

# *Innovative Teaching Practice and Exploration of Genetic Engineering Experiment*

**Mustafa Neamah Jebur**

*Amaster College, USA*

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**Abstract:** Genetic engineering is a key scientific and technological project in China and an important branch of bioengineering. In order to cultivate the post professional ability of genetic engineering students, realize zero docking with posts, the genetic engineering comprehensive training uses the task as the clue to determine the teaching content, the product production process as the carrier to design the teaching process, the vocational ability as the basis to reform the teaching method, and the development evaluation as the means to strengthen the skill formation. Practice has proved that the “genetic engineering comprehensive training” teaching reform is conducive to cultivating students' practical ability and practical innovation ability, and is conducive to promoting education with professional competence as the core.

## **1. Introduction**

Genetic engineering technology is a highly practical discipline based on genetics. It plays an important role in exploring the essence of life and promoting the development of the entire biology department. Genetic engineering experiment teaching is an important part of molecular biology experimental technology. It is the best way for students to master basic molecular biology techniques, to cultivate the ability to combine theory and practice, and to improve scientific thinking ability and independent operation ability. At present, genetic engineering experiments are widely carried out in the biological professions of colleges and universities, and they have long experimental periods, strong comprehensiveness, and are characterized by complex content and research methods. Therefore, stimulating students' interest in learning and cultivating students' scientific thinking, innovation and practical ability are the directions that genetic engineering experimental teaching needs to continuously strive and explore. Scientific research can promote teachers to keep track of the development frontier of professional disciplines, grasp the latest trends in the development of professional fields, enrich the teaching content of classroom teaching, and achieve professional teaching with the times.

## 2. Problems in the Teaching of Genetic Engineering Experiment

1) The experimental teaching content is outdated. In the traditional experimental course, the verification experiment is the majority, and the comprehensive and research experiments are few. In this teaching mode, the students only need to simply operate and observe. Therefore, in the absence of the purpose and requirements of the experiment, it is difficult for students to learn the necessary knowledge in the experiment, and it is impossible to correctly analyze the experimental results or the reasons for the failure of the experiment. Under this circumstance, it is difficult to mobilize students' enthusiasm for learning, and it is more difficult to cultivate students' innovative ability, which is not conducive to the cultivation of students' comprehensive quality.

2) The experimental teaching method is monotonous. Because traditional experimental courses generally have short and scattered shortcomings, the instructors may save the teaching time and avoid the waste of reagents when the students operate the experiment. Therefore, the teacher prepares the equipment required for the experiment before class and configures the reagents required for the experiment. In the experimental class, the teacher is taught and demonstrated, and the students are merely imitating. This traditional teaching mode is difficult to stimulate the enthusiasm and initiative of students, which restricts the cultivation of high-quality talents.

3) Theoretical teaching is out of touch with experimental teaching. Genetic engineering teaching includes two aspects: one is theoretical teaching and the other is experimental teaching. Experimental teaching is an effective way to train students to use theory, methods and means to discover, study and solve problems. It is an effective way to cultivate talents with practical ability and innovative spirit. However, in the traditional teaching process, teachers have always followed the traditional teaching mode of "first theory, post-experiment", and supplemented experimental teaching as theoretical teaching, which led to the idea of "Pay attention to theory and despise experiment" and made the real function of experimental teaching. It has not been fully exerted, lost the significance of experimental teaching, and to a certain extent restricted the in-depth study of experimental teaching reform.

4) The assessment method is unreasonable. Most of the contents of the genetic engineering experimental exam include after-school thinking questions, experimental principles, or just giving experimental results based on experimental reports. It can be seen that there is a certain randomness in the evaluation of the scores of the experimental courses, which leads to the students' enthusiasm for learning to a certain extent, and is passive in the experiment process.

## 3. Design Principles of Genetic Engineering Practice Teaching

The quality of genetic engineering practice teaching is related to whether students can master the practical skills of genetic engineering. It is the key to solving practical problems by using genetic engineering principles. It is related to the cultivation of professional quality and innovation ability of bioengineering students. Therefore, genetic engineering practice teaching should adhere to the principle that "focus on the comprehensiveness of experimental content and the practical operability of internship content, pay attention to the use of advanced practical teaching methods of multimedia and live video, and focus on the second classroom practical teaching based on teachers' scientific research topics", building a basic comprehensive experiment - professional internship in the school - research and innovation experiment "three levels" practical teaching system.

1) Focus on the comprehensiveness and design of the experimental content. In the experimental class, the verification experiment is gradually reduced, and the comprehensive and design experiment content is increased. At the same time, we insist on the combination of the basic skills in

the class and the opening of the extra-curricular laboratory (open time, open reagent preparation, open instruments and equipment, open pre-experiment), and carry out basic skills training for students to understand and master genetic engineering's basic principles, research, methods, techniques, and skills. It also provides solid basic experimental skills for subsequent courses in cell engineering, enzymatic engineering, fermentation engineering, biochemical engineering, and biotechnology pharmaceuticals.

2) Pay attention to the cultivation of students' innovation and scientific research ability. Focus on the "research style" and "full-course tutor system" training mode of the college, and adhere to the combination of comprehensive experimental and extra-curricular innovative experimental projects (open time, equipment and reagents). This is to cultivate students' comprehensive quality, innovation and scientific research ability, and emphasize the ability to guide, expand and construct the thinking process. With the teacher's topic as the "designed experimental system", the students choose the teacher's subject or the student applies for the school's innovative education fund project, so that the student can undertake a sub-topic of the teacher, complete the literature study, write the review, open the report, experimental design, experimental operation, experimental papers, etc. Through the interactive academic discussion and research of teachers and students, students are guided to study and promote learning. Through independent experimental design and practice, students develop the ability to analyze and solve problems and practical skills. At the same time, students' innovative thinking and interest and hobbies in life science exploration are cultivated, and the requirements of training objectives are realized, so as to cultivate students' innovative spirit and scientific research ability, and the development of knowledge structure and practical ability becomes more reasonable.

#### **4. Method of Innovative Teaching Reform in Genetic Engineering Experiment**

1) Lay a good foundation and cultivate innovative quality. The characteristics of college students are curiosity, active thinking, and even "whimsical", but the experimental skills training is relatively lacking. Therefore, before carrying out innovative experiments, students must be trained in good basic skills. For some basic verification experiments, students should practice repeatedly, not only master the method, but also should deeply understand the principles of genetic engineering, and carry out innovative experiments under the background of solid foundation. All of our teachers' research projects are closely linked to the students' innovative experiments, and the guidance and supervision of the instructors are intensified. Undergraduates can enter the research group they are interested in to carry out innovative experiments. At the same time, combined with postgraduate education, graduate students guide the innovative experiments of undergraduates in the course of experiments, which greatly improves the supervision and guidance of innovative experiments. It will enable students to have more opportunities for study and practice, and is conducive to the cultivation of students' scientific research quality and innovative ability, so that the laboratory truly becomes a base for cultivating high-quality innovative talents.

2) Be good at reading the literature and cultivating the ability to extract ideas. A qualified scientific researcher must know how to use the wisdom of his predecessors and learn how to master the most cutting-edge technology of the subject. This requires cultivating students to read the literature, collect, organize and analyze the literature, draw on the experience of the predecessors from the literature, and obtain the most cutting-edge technology. The teacher should instruct students how to read the foreign literature. Before the genetic engineering innovative experiment, ask the students to read a large number of relevant documents of the world's top magazines,

encourage students to listen to academic reports, communicate with teachers, and learn from them. Don't be anxious to seek success. The analysis of the literature is a logical thinking process, and it is also a process of enriching and perfecting the knowledge system. By reading a large amount of analytical data, you can accurately locate the direction and location of your innovative topics. According to their own ideas, determine the direction and route of innovative experiments. Students have to sort out the specific implementation steps of the experiment.

3) Develop the ability to solve problems and overcome difficulties. We pay special attention to cultivating students' ability to find problems, solve problems, and correctly treat difficulties and setbacks. When students encounter difficulties in the experiment, the instructor should be good at discovering the psychological changes of the students and give correct guidance and encouragement. Not only the training of students' experimental skills, but also the attitude of students to deal with difficulties and frustrations correctly. Help them analyze the gains and losses in experimental design and specific operations, and temper their tenacious will in repeated failures and successes. Let them really get the ability to solve problems through innovative experiments.

4) Cultivating students' team spirit is a symbol of collective unity, a manifestation of comprehensive strength, and the basis for major scientific research projects. This is also the basis for the forthcoming research work. Therefore, it is very important to cultivate students' sense of collaboration. In the process of genetic engineering innovation experiment, from the experimental design to the analysis of the results of the whole experiment, students should work closely together, rationally divide the work, and discuss together, the students really realize the importance of cooperation. The team members should focus on the overall situation. When doing experiments, they should not only think of themselves, but also work together. Through the development of innovative experiments, the teamwork spirit of students has been well cultivated.

5) In response to the characteristics of genetic engineering experiments, such as more content and strong continuity, the syllabus was re-established, and the amount of class was appropriately increased. The original small experiment was changed into a comprehensive large experiment. The experiment is scheduled to be completed on weekends or in an independent one to two weeks, and the validation and demonstration experiments are removed and replaced with autonomous and innovative experiments, which not only enhances students' enthusiasm for the course, but also helps to improve students' ability of independent innovation.

6) In order to train students' scientific thinking and awareness, students have the ability to design experiments and change the curriculum to open teaching. The teacher only explains the big framework of the experiment, the experimental goal, etc., so that the students can write the experimental plan in groups and the experiment can be started by the instructor. This not only cultivates students' self-learning ability, strengthens students' ability to access biological literature, but also helps students to fully exert their subjective initiative and innovative thinking. In the process of experimenting, students are required to pay attention to every detail operation, avoid cross-contamination, and the instructor patrols and instructs students to operate. Encounter individual problems, give separate guidance to the problem, truly teach students in accordance with their aptitude, and ask students to do a good job of experimental records, and analyze and explain the experimental results in order to cultivate students' rigorous scientific research attitude.

## **5. Evaluation Model for Innovative Teaching of Genetic Engineering Experiment**

The experimental teaching of genetic engineering can cultivate students' post professional ability, realize zero docking with post, cultivate students' practical ability and practical innovation ability,

and promote the education with professional ability as the core. Due to the different abilities of students, the teaching effect is also different. In order to understand the teaching effect of students, this paper uses the fuzzy comprehensive evaluation method to evaluate the teaching effect. In this paper, the genetic engineering experiment teaching evaluation is connected with the fuzzy comprehensive evaluation model, the weight set C of evaluation factors was determined as follows:

$$\sum_{i=1}^k c = 1, c = \sum_{j=1}^{n_i} c_{in_i} \tag{1}$$

The fuzzy relation matrix R between evaluation indexes and comments is established, the matrix is as follows:

$$R = \begin{bmatrix} r_{11} & r_{12} & \bullet & r_{1p} \\ r_{21} & r_{22} & \bullet & r_{2p} \\ \bullet & \bullet & \bullet & \bullet \\ r_{q1} & r_{q2} & \bullet & r_{qp} \end{bmatrix} \tag{2}$$

According to the scenario index weight C and the relationship matrix R, the final evaluation value B can be calculated, as shown in the formula:

$$B = C * R = C * \begin{bmatrix} r_{11} & r_{12} & \bullet & r_{1p} \\ r_{21} & r_{22} & \bullet & r_{2p} \\ \bullet & \bullet & \bullet & \bullet \\ r_{q1} & r_{q2} & \bullet & r_{qp} \end{bmatrix} = (b_1, b_2, \bullet, b_p) \tag{3}$$

The final evaluation value is the evaluation grade of teaching effect.

## 6. Research and Analysis on Innovative Teaching of Genetic Engineering Experiment

### 1) Analysis of problems in genetic engineering experiment teaching

Genetic engineering experiment is widely carried out in biological specialty in Colleges and universities, with long experimental cycle, strong comprehensiveness, complex experimental content and research methods, and some problems in experimental teaching. In order to understand the problems of genetic engineering experiment teaching, this paper uses the form of questionnaire survey, through the questionnaire analysis of genetic engineering experiment teaching problems, to understand the specific teaching problems. The results of the questionnaire are shown in Figure 1.

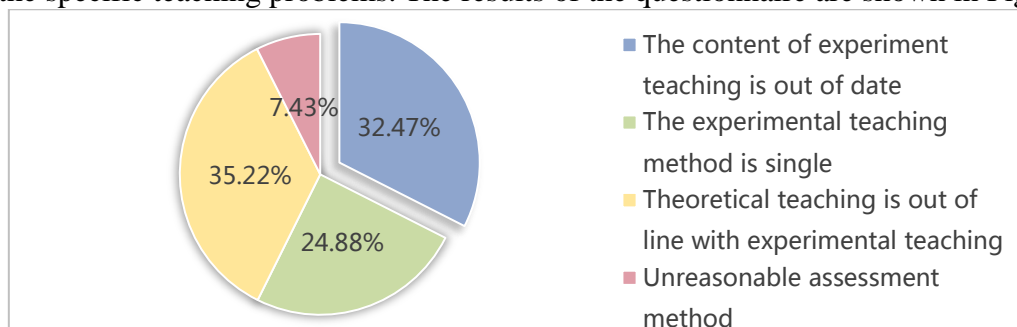


Figure 1. Analysis of problems in genetic engineering experiment teaching

As can be seen from Figure 1, among the problems of genetic engineering experiment teaching, 35.22% of the students think that the theoretical teaching is divorced from the experimental teaching, 32.47% think that the experimental teaching content is old, 24.88% think that the experimental teaching method is single, and 7.43% think that the examination method is unreasonable.

2) Feedback analysis of teaching evaluation model results

There is a certain degree of randomness in the evaluation of experimental results, which leads to students' learning enthusiasm to a certain extent and is passive in the process of experiment. The results of traditional experimental courses only focus on the experimental results, not on the process. Due to the different abilities of students, the teaching effect is also different, and the teaching evaluation model considers more and its evaluation is more objective. In this paper, a class of 50 people as the experimental object, using the traditional scoring model and teaching evaluation results model two models for performance evaluation, the data results are shown in Table 1.

Table 1. Analysis of traditional scoring model and teaching evaluation model

	excellent	good	pass	fail
Traditional scoring evaluation	17	18	12	3
Teaching model evaluation	22	16	11	1

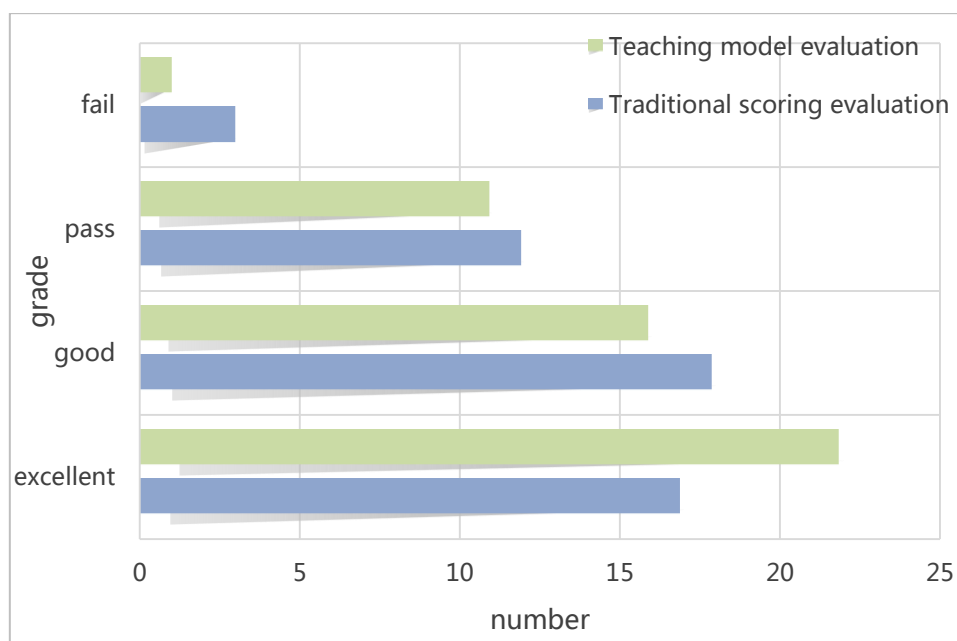


Figure 2. Analysis of traditional scoring model and teaching evaluation model

It can be seen from Figure 2 that after adopting the teaching evaluation result model, students' performance has a qualitative leap, the number of failed students has decreased, and the number of excellent students has increased. The teaching evaluation model can more comprehensively take care of students' teaching achievements and improve students' interest in learning.



## 7. Summary

In the practical teaching system with the purpose of innovative talent training, students have been well trained in the quality of scientific research in the implementation of innovative experiments in genetic engineering. However, these real problems are also faced. Due to the different abilities of students, the teaching effects are different. Students with strong interests and solid basic knowledge actively solve problems in innovative experiments, and their abilities have been improved. However, because genetic engineering is an emerging discipline, it is technically difficult, and some students' basic knowledge is not solid, in the course of the experiment, after the failure, their interest losses, and finally abandon it. For such students, we must find out in time and give timely help. In a word, innovative experimental teaching is an important aspect of teaching reform. The development of genetic engineering innovation experiment not only solidates the students' theoretical knowledge, but also cultivates students' innovative ability, scientific thinking habits, rigorous work style, and improves the overall quality. It improves the teaching level and contributes to increasing students' competitiveness.

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## Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

## Conflict of Interest

The author states that this article has no conflict of interest.

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