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Research Article

The Application of Online and Offline Hybrid Mode in Pharmacology Laboratory Teaching: A Case Study of the "Insulin Overdose Response and Rescue Experiment"

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Abstract

Pharmacology, as a core course for Pharmaceutical Engineering students, is a basic medical course, which is usually composed of "theoretical courses" and "experimental courses". Pharmacology experiments are a visual validation of the theoretical knowledge learned in the classroom. Through practical operation and observation of experimental results, we can have a deeper understanding of the concepts of drug mechanism of action, pharmacodynamics and pharmacokinetics. In order to meet diversified learning needs, optimize the utilization of teaching resources, and promote independent learning and collaboration ability, online and offline blended teaching is the mainstream teaching mode in the "Internet+" era, which provides a suitable environment and starting point for the ideological and political construction of the curriculum and the practice of the goal of cultivating people with virtue. It is especially necessary to conduct online and offline teaching methods for pharmacology experiments. This article uses the example of "insulin overdose reaction and rescue experiment" to demonstrate the blended teaching mode of online and offline teaching. It attempts to start with the necessity of strengthening students' innovative practical ability cultivation in pharmacology experiment teaching, analyze the problems exposed in current pharmacology experiment teaching in detail, and propose optimization measures such as effectively integrating teaching resources, designing different experimental projects, innovating experiment teaching mode, and emphasizing students' innovative practice based on the mastered situation, in order to provide reference for the blended teaching mode of pharmacology experiment online and offline.

Keywords

Pharmacology Experiments, Pharmacology, Online and Offline Mixed Mode

1. Introduction

Pharmacology laboratory is one of the compulsory courses for pharmacy-related majors, and it is also a discipline that closely combines pharmacology theory and practice [1]. The main task of the pharmacology laboratory course is to verify or prove the efficacy of drugs based on traditional pharmacological theories, incorporating laboratory animal pharmacodynamic experiments, and to investigate interactions between drugs and the body, such as drug indications, side effects, drug interactions, individual differences, etc., in order to visualize theoretical knowledge and promote the development of pharmacology. In the process of continuously promoting the development of pharmacology

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discipline, the pharmacology laboratory course also needs to adopt new teaching methods [2]. In this paper, we take the "Insulin Excess Response and Rescue Experiment" as an example to illustrate the application of the online and offline hybrid mode in pharmacology laboratory teaching [3]. Insulin is an important hormone that plays a key role in regulating the body's blood sugar levels. The development of insulin went through three processes, namely the discovery and improvement of insulin, and the emergence of insulin analogues. Clinically, insulin is one of the important drugs for the treatment of diabetes, especially for patients with type 1 diabetes, it is indispensable. For patients with type 2 diabetes, insulin is also required to control blood glucose in some cases [4]. The "Insulin Overdose Response and Rescue Experiment" not only covers the basic principles of drugs, but also allows students to experience the mystery of drug action through practical operations, and on this basis, they can deepen their understanding of pharmacology by using a hybrid online and offline teaching mode. In order to improve the teaching quality of pharmacology experiments, this paper explores the existing problems of offline teaching of single pharmacology experiments.

2. Experimental Principles and the Significance of Online and Offline Hybrid Mode of Experimental Teaching

2.1. Experimental Principle

Insulin, an acidic protein with a moleculer weight of 56 kDa, consists of two ploypeptide chains linked by two disulfide covalent bonds. It has a wide range of effects on the metabolic process of substances, such as increasing glucose transport in glucose metabolism, accelerating oxidation and digestion, promoting glycogen synthesis and inhibiting glycogenolysis and glycoproliferation [5]. Insulin is a class of hormones produced by the pancreas, which is conducive to the metabolism of substances and the crossing of various ions through cell membranes [6]. Additionally, it can promote the storage of energy substances in the body, stimulate the synthesis of glucose into liver glycogen, the lipid synthesis of fat, and the conversion of amino acids into protein and storage. There are two hypotheses for its mechanism of action. The first one is insulin induces second messenger formation, binds to the recombinant insulin receptor (INSR-α) subunit, activates autophosphorylation of the β-subunit, and activates tyrosine proteases on the β-subunit resulting in phosphorylation of the active protein, which in turn produces biological effects. And the other one is distributes glucose transporters from the intracellular to the cell membrane, promotes the synthesis and transport activity of glucose transporters, and accelerates the transport of glucose.

2.2. The Significance of Online and Offline Mixed Mode Experimental Teaching

Insulin is a class of hormones produced by the pancreas, which is conducive to the metabolism of substances and the crossing of various ions across cell membranes. Additionally, it can promote the storage of energy substances in the body, stimulate the synthesis of glucose into liver glycogen, the lipid synthesis of fat, and the conversion of amino acids into protein for storage [7]. As hypoglycemia worsens, mice may experience convulsions, coma, and possibly death. Throughout the process, it can be observed that the state of the mouse's fur may also change, for instance, becoming coarse. From the process and results of the experiment, students can deepen their understanding and mastery of pharmacological principles. Through experiments, students are able to experience the wonders of chemical reactions first-hand and stimulate their interest in pharmacology.

Cultivating experimental operation ability: adopting online and offline hybrid mode for teaching, experimental handouts and PPT will be released in advance through the learning pass before the start of the course, so that students can understand the experimental operation process in advance. In the process of teaching insulin overdose response and rescue experiments, students have hands-on experience and improve their hands-on ability and experimental skills, including correct injection methods, observation skills. Pharmacology research is inseparable from pharmacology experiments, which cultivates experimental operation skills, lays a foundation for future research, and provides students with tools to explore a broader scientific research space [8, 9].

Enhance professional quality: publish the experimental precautions in advance online, and then emphasize them offline. In the process of laboratory teaching, students are made aware of the importance of precision and safety in the use of drugs in the fields of medicine and biology, and cultivate their rigorous scientific attitude.

Stimulate interest in learning: the vivid experimental process can stimulate students' interest in pharmacology and further promote their active in-depth learning.

3. Experimental Teaching Process and Key Points

3.1. Preparation for Online Experimental Teaching

Before class, students will write experiment-related handouts, make power point (PPT) and prepare experimental operation videos to ensure that students fully preview the experimental content. After class, the exercises are assigned online to consolidate and improve, and the students' learning and test questions are fed back in the background, and targeted teaching guidance is carried out offline.

3.2. Preparation for Offline Experimental Teaching

Preparation of experimental materials

Animal: 18~22 g mice of the same sex.

Equipment: 1000 mL beaker, syringe size 1 mL, 2C-10 super constant temperature water bath.

Drug: picric acid, 40 U/mL insulin (batch number: R22023080462), 50% glucose.

Preparation for teaching

Before the start of the laboratory teaching, it is necessary to be well prepared. First and foremost, ensure the completeness and purity of experimental equipment and reagents to prevent affecting the experiment. Secondly, the experimental principles, operation steps, and precautions are explained and demonstrated in detail to ensure that students can correctly understand and master the essentials of experimental operation. Additionally, it is necessary to educate students on safety, to stress the significance of laboratory safety protocols, and to boost their awareness of safety.

3.3. Experimental Teaching Steps

Take three mice that have been fasted (without water) for 24 hours, weigh them with picric acid, place them in a beaker, and cover them with a perforated plate. The beaker containing the mice was then placed in a thermostatic bath with a water temperature maintained at 37~38 ℃, and their normal activities were observed for the three mice. Mouse 1 and mouse 2 were intraperitoneally injected with insulin at a concentration of 20 μg/mL, while mouse 3 received an injection of normal saline at a dose of 1.0 mL/10 g as the control. Following the injections, the three rats were placed in separate beakers and into a temperature-controlled bath with water temperatures maintained at 37-38 ℃ to observe their activities. Seizures, indicated by symptoms such as a bundled tail, screaming, violent shaking, and convulsions, prompted the injection of 25% glucose or normal saline, 0.5-1 mL intraperitoneally, respectively. Subsequently, the changes in behavior and activity were documented and compared between mouse 1 and mouse 2, as well as between mouse 2 and mouse 3. Experimental phenomena and records were shown in table 1.

Table 1. *Comparison of the effects of insulin injection in different mice and the post-drug reaction of the control substance.*

No.	Weight (g)	Sequence of administration and dose	Post-medication reactions
1	25	(1) 0.25 mL of 5 U/10 g insulin solution was injected first, and (2) 0.5 mL of 25% glucose was given	Five minutes after injecting insulin, the rat started to forage and exhibited slight shivering. However, the trembling subsided and the rat gradually recovered after being administered with glucose
2	23	(1) 0.23 mL of 5 U/10 g insulin was given first, and (2) 0.23 mL of normal saline was given	Compared to mouse 3, the rat experienced convulsions five minutes after receiving an insulin injection, and the hypoglycemic response was exacerbated following an injection of normal saline.
3	26	Given 0.26 mL of normal saline	The behavior of the mice in the control group remained largely unchanged.

Insulin primarily stimulates the storage of glycogen and fats in the liver, muscles, and other tissues. It enhances the breakdown of fatty acids and glucose, thereby increasing their utilization rates. Additionally, insulin promotes the transport of amino acids and nucleic acids, facilitates protein synthesis, and inhibits protein breakdown. It also encourages the entry of potassium ions into cells, which helps to lower blood potassium concentrations.

4. Evaluation of the Effect of Experimental Teaching and Suggestions for Improvement

4.1. Methods for Evaluating the Effectiveness of Online and Offline Mixed Experimental Teaching

To comprehensively and effectively evaluate the impact of blended learning, which combines online and offline elements, we can analyze the number of views for the notices posted on the Xuexitong platform, as well as the timestamps of when

students access the experimental handouts, PowerPoint presentations, and video tutorials. Such data allows us to determine whether the students have previewed the material prior to the experiment and gauge the quality of their preparation. Offline evaluation can be carried out using a variety of methods, such as evaluation of the quality of experimental reports, assessment of experimental operation ability, evaluation of classroom performance and participation, and student feedback surveys [10-12]. Through these assessment methods, it is possible to fully understand the students' understanding of the experimental principles, operating procedures and experimental results, as well as their mastery of experimental skills. At the same time, experimental teaching methods and strategies can be investigated and improved in a timely manner based on student feedback.

Evaluation of the experiment report: firstly, the handwriting and the overall structure of the experiment report are used to understand the students' learning attitude. Evaluate the students' understanding of experimental principles, operation procedures, and the interpretation of experimental results through their discussion of data and outcomes. The experimental report should include the purpose, principle, steps, data recording and analysis, as well as conclusions of the experiment.

Assessment of experimental operation ability: During the process of experimentation, students' experimental operation abilities are assessed, which includes skills such as capturing mice, using reagents, and the injection method. This assessment is conducted to evaluate students' practical abilities and their mastery of experimental techniques.

Evaluation of classroom performance and participation: observe students' performance in class to evaluate their learning attitude and interest. This includes questioning, discussion, and group work.

Student feedback survey: after the experiment, a questionnaire or interview was conducted to determine how well they adapted to the online and offline hybrid teaching mode, as well as to assess their satisfaction, perceived gains, and suggestions for improving the experimental teaching.

4.2. Suggestions for Improvement of Experimental Teaching

According to the evaluation of the experimental teaching effect and the feedback of students, we can start by refining the experimental handouts and refining the PTT content. Secondly, the students also reported that the safety measures of the experiment need to be strengthened, and in the process of catching mice, the mice may be irritable and fearful, causing the mice to bite, scratch and other actions, which may cause injuries to the students. In addition, more guidance is needed when students perform injection operations to avoid improper operation leading to the death of mice.

5. Case Study of Experimental Teaching

To better illustrate the effectiveness of the blended learning approach in the context of insulin overdose response and rescue experiments, the author has chosen a representative case for analysis. In this case, the students followed the experimental operation and observed the response of the insulin overdose mice, and then injected the mice with glucose to successfully rescue the insulin overdose mice. Through the case analysis, it can be found that considerable progress has been made in experimental teaching.

The background of the experiment and preparation phase is as follow. This experiment is a typical experiment in pharmacology, aiming to understand the regulatory effect of insulin on blood sugar, the consequences of overdose and how to rescue it. In order to improve the quality of teaching, 90 pharmaceutical engineering students from Lingnan Normal University were involved in this experiment, and batches were taught through classes, and then groups were subdivided into 10 groups, with 4~5 people in the group. Before the start of the experiment, online students preview the content of the experiment through learning, and then explain the details of the experiment to the students through PPT offline, emphasizing the safety of the experiment and precautions. Ensure that students have an initial understanding and adequate preparation for the upcoming experiment.

In the process of experimental teaching, students follow the experimental teaching steps provided by the teacher and operate with a rigorous attitude. They work together (marking, catching, injecting, observing, recording, etc.), and through a clear division of labor, students do their jobs well in the experiment. In addition, each student should also be familiar with the work of their peers to ensure the accuracy and fluency of the experiment. At the end of the day, students analyze the data and discuss the results of their experiments. By comparing the experimental data, the students were keenly aware of the problems and put forward targeted suggestions for improvement.

Judging from the results of the case, students have made significant progress through the hybrid teaching mode of online and offline. Their experimental skills have all improved considerably. For face-to-face teaching with traditional offline, the hybrid teaching mode combines digital teaching with digital teaching on the basis of traditional teaching, and obtains advanced teaching methods and tools through online teaching platforms. Blended teaching makes use of the abundant online teaching resources to improve students' learning efficiency, greatly expands students' learning space, and more importantly, online learning is not limited by time and space, which enhances students' initiative and enthusiasm for learning [13, 14]. At the same time, this teaching method also improves the teaching quality of teachers and provides convenience for course teaching [15].

6. Conclusion

In this paper, insulin overdose and rescue experiments are used as important contents in the teaching of physiology and pharmacology, and remarkable teaching results have been achieved through the online and offline hybrid teaching mode. In the online part, a wealth of teaching resources allows students to preview and gain an in-depth understanding of the background knowledge, principles and operation points of the experiment in advance. The video explanation vividly and intuitively shows the experimental process, so that students have a preliminary understanding and impression. The online interactive platform also provides a space for students to exchange and discuss, and they can share their doubts and opinions, which promotes the collision of ideas and the expansion of knowledge.

In the offline class, students conducted hands-on experiments and felt each step more realistically. Observing the various reactions of mice after an insulin overdose, from initial agitation to subsequent weakness and convulsions, etc., we vividly experienced the powerful effect of insulin on the body and the serious consequences of its overdose. In the process of rescue, I saw that the mice gradually recovered, and I really understood the effectiveness and timeliness of the rescue measures. This blended teaching model brings a variety of teaching effects. First of all, it enhances students' interest and initiative in learning, allowing them to participate more actively in learning. Secondly, through the combination of online and offline, the teaching of knowledge is more comprehensive and in-depth, and students not only master the theory, but also exercise the practical operation ability. In addition, it cultivates students' scientific thinking and problem-solving skills, and they learn to analyze and respond to various situations in experiments.

However, some areas for improvement were also identified during the implementation process. It is suggested that in the future teaching, online teaching resources should be further optimized to make them more concise and clear, and highlight the key points. At the same time, some more interactive online experiments and simulations can be added to allow students to better familiarize themselves with the operation process. In the offline experiment part, the guidance and supervision of students' operation specifications should be strengthened to ensure the accuracy of the experimental results. In addition, students can be encouraged to carry out group discussions and cooperation, analyze experimental phenomena and data together, and cultivate teamwork spirit.

In terms of teachers, they should constantly improve their professional quality and teaching ability to better guide students' learning. Teacher training can be organized on a regular basis to exchange teaching experience and methods, and jointly improve the quality of teaching. In addition, it can also carry out cooperation and exchanges with other institutions to learn from excellent teaching models and experiences. In conclusion, the online and offline hybrid teaching has played an important role in the insulin overdose and rescue experiments, and has achieved good teaching results. By constantly summarizing experience and improving deficiencies, it is believed that this teaching mode will play a greater advantage in future teaching and lay a foundation for students to explore and study the field of pharmacology.

Abbreviations

INSR-α	Recombinant Insulin Receptor
PPPT	Power Point

Author Contributions

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Conflicts of Interest

The author declares no conflict of interest.

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Biography

Huang Liping (1986-), female, from Zhanjiang, Guangdong, associate professor, Ph.D., main research direction is pharmaceutical engineering.