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Teaching Reform and Practice of the "Fundamentals of Materials Science" Course from the Dual Perspective of "Integration of Industry and Education&Curriculum Ideology and Politics"

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Abstract: *The Fundamentals of Materials Science is an important basic course for materials-related majors in engineering colleges. The rapid development of new materials industry puts forward higher requirements for specialized courses. This paper analyzes the current teaching situation of the Fundamentals of Materials Science, and puts forward the teaching reform scheme from the aspects of reconstruction of teaching content, integration of ideological and political elements, exploration and practice of integration of production and education. This paper discusses how to improve students' learning initiative and interest in specialized courses, so that students can understand basic knowledge and pay attention to moral education and innovative development, and stimulate students to form correct personality and noble value orientation.*

Keywords:*Integration of Production and Education, Fundamentals of Materials Science, Curriculum Ideology and Politics, Project-Based Teaching, Teaching Reform*

1. Introduction

The report of the 20th National Congress stresses that "education, science and technology, and talent are the fundamental and strategic supports for the comprehensive construction of a modern country." This important statement explains the significant strategic significance of deepening the realization of the strategy of renewing the country through science and education, and coordinating the coordinated and integrated development of education, science and technology, and talent. As the main battleground for talent cultivation, universities have continuously provided a large number of high-quality and specialized talents to various fields in the process of China's economic and social development, playing an irreplaceable role. However, the current labor market in China presents significant structural contradictions: on the one hand, college graduates face the reality of "difficult employment"; On the other hand, enterprises, especially in emerging industries and the real economy, are generally facing the development bottleneck of "recruitment difficulties". The phenomenon of "dual dilemma" not only reflects the deep mismatch between talent supply and market demand, but also poses a highly challenging era proposition for the reform and development of higher education in the new era. Some universities' professional courses are disconnected from the actual production and scientific research of enterprises, with a focus on theoretical lectures and a neglect of skill development; The construction of textbooks and teaching content lags behind the development of industrial technology, and the quality of talent cultivation cannot meet the actual needs of enterprises. Therefore, it is urgent to deeply implement the concept of industry education integration in teaching practice, actively explore new engineering professional course teaching reforms and practices that are suitable for the needs of industries and job positions.

This article will take the Fundamentals of Materials Science as an example, with the goal of effectively cultivating new engineering talents with both morality and ability, and explore the teaching reform plan and development path of Fundamentals of Materials Science course under the background of industry education integration.

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2. Analysis of the Characteristics and Teaching Status of Fundamentals of Materials Science Course

Fundamentals of Materials Science is a compulsory course for majors related to Materials Science and Engineering. The course content organically integrates the basic theories of metal materials, ceramic materials, and polymer materials, while also connecting subsequent courses related to material preparation, testing, and application. It serves as a bridge between basic courses and professional courses. The Fundamentals of Materials Science has many new concepts, principles, and laws, with complex and abstract knowledge points that are difficult to understand. Students generally feel that learning is relatively boring and lacks interest. In addition, students have completed basic courses but have not yet systematically studied professional courses. Students have a certain amount of basic knowledge accumulation and life experience, such as rubber or plastic aging over time, steel rusting, etc., but lack professional knowledge and understanding of most phenomena [1]. The Fundamentals of Materials Science is to enhance students' understanding and comprehension of specific material related knowledge from a theoretical perspective. Therefore, the Fundamentals of Materials Science has the characteristics of high difficulty and high requirements.

Moreover, the current knowledge update speed is fast, and the developed internet provides college students with a quick way to acquire knowledge. College students have a high acceptance of new affairs and are good at using the internet to acquire knowledge [2]. However, the authenticity and fragmentation of knowledge on the internet are difficult to distinguish, and students often lack in-depth understanding and thinking of the knowledge they have learned. At the same time, students who use electronic products for a long time are easily addicted to them and unable to extricate themselves, resulting in poor learning outcomes [3]. In addition, high school cramming education leads to poor self-directed learning ability and susceptibility to the influence of fast-moving internet culture, resulting in insufficient motivation for students to explore professional knowledge [4]. The current employment situation also leads to a lack of interest among students in their majors.

At present, there are generally the following problems in the teaching of Fundamentals of Materials Science courses: firstly, teachers still use classroom lectures as the main means of teaching, with relatively single teaching methods and poor teaching effectiveness; Secondly, the teaching content mainly focuses on imparting theoretical knowledge, with less integration with production and scientific research practice; Thirdly, the assessment and evaluation methods are single, and the proportion of paper scores is too high, which makes it unscientific to score students' process performance in group discussions and project-based teaching; Fourthly, emphasis is placed on imparting knowledge and cultivating abilities, while the integration of ideological and political education is lacking, neglecting the cultivation of students' correct emotional values.

This article takes the teaching of the course “Fundamentals of Materials Science” as an example. In the context of the integration of industry and education, the teaching content is reconstructed, ideological and political elements are integrated into classroom teaching, experimental teaching is closely combined with production and scientific research practice, and project-based teaching mode is adopted to stimulate students' interest and motivation for active learning, enhance professional recognition and pride, improve educational effectiveness, and provide reference for similar courses. Figure 1 shows the practical framework of the “Integration of Industry and Education+Curriculum Ideology and Politics” integrated teaching mode for the “Fundamentals of Materials Science” course. It clearly lists the problems, solutions, and goals currently existing in the “Fundamentals of Materials Science” course, providing new ideas for its teaching.

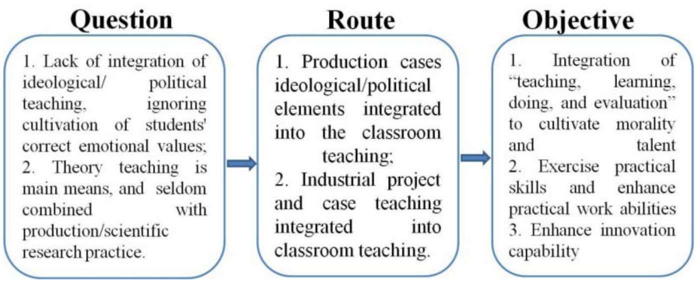

Figure 1 : Schematic diagram of the practical teaching mode of “integration of industry and education+curriculum ideology and politics” and “Fundamentals of Materials Science” course integration.

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3. Integrating production and education cases and ideological and political elements into the classroom teaching of “Fundamentals of Materials Science”

The introduction and research of many concepts or principles in the course of “Fundamentals of Materials Science” contain rich humanistic factors that can be used for ideological and political education. Therefore, in the context of the integration of industry and education, theoretical and experimental courses are used as carriers to deeply explore the content and characteristics of the “Fundamentals of Materials Science” course, reconstruct the teaching content, introduce a large number of production and scientific research cases, combine the development process of materials in China and the latest technological progress, and integrate ideological and political elements. This not only enhances the interest of the teaching content, but also cultivates students' correct emotional values such as innovation, entrepreneurship, patriotism, etc.

Firstly, strengthen the combination of basic theories and application cases. When explaining the basic theories of material microstructure, properties, etc., a large number of practical application cases are introduced.

Secondly, integrate into the development history and achievements of Chinese materials. Add the glorious achievements of ancient Chinese materials science to the Fundamentals of Materials Science courses. For example, the smelting technology of Chinese bronze ware originated in the late Neolithic period (around 3000 BC) and reached its peak in casting techniques during the Shang and Zhou dynasties, shaping the Chinese ritual and music civilization. In addition, the origin of Chinese ceramic production can be traced back to the early Neolithic period (around 14000 BC), starting from the WannianXianrendong site in Jiangxi. After thousands of years of technological iteration, a unique craftsmanship system has been formed, becoming an important material carrier of Chinese civilization.

Finally, examples of the rapid development of materials science in modern China can also be introduced. For example, the solid lubricating materials developed by the Lanzhou Institute of Chemical Physics of the Chinese Academy of Sciences have provided an effective guarantee for the reliable operation of the key moving parts of the “two bombs and one satellite”, ensuring the successful launch and normal operation of the satellite. The research and development of these materials is carried out under the major strategic needs of the country. Researchers have overcome many technical difficulties and, through extensive experiments and testing, have ultimately developed special materials that meet the requirements of spacecraft. Table 1 shows some typical examples of content reconstruction and integration of ideological and political elements in the Fundamentals of Materials Science. Through these examples, it is expected to inspire students’ national pride and cultural confidence, and make more and greater contributions to the economic development of our country.

Table 1:Examples of content reconstruction and integration of ideological and political elements in the Fundamentals of Materials Science.

knowledge point	ideological and political integration
1. Introduction	The bronze wares and related smelting technology of Xia Dynasty in Chinese history are the important features of human beings entering the civilized era, and cultivate students' national pride and feelings of home and country.
2. Crystallogra-phy Basis	At present, China's synthetic diamond technology is at the world's leading level, which is attributed to the continuous progress of domestic material preparation technology, which enhances students' professional identity and professional pride.
3. Diffusion of atoms and molecules in solids	At present, China's lithium battery new energy industry ranks first in the world, highlighting the responsibility of big countries, enhancing students' awareness of energy conservation and emission reduction and green development concept, and increasing students' sense of mission and national pride.
4. Binary phase diagram	China’s ceramic civilization for thousands of years is a process of continuous exploration and practice of the composition and properties of materials on the SiO_2-Al_2O_3 phase diagram, which is thousands of years earlier than the establishment of the phase diagram theory in the West.
5. Iron-carbon phase diagram	China's steel industry relies on scientific and technological innovation to lead the high-quality development of the industry, and its production capacity accounts for more than 50% of the world. Cultivate students' national pride, enhance national consciousness and patriotism.
6. Ternary phase diagram	Jin Zhanpeng, an academician of China, pioneered the study of the whole isothermal cross section of ternary phase diagram on one sample, and its efficiency was dozens of times that of conventional methods. Stimulate students to enhance their innovative ability.

4. Integrating industrial project teaching and case teaching into the “Fundamentals of Materials Science” classroom teaching

Teachers’ research, practical production in enterprises, subject competitions and other projects are

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introduced into the classroom. Project-based teaching and case teaching are carried out. They would improve students' practical ability, innovation consciousness and teamwork ability, while integrate ideological and political elements such as “professional spirit” and “craftsman spirit” into teaching.

The project-based teaching method takes students as the main body and drives students to learn independently through project tasks. It adopts a combination of in class and out of class activities, theoretical practice, and teaching, production, and scientific research. Students are free to group, cooperate, divide labor, and assist each other, explore and solve problems independently, cultivate practical skills, and enhance their ability to analyze and solve problems. After emphasizing the necessary concepts and methods taught by teachers, students participate in the selection, research, design, implementation, and acceptance reporting of the project as a team. Teachers follow up and guide students throughout the process, answer questions and clarify doubts, and guide their practical exploration, paying attention to the performance of each student in the project promotion process.

Taking the detailed project of “synthesis and characterization of titanium oxide nano powder” as an example, this article will introduce how to strengthen students' understanding and mastery of the Fundamentals of Materials Science course through project-based teaching, so that students can deeply understand the internal relationship between composition, structure, process and performance through this project, and improve students' innovation ability and practical skills.

4.1 Determine project objectives

When discussing the relationship between material composition, structure, process and performance, a comprehensive project was designed to “explore the influence of different synthesis methods on the characteristics of titanium oxide nano powder”. Students are divided into groups to prepare titanium oxide nano powder by different synthesis methods, compare the differences in structure and performance of materials obtained by different preparation processes, and analyze the reasons for these differences. The project teaching objectives are set as follows: (1) to enhance students' hands-on practical abilities, enabling them to analyze material testing data and identify problems; (2) Guide students to deeply understand the synthesis mechanism of titanium oxide, and understand the relationship between the performance of titanium oxide nano powder and the synthesis process through the analysis and comparison of experimental data.

4.2 Project Task Design

The key to the effectiveness of project-based teaching lies in carefully designed project tasks, which directly affect students' learning motivation. Teachers need to conduct in-depth research, optimize project task design, take “learning by doing” as the guide, stimulate students' learning enthusiasm, and cultivate their potential, innovation ability, practical skills, communication skills, and teamwork spirit.

In the project of “synthesis and characterization of titanium oxide nano powder”, task design needs to fully integrate theory and practice, and emphasize pertinence, operability and suitability. The teaching process should reflect the characteristics of mutual integration and progress, highlighting students' autonomous learning and knowledge action transformation.

For example, combining crystal structure, we inspire students to explore the influence of rutile and rutile structures on photocatalytic performance. Combining with the related content of crystal structure defects, we inspire students to discuss the influence of different doping elements on the photocatalytic performance of titanium oxide nano powder. Then we inspire students to explore the impact of different preparation processes on the final performance.

4.3 Project Implementation

Project implementation is the most critical link in project-based teaching. Students' professional knowledge, practical skills and operational ability are mainly obtained through this process. Students are the main body of learning, and teachers play an auxiliary and guiding role. Figure 2 shows the Schematic diagram of the Project Implementation.

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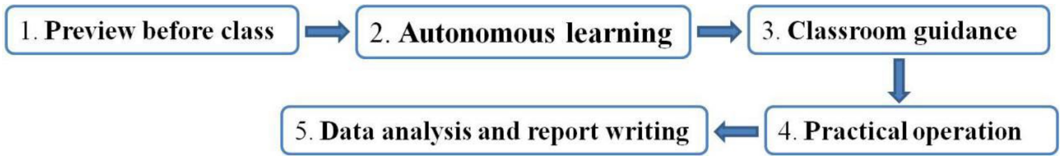

Figure 2 : Schematic diagram of the Project Implementation

(1) Preview before class: Teachers provide relevant project materials, release tasks and put forward project requirements.

(2) Autonomous learning: Students assign tasks and retrieve relevant literature.

(3) Classroom guidance: Teachers track the completion of students' tasks, answer questions and intervene at any time, and correct mistakes or shortcomings.

(4) Practical operation: Students conduct experiments such as synthesis, characterization and performance test of TiO_2nano-powder in the laboratory.

(5) Data analysis and report writing: Students analyze the experimental data, write the experimental report and make a defense.

Teachers combine students' self-evaluation, make evaluation, and make statistical analysis on the results of each link of project-based teaching, so as to provide basis for the continuous improvement of subsequent teaching and achieve the purpose of continuously improving teaching quality.

In this way, the integration of “teaching, learning, doing and evaluating” has been realized.

5. Conclusion

Fundamentals of Materials Science is a highly theoretical and essential professional foundation course, and exploring efficient teaching methods is crucial for fostering moral education and talent development. The integration of industry and education can provide new dimensions and developmental pathways for the teaching of this specialized course. This paper analyzes the characteristics and current teaching status of the Fundamentals of Materials Science course, proposing various approaches such as reconstructing teaching content, incorporating ideological and political elements into classroom instruction, closely integrating experimental teaching with production and research practices, and adopting a project-based teaching model. These strategies achieve the integration of the four key components—“teaching, learning, doing, and evaluating”—stimulating students' interest and motivation in active learning, enhancing their professional recognition and pride, and improving the effectiveness of moral education.

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