

Research on Teaching Reform of *Industrial Catalysis* Course Based on Ability Training

Ranran Chu^{a,1}, Hui Wang^{a,1,*}, Xinxin Wang¹, Li Han¹, Weijuan Gong¹

¹*School of Chemistry and Biological Engineering, Qilu Institute of Technology, Jinan, 250200, P. R. China.*

^a*These authors contributed equally to this work.*

^{*}*Corresponding author. Email: 924334478@qq.com*

ABSTRACT

Industrial Catalysis is a discipline based on the intersection of science and engineering, which is of great significance for cultivating the practical innovation ability of the students. According to the actual teaching experience, in this paper, the present situation and problems of the *Industrial Catalysis* course are summarized. The participatory teaching methods are developed to give full play to the teachers' leading role and the students' subjectivity. The classroom education is combined with the curriculum ideological and political education to cultivate the independent thinking ability of the students. Online teaching and Offline teaching are combined to improve the quality of learning content and diversify learning methods. Process evaluation and the promotion role of evaluation should be emphasized to explore the training mode of applied talents.

Keywords: *Industrial Catalysis, Participatory Teaching, Online and Offline teaching, Process Evaluation*

1. INTRODUCTION

In the era of knowledge economy, cultivating innovative talents and promoting quality-oriented education are effective ways to realize sustainable economic and social development. There are many intersections between chemical engineering and other disciplines, forming a number of cross-disciplines, such as biological chemistry, energy chemistry, material chemistry and environmental chemistry. The job types of chemical engineering graduates are diversified, and their employment is scattered. They have higher requirements on students' knowledge reserve and comprehensive ability. The knowledge content of chemical engineering subject needs to be expanded to adapt to the development of economy and science and technology in the new era.

Industrial Catalysis is an elective course for chemical engineering and technology majors, as well as an important basic course for chemical engineering majors to engage in process management and product process research and development in the future. As an applied frontier subject, *Industrial Catalysis* involves new knowledge and new methods across multiple disciplines. It is a "high threshold" course with rich content, multiple concepts and theories, and abstract and difficult micro-action principles. The teaching process requires teachers and students to work together.

2. PROBLEMS IN THE CURRENT INDUSTRIAL CATALYSIS TEACHING

The current teaching mode of *Industrial Catalysis* usually relies on classical textbooks, which are mainly taught by teachers in class and passively accepted by students to complete the teaching of given class hours. Such a fast-moving "cramming" teaching process is easy to lead to teachers' read-by-book teaching, which makes students unable to timely understand and digest the contents. Students are easy to lose interest in learning, resulting in the embarrassing situation that teachers are difficult to teach, students are afraid of learning, and teaching results are not ideal.

In addition, multimedia teaching method is applied, but the content is still based on textbook content, more text materials, less vivid animation, less theory and practice, can not improve students' interest in learning.

The current examination system also has many disadvantages, single examination method, more theory exam, little practical ability investigation, one examination makes conclusions, and less comprehensive evaluation at ordinary times assessment. The examination system did not reflect the appraisal of students learning process, making the

memory become the examination of the basic elements of success. This causes the phenomenon of “usually loose, tight before the exam, and forget after the exam” among students.

Obviously, this teaching mode cannot meet the requirements of college course teaching in the new era. In order to improve the current situation of course teaching, improve the teaching quality and cultivate students’ learning ability, practical ability, innovation ability and cooperative ability, curriculum teaching reform must be carried out.

3. TEACHING REFORM OF *INDUSTRIAL CATALYSIS*

Our school is an application-oriented private university. Therefore, the key problem to be solved in the teaching reform of *Industrial Catalysis* is the cultivation of innovative and application-oriented talents. We will carry out reforms in three aspects: teaching methods, teaching means, and teaching assessment methods. We plan to promote participatory teaching methods to realize flexible and diversified teaching methods, and build a teacher-student sharing learning platform by combining multimedia classroom teaching with online teaching, so as to cultivate students’ independent learning ability and optimize the teaching process.

3.1. Reform of teaching methods of *Industrial Catalysis*

In the teaching process of *Industrial Catalysis*, we should change the traditional teaching method of “full classroom teaching” to give full play to the dominant position of students in classroom learning.

Task-driven teaching is a kind of teaching method based on constructivism teaching theory. Students take real tasks to conduct independent exploration and interactive and collaborative learning through the active collection and application of learning resources. Combining with teaching practice, in the courses of the sixth chapter about the current energy structure and the existing problems, the energy carrier and transformation route and the restriction of energy development of resources and environment, take the current environmental issues as the entry point, arrange students to investigate and analyze the energy structure and existing problems in China, analyze the development direction of the future energy as well as the key points in the process of development, and make PPT explanations in groups, according to the national conditions and related policy of China. Teachers guide students to think combining with the current situation of “lack of gas and oil” in China, the role and significance of “One Belt One Road” and other policies in energy development in China, and to discuss the current situation of clean energy

development combining with the real life around, finally the teacher sums up. By setting questions, teachers can give play to students’ initiative in learning and guide students to have brainstorming. Students at different levels can propose solutions and solve problems based on their own understanding of current problems and their own unique experience, providing an open space for each student to think, explore, discover and innovate to establish students’ awareness of environmental protection, innovation and independent intellectual property rights, and make the classroom teaching process full of democracy, personality and humanity, and the classroom atmosphere really active.

In this process, students will continue to obtain a sense of achievement, which can further stimulate their desire for knowledge, gradually form a virtuous circle of perceptual mental activities, so as to cultivate the ability of independent exploration, pioneering and enterprising self-study [1-3]. In addition, students put their emotions into the process of collecting materials, preparing lessons, organizing teaching and communicating, so that they can have more emotional experience of what they have learned and said. From the perspective of teachers, task-driven teaching is a teaching method based on constructivist teaching theory, which transforms the traditional teaching idea of imparting knowledge into the modern teaching idea of solving problems.

3.2. Reform of teaching means of *Industrial Catalysis*

We should make rational use of computer technology in teaching to strengthen the integration of the modern information technology and education teaching. It adopts the teaching mode of combining multimedia classroom teaching with online teaching.

First of all, in multimedia classroom teaching, courseware content and blackboard writing content should be well organized and distributed, and courseware should be carefully designed. By combining rich animation, video, virtual simulation and other diversified materials with teacher-student interaction, the teaching rhythm of each teaching unit can be controlled well. Virtual simulation teaching is a practical teaching method to create corresponding virtual environment or tools by using real objects or computers to simulate the operation, design and operation of real cases. Virtual simulation technology is applied to the interactive teaching of *Industrial Catalysis*. It can extend the existing multimedia teaching method, show the chemical production process to students intuitively and vividly, stimulate their interest in learning, and cultivate their habit of independent learning and active learning, which plays an important role in promoting the improvement of teaching quality. In addition, students can intuitively feel the chemical production process, which can

reduce the difficulty of teaching. Beijing Obeier Methanol 3D Virtual Reality Cognitive Production Simulation Software as shown in Figure 1 is developed according to real chemical plant methanol project for the students majoring in chemistry and related fields. Students can use the software to practice cognitive and operational processes of typical processes. The training and learning costs can be effectively reduced, and the understanding of the students about the methanol production process can be deepen. Meanwhile, the knowledge point management system supported by the software can be used as a teaching assistant to improve the efficiency of lesson preparation.

Secondly, the online teaching platform should be fully utilized, especially under the outbreak, suspended class, ongoing learning. The teacher should constantly update education ideas, and give full play to the advantages of the modern teaching platform [4], such

as Super Star Learning APP, Rain Classroom and MOOC, to interact with the students in a more flexible way by combining online advantages with offline teaching. In the process of teaching, we could use Super Star Learning APP to carry out online teaching [5], through video, task points, discussion, chapter test tasks and assignments and other forms (Figure 2) to interact with students. As shown in Figure 3, the completion of each part of knowledge points and students' learning results can be intuitively reflected through the statistical results. The biggest advantage of online teaching is that it breaks the limitation of time and space. Teachers and students can complete the teaching and learning tasks without going out. Moreover, they can watch the broadcast replay after class, which makes up for the regret of not listening in time or not understanding at that time.



Figure 1 Beijing Obeier Methanol 3D Virtual Reality Cognitive Production Simulation Software

Grade 2019 > Achievement Management

[Return](#)

Score statistics | Weight settings | Certificate issuance Management

Please enter your school num.

Allow students to view grades.

[Export scores](#)

Serial number	Name	School / work number ↑	Course videos (20%) ↑	Chapter Quiz (20%) ↓	Chapter Learned (5%) ↑	Discussion (15%) ↑	Jobs (30%) ↑	Check-in (10%) ↑	Comprehensive results ↑
1		18	19.33	13.59	5.0	1.5	15.0	6.0	60.42

Figure 2 The operation interface of Super Star Learning APP. The composition of the score is composed of homework (30%), course video (20%), chapter test tasks (20%), discussion (15%), and assignments (10%), learning times (5%) and so on, and every student can check their grades in real time



Figure 3 Statistics of course learning progress. The Figures can intuitively reflect the completion progress (a) and average viewing time (b) of the task

3.3. Reform of teaching assessment methods of Industrial Catalysis

The traditional assessment method of evaluating students by scores should be reformed. Examination should be a comprehensive dynamic evaluation process. The exam focuses on examining students' ability to raise, analyze and solve problems, creativity and multi-directional thinking and so on, and not just the ability to learn and remember what you have learned. It should be emphasized that intelligence, practical ability, creativity is more important than scores and results.

In addition to the basic theories, basic knowledge and basic skills of the course, the exam content also includes the internalized analysis of the basic knowledge and basic theories, the comprehensive ability to solve problems and the ability to innovate. The examination method can take many forms, such as Online + Offline, written and oral. The examination time should be the whole course learning process, including the students' usual homework results, answers to questions and discussion-based speeches, and the final examination results. The test marking method should be reformed to gradually dilute the score and conduct substantive evaluation. Part of the content should be graded according to the ABC system, so as to stimulate students' interest in learning and promote their all-round development.

4. CONCLUSION

In summary, based on the characteristics of the *Industrial Catalysis* course and the talent training requirements in the future, the reform of *Industrial*

Catalysis teaching is mainly carried out from three aspects: teaching methods, teaching means, and teaching assessment methods. By guiding students to pay attention to the hot issues in the forefront of science, such as energy and catalysis, and connecting their knowledge with actual production and life, students' interest in the field of chemical engineering can be improved, and students' autonomous learning ability can be improved, and a new mode of training innovative and applied talents can be explored.

REFERENCES

- [1] J.Z. Zheng, Guidance on Application of Teaching Methods, East China Normal University Press, 2006.
- [2] L. Zhu, How to use Teaching Methods, East China Normal University Press, 2014.
- [3] Q.F. Hu, Optimizing Classroom Teaching: Method and Practice, China Renmin University Press, 2014.
- [4] M. Wang, Comprehensive Utilization of Diversified Materials in Analytical Chemistry Teaching under the Background of COVID-19, *University Chemistry*.35(5) (2020) 180-183. DOI: 10.1080/10408347.2020.1781592
- [5] Yan Xia, Yafei Yang, Some Thoughts on Analytical Chemistry Teaching under New Coronavirus Pneumonia, *University Chemistry*. 35(5) (2020) 7-9. DOI: 10.3866/PKU.DXHX202002039