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Research and Practice on the Construction of General Chemistry Curriculum in Applied Universities under the Background of "New Agricultural Sciences"

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Abstract **Review Article**

This paper, guided by the OBE (Outcomes-Based Education) philosophy of "New Agricultural Sciences," oriented by talent cultivation goals, and based on the construction of general chemistry courses in applied universities, elaborates on the construction ideas of general chemistry courses in applied universities. It discusses the diversified construction of general chemistry courses from aspects such as teaching syllabus, teaching model, and assessment methods. Data on students' overall achievement and course goal achievement under different teaching models are analyzed. The results show that the construction of general chemistry courses under the background of "New Agricultural Sciences" has achieved good practical effects.

Keywords: New Agricultural Sciences; Applied Universities; General Chemistry; Curriculum Construction.

1. RESEARCH BACKGROUND

The development of "New Agricultural Sciences" has evolved from conceptual research to strategic implementation. In the second half of 2018, the Higher Education Department of the Ministry of Education established the "New Agricultural Sciences Construction Collaborative Group." It introduced measures for the construction of "New Agricultural Sciences" across eight key areas to support educational reforms in colleges and universities with agricultural programs. These areas include optimizing professional construction, cultivating new types of talents, innovating course reforms, building practical bases, cultivating high-quality teachers, strengthening collaborative education, improving quality standards, and deepening open cooperation.

Abroad [1-7], numerous higher education institutions have advanced learning based on design principles, engaging students in open-ended projects. By completing these projects, students develop skills in modeling, simulation, as well as teamwork and communication. The proactive role of students is harnessed to foster and enhance their core competencies in a comprehensive and multifaceted manner. Domestically [8-12], a variety of higher education institutions have initiated the construction of "New Agricultural Sciences" at different levels, fields, and majors. Guided by industry demands, they have set goals for cultivating distinguished engineering talents, emphasizing the systematic, practical, and innovative aspects of the curriculum. The teaching approach in the context of "New Agricultural Sciences" underscores the importance of nurturing innovative and integrative thinking, linking theoretical knowledge with practical application, and integrating knowledge dissemination, skill development, and quality education. This holistic approach, both in and out of the classroom, encourages students to think actively and stimulates their potential, providing a solid foundation for their advanced studies in their major and for becoming highly skilled, applied technical professionals after graduation.

Applied undergraduate institutions, which are positioned with a focus on applied technology, should place even greater emphasis on cultivating students' practical and innovative capabilities during the educational process. While the policies of "New Agricultural Sciences" have directed its practice and research, there is still a need for further vertical deepening and horizontal expansion of the construction fields. General Chemistry, as a foundational course for non-chemistry majors in agricultural universities, plays an essential role in the cultivation process of technical talents in agriculture and is a compulsory basic subject that can significantly contribute to the realization of "Smart Agriculture." Additionally, as the first course for freshmen in agricultural science majors, the teaching methods, the integration of political education elements with course content, the combination with professional knowledge, and the diversification of assessment methods are crucial for fostering students' scientific thinking [13].

2. Construction of General Chemistry Curriculum in Applied Universities under the Background of "New Agricultural Sciences"

This study takes the cultivation goals of "New Agricultural Sciences" as its guiding principle, with the revision of the teaching syllabus centered on training objectives and talent demands. It focuses on the construction of teaching materials, teaching models, and assessment methods as the foundation, forming a student-centered educational philosophy, thereby carrying out diversified construction and practice of the general chemistry curriculum.

The purpose of this general chemistry curriculum construction is twofold: (1) to cultivate high-quality, compound new agricultural talents with strong practical and innovative capabilities and international competitiveness by optimizing and integrating teaching content, thereby improving the achievement level of students in the general chemistry course; (2) to adjust teaching models and assessment methods flexibly, to strengthen student-centered classroom teaching and the involvement of various methods, to highlight the autonomy, interactivity, sharing, and openness of the learning process, to stimulate interest, solidify foundations, expand skills, and enhance students' ability to integrate theory with practice, thus providing society with more high-quality applied talents for the construction of "New Agricultural Sciences".

3. Construction and Practice of the General Chemistry Curriculum

3.1 Key Issues to be Addressed in the General Chemistry Curriculum

The key issues that the general chemistry curriculum currently needs to address include: (1) The curriculum outline's training objectives only require students to master relevant knowledge, with less emphasis on the application in practice, which limits the flexible application of general chemistry courses to solve professional engineering problems; (2) The teaching models of general chemistry courses are mostly singular, with less integration of online and offline teaching through online platforms, restricting the autonomy, interactivity, and openness of students; (3) The assessment methods of the general chemistry courses are rigid, with weak process assessments centered on students and result assessments that reflect practical application abilities, as well as the ability to guide practical application with foundational knowledge.

3.2 Content of Curriculum Construction

By reviewing literature and related materials, a strong industrial development demand survey for engineering and technological talent has been constructed to analyze the gap between the current chemical foundation courses and the training goals of new agricultural science application-oriented talents. The construction of the general chemistry basic course is carried out in the following aspects:

(1) Revision of the General Chemistry Teaching Syllabus Based on the Training Goals of New Agricultural Science Application-Oriented Talents

The curriculum objectives are set in line with the OBE (Outcomes-Based Education) philosophy to meet the graduation requirements of various colleges. The achievement levels of the general chemistry course objectives are established, with Course Objective 1: Mastering the general properties of dilute solutions, the limits and rates of chemical reactions, chemical equilibrium, the relationship between the properties of substances and atomic and molecular structures, and the four major equilibria in solutions, among other basic theories. Course Objective 2: Mastering the basic principles of chemistry, related calculations, and their applications, using these basic principles to solve chemistry-related problems encountered in study and work, cultivating students' chemical thinking, problem analysis, and problem-solving abilities, laying the foundation for subsequent course studies.

(2) Reform of the Teaching Model of the General Chemistry Course

Increase the time and space for students to choose their learning, enhance teacher-student interaction, and form a learner-centered engineering education model. The general chemistry course adopts a combination of online and offline teaching models, making full use of the Smart Tree teaching platform, selecting mature MOOC resources suitable for our university's undergraduate majors, providing students with a teaching platform for timely previewing, learning, and reviewing, and at the same time using the flipped classroom to maximize student participation and expand the training approaches for applied talents. A teaching method combining "lecture, inspiration, guidance, questioning, practice, and discussion" is implemented to achieve a joint enhancement of students' knowledge and abilities.

(3) Reform of the Assessment Method of the General Chemistry Course

A balanced approach to process assessment and result assessment is adopted, strengthening the assessment of student participation in the process and the assessment of practical application abilities in the results.

① The regular score accounts for 40%, enhancing student participation: including classroom performance (classroom performance will include quick responses, voting, brainstorming, etc.), quizzes, and homework, etc.

② The final exam accounts for 60%, enhancing the resolution of practical application problems: The final exam is the main assessment method for students' learning, which not only examines the basic knowledge but also the ability of students to use basic knowledge to solve practical problems.

3.3 Practical Analysis of General Chemistry Curriculum Construction

1398 students from various majors in the Food College, Agricultural College, and Animal Science College in the 2023 class did not undergo construction and practice of the general chemistry course, while 454 students from five majors in the 2023 class, including Bioengineering, Pharmaceutical, Biological Science, Biotechnology, and Turfgrass, underwent construction of the general chemistry course. The final comparison of the overall achievement degree of Course Objective 1 and Course Objective 2 is shown in Table 1 and Figure 1.

(1) Overall Student Course Objective Achievement Degree

Table 1: Comparison Data of Overall Achievement Degree

Category	Non-Curriculum Development Class		Curriculum Development Class	
	Course Objective 1	Course Objective 2	Course Objective 1	Course Objective 2
Target Total Score	68.50	31.50	73.00	27.00
Target Achieved Score	52.43	9.43	59.67	14.26
Achievement Degree	0.7654	0.2993	0.8174	0.3170

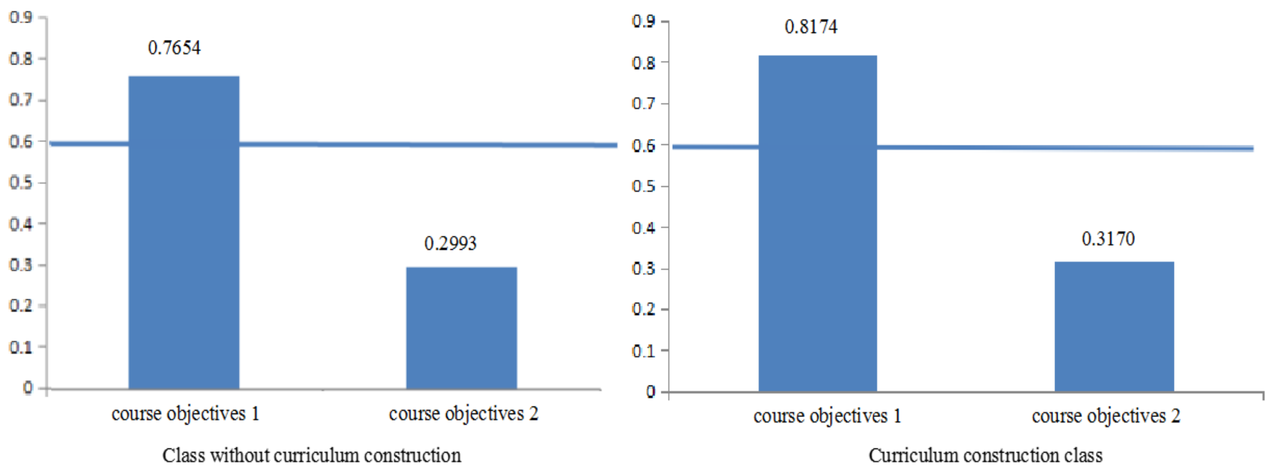

Figure 1: Comparison Chart of Overall Achievement Degree

As depicted in Table 1 and Figure 1, the Curriculum Development Class outperforms the Non-Curriculum Development Class in terms of course target scores, with an increase of 7.24 for Course Objective 1 and 4.83 for Course Objective 2, respectively. The data on achievement Degree also shows that the Curriculum Development Class has higher course target scores than the Non-Curriculum Development Class, with an advantage of 0.0520 for Course Objective 1 and 0.0177 for Course Objective 2. The achievement degree for Course Objective 1 in the Curriculum Development Class is 0.8174, surpassing the 60% mark, which is a relatively ideal result; the achievement of Course Objective 1 indicates that students have a better grasp of fundamental concepts and basic knowledge. The achievement degree for Course Objective 2 is 0.3170, significantly below 60%, indicating a less satisfactory outcome; the non-achievement of Course Objective 2 suggests that students have a weaker capacity to apply basic chemical theories to analyze and solve practical computational problems, and there is a need to enhance their transferable skills. A small number of students have a weak foundation in high school chemistry, lack the perseverance to continue learning, and lack the confidence to overcome difficulties, which also leads to their suboptimal performance.

(2) Individual Student Course Objective Achievement Degree

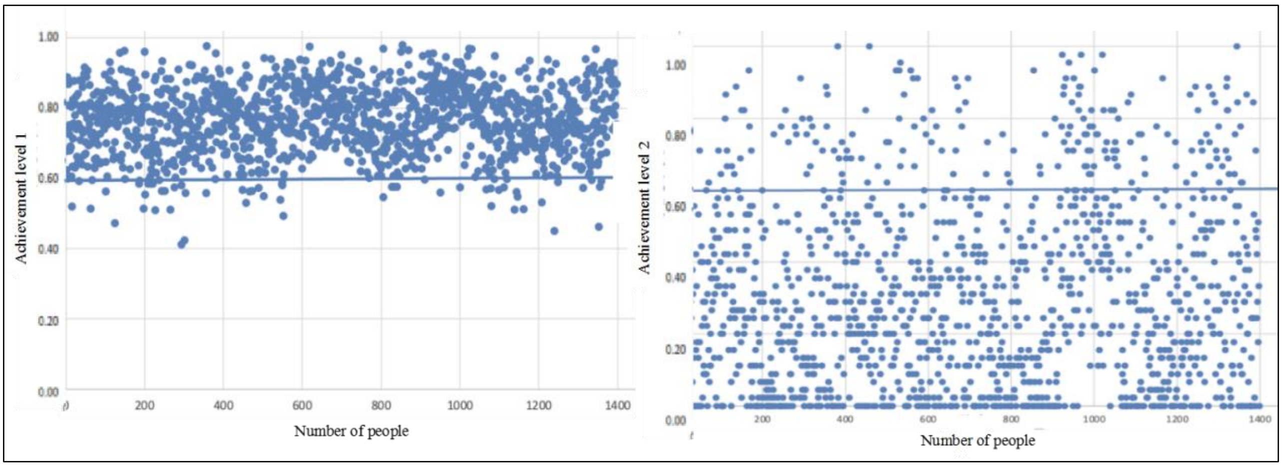

Figure 2: Scatter Plot of Achievement Degrees for Course Objective 1 in the Curriculum Development Class

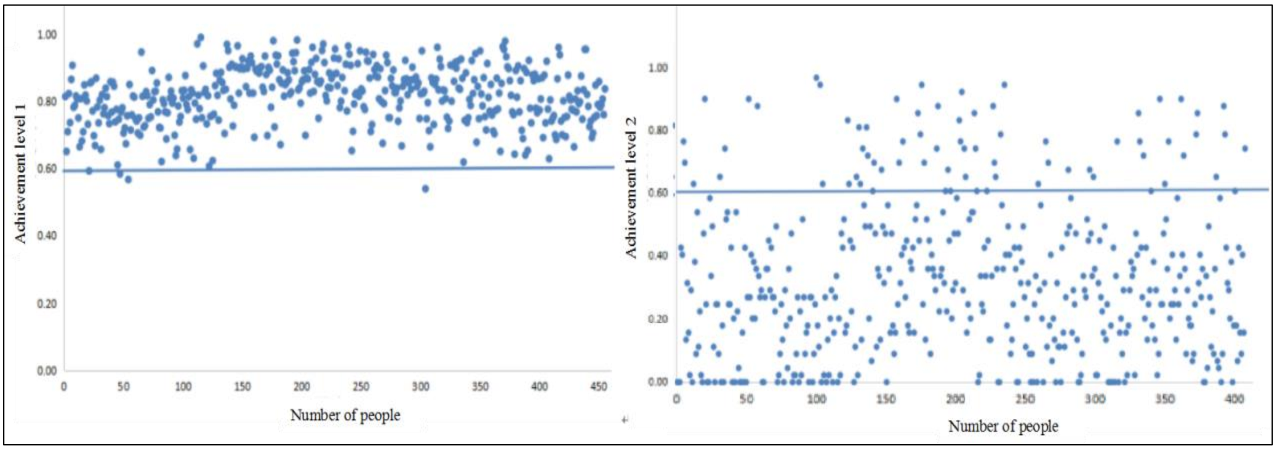

Figure 3: Scatter Plot of Achievement Degrees for Course Objective 2 in the Curriculum Development Class

As indicated by Figure 2, the majority of students have an achievement degree for Course Objective 1 that is higher than 0.6, which suggests that most students have a commendable learning attitude and have mastered the fundamental principles and concepts covered in the curriculum. However, a minority of students have an achievement degree below 0.6, indicating that they have not fulfilled the requirements for this particular objective. This reveals some students have a slight deficiency in learning capabilities and a need for specific improvements.

Figure 3 shows that only a small number of students have an achievement degree for Course Objective 2 that exceeds 0.6, signifying that the majority of students do not possess the ability to apply basic chemical theories and principles to analyze and resolve practical computational issues. A small fraction of students even have an achievement degree of 0 for Course Objective 2, which implies a lack of learning motivation and a formalistic approach to learning. Educators should focus on refining their teaching methods to strengthen students' computational and analytical skills.

It is also noticeable that the overall performance for both Course Objective 1 and Course Objective 2 in the Curriculum Development Class is better than that of the Non-Curriculum Development Class. This indicates that the strategies and techniques used in the curriculum construction have effectively enhanced students' understanding of the basic theories related to the properties of substances, the relationship between atomic and molecular structures, and the four major types of equilibrium in solutions. The thinking and capability to use these fundamental principles to address chemistry-related problems encountered in learning and work have improved; the curriculum construction has achieved satisfactory feedback outcomes.

4. CONCLUSION

This study has examined the construction of general chemistry courses in applied universities under the "New Agricultural Sciences" framework. It has involved the optimization and integration of teaching syllabi, teaching models, and assessment methods. The goal is to enhance students' proactive learning, strengthen their grasp of fundamental theories and basic knowledge, and cultivate their ability to apply theoretical knowledge to solve problems in life and practice. This aims to improve students' performance and achievement levels in general chemistry courses, thereby contributing to the society with a greater number of high-quality talents for the construction of "New Agricultural Sciences."

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