students in the experimental class, and improve their hands-on abilities by watching videos anytime and anywhere.

MATERIALS AND METHODS

Traditional Teaching Method

We used all the 1,110 students in the clinical medicine specialty in the three classes of 2011–2013 as the control group. The traditional teaching process was as follows:

Classroom Lecture

At the start of the class, the teacher used PowerPoint (PPT) to explain the purpose and the steps of the experiment one time, which required approximately 30–40 min.

Student Operation and Teacher Summary

The students operated autonomously using a small group as a unit, and the teacher provided an approximately 25–30 min summary at the end of the class period.

Operating Examination

At the conclusion of the semester, two students were randomly combined into a group to undergo the experimentation operating examination and were scored by the proctor on the spot. The examination contents covered basic surgical operations and the use of surgical instruments.

"Internet Plus" Teaching Method

We used all the 2,107 students in the clinical medicine specialty in the five classes of 2014, 2015, 2016, 2017, and 2018 as the experimental group. The specific implementation process was as follows:

Preclass Preview

We uploaded the produced experimentation microlectures onto the school website, which could be viewed both on the campus intranet and on the extranet. At the beginning of the semester, the students were informed about the experimental teaching model of the present semester, and we emphasized that a pretest would be administered before each experimentation class to urge the students to preview in advance.

Classroom Testing

A test of approximately 10 min was performed for the preview situation. The contents of the test included operating steps, predictions, and mechanisms of the experimental results.

Teacher's Explanation

The teacher used 10–15 min to provide feedback on the test situation and explained the questions on the test in combination with the main points of the operation in the present experiment.

Student Operation and Teacher Summary

The students operated autonomously using a small group as a unit, and the teacher provided an approximately 10–15 min summary at the end of the class period.

Operating Examination

The operating examination at the conclusion of the semester was the same as that applied for the traditional teaching method.

For example, in the experiment concerning factors affecting blood coagulation, the total class time was 200 min. By the "Internet Plus" teaching method, the teacher's explanation time was 30 min, which was much shorter than the 70 min provided by the traditional teaching method; thus, the students had more than 30 min to operate (**Table 1**).

Survey Questionnaire

Student Learning Survey Questionnaire at the End of the Semester

At the conclusion of the course at the end of the semester, an anonymous survey was supplied for each student to collect and analyze the students' feedback comments.

Student Learning Survey Questionnaire at a Later Stage

To understand whether this method helped students in subsequent courses, 400 students were randomly surveyed again 1 year after the physiology course ended.

Teacher Survey Questionnaire

To better assess this teaching method, we also surveyed the teachers of this teaching and research section and relevant teachers who engaged in teaching at a later stage.

Statistical Analysis

The results of the experimentation operating examinations for all students are presented as the mean ± standard deviation. The *t*-test was used to analyze the experimental operating examination results, and the chi-square test was utilized to analyze the excellent rate and failure rate. SPSS 17.0 was used to conduct the statistical analysis.

TABLE 1 | Comparisons between traditional teaching method and "Internet Plus" teaching method.

	Testing Time (min)	Teacher's explanation Time (min)	Operation time (min)	Teacher's summary time (min)
Traditional teaching method	0	40	130	30
"Internet Plus" teaching method	10	15	160	15

RESULTS

Experimentation Operating Examination Results

The experimental operating examination results for the control and teaching reform groups were all scored based on 10 points. The average result for the control group (n = 1,110) was 84.4 ± 2.27 points, and the average result for the teaching reform group (n = 2,107) was significantly higher at 89.3 ± 1.59 points ($P < 0.05$, see **Figure 1**). Analysis of each score segment showed (see **Figure 2**) that the proportion of the " ≥ 90-point score segment" was significantly higher in the teaching reform group (69.8%) than in the control group (54.5%,$P < 0.05$), whereas the failure rate was significantly lower (4.3% for the control group and 1.9% for the teaching reform group, $P < 0.05$).

Student Survey Questionnaire Results

Table 2 shows the questionnaire survey results from the students in the teaching reform group for the "Internet Plus" model. The questionnaire results showed that 99.80% of the students indicated preclass use of the microlectures during the previews and that 87.67% of the students viewed the videos more than two times before each experimentation class, with some students viewing the videos up to six times.

Table 3 shows the survey results (n = 400) of the effect on the students in the teaching reform group in subsequent relevant courses (pharmacology and pathophysiology). The results showed that 95% of the students believed that the "Internet Plus" educational model enhanced their interest in surgical operations during pharmacological or pathophysiological experimentation and that 89% of the students hoped that subsequent courses would also adopt this teaching model.

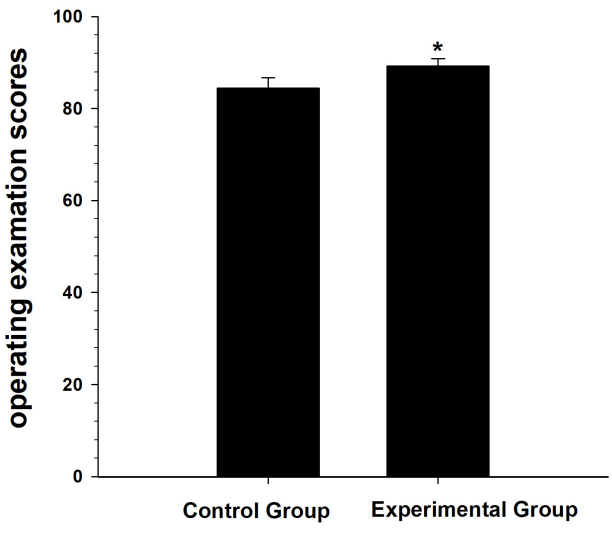

FIGURE 1 | Comparison of the experimentation operating examination results for the two groups of students. The average result for the teaching reform group was significantly higher. *$P < 0.05$ vs. control.

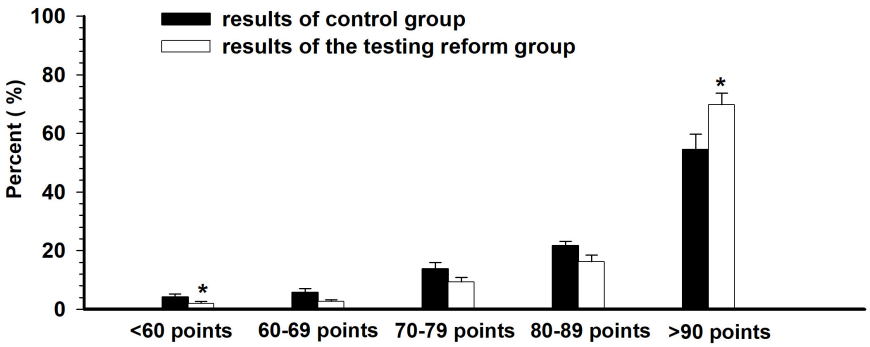

FIGURE 2 | Comparison of the distribution of the experimentation operating examination results for the two groups of students. In the teaching reform group, the proportion of the "=90-point score segment" was significantly higher, and the failure rate was significantly lower. *$P < 0.05$ vs. control.

TABLE 2 | Student evaluation of the degree of identification with the "Internet Plus" model ($n = 494$).

Survey contents	5 or 4 points (%)	3 points (%)	2 or 1 point (%)
This model helped enhance interest in learning	459 (92.91)	24 (4.86)	11 (2.23)
This model helped cultivate hands-on operating abilities	482 (97.57)	5 (1.01)	7 (1.42)
The teacher-produced micro lectures were helpful for experimentation operations	491 (99.39)	2 (0.40)	1 (0.20)
Satisfied with this model	445 (90.08)	49 (9.92)	0 (0.00)

5 points, strongly agree; 4 points, agree; 3 points, neutral; 2 points, disagree; 1 point, strongly disagree.

TABLE 3 | Survey feedback of the effect on the student learning process in courses at a later stage ($n = 400$).

Survey contents	5 or 4 points (%)	3 points (%)	2 or 1 points (%)
Improved interest in surgical operations during pharmacological and pathophysiological experimentation classes	380 (95)	13 (3.25)	7 (1.75)
Improved confidence in the surgical operating process during pharmacological and pathophysiological experimentation classes	364 (91)	26 (6.5)	10 (2.5)
Improved hands-on abilities during pharmacological and pathophysiological experimentation classes	369 (92.25)	21 (5.25)	10 (2.5)
I hope subsequent courses also adopt this method	357 (89.25)	27 (6.75)	16 (4)

5 points, strongly agree; 4 points, agree; 3 points, neutral; 2 points, disagree; 1 point, strongly disagree.

Teacher Survey Questionnaire Results

The results of the feedback survey administered to the classroom teachers in this teaching and research section showed (**Table 4**) that the teachers unanimously believed that the students' interest in surgical operations and the purpose and standardization of the operating process improved significantly compared with those obtained using the traditional teaching model and unanimously expressed a willingness to continue using this teaching model.

The feedback survey results for the teachers in courses taught at a later stage showed (**Table 5**) that 81.8% of the teachers believed that the students' interest in experimentation operations, hands-on abilities, proactivity, and other aspects was improved compared with those of students taught under the traditional teaching model and expressed a willingness to try this teaching model in the future.

DISCUSSION

In our traditional experimental teaching, generally, the teacher must explain the steps of the experiment in detail in the classroom since the students do not preview. This step usually requires 30–40 min, and some of the more complicated experiments may require nearly an hour of explanation. As a result, the teachers have to spend more time on class-room teaching while most students are unable to grasp the main points of the operation (Chengting, 2021) and may be inactive in the classroom. The students only operate step by step under the guidance of the teacher and have superficial knowledge of whether the experimental result is correct and what issue the experimental result illustrates. In addition, a small number of students lack self-confidence. Because they are afraid of making an error, these students must first ask the teacher about each step of the operation before daring to start work. With the limitation of class hours, the hands-on operating time of the students is limited, which is very unfavorable for improving the students' operating skills, especially for students whose hands-on abilities are weak. However, in the current era, medical education is shifting from a traditional content-based curriculum to a competency-based curriculum (Banerjee et al., 2019; Naidoo et al., 2020). The "Internet Plus" educational model offers the opportunity to enjoy a non-judgmental learning

TABLE 4 | Feedback survey from the classroom teachers in this teaching and research section (n = 10).

	5 or 4 points	3 points	2 or 1 points
Compared with the traditional teaching model, the students' interests in surgical operations in the experimentation class improved	10	0	0
Compared with the traditional teaching model, the students' purposes and confidence during the surgical operating process in the experimentation class increased	10	0	0
Compared with the traditional teaching model, the students' basic operations in the experimentation class were more standardized	8	2	0
Compared with the traditional teaching model, the students' hands-on abilities in the experimentation class increased	10	0	0
Compared with the traditional teaching model, the students' basic operations in the experimentation class were more proactive	10	0	0
Compared with the traditional teaching model, the students' success rates in the experimentation class were higher	9	1	0
Compared with the traditional teaching model, I feel that the experimental teaching was more relaxed	10	0	0
I am willing to continue to adopt this teaching model in the experimentation class	10	0	0

5 points, strongly agree; 4 points, agree; 3 points, neutral; 2 points, disagree; 1 point, strongly disagree.

TABLE 5 | Feedback survey results from the classroom teachers in courses taught in a later stage (n = 22).

	5 or 4 points	3 points	2 or 1 points
Compared with the traditional teaching model, the students' interests in surgical operations in the experimentation class improved	18	4	0
Compared with the traditional teaching model, the students' confidence in the surgical operating process in the experimentation class increased	18	4	0
Compared with the traditional teaching model, the students' basic operations in the experimentation class were more standardized	18	2	2
Compared with the traditional teaching model, the students' hands-on abilities in the experimentation class increased	18	4	0
I am willing to try to adopt this model in teaching the experimentation class	18	4	0

5 points, strongly agree; 4 points, agree; 3 points, neutral; 2 points, disagree; 1 point, strongly disagree.

environment (Kim et al., 2017) and the teaching process can be controlled by the students. For concepts they do not understand or details that they do not observe clearly, they can pause the video or think through and analyze the information through repeated viewing of the video (Salter et al., 2014; Wu et al., 2018). "Internet Plus" model makes up for the shortcomings of traditional experimental classroom teaching, such as long teaching time, unclear understanding and not deep impression.

During hands-on operations in the experimentation class, the students were familiar with the steps of the experiment, which markedly reduced the teacher's explanation time. Because the students' hands-on operating time is relatively extended, hands-on opportunities also increase correspondingly. In the survey questionnaire, 97.57% of the students believed that this teaching model was very helpful for their hands-on abilities. The statistical analysis of the experimentation operating examination results also showed that this teaching model could attain the outcomes of traditional teaching (Curtis et al., 2018) and could even enhance the students' hands-on abilities by inducing improvement in the students' operating skills (Soucisse et al., 2017). This improvement is related to the advantages of "Internet Plus" education (i.e., the students can repeatedly view the microvideos during the preview and thoroughly consider the information). Digital teaching will positively affect future learning (Behrends et al., 2020).

Preview is an important link in learning. If the preview of the experimentation class is limited to only textual presentation, it seems more abstract and boring. The microlectures that we developed allowed the students to learn intuitively, thereby compensating for the shortcomings in this area. Research shows that relative to the traditional teaching method, students prefer this type of teaching in video form (Roopa et al., 2013). Therefore, learning based on microvideos becomes an important part of "Internet Plus" education. Microvideos are short and pithy. In only a few minutes, the videos can completely introduce students to the main points of the operation in the experiment and allow the students to preview the information in a manner that is unrestricted by time and place. In the preview, the students can more easily concentrate their attention, thereby improving the preview outcomes.

Testing is the conductor's baton of learning and can drive students to spend more time viewing videos. Therefore, we first pretested the students in the experimentation class to encourage them to take the preview more seriously. Unlike other "distance learning" models test, the "Internet Plus" model test provide the students with not only answers but the relevant explanation in the form of face-to-face discussion, instant response for students' questions, and savings in terms of time, which helps the students to obtain full understanding of some topics (Yu et al., 2021). The questionnaire survey showed that 92.9% of the students believed that the microlectures increased their interest in

physiological experimentation, and 69.2% students watched the videos 2∼3 times, and 16.2% watched ≥ 4 times before class (data not shown). Research has shown that the more fully prepared students are, the greater they can actively participate in the course of learning activities (Carrasco et al., 2018). The questionnaire survey of the classroom teachers also showed that a preview of the experimentation microlectures increased the confidence of the students in the course of experimentation operations, with more proactive operations. Compared with the traditional teaching method, the number of times that students needed the help of teachers in the course of operations decreased; the classroom pressure on teachers also decreased, increasing their comfort with teaching.

To promote active thinking in students and to truly apply all of the knowledge learned, only the operating process is shown in our microlectures on physiological experimentation. The experimental results appear in a question form to guide students in using the theoretical knowledge they have learned to predict and elaborate on experimental results through preclass autonomous learning. This type of question-based learning is associated with positive outcomes (McParland et al., 2004). Moreover, since the students already conducted their basic learning outside of class, time is left in the classroom to extend the analysis of more difficult content to improve the students' abilities to analyze and solve problems (Herbert et al., 2017).

Introducing "Internet Plus" education into the classroom can make the educational process more up-to-date, challenging, and attractive (Velez Rueda et al., 2019).

The survey results showed that the cultivation of hands-on abilities in physiological experimentation obtained by the students helped the students' learning in subsequent courses. The questionnaire survey of the students after 1 year showed that the new teaching model for physiological experimentation as a foundation substantially increased the students' interest and confidence in the operating process of experimentation classes in subsequent courses; a total of 89.25% of the students hoped that subsequent courses would also adopt this teaching model. In addition, the questionnaire survey of the classroom teachers for subsequent courses showed that the teachers believed that the students who participated in the new teaching model for physiological experimentation had increased hands-on abilities and initiative. Furthermore, 82% of the teachers expressed a willingness to try to use this teaching model.

CONCLUSION

The "Internet Plus" teaching model was effective in teaching physiological experimentation and can improve students' interest, confidence, and hands-on abilities in experimental classes. Students previewed and controlled the process more actively and independently. As a result, this model was very favorably evaluated by both teachers and students.

Limitations

Although there was no significant difference between the control group and the "Internet plus" group in the age, gender distribution and admission scores, the time interval between the 2011 and 2018 class is relatively long. There is no denying that, with technology development and emergence of online education platforms, it becomes easier for students in 2014–2018 classes to obtain information about medical information, which greatly facilitates their learning and understanding of the course content. Moreover, during the long period, the unexpected faculty turnover in the involved departments may also affect the quality of our students to some degree. Therefore, in our future teaching reform, more attention should be paid to the project design, and more careful and appropriate selection of students entering teaching reform is needed. These would increase the comparability between different classes. Meanwhile, more detailed information concerning students' performance in viewing the videos, such as supplementary survey about the frequency and duration of students' view, may be helpful to get an accurate conclusion about the teaching reform value.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Human Research Ethics Committee of Guilin Medical University. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work, and approved it for publication.

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