Incorporating Ideological and Political Education in Civil Engineering Mechanics Courses

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Abstract. In recent years, the Chinese government has vigorously promoted Ideological and Political Education (IPE) in higher education, which involves integrating IPE into the teaching of specialized courses. This approach is an important means to achieve the coordinated development of professional knowledge and moral education. Mechanics, as a significant and extensive course in the civil engineering major, serves as a crucial platform for implementing IPE. This paper analyzes the current status and existing problems of IPE in mechanics courses and proposes several approaches to IPE in mechanics courses based on the characteristics of the civil engineering discipline. It also highlights the pitfalls to avoid during implementation, ensuring that mechanics courses truly achieve an organic integration and coordinated development of specialized education and IPE.

Keywords: Ideological and Political Education; Civil Engineering; Teaching Reform.

1 Introduction

In 2016, Chinese President Xi Jinping emphasized at the National Conference on Ideological and Political Work in Colleges and Universities that classroom teaching should be the main channel for integrating ideological and political education (IPE) throughout the teaching process [1,2]. This directive has elevated the importance of IPE in higher education, shifting from standalone "ideological-political courses" to "Courses with Ideological-Political Education (CIPE)"[3]. Classroom teaching, as the main avenue for talent cultivation, plays a crucial role in nurturing well-rounded individuals. The core of CIPE is to embed IPE into professional courses, merging it deeply with specialized knowledge to create a synergistic effect, ultimately achieving the goal of "fostering virtue through education."

Mechanics courses are fundamental to civil engineering programs, as all students in this field must take multiple mechanics courses. Thus, mechanics courses are ideal for integrating IPE[4-6]. Traditionally, professional courses and IPE have been separate, with little interaction between them. Traditional IPE, conducted through theoret-

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ical study, can feel abstract and rigid, while professional courses without IPE guidance often fail to inspire students' enthusiasm for national development. Combining the two can enhance both aspects. For example, demonstrating the role of mechanics in national development can foster students' sense of mission and responsibility. Since mechanics courses are abstract and challenging, integrating IPE can make the classroom more engaging, stimulate interest, improve teaching quality, and enhance students' cultural literacy, achieving multiple benefits.

Based on the author's teaching practice, this paper analyzes the current issues in integrating IPE into mechanics courses, explores construction paths and measures for IPE, and contributes to the effective implementation of CIPE.

2 Current State and Problems of CIPE in Mechanics Courses

Currently, many universities have made numerous attempts and achieved certain successes in promoting CIPE teaching reform[7,8]. However, there are still many problems in CIPE construction to date. Taking mechanics courses as an example, the main issues are as follows:

2.1 CIPE Concept Has Not Been Effectively Established

Most mechanics course teachers have not yet established the correct relationship between imparting professional knowledge and cultivating values in their mindset. They still believe that merely explaining professional knowledge to students is sufficient. They are indifferent to the current situation, pushing the responsibility for moral education entirely onto IPE teachers, which naturally prevents the organic integration of professional courses and IPE.

2.2 Inadequate CIPE Construction Mechanism

In the process of promoting IPE construction in professional courses, there is a lack of an effective management plan, making it impossible to form an effective incentive system. Teachers who actively engage in this work do not receive effective encouragement, making it difficult to sustain long-term enthusiasm.

2.3 Low IPE Level Among Mechanics Course Teachers

Most mechanics course teachers focus their energy on professional teaching and lack sufficient research on IPE, resulting in generally low levels of IPE proficiency. Sometimes, when ideological and political elements are temporarily added to the course, it comes across as too rigid, failing to achieve the desired effect.

It is evident that although CIPE is gradually emerging in university teaching, there is still room for improvement in terms of concept, system, and teaching methods. Therefore, continuing to explore more effective IPE methods and avoiding pitfalls in the teaching process are important aspects of future IPE construction.

3 Exploration of Construction Methods for IPE in Mechanics Courses

3.1 Enhancing Students' Sense of Pride by Reviewing Historical Achievements in Mechanics in China

China has a long history and a splendid culture, significantly contributing to world civilization's progress. Historical achievements in mechanics also stand out in the history of global science and technology. Incorporating these historical elements into mechanics teaching enhances students' understanding of theoretical knowledge and significantly strengthens their national pride and cohesion.

For example, when explaining the concept of inertial force, the seismometer invented by Zhang Heng, a scientist from the Han Dynasty, can be used. According to research, the "central pillar" in Zhang Heng's seismometer utilized the principle of an inertial pendulum. When seismic waves passed through, the pillar would lose balance and fall into one of eight surrounding channels, triggering a lever mechanism and releasing a bronze ball from the corresponding dragon's mouth as an alarm. This example helps students understand mechanics principles such as the center of gravity, inertia, and levers while appreciating the wisdom of our ancestors.

Another example is when explaining Hooke's Law of elasticity. Ancient Chinese scholars made similar discoveries. Zheng Xuan (?-86 AD), a Han Dynasty scholar, annotated an ancient Zhou Dynasty text, stating, "Suppose the bow's strength exceeds three stones, draw it to the middle three feet, release its string, and gently bind it with a rope. For each additional stone of weight, the bow stretches one foot." This indicates that within the elastic range, the tension of the bow is directly proportional to its deformation, a concept proposed approximately 1,500 years before Hooke. Learning this, students can marvel at the early understanding of elasticity and its application in production, enhancing the effectiveness of IPE.

The Zhaozhou Bridge, built during the Sui Dynasty (581-618 AD), is another illustrative example. As the oldest and largest span arch bridge, it aligns with modern mechanical principles, remaining intact and functional for over 1,400 years. In 1991, the American Society of Civil Engineers recognized it as an "International Historic Civil Engineering Landmark." Using this example in structural mechanics demonstrates how arch structures utilize material properties, inspiring students to appreciate their predecessors' profound understanding and application of mechanics.

These historical achievements provide excellent materials for IPE in teaching. Integrating them into mechanics courses helps students understand the embedded wisdom, fostering recognition and pride.

3.2 Enhancing Students' Patriotism and Dedication by Sharing the Research Experiences of Chinese Mechanics Scientists

Modern China has produced renowned mechanics scientists who have significantly contributed to scientific research and demonstrated admirable patriotism. Sharing their stories can guide students toward a correct outlook on life, values, and the world, inspiring them to explore and innovate continuously.

For instance, after the establishment of the People's Republic of China, Qian Xuesen overcame numerous obstacles to return to China, making pioneering contributions to the missile and space programs. Guo Yonghuai, another notable scientist, sacrificed his life protecting valuable research materials during a plane crash. Huang Xuhua, known as the "father of China's nuclear submarines," dedicated his life to the nation's nuclear submarine project, ceasing all contact with his family and friends from 1957 to 1986.

Countless mechanics scientists have worked tirelessly for China's independence and self-reliance, forming the nation's backbone. These stories, shared in mechanics courses, uplift students' spirits, inspiring their curiosity and drive for knowledge while strengthening their patriotism and dedication.

3.3 Introducing Current Major Engineering Projects in China to Inspire Students' Pride and Sense of Responsibility for National Development

China is currently in a period of rapid development. The "Belt and Road" initiative and the national rejuvenation strategy have brought unprecedented opportunities for the civil engineering industry, resulting in remarkable achievements in construction that have attracted worldwide attention. These projects integrate almost all the knowledge of mechanics and cutting-edge technologies in civil engineering, placing them at the forefront globally. Introducing these projects in mechanics courses can help students better understand theoretical knowledge, broaden their horizons, and enhance their confidence and sense of responsibility towards national development.

For example, the Hong Kong-Zhuhai-Macao Bridge, spanning 55 kilometers, integrates bridges, islands, and tunnels. It set seven world records during its construction:

The world's longest sea-crossing bridge: Combining islands, tunnels, and bridges, the total length is 55 kilometers, making it the longest sea-crossing bridge in the world. Its design life of 120 years breaks the century-long convention of similar bridges.

The world's longest underwater immersed tube tunnel: The underwater tunnel, with a total length of 5,664 meters, consists of 33 reinforced concrete segments and achieved a "watertight" status for the first time globally.

The world's largest cross-section highway tunnel: The Gongbei Tunnel section of the bridge adopts a double-layer highway tunnel design with an excavation cross-section height of 21 meters, width of 19 meters, and an area of approximately 336.8 square meters, more than three times the area of similar highway tunnels.

The world's largest prefabricated factory for immersed tubes: In 2012, the world's largest modern prefabrication factory for immersed tubes was built on Niutou Island in Zhuhai City. Each standard tube measures 180 meters long, 37.95 meters wide, 11.4 meters high, and weighs about 80,000 tons, making it the largest immersed tube to date.

The world's largest eight-directional hammer: The construction of artificial islands used the world's largest eight-directional hammer, lifting 120 giant steel cylinders and pioneering the rapid island-building technology with deep-inserted steel cylinders.

The world's largest floating crane: The "Zhenhua 30," the world's largest floating crane independently built by China, ensured the successful installation of the final joint. The crane is approximately 297.55 meters long, 58 meters wide, and 28.8 meters from the hull bottom to the main deck, with a displacement of about 158,000 tons and a main deck area equivalent to 2.5 standard football fields.

The world's largest rubber seismic isolation bearings: The bridge uses the world's largest high-damping rubber seismic isolation bearings, independently developed by China, measuring 1.77 meters long and wide. These bearings, with a load capacity of about 3,000 tons, allow the Hong Kong-Zhuhai-Macao Bridge to withstand typhoons of 16 grades, earthquakes of magnitude 8, and collisions with 300,000-ton ships.

Another example is the Sichuan-Tibet Railway, which has been in the planning stages since the early days of the People's Republic of China and officially began construction only in recent years. Dubbed "the world's most difficult railway to build," the Sichuan-Tibet Railway involves more than 80% of its length being constructed as tunnels and bridges, with a cumulative elevation gain of over 16,000 meters—equivalent to climbing Mount Everest twice. The complex geological conditions along the route make it akin to building a "giant roller coaster" through perilous mountains and valleys, representing the most challenging engineering project in the history of railway construction. During the construction of the Sichuan-Tibet Railway, numerous mechanics problems arise, providing rich material for open discussions in teaching. For example, in engineering geology, students can be guided to think about the geological challenges the Sichuan-Tibet Railway might face. Their responses can be combined with knowledge from courses like "Engineering Geology" and "Soil Mechanics," strengthening their understanding of terrain, geological structures, rock formations, hydrogeological conditions, surface geological phenomena, and the geological and physical environment. In teaching of slope protection, the steep slopes along the Sichuan-Tibet line can be used as examples to analyze and discuss monitoring technologies, disaster assessment techniques, and comprehensive treatment technologies for landslides and collapses along the route.

The above methods are just a starting point. In reality, IPE can permeate all aspects of classroom teaching. As the concept of curriculum-based IPE becomes more ingrained, various new methods and approaches will emerge accordingly.

4 Avoiding Pitfalls in IPE in Mechanics Courses

In integrating ideological and political education (IPE) into mechanics courses, it is crucial to avoid blind and superficial implementation[9,10]. Effective integration requires bold practice while steering clear of common pitfalls.

4.1 Avoid Singular Implementation

Currently, many IPE activities are conducted independently by individual teachers, leading to isolated efforts. There is often a lack of a unified plan at the school level and insufficient communication and coordination among teachers. This can result in unclear educational goals, repetitive content, and varying depths of instruction, making it difficult to achieve the desired outcomes. Therefore, school management should plan holistically, design reasonable integration between various professional courses and IPE, and coordinate the efforts of different subjects to work together, progressively deepening the content and ensuring division of labor and cooperation to form a synergistic effect.

4.2 Avoid Rigid Application

In teaching, rigid and forced educational methods should be avoided. Instead, the course content and IPE should be organically integrated, using professional courses as a vehicle and incorporating IPE seamlessly into the course material. Through this organic integration, a synergistic effect can be achieved, resulting in outcomes greater than the sum of their parts.

4.3 Avoid Short-term Efforts

Building IPE in courses is a long-term, systematic project that cannot be accomplished overnight. Short-term, perfunctory efforts and temporary enthusiasm must be avoided. Long-term planning and systematic steps are required, with actionable and inheritable plans that are adhered to and continuously improved for sustainable development.

Of course, the current reform of IPE in courses is still in a continuous exploration stage, and some pitfalls are inevitable. However, as the construction of IPE in courses continues to improve, the "big IPE" effect will be better realized, and the fundamental task of cultivating virtue and nurturing people will be more effectively achieved.

5 Conclusion

In summary, effectively integrating IPE into mechanics courses in civil engineering is a crucial aspect of the "cultivating virtue and nurturing people" educational philosophy in the new era. Continuous exploration, innovation, and active identification of the organic combination points between professional mechanics courses and IPE are necessary. Systematic and long-term advancement of these efforts will promote a synergistic effect between professional knowledge and IPE, mutually enhancing both aspects.

Integrating Ideological and Political Education (IPE) into civil engineering mechanics courses is crucial for holistic student development. Here are concise recommendations:

1. Conceptual Shift: Mechanics instructors need to recognize the importance of combining professional knowledge with moral education.

2. Structured Plans: Universities should create clear frameworks and structured plans for IPE integration with specific objectives.

3. Teacher Training: Continuous professional development focused on IPE should be available to instructors.

4. Historical and Contemporary Case Studies: Using historical achievements and modern engineering projects as case studies enriches learning and instills national pride.

5. Student-Centered Learning: Implement IPE through interactive and student-centered methods.

6. Long-Term Commitment: Treat IPE integration as a long-term project with multi-year plans and regular reviews.

7. Avoiding Pitfalls: Ensure coordinated efforts, natural integration, and avoid short-term measures.

By following these recommendations, civil engineering programs can achieve effective IPE integration, fostering both professional and moral development in students.

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