

The Reform and Practice of the “Cell Engineering” Course based on the Cultivation of Critical Thinking Skills¹

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Abstract: The cultivation of critical thinking ability is an important part of the education and teaching reform in colleges and universities. Students with critical thinking ability can not only solve practical problems and better adapt to the society, but also cultivate the spirit of innovation. This paper introduced in detail an effective practical process of curriculum reform in the Cell Engineering course. The process included confirming the teaching objectives, proposing teaching reform issues, reconstructing teaching content, strengthening the direction of course reform and improving course evaluation methods. Through curriculum reform of Cell Engineering course, students could gradually develop critical thinking skills to meet the needs of the current society, so as to realize the comprehensive development and improvement of applied talents' abilities.

Keywords: Critical thinking skills; Curriculum reform; Cell Engineering

Introduction

When reforming the content of Cell Engineering, teachers need to increase critical thinking in the teaching process, and students can make reasonable use of critical thinking on the basis of the corresponding course knowledge, and effectively strengthen the learning effect of knowledge with the practical improvement of this thinking ability.

1. Optimize the teaching objectives and contents of the course

The training objectives of cultivating students' critical, creative and independent thinking ability are introduced into the curriculum, and the conditions for students to develop critical thinking is created in the classroom teaching. Looking for the combination of critical thinking training and course teaching objectives, combined with the specific course teaching content, actively explore the ways and methods to cultivate students' critical thinking ability.

1.1 Respecting the principal position of students: Group Teaching

The critical thinking pays more attention to the participation of students and requires the student to be independent, skeptical and open in thinking. Based on that, group teaching is achieved in class. The class is divided into groups according to the basic situation and characters of students who master the basic knowledge and theory, in order to realizing the organic combination of theory and practice. Teachers assign cases such as "Would you accept an organ transplant?", "Do you know the real life of experimental animals in animal experiments?", "Is GM is really safe? ", "What are the advantages and disadvantages of COVID-19 to human beings?", etc. Students express their views after the group discussion, to cultivate their critical thinking ability. Group teaching seems simple, but in fact it is more difficult to control than ordinary classroom teaching. It emphasizes individual responsibility and group cooperation, at the same time, the collision of ideas among the same group and between different groups can cultivate critical thinking and finally are internalized into their own consciousness.

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1.2 The definition of curriculum objectives and the determination of teaching content

Based on the concept of critical thinking ability training, the current curriculum reform of Cell Engineering intends to shift from the traditional teaching mode focused on the basic knowledge to the competence-based teaching model which improves the active initiative and the ability of combining theory with practice, independent thinking, problem exploration, innovative thinking. Based on the various, scattered content of current Cell Engineering course, the content is divided into three parts: intensive lecture, brief lecture and students' self-directed learning part, combination with the training objectives of the course. The contents closely related to the current hot spots and widely used will be intensively explained, including the concept, principle and application part. The brief part is the content that is easy to understand and master, including the materials, steps and methods of various technologies. The parts not mentioned are the ones that are not related to the hot spots, the industrialization or the popularization and application are complete, and mainly involve the content of plant cell culture and plant tissue engineering.

2. Explore new teaching methods to improve students' logical literacy

We should reform the teaching methods of the course, actively explore various teaching methods such as inspiration, scene, debate, discussion and collaboration, and guide students to form a two-way or even multi-directional ideological collision and exchange and interaction process between teachers and students. In the teaching of Cell Engineering, Case Teaching method, Simulated Scene Training method and Actual Combat Exercise method are the most effective methods.

In the process of Case Teaching, teachers choose appropriate case according to the teaching objectives and contents. Students can actively participate in the class, stimulate their interest of the course, and perform critical thinking and evaluation with rigorous logical reasoning ability. In the process of Case Teaching, students could try to discover, understand and master theories by collecting and analyzing relevant information and putting forward hypotheses on various problems in cases. The step of Case Teaching is to introduce multiple knowledge points through interesting or real-life cases, followed by the purposeful training of knowledge points, the evaluation of different opinions, the synthesis of the same conclusion. The process of critical thinking not only provides students with a unique learning atmosphere to analyze and solve problems, but also helps them understand the rules of reasoning and argumentation deeply, stimulates their questioning spirit and improves their argumentation ability.

The Simulated Scene Training mainly focuses on the students to carry out scene simulation exercises in the classroom, reproduce the real scene, so that students can deepen their understanding and comprehension of knowledge in the role playing. In the process, the teacher uses the textbook theory to set the scene to guide and summarize in time, so that the students can master the theory, internalize the behavior and improve their quality.

Actual Combat Exercise Teaching is also a very effective teaching method, which could greatly increase students' interest in learning. Actual Combat Exercise Teaching consists of two parts: a special report and the debate. The special report requires students to consult the literature, write the outline of the report, and complete the design, modification and practice of the subject by thinking deeply about the cutting-edge or/and controversial course characteristics in the field of Cell Engineering. After the above training, students could understand knowledge better by repeatedly "comparison-screening-prediction-reflection" on various situations in scientific research practice, improve their "judgment-regulation-feedback-critical thinking" level, and effectively cultivate students' ability of think independently and solve problems form the habit of lifelong learning. Debate is an important way to train critical thinking, which can be used in preparation, process and later stage of the debate. The following

Table 1 Critical thinking skills correspond to specific indicators in the debate session

skills	Specific indicators
interpretation	Able to clarify the theme, clearly express the information and different views, find the main problems, categorize the information, and summarize the idea in your own language.
Analysis	Able to identify evidence, identify reasons for problems, identify relationships between statements, concepts, judgments, and opinions, and distinguish statements that are not relevant to the subject.
evaluation	Ability to question evidence, evaluate evidence and ideas, express ideas clearly and accurately, and use relevant evidence to support ideas.
reasoning	Able to put forward alternative hypotheses, carry out logical reasoning, find solutions to problems and draw conclusions based on the reasons obtained from analysis, and explain with breadth and breadth
Self-reflection	Ability of self-reflection, self-assessment, self-correction

table 1 shows the critical thinking skills corresponding to specific indicators in the debate session. Debate enables students to engage in a wide range of activities and actively think. In the construction, analysis and discussion of arguments and argumentation methods, students can exercise their thinking skills and cultivate the quality of critical thinking.

3. Reform the teaching evaluation method to evaluate students' thinking ability

The cultivation of critical thinking ability should be incorporated into the curriculum evaluation system. According to the course content, more diversified assessment methods will be developed to encourage students to think and express freely, independently and critically. At present, the achievement accounting system of Cell Engineering is mainly evaluated by final examination result. The disadvantages of this evaluation mode are that many students ignore the accumulated knowledge day by day and just recite each knowledge point before the exam. But short-term memory quickly is forgotten after exam, so the actual ability of students has not been improved. Therefore, the key of course examination mode is to shift from the original knowledge examination to a competency-based assessment. As an important part, the usual score includes attendance, class performance, teamwork, group discussion, etc. The proportion of usual score will be increased to 40% of the total grade in order to encourage students to improve the ability of logical thinking, deductive reasoning and critical thinking. The final examination focuses on debate and special report, which mainly includes literature review, outline writing, PPT presentation, explanation, on-site debate, etc. It mainly tests students' critical thinking abilities of analysis, synthesis, reasoning and argumentation. The cultivation of critical thinking can be divided into the following three stages (table 2).

Table 2 The implementation steps of critical thinking cultivation

	Phase	The goal of critical thinking	The teaching content	The teaching method	The assessment content	Teachers' activities	Student activities	Note
1	early stage	Guide students to establish a thoughtful thinking attitude, especially a rational attitude of doubt and reflection	Basic concepts, theory and application of plant cell engineering and animal cell engineering	Teaching, inspiration, situational, case teaching method	Attendance, class performance	Through the case teaching, students actively participate in the learning process, stimulate interest.	Students can think and evaluate critically under the strict logical thinking and inference ability.	To arrange courses reasonably according to the characteristics of students in different stages. Focus on cultivating different thinking qualities in each stage and building up students' confidence in self-development and application of critical thinking.
2	elementary stage	Help students to develop thinking qualities such as clarity, relevance, consistency, legitimacy and foresight	Introduction and application of typical cases in each chapter of plant cell engineering and animal cell engineering	Teaching, inspiration, discussion, collaboration, simulated scene training method	Attendance, class performance	Through inspiration and guidance, students can master the theory, internalize the behavior and improve their quality	Students perform scene simulation exercises in class, reproduce the real scene, and deepen the comprehension of knowledge in the role playing.	
3	core stage	Students master the techniques and methods of critical thinking, apply flexibly in practice, and finally cultivate the personality with critical thinking	The key contents of each chapter are related and integrated	Inspiration, scenario, discussion, collaboration, debate, reporting, actual combat exercise method	Debate performance, special presentation, group discussions	Build a democratic and harmonious relationship between teachers and students, students participate in a wide range of active thinking, exercise thinking skills and cultivate critical thinking quality in the construction, analysis and discussion of arguments and argumentative methods.	Students are encouraged to develop the habit of lifelong learning. Students use critical thinking to digest knowledge, cultivate ability to think independently and solve problems, and realize the reconstruction, internalization and transfer of knowledge.	

To conclude, teachers in higher education should combine critical thinking with the innovation of the content of Cell Engineering, so that students can learn more knowledge of a practical nature, and the new mode of thinking will enhance students' critical thinking skills and improve the application of their knowledge structure when reform practice of the course content was carried out in the classroom.

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