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# Application of Case-Based Learning in Food Toxicology Course of Public Health Major

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**Abstract.** Computer science and technology have gone deep into many fields, including medical care and public health. The network teaching platform, online courses and formative evaluation developed based on computer science and technology have been widely used in the teaching process of public health, and have played a key role in training qualified public health talents. Case-based learning is a teaching method that takes students as the center and cases as the basis, in which students are guided to find, analyze and solve problems by presenting case situations, and closely combining theory with practice, so that they can understand theories, form their own views and improve their abilities. In this study, the necessity and importance of case-based learning, the basic strategy for the construction of case database, and the design of typical cases of food toxicology were investigated in combination with the training objectives of public health major and the basic situation of food toxicology course in our university. At the same time, a case-based learning was applied in the course of food toxicology, and it was found that this teaching mode could effectively improve the students' academic performance and teaching satisfaction, and should be of great help to students' ability to obtain information, learn independently and evaluate information, worth popularizing.

**Keywords.** Food toxicology, case-based learning, teaching reform, public health

## 1. Introduction

With the rapid development of economy and the continuous improvement of people's living standards in China, people pay more and more attention to food safety [1]. However, at present, food safety problems are emerging in an endless stream in China, causing a public concern. There are many kinds of harmful substances threatening the food safety, bringing severe challenges to the development of food toxicology work. The 13th Five-Year Plan for National Food and Drug Safety was issued in 2017, clearly pointing out that by 2020, the scope of food safety sampling inspection would cover all food categories and varieties. In the face of the current situation, the public health specialty should pay attention to the education of food toxicology course, so as to cultivate high-quality applied talents who can solve food safety problems for our country.

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Food toxicology is a subject that studies the properties, sources, adverse reactions and possible damage effects and mechanisms of exogenous chemicals in foods, determines the safety limits of these substances and evaluates food safety [2]. From the perspective of toxicology, food toxicology studies the harm of exogenous chemicals that may be contained in foods to the health of consumers, and tests and evaluates the safety or safety range of foods, so as to achieve the purpose of ensuring human health [3]. This paper was aimed to summarize and introduce the case database construction and case-based learning of food toxicology course in public health specialty of our university.

## 2. Necessity and Importance of Case-Based Learning in Food Toxicology Course of Public Health Major

In recent years, public health has become a key construction specialty in the society in China [4]. Especially in recent years, food safety problems are prominent under the pandemic of COVID-19, which makes it a top priority for colleges and universities to do a good job in the education of public health specialty. Food toxicology plays an important role in the course of public health specialty. Generally speaking, the knowledge of public health specialty is boring, and it is difficult for students to learn. Colleges and universities should take some effective measures to improve the effectiveness of the classroom and stimulate students' interest in the learning of public health courses. Case-based teaching method is the golden key to improve the teaching level of public health courses. Through case-based teaching, some representative cases are introduced and analyzed, and at the same time, students should be allowed to conduct the analysis and discussion. In this way, students can provide many constructive opinions and suggestions for their future work through the learning and analysis the cases, which is also considered to be very beneficial to their study. The case-based teaching can effectively promote the teaching of public health specialty to become realistic and practical, and help students better adapt to their future jobs and walk the road of their life.

## 3. Basic Strategies for the Construction of Food Toxicology Case Database

### *3.1. Case Collection and Processing*

Constructing a typical, enlightening and open case database suitable for teaching requirements is an important guarantee for carrying out case-based teaching [5]. At present, there is no unified concept for the definition of case database, and it is widely accepted that case database is interpreted as a collection of cases composed of a variety of cases, including case themselves, editing and maintenance of cases, planning and integration of cases, etc. To construct a case database, firstly, the cases must be collected and sorted out, which is a very difficult and key work as well as an important link to ensure the smooth implementation of case-based teaching; the cases should be collected around one theme as far as possible, with positive and negative cases combined, arranged from multiple angles, reflecting public health thinking, in standardized language, with a clear expression of professional terms and rich contents; the case materials that are closely related to public health and close to the actual life of students should be selected, which require a high degree of simulation and representativeness, give consideration to interest, and fully reflect the key knowledge points, teaching priorities and difficulties of

the teaching contents. Secondly, the in-depth processing and reasonable arrangement of cases should be carried out. The difficulty of cases should not only reflect the key and difficult points of teaching, but also cultivate students' ability to analyze problems. The setting of case-based problems should match the students' knowledge level and analysis ability to meet the teaching needs of students at different levels. General cases can be combined with typical cases, covering simple cases, complex cases and comprehensive cases. The gradient arrangement of cases can be carried out according to simple, difficult, and complex cases, so as to facilitate the targeted selection and use of teachers and students. The main sources of teaching cases include the adaptation of cases in the original textbook, adaptation of real cases on the front line of disease control, adaptation of academic papers and processing of resources from internet. Students can be also mobilized to collect cases through the network since the collection activity itself can fully mobilize students' enthusiasm, promote the cultivation of public health thinking, and help teachers broaden their teaching horizons, design good cases that students are familiar to and recognized by experts, so as to achieve a mutual growth in teaching. By investigating the teachers' and students' requirements for the case-based teaching, and referring to the experience of other colleges and universities, we have held many teaching meetings to discuss the selected cases, and invited peer experts to review, so as to ensure the effectiveness of the case database construction.

### *3.2. Warehousing and Later Maintenance of Cases*

It should be considered in the design and use of cases whether the contents of the cases are properly presented, and whether they can guide students to think independently, find and solve problems, etc. [6]. The designed cases can be applied to teaching for achieving twice the result with half the effort. The cases in the early stage can be WORD document in a static state, and in the later stage, we can cooperate with software companies to develop a case database application management system with interactive interfaces, which can be used with the help of mobile phones, computers and other platforms. The system can be used to design modules such as case introduction, case presentation, case search, case review and case deletion as required, with the functions of online question answering, knowledge link, video playing and so on. The cases can be sorted into the database by developing the case database management system platform, which is convenient for the system management and the use of cases. Due to the complexity and long-term nature of environmental changes, the theory and practice of public health are developing with each passing day, so the maintenance of the case database is an issue to be considered in the construction of the case database, the content of the case database should keep pace with the times, and the valuable cases should be updated and supplemented timely. A dynamic feedback mechanism should establish during the use of the case database, through which the feedback information from both teachers and students can be collected, and experiences for the construction and maintenance of the case database can be accumulated. Teachers should collect, sort out and process public health-related events at ordinary times to make them suitable teaching cases. At the same time, network resource should be mad full use to select new cases, and the resource advantages of smart phones should be given full play in combination with the characteristics of the times. For example, a new way should be designed to attract students' attention through the release of mobile WeChat. The dynamic, novel and scientific nature of the case database should be maintained through continuously

updating and improving it to better serve the case teaching and skill assessment of food toxicology.

## 4. Design of Typical Cases of Food Toxicology

The course of food toxicology is a compulsory course for the secondary discipline of public health in our university, with a total of 16 class hours. The course of food toxicology is a required course for the master of public health in our university, with a total of 16 class hours. The course mainly includes 6 parts: research progress of food toxicology, basic concepts of food toxicology, biotransformation and transport, influencing factors of toxicity, general toxicity and special toxicity. The teaching team has designed the following six cases according to the teaching priorities and difficulties of the above six parts of teaching content.

### *4.1. Sour Soup Poisoning*

On October 5, 2020, a family had a dinner in Jidong County, Jixi City, Heilongjiang Province, causing 9 people to be poisoned by "sour soup". The main symptoms of the patients were general weakness, diarrhea, vomiting and other non-specific symptoms. In severe cases, the patients suffer symptoms of liver, brain and kidney damage, and in emergencies, they suffer from shock and even death. The epidemiological investigation and the sampling detection by the CDC confirmed that this event was a food poisoning event caused by the bongkrekic acid (BA) produced by contaminated by *Pseudomonas cocoanulatus*. Based on the above cases, the following questions are raised: (1) How to confirm whether it is a food poisoning event? (2) What are the pathogenic substances that can cause this food poisoning and what foods may contain them? (3) What is the poisoning mechanism of BA? Through this case, the importance of food toxicology course is emphasized, and the research content, task and significance of food toxicology are introduced.

### *4.2. Clenbuterol Incident*

In 2021, the issue of “Clenbuterol” reported by CCTV 315 evening party attracted much attention. “Clenbuterol” is not a specific substance, but a kind of drugs called β-receptor agonists, commonly referring to clenbuterol hydrochloride, salbutamol, ractopamine, dopamine hydrochloride, etc. The toxicity of clenbuterol hydrochloride is not strong since its median lethal dose ($LD_{50}$) in mice and guinea pigs in intravenous injection is 27.6 mg/kg and 12.6 mg/kg, respectively, but it has a long half-life and slow metabolism in *vivo*, and is very easy to accumulate and remain in the body of animals [7]. Based on the above cases, the following questions are raised: (1) what is clenbuterol? what are the health problems after eating animal meat products fed with clenbuterol? (2) what is acute toxicity? what is the $LD_{50}$ of clenbuterol? (3) what are the indicators for evaluating the acute toxicity of clenbuterol? (4) what is the basis of the acute toxicity of clenbuterol and how to evaluate the acute toxicity? Through this case, knowledge points such as acute toxicity, $LD_{50}$, acute toxicity index and evaluation basis are introduced to increase students’ interest in learning.

### *4.3. Saccharin Sodium Incident*

Saccharin sodium is a commonly used synthetic sweetener in the food industry, with a long application history, but it is also the synthetic sweetener that has caused the most controversy [8]. Saccharin sodium is 300~500 times sweeter than sucrose, and it is not decomposed in the organism and discharged from the body through the kidney. Saccharin sodium is not very toxic, and its carcinogenicity is the main cause of controversy. Saccharin sodium is carcinogenic to animals, but it does not mean that it is carcinogenic to humans too, which is caused by the different metabolism and excretion rates of saccharin sodium in animals and humans. Based on the above cases, the following questions are raised: (1) what are the main factors affecting the pathogenicity of saccharin sodium? (2) why is the safety of saccharin sodium basically affirmed, but consumers are still worried about its toxic effect? (3) how to evaluate the toxicological safety of saccharin sodium correctly? (4) besides saccharin sodium, what other sweeteners do you know? Through this case, it is further explained that the factors affecting the pathogenicity of exogenous chemicals mainly include chemical factors, body factors, species and strain differences, exposure factors, environmental conditions and the combined action of chemicals.

### *4.4. Itai-itai Disease Events*

From 1955 to 1972, the cadmium poisoning occurred in Toyama Prefecture, Japan was caused by people eating cadmium-contaminated rice and drinking cadmium-contaminated water for many years [9]. In fact, itai-itai disease is a typical chronic cadmium poisoning. Based on the above cases, the following questions are raised: (1) what are the causes and main symptoms of pain? (2) what is chronic toxicity? What is the purpose of the chronic toxicity test? (3) how to conduct the study on chronic toxicity? By discussing, analyzing and summarizing the relevant issues of the case, students can master the basic concepts and test purposes of chronic toxic effects, be familiar with the test design principles of chronic toxic effects, and understand the causes and main symptoms of itai-itai disease.

### *4.5. Esophageal Cancer Incident in Lin County*

The "three impasses" (water, road and esophagus) in Lin County, Henan Province, China was reported at the central rural work conference. Premier Zhou Enlai sent experts to the mountainous areas of Lin County to investigate the prevalence and distribution of esophageal cancer [10]. The study demonstrated that the high incidence of esophageal cancer has a great relationship with the local people's eating habits. Local people preferred to eat pickled vegetables that contain a lot of nitrite, and the long-term consumption of them will induce cancer. Based on the above cases, the following questions are raised: (1) what are the main carcinogenic chemicals of esophageal cancer in Lin County, and what is its mechanism of action? (2) what are the main clinical manifestations of nitrite poisoning? (3) through the above event, try to explain the main processes and stages of chemical carcinogenesis. In the process of introducing the case, let the students master the mechanism and process of chemical carcinogenesis, be familiar with the classification of chemical carcinogens, and understand the basic methods of distinguishing chemical carcinogenicity.

### *4.6. Sudan Red Duck Egg Incident*

The "red heart duck eggs" produced by feeding ducks with Sudan red feed were sold in Shijiazhuang, Hebei Province, China. Sudan red was detected in the duck eggs, and the content ranged from 0.041 ppm to 7.18 ppm. It has been found that the mutagenicity of Sudan red is related to the metabolic amines in *vitro* mutagenicity tests and animal carcinogenicity tests. Based on the above cases, the following questions are raised: (1) what is mutagenesis and how many types of chemical mutagenesis are there? (2) briefly explain the mechanism of exogenous chemicals on DNA damage. (3) what are the adverse consequences of mutation? Through the explanation and analysis of the case, students can master the mutagenicity and the types of mutagenicity, be familiar with the mechanism of DNA damage caused by exogenous chemicals, understand the adverse consequences of mutation and other knowledge points, and be able to use them in future practical work.

## 5. Application of Food Toxicology Case Database

Students majoring in public health 2020 and 2021 were selected as the research objects, of which students in 2020 were assigned in the control group and taught by the conventional teaching method, and those in 2021were assigned in the experimental group and taught by case-based learning. At the end of the course, the students' academic performance, teaching satisfaction and learning ability in the two groups were compared. The full score was 100 points for academic performance and learning ability, and the teaching satisfaction was expressed in percentage. SPPSS20.0 software was used to process the data of each evaluation index, and the differences of relevant indexes were compared and analyzed by Chi square test and *t*-test.

### *5.1. Comparison of Learning Achievement and Teaching Satisfaction between the Two Groups*

The results showed that the academic performance and teaching satisfaction of students in the experimental group were higher than those in the control group ($P < 0.05$), suggesting that case-based learning should help to improve their academic performance and teaching satisfaction in the teaching of food toxicology (Table 1).

**Table 1.** Comparison of learning achievement and teaching satisfaction between the two groups.

| Group | No | Academic achivement/point | Teaching satisfaction/% |
|---|---|---|---|
| Control group | 23 | 83.52±9.84 | 78.26 |
| Experimental group | 25 | 92.17±5.60* | 88.00* |

Compared with the control group, $^{*}P < 0.05$.

### *5.2. Comparison of Learning Ability between the Two Groups*

After the implementation of different teaching methods, compared with those in the control group, the experimental group students' abilities of obtaining information, autonomous learning and information evaluation were significantly improved ($P < 0.05$),

indicating that case-based learning is of great significance in improving students' learning ability in the teaching of food toxicology (Table 2).

**Table 2.** Comparison of learning ability between the two groups.

| Group | No | Obtaining information/point | Autonomous learning/point | Information evaluation/point |
|---|---|---|---|---|
| Control group | 23 | 76.65±7.82 | 79.54±8.92 | 82.41±10.22 |
| Experimental group | 25 | 85.07±9.49* | 91.78±7.45* | 90.38±8.16* |

Compared with the control group, $^{*}P < 0.05$.

## 6. Conclusion

Because there is no ready-made model for the construction of food toxicology case database, it is still in the exploration stage, the case resources are limited, and the arrangement quality is not easy to control. The construction of case database is a time-consuming, labor-intensive and money consuming work. The lack of funds for case preparation may restrict the quality of cases to a certain extent. It was found in this study that the application of case-based learning in the teaching of food toxicology course of public health specialty in our university could effectively improve students' learning performance and teaching satisfaction, and greatly help students improve their abilities to obtain information, learn independently and evaluate information, worth popularizing.

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