

Exploration and Practice of Integrating Ideological and Political Education into the 'Powder Modification Technology' Course under the Emerging Engineering Education Background

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Abstract

Powder Modification Technology is a core course in Powder Materials Science and Engineering. Based on the curriculum objectives under the Emerging Engineering Education initiative, a case repository was established for ideological and political education. To fully leverage specialized courses as vehicles for moral education, the "Four-Oriented" principle was implemented, namely creating student-oriented high-quality classrooms, enriching ideological integration-oriented teaching resources, enhancing engineering case-oriented professional competence and ethics, transforming instructional strategies-oriented learning paradigms. This reform has significantly improved teaching effectiveness, achieving a synergistic integration of knowledge delivery, skill development, and value cultivation.

Keywords

Ideological and Political Education, Powder Modification Technology, Emerging Engineering Education, Teaching Practice.

1. Introduction

Amidst the deepening reform of Chinese higher education, the Emerging Engineering Education initiative has garnered significant attention as a pivotal strategy to drive innovation in engineering education. Beyond updating disciplinary content and restructuring knowledge systems, Emerging Engineering Education fundamentally emphasizes the integration of ideological and political education with specialized instruction, aiming to cultivate high-caliber engineering talents aligned with national strategic demands in the Emerging era [1-2]. This paradigm shift raises a critical question for materials science-related disciplines: how to achieve organic synergy between professional curriculum delivery and ideological-political education principles.

As foundational materials underpinning modern industry and high-tech sectors, powder materials require performance optimization and functional modification. The Powder Modification Technology course, serving as both a core component of Powder Materials Science and Engineering programs and a crucial platform for fostering innovation capabilities and engineering praxis [3], directly connects with advanced material development, traditional industry upgrading, and cutting-edge technological applications. Nevertheless, current pedagogical practices predominantly emphasize foundational knowledge transmission and

technical skill acquisition, while inadequately addressing the cultivation of social responsibility, innovative mindset, and professional ethics [4].

The present paper aims to explore the practice of ideological and political education in the course of Powder Modification Technology with the view of Emerging Engineering Disciplines. To this end, a teaching system has been developed that integrates knowledge transfer, the cultivation of skills, and value leadership. This system combines professional education with ideological and political education, thereby achieving an organic fusion of both educational models. It establishes a novel engineering education model that integrates theory and practice, unifying the cultivation of individuals and talents.

2. Course Objective Orientation

The Powder Modification Technology course, serving as a core curricular component in Powder Materials Science and Engineering programs, functions as a critical nexus bridging theoretical knowledge with industrial practice, as well as academic training and enterprise requirements (Figure 1). In accordance with the disciplinary positioning and industry demands under the Emerging Engineering Education framework, this course transcends conventional pedagogical objectives limited to foundational knowledge transmission and technical competency development, and strategically prioritizes value cultivation and paradigm-shaping thinking modes. Aligned with graduation attainment requirements for professional talent development, the course establishes three-tiered learning objectives.

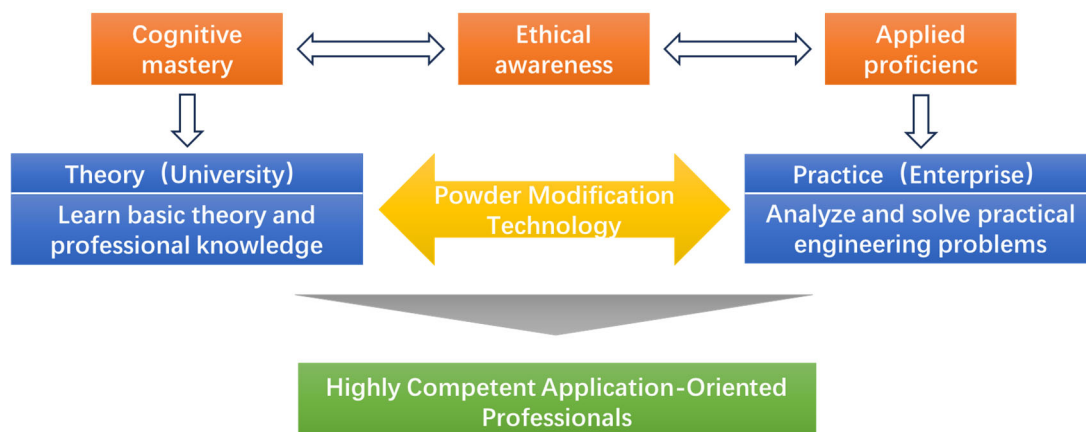


Figure 1. Role of "Powder Modification Technology" course

(1) Cognitive mastery: Understand and master the fundamental theories and professional knowledge regarding surface modification methods and principles, surface modification techniques, surface modification equipment, and surface modification agents. Acquire comprehension of the fundamental knowledge related to detection and characterization involved in process control and product evaluation of surface-modified products, as well as the professional knowledge associated with complex issues in the field of powder engineering.

(2) Applied proficiency: Be capable of identifying interaction mechanisms between powder surfaces or interfaces and modification agents. Be able to process design, equipment selection, and agent optimization tailored to specific powder characteristics and operational requirements. Be capable of establishing correlations between evaluation methods and powder properties, and ultimately achieve systematic problem-solving capabilities for powder engineering through integrated application of professional knowledge.

(3) Ethical awareness: Cultivate patriotic commitment with unwavering loyalty and a profound sense of national responsibility. Develop scientific integrity grounded in truth-seeking

pragmatism, practical innovation, and intellectual rigor. Nurture professional excellence through diligent rigor, resilient perseverance, and a relentless pursuit of mastery. Promote the national ethos, foster cultural confidence, and cultivate a profound understanding of engineering ethics and professional integrity.

3. Construction of Ideological and Political Case Library

Guided by the Curriculum Ideological and Political Construction Guidelines for Higher Education Institutions, the instructional team has systematically integrated high-value ideological-political elements into the Powder Modification Technology course through multidimensional alignment with its technical characteristics, cognitive frameworks, and inherent value propositions.

Case development adheres to socialist core values while addressing the dual demands of socioeconomic advancement and industrial upgrading in powder materials. This pedagogical architecture aims to foster students' ethical worldview, life philosophy, and value system, strengthen professional and disciplinary identity, and implement holistic education through comprehensive coverage, diversified approaches, and targeted integration.

The curriculum's ideological-political matrix crystallizes into five thematic pillars: patriotic dedication through powder technology, cultivation of craftsmanship ethos, cultural confidence in materials innovation, pioneering spirit in technological breakthroughs, professional ethics compliance in engineering practice.

The instructional team implements a dual-modal framework for case selection and ideological-political element integration, combining top-down and bottom-up approaches [5]. Top-down methodology strategically aligns curriculum objectives under the Emerging Engineering Education paradigm with value cultivation targets. A representative implementation includes the documentary film of *China's Decade: A Nation in Confidence*, which was introduced in the first lecture. The screening of this documentary will facilitate the cultivation of a quadripartite awareness of global, national, political and societal landscapes. The result will be an enhanced tripartite identification of political, ideological and emotional aspects with innovation theories of the Party and the State. Inversely, bottom-up methodology reverse-engineers ideological-political connections from technical content. For instance, when instructing on mechanochemical modification, the comparison of ancient Chinese powder milling technologies with modern equipment can be employed to elucidate the engineering axiom "Precision tooling determines technical mastery". This approach has resulted in the formulation of the case of *Never Undertake Milling without Diamond-grade Implements*, which has been shown to achieve two objectives: namely, the enhancement of both technical comprehension and cultural heritage appreciation. The ideological and political systems, cases and integration methods of "Powder Modification Technology" course are shown in Table 1.

4. Practices of Ideological and Political Teaching

In the ideological-political pedagogy of Powder Modification Technology, the instructional team not only excavate discipline-specific educational resources with strong ideological relevance, but also integrate the political-education into professional courses through reasonable methods and means. In order to give full play to the function of professional courses as a carrier of ideological education, the "Four-Oriented" pedagogical approach was implemented.

4.1. Create student-oriented high-quality classrooms

The course strategically highlights China's groundbreaking achievements in powder science, including bottleneck-defying ultrafine powders critical to microelectronics, stealth-enabling nanocomposites for aerospace applications, and biomimetic particulate systems inspired by

natural principles. These case studies enable students to recognize the strategic value of powder technology in cutting-edge industries while fostering pride in national scientific capabilities, thereby cultivating the patriotism and research dedication.

Pedagogically, the curriculum bridges historical culture with modern innovation by exploring China's ancient powder techniques, contemporary breakthroughs by leading scientists, and emerging frontiers pioneered by young researchers in advanced powder materials. This temporal integration constructs a narrative of civilizational continuity through powder science, strengthening cultural confidence in material innovation.

Table 1. Ideological and political systems, cases and integration methods of "Powder Modification Technology" course

Systems	Cases	Integration Methods
Patriotic Commitment & National Service	China's decade: A nation in confidence	Video introduction
	Youth's potential: The May Fourth spirit empowering young responsibility	Thought provoking
	Junior, you were born in a great country	Task-driven
	Perfection through mundane mastery: The charm of craftsmanship	Independent enquiry Inspired teaching Comparative analysis
Powder Masters & NextGen Pioneers	A heart to serve the country, a lifetime of powdered love: Academician Huang Boyun	Video showcase
	Twenty years for a singular particle: Prof Li Jianguo	Throwback
	Commitment to powders, actualization of self: Exemplary Bo Kailong	Storytelling
	Revolutionizing superconductivity through individual ingenuity: Young scientist Cao Yuan	Summary reflections Situational modelling Group discussions Role-playing Professional experience Characters introduction Inspiring teaching
Cultural Legacy & Powder Development	Ancient dehulling vs. modern selective comminution	Case studies
	'Salt substitute' programme for powder technology	Comparative migration
	Never undertake milling without diamond-grade implements	Physical actions
	Winnowing wisdom: from wheat threshing to pneumatic separation	Interactive Q&A Case studies Interactive Q&A Case inspiration Invisible penetration
Powder Innovation & Societal Impact	Mystery of Bing Dwen Dwen's shell material in Winter Olympics	Problem solving
	Micronised powders give fighter jets a 'cloak of invisibility'	Teamwork
	Microsphere powder: the national industry can not bear the weight	Brainstorming
	Powder economies: Building Hezhou's industrial citadel	Summarising, reflecting Inspired teaching Small group seminar Case studies Interactive discussion
Powder Safety & Professional Ethics	Powder 'fire' can not be underestimated	Task implementation
	Environmental storm is not a bad thing for China's powder industry	Learning by examples
	Powdering the sky: Sustainable dispersion strategies	Online learning
	Laboratory magnesium powder dust cloud explosion prompts thoughts	Self-directed analysis Mission implementation Breakout groups Creating situations Role-playing

Innovations in powder technology and safety issues were incorporated into the classroom curriculum, including the economic transformation of Hezhou driven by powder technology, and the functional material behind the shell of the Olympic mascot Bing Dwen Dwen. This pedagogical approach fosters students' engagement with contemporary issues pertaining to powder technology. Besides, some powder safety and environmental protection cases were introduced, such as beware of 'self-heating hot pots', and powder 'fire' can not be underestimated. These cases serve to remind students of powder safety issues and stimulate deeper thinking about production safety and ethics.

The integration of ideological-political education not only reinvigorates conventional disciplinary instruction by transcending its monotony but also transforms students' stereotypical perception of theoretical courses as "dry" and "inaccessible." This pedagogical approach enhances the efficacy of value-driven education while fostering a high-quality academic environment that harmonizes technical expertise with ethical literacy.

4.2. Enrich ideological integration-oriented teaching resources

Guided by the talent cultivation objectives and syllabus requirements of powder materials science, revamp teaching content by integrating value-based components to establish a holistic ideological-political framework within the New Engineering Education. It is imperative that the teaching content is updated in accordance with the development and changes of the times. This includes the integration of socialist core values, Chinese excellent traditional culture, and the ideological and political elements related to professionalism and professional ethics into the teaching cases. This approach will enable students to learn the principles and methods of powder modification technology and, at the same time, understand its role and value in the development of society.

The excavation of the ideological elements and the implementation of the corresponding instructional design can also guide the construction of teaching resources for the Powder Modification Technology Course. Therefore, the teaching team has undertaken the construction of the case library for the course civics, as well as the revision of the syllabus and the preparation of the lecture plan. Based on curriculum ideology and politics, deepening the teaching resources construction of the course 'Powder Modification Technology' can effectively promote the deep integration of professional education and ideological and political education. Concurrently, the construction of advanced teaching resources will certainly promote and drive the reform of the teaching mode and teaching method of powder materials science and engineering, and promote the teaching reform of related professional courses and improve the teaching level of teachers.

4.3. Enhance engineering case-oriented professional competence and ethics

The Powder Materials Science and Engineering specialty is an emerging interdisciplinary field encompassing science, engineering, agriculture, medicine, and other domains [6]. Due to its relatively late establishment, high-quality teaching resources for this discipline remain insufficient, with a notable scarcity of curriculum-based ideological and political elements grounded in engineering case studies [7]. To strengthen students' professional competence and ethical awareness, course design must emphasize the integration of cutting-edge scientific achievements, practical engineering cases, and safety incidents related to improper operations in powder modification technology. For instance, the presentation of research on the impact of high-temperature mechanochemical modification of iron oxide on the anti-corrosion properties of epoxy coatings can serve to demonstrate to students the application of frontier scientific advancements in powder materials. Incorporating case studies like the modification of plastic powders using Aoda powder dispersants can help students to analyze their practical effects in industrial applications. The discussion through safety risks of real-world incidents such as the December 26 magnesium powder dust cloud explosion at Beijing Jiaotong

University and potential explosion hazards in everyday items like hand warmers, can highlight the safety considerations in powder material usage.

By leveraging advanced scientific achievements and authentic engineering cases, students can cultivate a pragmatic work ethic, rigorous scientific mindset, professional dedication, and social responsibility. This approach not only enriches disciplinary content but also nurtures craftsmanship spirit and professional integrity, laying a solid foundation for students' future careers in powder engineering technology.

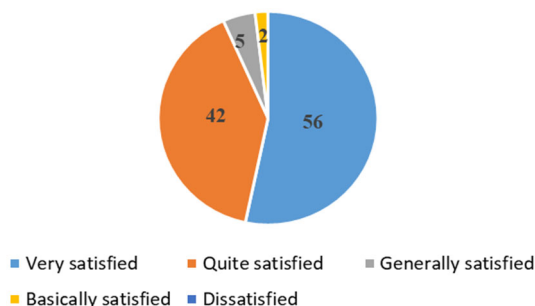
4.4. Transform instructional strategies-oriented learning paradigms

During the teaching process, it is important to focus on scientific enquiry, highlight problem orientation and emphasise the creation of problematic situations. By adapting to students' characteristics and course content, diverse teaching strategies are flexibly employed, including demonstration-based, case-based, heuristic, task-driven, group discussion-based, and inquiry-based teaching methods. These approaches actively engage students' enthusiasm and participation, guiding them toward self-directed and personalized learning, thereby transforming traditional learning paradigms. Additionally, leveraging available teaching resources, multimedia platforms such as Tencent Meeting, Superstar Fanya Online Teaching Platform, MOOC China, and Rain Classroom are strategically utilized. Through online-offline blended teaching models, course content is presented comprehensively and multidimensionally, fostering students' abilities to critically identify, analyze, and resolve problems. This integration strengthens students' cognitive understanding of specialized course content and enhances their professional competencies.

5. Evaluation of the Reform Effectiveness

The teaching team remains steadfast in upholding its primary responsibility for ideological and political education, positioning curriculum development as the "central battlefield" and transforming classroom instruction into the "primary channel" for seamlessly integrating moral education elements into specialized courses. This approach ensures the efficient transmission of values to students, achieving a "gentle yet profound educational impact with a humanistic touch". In advancing curriculum ideology and politics, active student participation has catalyzed the creation of high-quality classroom environments, the development of a curriculum ideology and politics case study repository has enriched teaching resources, engineering case analyses have strengthened students' professional competence and ethical awareness, and diverse teaching methodologies have driven innovation in students' learning approaches. This systematic integration fosters both disciplinary expertise and moral cultivation, exemplifying a holistic educational paradigm.

Are you satisfied with the effectiveness of the Civic Education of Powder Modification Technology course? (Single choice)



What are your favourite elements of the course's Civics? (Multiple choice)

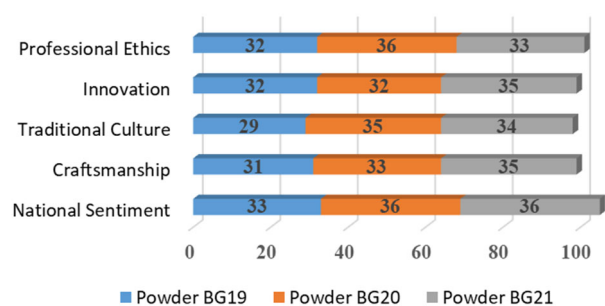


Figure 2. Results of the questionnaire survey on ideological and political education

To objectively evaluate the educational efficacy of ideological and political integration in the Powder Modification Technology course, we conducted a "Survey on Student Acceptance of Ideological and Political Education in Powder Modification Technology" targeting Powder Materials Science and Engineering majors over the past three years, yielding 105 valid responses. The results are illustrated in Figure 2. Regarding satisfaction with the ideological and political education outcomes, 53.3% of students reported being "very satisfied", 40.0% were "quite satisfied", 4.8% expressed "generally satisfied", and 1.9% indicated "basically satisfied". Notably, no students selected "dissatisfied", demonstrating overwhelming approval of the curriculum's educational impact. When asked about their most favored ideological and political elements, patriotic sentiment received 100% endorsement. Craftsmanship spirit, innovative mindset, and professional ethics garnered 94.3%, 94.3%, and 96.2% support respectively. Traditional cultural values achieved 93.3% approval. These results reflect broad consensus among students, with no significant preference. Overall, the survey confirms that curriculum-based ideological and political education has played a pivotal role in the Powder Modification Technology course, exerting a positive impact on both teaching practices and student development.

6. Conclusion

The Ideological and Political Teaching Practice in the Powder Modification Technology Course plays an irreplaceable role in cultivating students' patriotic sentiment, fostering a craftsmanship spirit, strengthening cultural confidence, enhancing social responsibility, and upholding professional ethics. The curriculum's ideological and political case repository comprises five core systems, namely, *Patriotic Commitment & National Service*, *Powder Masters & NextGen Pioneers*, *Cultural Legacy & Powder Development*, *Powder Innovation & Societal Impact* and *Powder Safety & Professional Ethics*, as well as twenty exemplary cases. In the reform of ideological and political teaching practices, the course emphasizes student-centered pedagogy to create high-quality classrooms and highlights the critical role of engineering case studies in advancing professional competence and ethical awareness. By adopting diverse teaching methodologies, the curriculum achieves deep integration of ideological and political education, driving holistic progress in knowledge transfer, skill development, and value cultivation, with remarkable educational outcomes. This practice serves as a valuable reference for course development under the New Engineering Education model, demonstrating how technical disciplines can synergize professional training with moral education.

Acknowledgements

This work was supported by the Ministry of Education's Industry-Academia Collaborative Education Program [2412041118], and the Liaoning Institute of Science and Technology's Curriculum-Based Ideological and Political Education Model Course Development Project.

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