

# Curriculum Reform Practices in “Cosmetic Product Formulation Design and Preparation Technology” Under the Perspective of Integration of Industry, Education, and Research

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**Abstract:** With the upgrading of industries, the cosmetics industry has posed new requirements for technical talents. As a professional core course in cosmetic technology, “Cosmetic Product Formulation Design and Preparation Technology” serves as the foundation for cultivating students’ abilities in cosmetic development and preparation. To foster high-quality skilled talents capable of adapting to the rapid growth of color cosmetics and to better promote the deep integration of scientific and technological industries with curriculum teaching, the teacher team embarked on active explorations and practical teaching research for curriculum teaching reform from four dimensions: strengthening top-level design, enriching teaching content, optimizing teaching design, and reforming assessment methods. These efforts have enhanced students’ comprehensive vocational qualities and innovative consciousness, contributing to the teaching reform in higher vocational colleges under the integration of industry, education, and research.

**Keywords:** Cosmetic Product Formulation Design and Preparation Technology; Curriculum teaching reform; Integration of industry, education, and research; Cosmetic technology

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## 1. Introduction

The rapid advancement of technology and the swift development of modern industries have brought about a situation where China’s industrial demand side and the supply of talent cultivation are not yet fully aligned in quality and level. The report of the 20th National Congress of the Communist Party of China emphasizes education, research and technology, and human resources as fundamental and strategic pillars of the nation, proposing to deeply implement the three strategies of invigorating the country through research and education, strengthening the nation with talented individuals, and driving development through innovation. It highlights the importance of integrating industry, education, and research, as well as the convergence between research and education <sup>[1]</sup>.

In talent cultivation, curricula are the core for achieving educational transformation and continuously improving the quality of talent training<sup>[2,3]</sup>. Both advanced teaching concepts and cutting-edge content must pass through the critical curriculum channel to impact students' learning outcomes and practical skills. Therefore, the concrete integration of industry, education, and research into curriculum development for cultivating high-quality talents with innovative spirit and practical skills represents a significant and pressing issue in the current vocational education reform.

“Cosmetic Product Formulation Design and Preparation Technology” is a core course for the major in cosmetic technology. The course is set up based on the requirements of the national occupational standards for cosmetic formulators and the professional competency needs of cosmetic R&D positions. Its main task is to deepen students' understanding of market demands by studying various cosmetic product formulations and preparation methods and to master typical cosmetic formulation design, production techniques, and equipment operation skills. With the upgrading of the industry, the pace of updating and replacing cosmetic products has accelerated, gradually moving towards functional, high-value-added, and personalized products. At the same time, new formulations, materials, and processes continue to emerge, thus presenting new demands for skilled talents in the cosmetic industry<sup>[4,5]</sup>. Therefore, it is essential to reform and innovate this course under the background of industry-education-research integration to improve students' innovation and practical application skills, and to adapt to the new demands of the cosmetics industry.

## **2. Fundamental conditions for the curriculum reform of “Cosmetic Product Formulation Design and Preparation Technology”**

After years of development, the “Cosmetic Product Formulation Design and Preparation Technology” course, as a core subject of cosmetic technology, possesses a solid foundation for implementing the practical teaching reform of “industry + education + research” integration. The course relies on teaching and research platforms such as laboratories for cosmetic technology, national collaborative innovation centers, Guangdong engineering centers, national teaching resource libraries, Light Industry Education online courses, and Super Star Learning platform, ensuring effective implementation of both online and offline teaching activities for this research. Additionally, the faculty team of this major has achieved remarkable results, including two national teaching achievement awards and the first prize in a national teaching competition. The team has also been recognized as the “National Model Teacher Team of Huang Da-nian” and “National Vocational Education Teacher Teaching Innovation Team,” laying a good foundation for conducting deep industry-education-research integrated teaching reforms in this course.

## **3. Problem analysis for “Cosmetic Product Formulation Design and Preparation Technology”**

### **3.1. Outdated teaching content causing a decline in student learning interest**

Firstly, the teaching methods in our university's specialized courses are relatively simple. Most courses are still based on classroom lectures led by teachers, which passively transmit knowledge and fail to embody the “student-centered” teaching philosophy. Moreover, traditional lecture-based teaching can easily lead to student boredom and apathy, making it difficult to stimulate their learning interest. Secondly, this course involves many new raw materials, product formulas, and preparation processes, which are prone to confusion among students and present a challenge to their learning. Thirdly, the update speed of course teaching resources is slow, resulting in a disconnect from the forefront of the cosmetics market, making it difficult for students to



independently access the latest product trends and technological methods. Therefore, as a market-oriented and dynamically evolving course, the traditional teaching method does not enable students to integrate course knowledge with reality, hindering students' development.

### **3.2. Separation of scientific research and teaching with insufficient effort in cultivating students' research literacy**

In the traditional talent cultivation process, there is a clear separation between scientific research and teaching. Vocational teachers usually only undertake the responsibility of teaching and educating, imparting abstract and difficult-to-understand knowledge points by rote, neglecting the supportive role of research results in teaching. On the other hand, some teachers focus solely on scientific research due to the pressure of professional title evaluations, ignoring the importance of educating students. This has resulted in the emergence of the “two skins” problem in scientific research and teaching, which hinders the cultivation of students' innovative spirit. Due to the lack of engaging real-world research cases in the teaching content and the absence of in-depth discussions on cutting-edge topics, teachers often struggle to pique students' interest and resonate with them, hindering the development of students' problem-solving skills.

### **3.3. Unreasonable assessment methods inhibiting the development of students' comprehensive abilities**

Contemporary university students often exhibit a pattern of “cramming before exams and forgetting everything afterward.” Implementing closed-book exams as the sole assessment method can lead to a phenomenon of “one exam determines the entire grade,” neglecting the importance of evaluating students' learning process. This approach fails to effectively stimulate students' desire to learn and hinders the objective evaluation of students' comprehensive abilities, research literacy, and innovative thinking skills. Additionally, the design of the examination content is not comprehensive enough. Exam questions are mostly based on textbooks or the content of classroom lectures, failing to reflect students' practical skills, theoretical knowledge, and autonomous learning capabilities. Therefore, the traditional assessment method is no longer effective in supporting the objectives of talent cultivation and is inconducive to examining students' overall vocational skills and qualities.

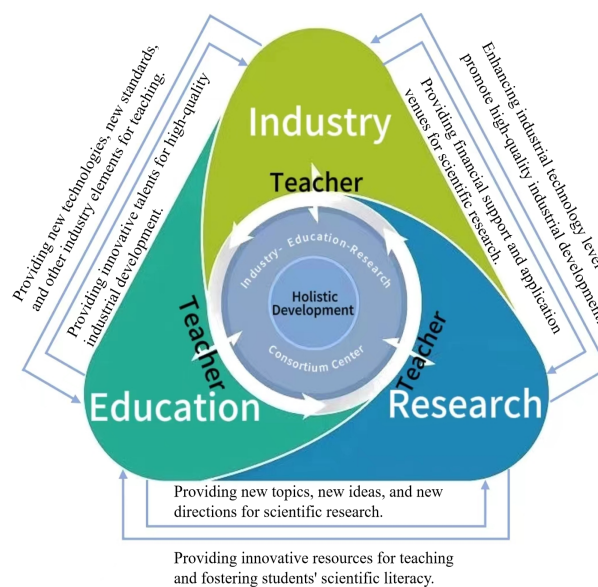
## **4. Exploration and practice of teaching reform under the integration of industry, education, and research**

### **4.1. Strengthening the “top-level design” of talent development**

The integration of research and education refers to the combination and interconnection between scientific research and talent cultivation, which is reflected in teachers integrating their research findings into teaching, and providing new knowledge, ideas, and education materials <sup>[6,7]</sup>. Vocational education can promote the deep integration of technological transformation, industrial upgrading, and educational reform in all areas, chains, and elements through the “integration of research and education,” serving innovative development. Industry-education integration refers to the seamless integration and interconnectivity of enterprises, scientific research, and talent cultivation. This approach embodies the incorporation of industry and scientific and technological development needs into teaching, achieving collaborative talent cultivation <sup>[8,9]</sup>. Vocational education, through “industry-education-research integration,” facilitates the transformation of educational elements and scientific research into production elements for enterprises. This approach also promotes closer collaboration between schools and enterprises, fostering a deep integration between the industrial chain and the professional chain <sup>[10]</sup>.

In response to the prevalent separation of research, education, and industry in higher vocational colleges,

our faculty team innovatively proposed the “mutual integration and symbiosis” model of integrated education with research and industry to support high-quality industrial development (**Figure 1**). With education as the core, high-quality industrial development is the goal, and the integration of research and education is the means; research serves as the source of teaching, transforming research results into teaching resources, innovating teaching content, cultivating students’ innovative abilities and scientific spirit, and enhancing research literacy; teaching is the driving force behind research, uncovering research topics and optimizing research ideas during the processing and sorting of teaching content, that is, “teaching poses questions, and research seeks solutions.” The integration of research and education provides a driving force for high-quality industrial development, stimulating industries to actively contribute back to research and teaching. Based on this, our faculty team has transferred and empowered the advantages of research and teaching resources to entrepreneurial talent development and high-quality industrial growth, achieving deep coupling of the four chains: “research chain-industrial chain-educational chain-talent chain,” thereby integrating teaching, research, and industry into a “mutual integration and symbiosis” relationship and initially forming a virtuous cycle ecosystem.



**Figure 1.** The “mutual integration and symbiosis” model of the virtuous cycle of industry, research, and education

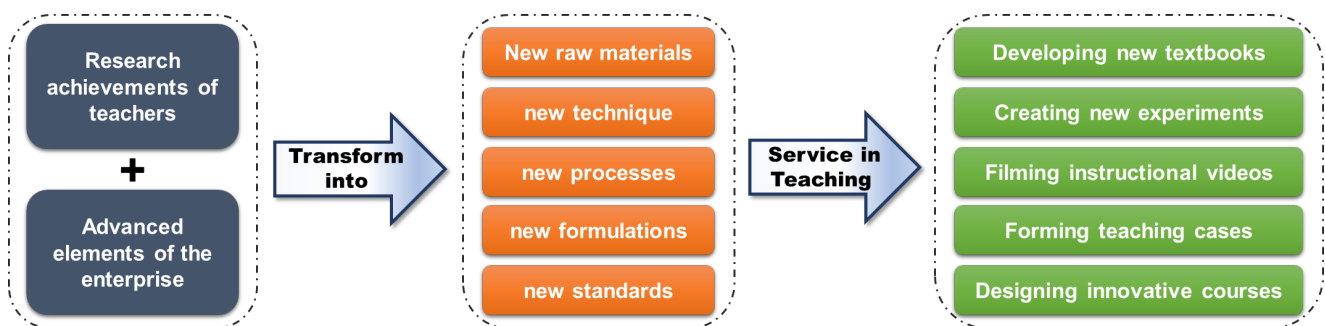
## 4.2. Enriching teaching content

### 4.2.1. Integrating ideological and political elements into classroom teaching and promoting ideological and political education in professional courses

Professional core courses are crucial in the process of talent cultivation, as they not only impart professional knowledge and skills but also foster students’ correct outlook on life and values. Therefore, our faculty has thoroughly explored the ideological and political elements within these courses, actively engaging in ideological and political education during the delivery of professional knowledge. For instance, by having students search for Tang and Song poems containing words like “eyebrow” and “rouge” and tracing the historical changes in lip and eyebrow makeup styles across different dynasties, students can not only learn about the historical stories and poetry of ancient Chinese makeup but also enhance their interest in learning and cultural confidence. Furthermore, transforming the entrepreneurial stories of domestic cosmetic brands and the development process of makeup bestsellers into teaching cases allows students to analyze the causes and performance of cosmetic bestsellers, thereby cultivating their scientific literacy, craftsmanship spirit, and practical skills.

### 4.2.2. Transforming scientific research technologies into digital teaching resources

To enhance the practical, vocational, and standardized nature of teaching content, faculty members in this program have integrated cutting-edge elements from industry, such as new technologies, processes, standards, and regulations, along with their research innovations into curricula and textbooks. They have collaborated with industry professionals to develop novel loose-leaf and work-manual style textbooks. Moreover, collaborative efforts between the institution and industry partners have resulted in the development of shared teaching resources, including micro-lecture videos, case study libraries, and question banks. These resources are dynamically updated in response to advancements in information technology and industry upgrades (**Figure 2**). The program has also established partnerships with cosmetics companies like Huanya, leading to the co-creation of a virtual reality (VR) exhibition hall for beauty and cosmetics, as well as virtual simulation software for makeup applications. These instructional resources not only effectively address the challenging concepts of product color matching and color blending but also significantly enhance students' visual learning experience and immersive engagement.



**Figure 2.** The schematic diagram of transforming scientific research achievements and enterprise elements into teaching resources

### 4.2.3. Optimization of teaching design

The course's target audience has consisted primarily of "post-00s" students who have grown up immersed in the digital world and possess a strong sense of internet thinking with pronounced individuality. Unlike their predecessors, these students tend to prefer acquiring knowledge and skills through practical experiences, hands-on activities, and online resources rather than adhering strictly to textbook learning <sup>[11]</sup>. To cater to this cohort, we have vigorously integrated modern information technology into our teaching methods, offering diverse educational approaches tailored to the "post-00s." By leveraging the national teaching resource library and top-tier open courses led by our department, we have uploaded animations, micro-lectures, and other digital resources to the cloud, supporting ubiquitous learning and helping students recognize their pivotal role in the learning process, thereby cultivating autonomous learning consciousness and good self-directed study habits. Additionally, we utilize platforms such as Super Star Learning, the national teaching resource library, and the Light Industry Education online course, assigning tasks and facilitating teacher-student interactions before, during, and after classes, implementing a blended online-offline instructional model. Furthermore, during lectures, we incorporate aspects of faculty research projects such as technical processes, product formulation mechanisms, simulation cases, and academic achievements into the curriculum, guiding students in analyzing and exploring cosmetic products, enhancing their problem-solving skills, and significantly improving student engagement and learning outcomes in class. For instance, when examining the "Hundred Birds Worshipping the Phoenix" carved eye shadow product, we introduced new knowledge points like the "chameleon" type pearlescent material and "baking powder preparation" techniques while informing students about ongoing

research on “structural color” by our faculty team, showcasing various types of structural color materials in class to ignite significant interest in scientific research among students.

In experimental and practical training sessions within this course, we invite skilled artisans and industry veterans to participate in teaching, employing a student-centered “problem-oriented” teaching and “real project iterative trial-and-error” practical training approach (Figure 3). Students are assigned development tasks related to cosmetic product projects, which are then taught by a dual-mentor team composed of both school and enterprise instructors. Upon receiving their assignments, students work in groups to complete tasks such as researching information, devising plans, refining proposals, executing strategies, and summarizing experiences, gaining firsthand exposure to the development process of cosmetic products. This methodology aims to foster students’ practical working capabilities and cultivate a spirit of pragmatic innovation in scientific endeavors.



Figure 3. Schematic diagram of the “problem-oriented” teaching and “real project iterative trial-and-error” training method

#### 4.2.4. Reform of student assessment and evaluation methods

This course emphasizes the assessment of students’ abilities in designing cosmetic product formulations and preparing small-scale samples. It adopts a “whole-process, multi-dimensional, diversified” evaluation system.

The assessment process encompasses a combination of formative and summative evaluations throughout the pre-class, in-class, and post-class stages. This multi-dimensional evaluation integrates the assessment criteria of the “National College Students’ Cosmetic Formulation Competition” and the “Cosmetic Formulator Professional Competency Level Certificate,” encompassing five distinct dimensions. Furthermore, the diversification aspect is embodied through the Super Star Learning platform to carry out self-assessments and peer assessments, where multiple subjects including teachers, corporate mentors, and students are involved, ensuring a scientific, systematic, and comprehensive evaluation result. This assessment approach facilitates a greater focus on students’ learning processes, enabling a comprehensive evaluation of their overall competency, analytical and problem-solving skills, and practical skills in product formulation.

### 5. Analysis of teaching application effects

#### 5.1. Significant enhancement of learning interest and scientific enthusiasm

The implementation of “problem-oriented” teaching and “real project iterative trial-and-error” training methods effectively motivates student engagement, guiding them in conducting in-depth analyses of best-selling cosmetics, engaging in independent learning and exploration, and enhancing their analytical and problem-solving skills. This approach simultaneously fosters a strong sense of teamwork among students. Meanwhile, integrating research achievements such as invention patents and scientific and technological progress awards

into teaching, supported by real enterprise projects, sparks students' interest in scientific innovation. After the reform, the proportion of students who enjoy the course increased by 28.5%, indicating a significant rise in learning interest; moreover, the number of students participating in research projects rose by 27%, marking a substantial increase in scientific enthusiasm among students.

### **5.2. High achievement of the three-dimensional teaching objectives**

Through the development of teaching resources and implementation of teaching designs, the teaching process progresses from easy to difficult tasks in a step-by-step manner. The use of intelligent testing instruments, virtual makeup simulation software, and other information technologies effectively overcomes teaching difficulties, significantly improving classroom efficiency. This enables students to master the principles and methods of cosmetic product formulation design and sample preparation, enhancing their ability to optimize formulations and prepare samples. Immersive experiences in the “Beauty and Cosmetics VR Museum” co-developed by the school and enterprises allow students to understand Chinese beauty culture and traditional foundation preparation techniques, strengthening national confidence. Incorporating relevant laws and regulations, and designing cosmetics that are safe, healthy, and suitable for Chinese characteristics cultivates a scientific and rigorous craftsman spirit and the courage to innovate. Through hands-on practice, students establish the concept that labor is honorable, enhancing their labor skills, practical skills, innovative capabilities, and employability, achieving professional pride, and fulfilling the three-dimensional objectives of knowledge, skills, and qualities.

### **5.3. Wide recognition of teaching reform**

The curriculum reform received first prize in the “2021 National Vocational Colleges Skill Competition Teacher Teaching Ability Contest,” and it was selected as a typical case of “Classroom Revolution” in Guangdong Higher Vocational Education for 2022, receiving detailed reports on platforms such as “Voice of Vocational Education” and “Vocational Education Communication.”

## **6. Conclusion**

Within the rapid advancements in vocational education, curriculum development serves as a fundamental point of convergence between research and teaching, as well as industry and academia. This paper presents a pedagogical reform study of the “Cosmetic Product Formulation Design and Preparation Technology” course, encompassing aspects of top-level design, teaching content, teaching methods, and teaching evaluation. The study demonstrates the feasibility of integrating “research and education” with “industry and education” within specialized courses, enhancing students' professional competence and innovative thinking. This approach effectively addresses the growing demand for highly skilled technical personnel in the rapidly evolving cosmetics industry.

### **Disclosure statement**

The authors declare no conflict of interest.

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