

# *Exploration and Practice of a New Teaching Model for the Course of "Nanocomposite Materials" in the Context of New Engineering*

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**Keywords:** Nanocomposites; Teaching; Reform; Curriculum

**Abstract:** "Nanocomposite Materials" is a compulsory course for undergraduate students in materials chemistry and an important professional foundation course. The aim is to enable students to master the basic theory, preparation methods, characteristic research, characterization techniques, applications of nanomaterials, and some new nanomaterial applications of nanomaterials, and to strengthen their dynamic grasp of relevant cutting-edge research at home and abroad. In response to the pain points and problems in previous teaching work of the curriculum, we have deepened teaching reform from four aspects: talent cultivation mode, curriculum system construction, educational teaching methods, and experimental teaching mode. This not only improves the teaching quality and learning effectiveness of the curriculum, but also improves the cultivation mode of high-level and elite talents. It has important demonstration and promotion significance for the construction of relevant courses in the School of Materials Science and Engineering.

## 1. Introduction

Nano composite materials "is a compulsory course for undergraduate students in material chemistry and an important professional foundation course. The course has a total of 24 hours, aiming to enable students to understand the applications of nanomaterials in new materials, new energy, and other fields, and to have a correct understanding of the impact of nanomaterials on modern human society; Enhance understanding and understanding of the development field of cutting-edge nanotechnology, cultivate scientific research thinking and innovative abilities, and lay a solid foundation for cultivating talents with comprehensive qualities, innovative awareness, and abilities.

## 2. The problems to be solved in the teaching of "Nanocomposite Materials" course

### 2.1. Construction and improvement of curriculum system

The construction of curriculum system is the core field and substantive link of talent cultivation mode reform, and the cultivation goals of education and teaching must ultimately be achieved through the implementation of curriculum. The construction of a curriculum system is a guarantee of educational quality and a cornerstone of social and economic development.[1] Building an

educational curriculum system that is oriented towards cultivating scientific and technological talents and conforms to the characteristics of subject teaching is a reflection on the current development of nanomaterials and a need to reflect the characteristics of our school's education.

Not only should we simplify the classic content of the course, but we should also continuously introduce new research results, enrich teaching content, and make students feel the charm of nanocomposites. With the development of science and technology, more and more new nanocomposites are being developed and applied. Therefore, the latest developments in the field of nanocomposites both domestically and internationally should be promptly introduced into the classroom to stimulate students' interest in learning. At the same time, pay attention to the current research hotspots and difficulties in the field of nanocomposites, guide students to express their innovative ideas, and cultivate students' innovative thinking and research interest.

## **2.2. Improving and implementing education and teaching methods**

A complete and rich curriculum system is certainly very important, but it must be combined with practical teaching operations in order to implement the curriculum, or in other words, our curriculum can truly play the role of promoting student development. [2] The fundamental task of education is to cultivate virtue and cultivate people. To achieve this, it is necessary to answer the question of "what kind of curriculum to educate, guide, and develop people". [3]

Enable students to master the basic knowledge, theories, and scientific and technological systems involved in the preparation and processing of nanocomposites, master the design skills of nanocomposite related products, and be able to solve complex engineering problems related to nanocomposites. Design innovative and cost-effective technical solutions. Be able to use modern analytical instruments to analyze and characterize the microstructure and basic properties of nanomaterials and prepared nanocomposites, and master the interrelationships between composition structure performance of filled, hybrid, and intercalated nanocomposites. Able to apply the basic principles of nanocomposites, independently analyze the technical development, process design, and solutions to complex engineering problems in the actual production process of nanocomposite related products through literature review, translation, and research at home and abroad. Be able to conduct literature research both domestically and internationally, pay attention to the latest development trends and research hotspots in the field of nanocomposites, and understand the development trends and differences of nanocomposites in different countries. [4]

## **3. Reform and practice of the course "nanocomposite materials"**

The course 'Nanocomposite Materials' covers a wide range of knowledge, has strong theoretical and practical applicability, and has a certain depth and complex engineering significance. So it is necessary to continuously carry out teaching reforms and cultivate students who conform to the concept of engineering education. [5]

In response to the urgent issues that need to be addressed in the "nanocomposite materials" course mentioned above, our college focuses on deepening teaching reform and improving undergraduate scientific research capabilities from four aspects: talent cultivation mode, curriculum system construction, education and teaching methods, and experimental teaching mode. [6] The specific reform and practical measures are as follows.

### **3.1. Combining multimedia teaching with classroom discussions, while incorporating ideological and political elements**

Compared to traditional teaching methods, modern multimedia teaching not only has a large

capacity, but also vivid images, making it easier to highlight difficulties and key points. The development of nanocomposites in the new era is rapid and widely used. The use of modern multimedia technology can more vividly and directly display the production and living examples of materials and the latest research results, improving classroom efficiency. [7]

Adopting a combination of multimedia teaching and classroom discussion to stimulate students' exploration. For example, in the course "The Birth of Nanomaterials", it is proposed that the birth of nanomaterials is an innovation in thought and an education in innovative spirit for students; When discussing the "small size effect", the physical and chemical properties of nanomaterials that possess the "small is different" concept are used to educate students on the idea of "quantitative change leading to qualitative change". A combination of classroom literature discussion and online teaching is used to help students think deeply. Furthermore, nanomaterials have a series of novel small-scale characteristics in electrical, thermal, mechanical, optical, and magnetic fields. After years of development, they have been widely and profoundly applied in fields such as national defense, optoelectronics, aviation, energy, chemical engineering, building materials, and medicine, and have had a wide and profound impact on the production and daily life of modern society. Allowing students to fully understand that 'quantitative change leads to qualitative change' is of great help in stimulating their interest, guiding them to persist in learning, and enhancing their self-confidence. They firmly believe that through their own efforts, they can achieve the improvement of their 'quantitative change leads to qualitative change', and convey the socialist core values and the 'Four Confidences' to students.

Integrating ideological and political education into the professional curriculum system of universities is an important construction and reform, and it is an inevitable requirement to achieve the goal of integrating ideological and political education into the entire process of college students' learning. However, the key to integrating ideological and political content into professional curriculum teaching is how to "adapt to the situation and follow the trend", achieve the same direction as professional courses and ideological and political theory courses, and ultimately achieve a silent and subtle effect on ideological and political education. The course of nanocomposite materials aims to deeply explore and extract the ideological and political elements contained in the course, as well as the moral education functions it carries, and to implement education work in the main channel of classroom teaching. Explore the ways and methods of carrying out ideological and political education in professional course teaching, guide students to uphold a rigorous scientific attitude, grasp the main contradictions when viewing problems, understand the specific analysis of specific problems, and clarify the importance of correct choices. At the same time, in life and work, one should have a broad mindset, innovative spirit, and patriotism. Encourage students to strive for glory for their country and establish a correct worldview, values, and outlook on life through their unremitting efforts. [8]

### **3.2. Increase course interactivity**

Timely evaluate students' daily performance in the classroom, identify their strengths and weaknesses, and maintain their development or improvement. Allowing students to freely form study groups not only enhances their mastery of knowledge, but also enhances their own activity in thinking, language organization, and expression abilities. At the same time, they can fill their own cognitive gaps and expand their thinking from the knowledge and opinions of other members. At the end of the semester, students will be educated on their practical abilities. After grouping, each student will be assigned a paper on the latest internationally published nanomaterials, which will be translated into Chinese before writing a reading report. While testing the level of knowledge mastery, it also increases the understanding and mastery of knowledge in the process of solving problems encountered. Then, case speeches are given based on the types of nanomaterials, and questions from

teachers and classmates are accepted. To train students' comprehensive abilities such as hands-on skills, teamwork, speech expression, on-site adaptability, and interpersonal communication. Implement the teaching concept of "four pursuits", guide students to pursue truth and objective justice, stimulate their innovative consciousness and good at exploration, encourage students to think deeply and draw inferences from one example, and cultivate students' ability to apply what they have learned and practice.[9]

Introduce the products of nanocomposites used in daily life into classroom teaching, making students realize that the learning of this course is closely related to daily life. At the same time, using relevant examples in actual production as classroom guidance, the practical application of relevant theoretical knowledge in engineering is presented to students, attracting their attention and improving their learning initiative. Increase interaction, liven up the classroom atmosphere, and timely track and provide feedback on students' mastery of knowledge.

### **3.3. Increase communication frequency between teachers and students**

Increase communication with students, appropriately understand their learning status and views on the course, answer questions and clarify key and difficult points in their learning process, so that they can view learning and the course with a more relaxed attitude. More importantly, it is necessary to cultivate students' learning methods. Through this "teaching by fishing" method, students can learn to use the learning methods taught in this course to explore other learning content. They can use the basic knowledge they have learned before to understand the course they are currently learning. Simply put, knowledge is generated through knowledge, which has the ability to self-generate blood, allowing them to understand the carrying role of the basic knowledge they have learned in professional courses, Make yourself an innovative talent. [10]

Nanocomposite materials cover a wide range of content and have strong practicality, so they need to be integrated with scientific research in the course teaching process. Teachers generally have solid theoretical knowledge, profound professional background, and strong practical work abilities. Introducing research results into the classroom is an effective means for students to deeply understand nanocomposites. [11] Encourage students to actively participate in teachers' research work, experience the joy of putting theory into practice, and even encourage and help students participate in relevant research competitions. These practical activities not only deepen students' mastery of the theoretical knowledge of the course, but also cultivate their innovative thinking and hands-on abilities, and enhance their ability to analyze and solve problems. [12]

### **3.4. Regularly conduct research group discussions to ensure that research is carried out as planned**

Conduct a research personnel meeting every two weeks to organize teachers to discuss the research of this topic and assign the next stage of research work. The core group members gather for a regular meeting once a month to discuss and summarize the work on this topic.

## **4. Concept of course construction for nanocomposite materials**

In the strategy of "Made in China 2025", new materials are one of the ten key areas of development, with special emphasis on "advance layout and development of strategic frontier materials such as nanomaterials". In recent years, the progress of nanomaterials and nanotechnology has strongly supported the rapid development of various high-tech industries, becoming the most important technological foundation in these fields and regarded as an important symbol of modern high-tech.

#### **4.1. Respect knowledge and creativity**

The original material talent cultivation model based on industry characteristics cannot meet the needs of high-level new material innovation talent cultivation characterized by foresight, innovation, crossover, and cutting-edge. The contradiction between the demand for new material innovation talents in key core technology fields in China and the current lack of talent cultivation is constantly deepening, so it is necessary to focus on cultivating nanomaterial talents. [13] We need to be guided by advanced concepts and implement the reform of talent cultivation mode with the "nanocomposite materials" course as the starting point. According to the requirements of technology talent cultivation, increase teaching hours and increase knowledge dissemination efforts. To provide development cooperation for the growth of good academic talents who respect knowledge and creation, and continuously create a new situation where talents emerge in large numbers.

#### **4.2. Adhere to student-centered approach and focus on curriculum construction**

Focusing on curriculum reform, integrating ideological and political education into the entire process of curriculum teaching and reform, and achieving the curriculum goal of "combining knowledge transmission with value guidance". From the perspective of the history of material development, the key to whether the most advanced materials are used to open the gates of heaven or forge the path to hell is to see where they are applied, how they are applied, and who holds them. This is a very significant ethical issue. Integrating ideological and political education into the study of nanomaterials science and technology will further transform it into an inherent virtue of oneself, to become their steadfast and starting point for understanding and transforming the world, and to form their qualities and cultivation in dealing with the world. [14]

#### **4.3. Integrating teaching content and innovating teaching system**

Taking "cultivating morality and cultivating talents" as the fundamental principle, guided by the school motto of "advocating morality and learning, and striving for self-improvement and action", we will deepen the reform of teaching content and curriculum system, strengthen the intersection and integration with other courses and related content, integrate teaching content, and promote innovation in curriculum and practical teaching system; Vigorously promote the "Internet plus" teaching method, and promote the application of curriculum content and computer technology. In terms of teaching concepts, it advocates adapting to individual differences and teaching students according to their aptitude, emphasizing the shift of teaching focus from "teaching" to "learning".

#### **4.4. Exploratory teaching and innovative experiments**

On the basis of the construction of the college's teaching experimental base, we will further strengthen the reform and practice of practical teaching links, increase the intensity of experimental teaching reform, and replace the new education model with "inquiry based teaching and innovative experiments" as the main body with "acceptance based teaching and verification based experiments" as the main body. Enable students to hands-on operate, improve acceptance, hands-on ability, and innovation ability. Effectively improve the quality of teaching and promote the cultivation of innovative and applied talents. [15]

It is necessary to establish a multi-level and multi-form teaching exchange and display platform for nanocomposite materials courses. In the teaching practice of courses in the School of Materials Science and Engineering and other colleges, multi-level teaching exchanges and seminars are carried out in different departments, majors, and colleges, steadily promoting the development of high-

quality teaching [16].

## 5. Effect of course construction on "nanocomposite materials"

Through this research project, we aim to increase the number of innovative and entrepreneurial projects carried out by students based on nanoscience, complete the construction of a talent training model based on the rapid development of international and domestic nanomaterials, and reflect it in the new training plan formulated for nanocomposite materials courses, which will be further promoted to the outside world; We will initially achieve a deep integration of the curriculum chain and the industry chain, forming a comprehensive industry education system. We will initially build an "integrated" educational practice base that integrates cultivation, training, research, internships, and services, and build an off campus practical education base to achieve "practice+employment" in the context of innovation and entrepreneurship, and cultivate students' innovation and entrepreneurship abilities; Develop a teaching syllabus for nanocomposite materials courses, improve course teaching models, and build a professional nanocomposite material teaching team; Develop a research report on this topic. [17]

## 6. Conclusion

The "Nanocomposite Materials" course is tailored to the country's demand for talents in the new era, combined with the training goals and learning characteristics of the Materials Chemistry major, and follows the development laws of education and teaching. Through collaborative reforms in four aspects: talent cultivation mode, curriculum system construction, education and teaching methods, and experimental teaching mode, it not only improves teaching quality, creates high-quality courses, enhances teachers' teaching abilities, and establishes high-quality teaching teams, The improvement of the training mode for high-level and elite talents has important demonstration and promotion significance for the construction of relevant courses in the School of Materials Science and Engineering.

## Acknowledgement

2022 Beihua University's "Four New" Special Project Project "Exploration and Practice of New Teaching Models for Nanocomposite Materials under the Background of New Engineering" (XJYB20220012).

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