

Discussion on Cultivating Students' Innovative Ability in Comprehensive Design Experiment

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Abstract: In order to further improve the students' innovative and practical abilities, this paper takes the comprehensive design experiment of '*Storage and processing of fruits and vegetables*' as an example, discusses the design, implementation and result evaluation of the comprehensive design experiment. The result shows that the comprehensive design experiment improves the students' ability of experimental design, experimental operation and technological innovation, and lays a foundation for the cultivation of applied research talents.

1. Introduction

Experimental teaching is an important part of the teaching system of higher education which is conducive to students' innovation consciousness, operational ability, analysis and problem-solving ability. It is an important way to full implement of quality education [1-3]. Comprehensive design experiment refers to the experimental content involving multiple knowledge of the course or knowledge related to it of other courses. The teacher guides the students to design the experimental plan and implement it according to the experimental purpose and experimental conditions, which can improve the practical operation ability and innovative ability of the university students [4-5].

The major of food science and engineering is the pilot project of *china's* 'excellent agricultural and forestry talents' top-notch innovative talent training. '*Storage and processing of fruits and vegetables*' is the core curriculum of this specialty. Since 2014, our school had reformed and integrated the experimental content of this course into a new comprehensive design. In the experiment, the students designed and experimented on their own under the guidance of the teacher and received good results.

2 Comprehensive design experiment is an important way to improve students' innovative ability

Carrying out comprehensive design experiment is an important way to cultivate innovative ability. The biggest difference between it and traditional verification experiments is that it is student-oriented, teacher-aided, and realizes the organic combination of multiple single experiments, which is more conducive to the solution of practical problems [6-8]. Improving students' innovative ability in the following aspects:

Comprehensive design experiment is a new experimental teaching method developed. Through design and operation experiments, students' curiosity and thirst for knowledge can be stimulated, which plays a key role in education and personnel training.

In the comprehensive design experiment, students complete their tasks by the process of consulting documents, designing experiments, operation and implementation, etc. In addition to consolidate old knowledge by analyzing phenomena and experimental data, the students' comprehensive ability to collect and process documents, as well as to analyze and solve problems has been improved.

Teachers and students formed a lot of research-development and teaching ideas in the process of comprehensive design experiment to reflect the theory through reality, while the failures and

setbacks can exercise the willpower of students.

3. Organization design of comprehensive design experiment of '*storage and processing of fruits and vegetables*'

3.1 Selection of comprehensive design experiment time

'*Storage and processing of fruits and vegetables*' requires students to master the relevant basic and experimental skills in *food chemistry*, *food microbiology*, *food nutrition* and *food analysis* [9-10]. Therefore, in the third-grade semester of the university, the middle-to-bake period of the theoretical teaching of '*Storage and processing of fruits and vegetables*', and the comprehensive design experiment was carried out from the 5th to the 24th class hour of the experimental teaching.

3.2 Selection of comprehensive design experiment content

'*Storage and processing of fruits and vegetables*' is divided into two parts: storage of fruits and vegetables, and processing of fruits and vegetables. In the storage of fruits and vegetables, students are required to master the knowledge of storage of fruits and vegetables, nutrient composition analysis and commercial processing; in the processing of fruits and vegetables, students are required to master the processing technology of fruit and vegetable products, such as cans, juices of fruit and vegetable, preserved fruit, and pickles. Comprehensive design experiment involves multiple knowledge points, and it is important to integrate the entire discipline or interdisciplinary knowledge into a single experimental program. In order to cope with the discipline and highlight the design features, the design should follow the following principles.

(1) The theory involved in the experiment has a certain correlation within the discipline of '*Storage and processing of fruits and vegetables*' or between disciplines.

(2) The experimental design should reflect the comprehensiveness, diversity and applicability of raw materials, equipment and means.

(3) The design of the product and the process should be adapted to the needs of the market.

Therefore, in the '*Storage and processing of fruits and vegetables*' experimental course, a comprehensive design experiment was arranged, that is, '*Evaluation method of nutritional composition based on different product characteristics of fruits and vegetables*' (4 class hours), '*Development of a degradable preservation film and evaluation of its preservation effect*' (8 class hours), '*Developing a new product based on nutritional characteristics of fruits and vegetables (results of experiment 1)*' (4 class hours), '*Comprehensive utilization of fruit and vegetable skin residue (triads of experiment 3)*' (4 class hours), four designs throughout the course content of '*Storage and processing of fruits and vegetables*', the interlocking and innovative topics can effectively mobilize students' enthusiasm and initiative, and train students' ability to analyze and solve problems, and then cultivate students' innovative ability.

4. The implementation process of comprehensive design experiment

4.1 Design and validation of experimental schemes

Inform students in advance of the topic of comprehensive design experiment, on the basis of the basic theory, the students consult relevant documents to determine the scheme and discuss the design of the experiment in groups. The requirements are to write the experimental principle, experimental materials and equipment, technical routes, operating points clearly, the design should be detailed and actionable, and the possible problems and precautionary measures in the experiment process should also be pointed out.

After the design is completed, the best design is selected by mutual-evaluation among groups according to the experimental design criteria (*Table 1*), teachers suggest modifications and optimizations to the selected schemes. After revision, the teachers will validate the schemes. A scheme designed by the students with their own efforts, the teacher should not only give advice but also acknowledge them. In the experiment of '*Developing a new product based on nutritional*

characteristics of fruits and vegetables', the best group design should be selected, and orthogonal experimental scheme needs to be introduced through optimization design, and all groups should be involved in product design and experimentation by assigning them properly. Through inter-group cooperation, students can complete the whole orthogonal experiment in a short period of time, and further strengthen the theoretical knowledge of orthogonal data analysis in the experimental report.

Table 1 Experimental design gauge

NO.	Items	A (10')	B (9')	C (8')	D (6')	E (5')
		Outstanding	Excellent	Good	Fair	Poor
1	Does the design provide sufficient background, principles, and all relevant references?					
2	Is the research design appropriate					
3	Are the experimental methods fully described and operable?					
4	Predict the problems that may be encountered during the experimental process. Are there preventive or coping measures?					
5	Is the design novel or practical?					
6	Is the format standardized?					
7	Does the exhibitor have clear logic and verbal ability when the design document is displayed?					
8	Is the sound loud and proper body language when the design document is displayed?					
9	Do you have a spirit of cooperation in the design process?					
10	Are you persistent and hard-working during the design process?					
11	Total Score					

4.2 Implementation and analysis of comprehensive design experiment

According to the design of the experiment, students should divide into groups and divide the work reasonably, discuss with each other if there are difficulties in the process of implementation, and record the process of the experiment at the same time. In the process of implementation, teachers should answer the questions that raised by the students at any time, deal with some prominent problems in the experiment in time to ensure the progress of the experiment is proceeding smoothly. For example, in the experiment of '*Development of a degradable preservation film and evaluation of its preservation effect*', students design moisture changes measured by an efficient infrared moisture meter, but the students don't understand the principle and the way to use it, so teachers should give them proper explanation and help.

4.3 Writing of the report of comprehensive design experiment

The report of comprehensive design experiment includes experimental principles, experimental materials and equipment, technical routes, operating procedures, experimental results and analysis, problems encountered in the experiment and solutions, experimental insights and references, etc. The report of experiments does not require the students to draw a fixed conclusion, but a process to train the students' thinking and condense their scientific research language. The whole writing process is beneficial to the writing of scientific papers and lays the foundation for scientific research and production practice.

In the experiment, students were asked to take three photos, recording the three moments that students consider most important, most memorable, and most rewarding to themselves, these will be attached to the experimental report as a supplementary material for the experimental perception. This practice arouses the enthusiasm of the students and improves their ability to find problems and solve problems.

4.4 Assessment of the grade of comprehensive design experiment

In the comprehensive design experiment, teachers should observe the performance of each student at any time, in order to guarantee the scientific, fair and impartial evaluation of each student's experimental result during the whole experiment. To adopt the comprehensive scoring system, the total score of the experiment is 30%, the experimental scheme is 30%, the experimental operation is 40%, the experimental report is 30%.

5. The effects of comprehensive design experiment

In the past four years, the comprehensive design experiment of '*Storage and processing of fruits and vegetables*' has been set up, the contents of the experiment are constantly updated, the process of organization and implementation is constantly improved. The students' innovation consciousness and innovative ability are generally improved, and the practical operation ability is also greatly enhanced, which shows good reform effect. Through comprehensive design experiment, teachers have better understanding of the content of innovative talents training scheme and improved the quality of experimental teaching.

Mobilizing the enthusiasm of students. Through the topic of '*Developing a new product based on nutritional characteristics of fruits and vegetables*', the students will propose many novel designs with practical and personal hobbies.

Improving the ability of comprehensive induction, analysis and problem-solving. In the process of designing '*Development of a degradable preservation film and evaluation of its preservation effect*', students should consult a large number of references to understand the film formation mechanism and the criteria for preservation evaluation, and then rational design and analysis experiments.

Improving students' practical ability and innovative ability. The novel topics such as the '*Comprehensive utilization of fruit and vegetable skin residue*' and the enriched experimental process can mobilize the enthusiasm of students, improve their innovative abilities and environmental awareness, and cultivate their practical ability to contribute to environmental protection.

Cultivating students' ability to work together. The students completed the entire design and operation of the comprehensive experiment within the prescribed time, rationally arranged the reagent preparation, raw material processing, product production, index measurement and other processes, and carried forward the teamwork of students to learn from each other and complement each other.

Enhancing teachers' capacity of teaching and scientific research. The comprehensive design experiment have high requirements on teachers' quality, promotes teachers' continuous learning, understands the subject frontier, improves their professional level, and connects scientific research with teaching to achieve improving between teaching and learning.

6. Conclusion

The development of comprehensive design experiment is a direction of experimental teaching reform. Its application in the experimental teaching of '*storage and processing of fruits and vegetables*' subverts the traditional 'teachers-oriented' and embodies 'students-oriented' and cultivates students' innovative thinking ability, research interest and scientific research enthusiasm, improve students' experimental level and ability to solve practical problems.

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