

Investigation on the Ideological and Political Elements of “Materials for Mechanical Engineering”

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Abstract: “Materials for Mechanical Engineering” is an essential foundational course for the students majoring in mechanical engineering. Professionals in the field of mechanical engineering are the core force for the development of industry. While imparting technical knowledge, it is equally significant to pay attention to the students’ ideological and political education, thus achieving the unity of fostering both technical expertise and character development. In this work, the main contents of the “Materials for Mechanical Engineering” are summarized. Ideological and political elements are comprehensively investigated from three perspectives. Entry points for the organic integration of ideological and political elements with the course contents are also provided. Furthermore, assessment methods for ideological and political education are explored. A process-based evaluation system for ideological and political education is established in the background of professional engineering accreditation.

1. Introduction

“Materials for Mechanical Engineering” is a mandatory foundational course for second-year students majoring in mechanical engineering in China. It serves as an introductory course that guides students into the field of mechanical engineering and lays the foundation for subsequent courses. The key objective of the course is to help students understand material properties, grasp the processing and shaping methods, acknowledge the technological processes of commonly used engineering materials, and be able to select appropriate materials and processing methods. As known to all, students in mechanical engineering will be the core force in the development of the industry. To achieve the unity in fostering both talent and character, more efforts should be paid to the ideological and political education of the students in addition to imparting technical knowledge [1,2]. The “Guidelines for Ideological and Political Education in Higher Education Courses” issued and implemented by the Ministry of Education in June 2020 provides an overall plan and deployment for the ideological and political education in higher education courses [3]. It is explicitly emphasized to collaborate of professional education with ideological and political education and create a synergistic effect on development of students. Besides, introducing

ideological and political elements in the teaching of “Materials for Mechanical Engineering” not only enriches the content of the course but also guides students to contemplate the applied value and influence of materials science. This, in turn, enhances students’ professional ethics, strengthens their sense of social responsibility, and promotes their overall development. Therefore, it is worth to explore how to align the professional education and the ideological and political education in the course “Materials for Mechanical Engineering”.

A suitable ideological and political element could effectively highlight the key point of a chapter, and an appropriate integration method of the element and key point will make the teaching process more attracting. However, the main challenge currently faced in the teaching of “Materials for Mechanical Engineering” is the lack of ideological and political elements. The absence of ideological and political information, coupled with the inability to directly identify the ideological and political element in the textbooks, makes it difficult to proceed with ideological and political education. Generally, the exploration of ideological and political elements needs to start from the knowledge points of the course and find the content that could be extended into ideological and political education. This content is regarded as an entry point for the implementation of ideological and political education. Moreover, the ideological and political elements should align with the professional content [4]. A seamless connection between the ideological and political information and the professional knowledge is essential to achieve better educational performance. Furthermore, a reasonable assessment method can genuinely reflect the students’ learning outcomes, which is useful for the improvement of the ideological and political education in the future. Therefore, developing a reasonable assessment method is crucial for ideological and political education [5].

This study aims to deeply explore the ideological and political elements, and achieve their organic integration with the course content. Simultaneously, it delves into the methods of evaluating ideological and political education and establishes a reasonable course assessment method. The main contents are structured as follows: the main content of the course is introduced in Section 2, and the ideological and political elements are investigated in Section 3. Then, the assessment method of ideological and political education is explored in Section 4. Finally, the main conclusions of this study are presented in Section 5.

2. Contents of the Materials for Mechanical Engineering

“Materials for Mechanical Engineering” is a specialized engineering course within the field of engineering. The course does not inherently contain explicit ideological and political elements. Therefore, instructors need to systematically review and summarize the key knowledge points of each chapter, and use these as a basis to identify entry points for ideological and political education. The “Materials for Mechanical Engineering” course consists of seven chapters: Chapter 0 is the introduction of course; Chapter 1 introduces the material property; Chapter 2 presents the material Structure; Chapter 3 is about the solidification of material; Chapter 4 includes the deformation and recrystallization of metal; Chapter 5 presents the heat treatment of Steel; Chapter 6 introduces the industrial steel. The key knowledge points for each chapter are summarized as Table 1.

3. Exploration on the Ideological and Political Elements

For the technical courses such as the “Materials for Mechanical Engineering”, only the ideological and political elements inspired by the discipline could resonate with students and enhance the effectiveness of teaching. Therefore, it is necessary to integrate these elements with the specific characteristics of the profession. Based on the summary of the course knowledge points in Section 2, three aspects related to the profession are investigated in this section to discover the ideological and political elements. Besides, the objectives of the ideological and political education

are also clarified, and examples of ideological and political education corresponding to the knowledge points are provided to integrate these elements into the teaching process. The entry points of the ideological and political elements, as well as the goals of ideological and political education, are illustrated in Figure 1.

Table 1: Knowledge points of “Materials for Mechanical Engineering”.

Chapters	Key knowledge points
Chapter 0 Introduction	Classification and application of materials; purpose, content and learning requirements of the course
Chapter 1 Property of material	Mechanical, physical and chemical properties of materials
Chapter 2 Structure of material	Combination of atoms; basic concepts of crystal structure; structure of metals
Chapter 3 Solidification of material	Crystallization of pure metal and alloy; phase diagram of iron-carbon alloy
Chapter 4 Deformation and recrystallization of metal	Plastic deformation of metals; plastic deformation and strengthening of alloys; effects of plastic deformation on materials; recovery and recrystallization
Chapter 5 Heat treatment of steel	Transformation of steel during heating and cooling; annealing, normalizing, quenching and tempering of steel; surface heat treatment of steel
Chapter 6 Industrial steel	Classification and numbering of steel; structural steel, tool steel, special performance steel

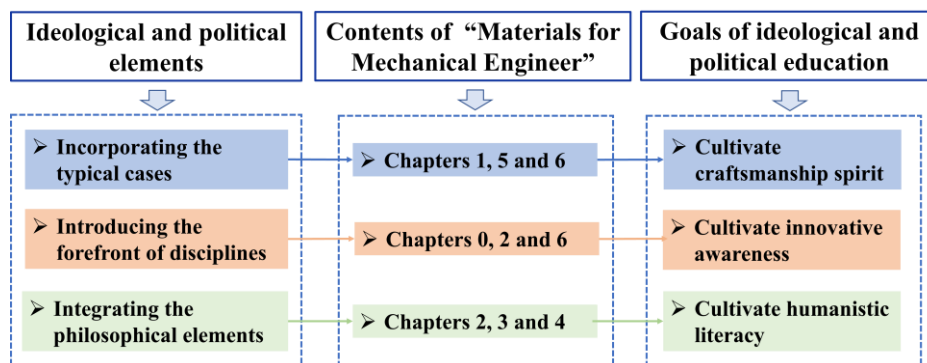


Figure 1: Implantation of the ideological and political elements.

3.1. Incorporating the Typical Cases to Cultivate Students’ Craftsmanship Spirit

The field of materials science has a long history of development. Introducing the typical cases that have influenced the development of materials science during the teaching process can stimulate students’ thinking, thus fostering a spirit of diligence, concentration and excellence akin. The positive cases can inspire the students, while the negative examples can serve as a cautionary reminder which also achieves the goals of ideological and political education. For example, when introducing the mechanical properties of materials in the Chapter 1, students can be educated about the strict and unwavering work attitude required in design, manufacturing and scientific research by using the example of the Titanic’s accident due to the material low-temperature brittle fracture. When discussing the heat treatment of metals in Chapter 5, it is essential to emphasize that the heating and cooling processes of materials require the strict control of temperature and time to ensure the optimal enhancement of material properties. This example could help students cultivate the qualities of patience and attention to detail. For the industrial steel in Chapter 6, the China's

successful development of 16Mn steel could be introduced to students, and the 16Mn steel has been applied in the construction of the Nanjing Yangtze River Bridge after decades of research. This can inspire students to remain resolute and have the courage to overcome the industry challenges.

3.2. Introducing the Forefront of Disciplines to Cultivate Students' Innovative Awareness

Introducing the forefront of disciplines as ideological and political elements and using professional hot topics to ignite curiosity can inspire students to develop innovative thinking and abilities, thereby achieving the desired educational goals. For example, when introducing the application of materials in Chapter 0, you can present current developments in new materials, such as 3D printing materials and environmentally friendly materials. Additionally, it's essential to discuss present research trends and challenges during the teaching process. In Chapter 2, focusing on the material structures, it is recommended to introduce advancements in grain boundary theory and their significance in the development of new energy batteries. In Chapter 6, covering industrial steel, you can list common failure modes in typical engineering components, present the latest failure analysis methods, and outline improvement measures. What's more, teachers can share their research ideas, methods, and progress with students through various means, such as case studies and class discussions.

3.3. Integrating the Philosophical Elements to Cultivate Students' Humanistic Literacy

Excellent thinking patterns are important for students' future learning and working. Although the "Materials for Mechanical Engineering" is a technical course, it is essential to emphasize the cultivation of students' philosophical thinking and humanistic qualities. For instance, when discussing the material structures in Chapter 2, students could investigate the material from different dimensions (i.e., macroscopic, microscopic and nanoscopic) by the use of optical and electron microscopes. This could inspire students to cultivate the philosophical thinking and ability to comprehensively analyse issues from multiple perspectives. In Chapter 3, it should be emphasized that the grain strengthening will appear during the solidification process of materials. The metal's strength firstly increases as the grain size decreases, but when the grain size reaches the nanoscale, further reduction can actually decrease material strength. The same principle applies to the effect of plastic deformation on the material strength, as discussed in Chapter 4. Using these physical phenomena illustrates the duality of objects and encourages students to adopt the dialectical thinking when solving problems.

4. Assessment Methods for the Ideological and Political Elements

Establishing a scientific, rational and comprehensive assessment method is a significant way to evaluate the student learning outcomes and enhance the teaching quality. Furthermore, accurately reflecting the effectiveness of ideological and political education in the course assessment is meaningful for the improvement of ideological and political education. To increase the students' initiative and engagement, a multifaceted and multilayered approach should be adopted in the assessment, changing from the traditional closed-book examination model to the evaluation of comprehensive skills and abilities. Relevant assessment methods should be formulated to promote students' all-around development. In the background of the engineering education accreditation, it is imperative to leverage modern educational technology, employ continuous assessment methods, record students' participation and analyse the effectiveness of ideological and political elements. Timely feedback should be provided to students, and the process evaluation results should be achieved. This section explores the process-oriented assessment methods from three perspectives,

and Figure 2 provides the assessment methods along with their corresponding weights, including class discussion, research report and report presentation. It should be stated that this section only investigates the assessment methods for the ideological and political education. The assessment results derived from this section could be combined with that of course knowledge to form the final assessment grade.

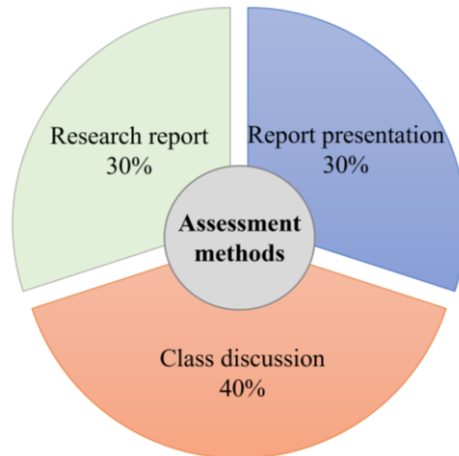


Figure 2: Assessment methods and proportions.

4.1. Class Discussions

In general, class discussions are designed to involve the students working in small groups to discuss and elaborate on the key points and case studies presented during the lecture. Students are selected to present their viewpoints. Class discussion could enhance the learning atmosphere, assess the students' understanding of ideological and political elements, and provide timely insights into their value orientation. By conducting multiple class discussions, each student is given at least one opportunity to present their ideas, and their performance is graded accordingly. Class discussion results contribute to the 40% of the ideological and political assessment.

4.2. Research Reports

Research reports are designed for students to work in groups and independently choose topics related to engineering materials. Firstly, they have to collect information through methods such as data research and surveys. Then students should establish the connections between their research and the course's specialized knowledge. Finally, a course research report needs to be formed. Research reports could assess students' command of specialized knowledge, evaluate their comprehensive problem-solving abilities and improve their teamwork skills. Additionally, each student's specific role in the research report should be stated in the report. Students are assessed and graded based on the report's quality and individual contributions. Research report grades account for 30% of the ideological and political assessment.

4.3. Report Presentations

The aim of report presentations is to let students present in class based on their research reports. Various forms, such as using PowerPoint (PPT) and videos, could be selected. During presentations, all students in the group are required to participate in the live speech. In special circumstances, they can also choose to record a video or audio presentation. Report presentations could reinforce the students' understanding of specialized knowledge and motivate their active participation. Also,

students will improve their communication and teamwork skills. Students are graded based on their live performance. Report presentation grades account for 30% of the ideological and political assessment.

5. Conclusions

In this work, the ideological and political elements of “Materials for Mechanical Engineering” course are investigated. Incorporating typical cases, introducing the forefront of disciplines, and integrating philosophical elements can cultivate students’ craftsmanship spirit, innovative awareness, and humanistic literacy. These methods are effective for conducting ideological and political education. Additionally, an assessment system is proposed, which comprises three assessment methods including class discussions, research reports, and report presentations. The results derived from this work can serve as references for the ideological and political education of “Materials for Mechanical Engineering”.

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