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Construction and Application of "Trinity" Ideological and Political Teaching Model in Introduction Course of "Introduction to Mechatronics Engineering"

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Abstract: Introductory courses serve as the foundational starting point of higher engineering education, and the effectiveness of their ideological and political teaching is absolutely crucial for shaping the core professional values and ethical frameworks of future engineering students. To systematically address the common pedagogical problems of "forced integration" and the "separation of two layers" prevalent in the current ideological and political education of introductory courses, this comprehensive study takes the introductory lesson of the "Introduction to Mechatronics Engineering" course as the primary teaching unit. It constructs an innovative "trinity" ideological and political teaching model, featuring the deep, synergistic integration of "value shaping, knowledge imparting, and ability cultivation" at its core. Using "major national projects" as an engaging narrative vehicle, the proposed model meticulously designs a four-stage progressive teaching path consisting of "emotional tracing, cognitive decoding, vision pursuit, and mission commitment." This framework organically integrates vital elements such as national sentiment, the craftsmanship spirit, and rigorous engineering ethics into the entire process of professional cognitive initiation. Through two comprehensive rounds of empirical teaching practice, detailed classroom observations, rigorous student assignments, and qualitative feedback, results indicate that this model significantly enhances freshmen's professional identity, intrinsic learning motivation, and profound sense of social mission. Ultimately, this research provides a highly replicable, operable, and effective paradigm for advancing the ideological and political teaching reform of engineering introductory courses in modern higher education.

Keywords: mechatronics engineering; engineering education; teaching model; curriculum reform; professional ethics

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1. Introduction

Under the context of emerging engineering education, the scope of engineering education has evolved significantly [1]. It now emphasizes the cultivation of innovative and interdisciplinary talents capable of adapting to and driving the development of future industries. This transformation imposes higher expectations on the introductory courses of engineering majors, which serve as the foundational lessons for students entering these fields. These courses must not only introduce professional knowledge but also inspire learning enthusiasm, instill professional ethics, and guide students in establishing career aspirations through value-oriented education. As the initial course for the Mechatronics Engineering major, the effectiveness of the introductory lesson titled "Introduction to Mechatronics Engineering" plays a pivotal role in shaping students' understanding of this interdisciplinary domain. It also helps them develop a positive attitude toward their chosen profession, laying the groundwork for their academic and professional journey.

Traditional introductory teaching methods often encounter two significant challenges. The first is a reductionist approach that merely presents a "course catalog

description," listing subsequent course names without engaging students or sparking their interest. The second challenge is the tendency to transform the course into a "technology achievement exhibition hall," showcasing advanced technologies without delving into deeper ideological exploration. Furthermore, the integration of ideological and political education in these courses often relies on superficial methods such as labeling or using slogans, which are disconnected from the professional knowledge being imparted. This approach frequently fails to resonate with students and may even provoke resistance. Consequently, there is an urgent need to develop an introductory teaching model that seamlessly integrates value guidance, knowledge dissemination, and foundational skill-building, ensuring a holistic and impactful learning experience [2, 3].

Drawing from the teaching practices of the "Introduction to Mechatronics Engineering" course at North China University of Technology, this study proposes and implements a "value-knowledge-ability" trinity model for ideological and political education. This innovative approach aims to transform ideological and political education from being an external addition to becoming an intrinsic component of the course. Through meticulous teaching design, the model seeks to enable students to establish positive professional values while simultaneously constructing their foundational knowledge framework. By integrating these elements during the initial stages of their academic journey, the model lays a robust ideological foundation that supports and enhances subsequent professional learning. This approach not only addresses the shortcomings of traditional teaching methods but also ensures that students are better prepared to navigate the complexities of their field with a strong sense of purpose and ethical commitment [4, 5].

2. Theoretical Construction of the "Trinity" Ideological and Political Teaching Model

2.1. Core Concept: Synergistic Integration, Moving in the Same Direction

The essence of the "trinity" teaching model is to dismantle the traditional divisions between value, knowledge, and ability, emphasizing their interconnectedness and mutual reinforcement [6]. This approach posits that effective professional education must integrate value formation with a robust foundation of knowledge, ensuring that the imparting of knowledge directly contributes to the development of advanced skills. Furthermore, the process of enhancing abilities reinforces the internalization of professional values, creating a cohesive and dynamic learning experience. By aligning these three elements, the model seeks to cultivate well-rounded individuals who can seamlessly apply their knowledge and values in practical scenarios, fostering both intellectual and ethical growth.

In the context of introductory lessons, the interplay between value shaping, knowledge imparting, and ability cultivation becomes particularly evident [7]. Value shaping serves as the guiding principle, providing the purpose and direction for the learning process by addressing the fundamental question of why education is essential. Knowledge imparting acts as the foundational mechanism, offering tangible and credible content that supports the development of values and skills. Meanwhile, ability cultivation represents the ultimate objective, enabling students to transform the acquired values and knowledge into personal competencies. This process equips learners with critical skills such as analytical thinking, effective communication, and strategic planning. By fostering this integration, the model ensures that students not only gain theoretical understanding but also develop practical capabilities that prepare them for real-world challenges.

2.2. Content Vehicle: The Narrative Power of "Major National Projects"

To achieve the seamless integration of the three core elements, this model strategically selects "major national projects" such as high-speed rail systems, space exploration initiatives like the China Space Station, and advancements in new energy vehicles as the primary teaching framework. These projects serve as exemplary case studies due to their multifaceted benefits and relevance to modern engineering education. By focusing on these significant achievements, educators can effectively bridge theoretical

knowledge with practical applications, creating a robust learning environment that fosters both technical expertise and broader societal understanding.

Technological integration is a key feature of these projects, as they represent the pinnacle of mechatronics and interdisciplinary engineering. These initiatives embody the convergence of mechanical, electronic, and computational technologies, making them ideal for illustrating complex technical concepts. By analyzing these projects, students gain a comprehensive understanding of how various engineering disciplines interact and complement each other in real-world applications, thereby enhancing their ability to tackle multifaceted challenges in their future careers [8].

These projects also evoke a strong sense of emotional proximity, as they symbolize significant national achievements that resonate deeply with students [7]. By highlighting these accomplishments, educators can naturally inspire a sense of pride and enthusiasm, fostering a positive emotional connection to the subject matter. This approach not only enhances engagement but also reinforces the importance of contributing to societal progress through engineering innovation.

From a contemporary perspective, these projects are closely aligned with national strategic priorities, showcasing the dynamic and evolving nature of the engineering profession. By examining these cutting-edge initiatives, students can clearly see the vast opportunities and potential within the field of mechatronics. This understanding serves as a powerful motivator, encouraging students to pursue excellence and innovation in their academic and professional endeavors [9].

Furthermore, these projects inherently carry significant ethical considerations, such as ensuring safety, upholding responsibility, and promoting sustainable development. The processes involved in their development and application provide rich material for exploring engineering ethics. By engaging with these issues, students can cultivate a deeper awareness of their professional responsibilities and the broader societal implications of their work [3]. This ethical dimension is crucial for shaping well-rounded engineers who are not only technically proficient but also socially conscious.

2.3. Implementation Path: The "Four-Stage Progression" Teaching Method

To ensure the practical application of the teaching model, a structured "Emotional Tracing - Cognitive Decoding - Vision Pursuit - Mission Commitment" four-stage progressive teaching path has been developed. This framework transforms the introductory lesson into a multi-layered and engaging intellectual journey, designed to stimulate both thought and participation [2]. Each stage is carefully crafted to build upon the previous one, ensuring a seamless progression that fosters deeper understanding and engagement.

Stage 1: Emotional Tracing - This stage emphasizes the use of historical narratives to foster a sense of identity and pride. By recounting the inspiring stories of scientific pioneers in the field of mechatronics, the development of the profession is contextualized within the broader historical framework of national progress. This approach allows students to connect emotionally with the subject matter, cultivating an initial sense of professional honor and belonging. **Stage 2: Cognitive Decoding** - In this stage, technology serves as the medium for constructing knowledge. Through detailed analysis of the technical core of significant national projects, such as the control systems of high-speed rail or the robotic arm of the space station, abstract concepts are made tangible. Metaphors like "skeleton-nerve-brain" are employed to simplify complex ideas, enabling students to grasp the principles of mechatronics integration more effectively. **Stage 3: Vision Pursuit** - This stage focuses on inspiring motivation by aligning personal academic goals with national strategic objectives. By showcasing the pivotal role of mechatronics technology in advancing key national initiatives, such as manufacturing, transportation, and aerospace development, students are encouraged to envision their future contributions to these fields. This connection between individual aspirations and collective goals ignites a passion for academic and professional growth. **Stage 4: Mission Commitment** - The final stage emphasizes the internalization of values through action. Students are tasked with

thematic assignments, such as reflecting on their personal connection to major national projects. This process encourages them to consider their responsibilities, plan their academic careers, and transition from passive reception to active expression, ultimately fostering a sense of mission and purpose [10].

This teaching path forms a comprehensive and cohesive framework, ensuring that students are fully engaged and experience growth across cognitive, emotional, and behavioral dimensions. By integrating these stages into a unified process, the model not only enhances academic understanding but also instills a deeper sense of purpose and commitment, preparing students to contribute meaningfully to their chosen fields.

3. Practical Application of the "Trinity" Model in the Introduction Lesson

This section uses a comprehensive introduction lesson, spanning two class hours, from the course "Introduction to Mechatronics Engineering" as a detailed example to illustrate the practical implementation of the "Trinity" model. The lesson is designed to integrate theoretical knowledge, practical application, and interactive engagement, ensuring that students gain a holistic understanding of the subject matter. By employing this model, educators can effectively bridge the gap between abstract concepts and real-world applications, fostering a deeper comprehension among students. The structure of the lesson is meticulously planned to include clear objectives, step-by-step demonstrations, and opportunities for active participation. This approach not only enhances the learning experience but also equips students with the skills necessary to apply their knowledge in practical scenarios.

3.1. Teaching Theme and Objectives

Theme: Mechatronics - The "Soul Engineer" of Major National Projects. **Teaching Objectives:** Value Objectives: This theme aims to inspire a profound appreciation for the remarkable achievements and the challenging journey of China's mechatronics industry. It seeks to foster a strong sense of national pride, a dedication to craftsmanship, and a commitment to advancing the nation through technological innovation. **Knowledge Objectives:** Students will gain a comprehensive understanding of the interdisciplinary nature of mechatronics, which integrates machinery, electronics, control systems, and computer technologies. This knowledge will highlight the pivotal role of mechatronics in driving the success of significant national projects, emphasizing its importance in modern engineering and technological advancements. **Ability Objectives:** Learners will develop the foundational skills to apply systems thinking in analyzing typical mechatronic systems. They will also be encouraged to articulate their personal perspectives on the professional value of mechatronics and outline their future academic and career aspirations [11]. This objective is designed to cultivate analytical and reflective abilities, ensuring students are well-prepared to contribute meaningfully to the field of mechatronics in the future.

3.2. Teaching Process Implementation

3.2.1. Introduction (5 minutes) - Creating Context, Posing Core Questions

The teaching process begins by posing a thought-provoking question to the students: "What is the 'super key' to addressing major national challenges such as energy transformation, breakthroughs in core technologies, and advancements in deep space exploration?" This question is designed to immediately engage the students and stimulate their curiosity. The answer, "Mechatronics Integration Technology," is then introduced as a pivotal concept. This approach not only captures the students' attention but also underscores the strategic importance of the mechatronics profession in addressing critical global and national challenges. By framing the discussion in this manner, the lesson aims to instill an appreciation for the value and relevance of mechatronics in solving complex, real-world problems [5]. This initial phase of the teaching process serves as a foundation for value-oriented guidance, encouraging students to recognize the broader implications and potential of their field of study.

3.2.2. New Knowledge Lecture (60 minutes) - Four-Stage Progression, Deep Integration

Segment 1: Emotional Tracing (15 minutes). Begin by presenting a short film or narrating stories about notable scientists who have made significant contributions to technological advancements. Pose the thought-provoking question: "What kind of spirit should we inherit from these pioneers?" Facilitate a guided discussion among students to establish a strong value-oriented foundation for the class. This segment aims to inspire students by connecting them emotionally to the achievements and dedication of past innovators. Segment 2: Cognitive Decoding (30 minutes). This is the core knowledge dissemination phase. Use the examples of China's high-speed rail system and the China Space Station to illustrate advanced engineering concepts. For the high-speed rail case, focus on its "super brain," the train control system, which integrates sensing (state perception), control (decision-making and command execution), and execution (vehicle operation) technologies. This provides a vivid interpretation of the mechatronics system. Encourage students to reflect on the importance of independent research and development, emphasizing the critical role it plays in ensuring technological sovereignty and national security. For the space station case, highlight the "intelligent robotic arm," explaining its components, including precision machinery (skeleton), servo drive (muscles), visual and force sensing (nerves), and intelligent control (brain). Discuss the broader concept of international collaboration and the vision of a shared future for humanity, fostering an understanding of global engineering ethics and perspectives. Engage students in systems analysis through continuous questioning and interactive discussions, enhancing their critical thinking and problem-solving skills. Segment 3: Vision Pursuit (10 minutes). Provide a rapid overview of the latest advancements in fields such as new energy vehicles and industrial robotics. Use a map-style presentation to showcase the diverse career opportunities in mechatronics within the context of national strategic initiatives. This segment aims to answer the question, "What can I do after studying mechatronics?" and to ignite intrinsic motivation among students by linking their studies to tangible future prospects. Segment 4: Mission Commitment (5 minutes). Transition seamlessly into the course assessment by introducing the final thematic report titled "Me and the Major National Projects." Encourage students to align their personal interests with their envisioned future roles, promoting the integration of knowledge, skills, and values. This final segment reinforces the importance of personal commitment to national and global engineering challenges.

3.2.3. Summary and Task Assignment (5 minutes)

This section serves as a reflective conclusion to the lesson, emphasizing the progression from historical foundations to future advancements, and from technological innovations to the deeper, intangible aspects of engineering [12]. It reiterates the critical role of mechatronics engineers as individuals who not only design and implement systems but also embody the essence of creativity and problem-solving, often referred to as "soul engineers." By reinforcing this perspective, the lesson aims to solidify the comprehensive understanding of the subject matter, ensuring that students grasp the interconnected nature of technical knowledge, practical application, and ethical responsibility. This holistic approach, often described as a "trinity," is designed to leave a lasting impression, fostering both intellectual growth and professional development.

4. Teaching Effectiveness and Reflection

4.1. Analysis of Teaching Effectiveness

After conducting two rounds of teaching practice, including classroom observations, student final reports, and post-class interviews, this educational model has demonstrated notable effectiveness. Firstly, there has been a marked improvement in classroom engagement and emotional connection. Compared to traditional lecture-based methods, the incorporation of case-based teaching and interactive discussions significantly increased student attentiveness and participation. The "heads-up rate"—a measure of active engagement—was notably higher, and students exhibited strong emotional

responses when discussing pioneering achievements and technological advancements [3]. This created a vibrant and enthusiastic classroom atmosphere conducive to learning. Secondly, the integration of professional knowledge with value identification has been deeply enhanced. Analysis of final reports revealed that students not only grasped the core concepts of mechatronics integration but also articulated its broader societal implications. For instance, one student expressed that the work of mechatronics engineers transcends technical tasks, embodying a commitment to public safety and welfare. Such reflections highlight the model's success in fostering a sense of responsibility and ethical awareness. Thirdly, the approach has helped students clarify their learning objectives and align them with personal aspirations. Many students demonstrated the ability to connect their academic pursuits with significant technological initiatives, outlining specific career goals such as contributing to the development of advanced space robotics. This indicates that the model effectively instills a sense of purpose and mission, encouraging students to envision their future contributions to the field. Overall, the results underscore the model's capacity to enhance both academic understanding and personal development.

4.2. Reflection and Improvement Directions

4.2.1. Advantages

The model is designed to be systematic, offering a clear and structured approach that facilitates ease of operation. By utilizing the "major national projects" as a central vehicle, it ensures precise alignment with educational objectives, seamlessly integrating ideological and political elements into the learning process. Furthermore, the four-stage progression method is thoughtfully crafted to align with cognitive development principles, enhancing its applicability and effectiveness in teaching scenarios. This structured approach not only simplifies implementation but also promotes deeper engagement and understanding among learners. The model's adaptability allows it to cater to diverse educational contexts, making it a valuable tool for fostering comprehensive learning outcomes. Its emphasis on clarity and integration demonstrates significant potential for improving both teaching methodologies and student comprehension, thereby contributing to the advancement of educational practices.

4.2.2. Challenges and Improvements

Case update and depth balance are essential for maintaining a dynamic and relevant case library. This involves the timely inclusion of new cases, such as advancements in domestic industries, while ensuring that the focus remains on in-depth exploration of one or two cases rather than broad generalizations. Such an approach allows for a more comprehensive understanding of the subject matter and fosters critical thinking among students. Precise evaluation of effectiveness is another critical area for improvement. Future efforts should aim to incorporate scientifically designed evaluation tools, such as pre- and post-test questionnaires, to measure changes in students' professional values. Additionally, coding analysis of final reports can be employed to quantitatively assess the achievement of educational goals related to values. The transfer and relay of the educational model also require attention. While this study emphasizes the introductory lesson, the challenge lies in integrating the core principles of the "trinity" concept into subsequent professional courses. Achieving a seamless, full-process ideological and political education across the curriculum demands further exploration and refinement [3, 5]. This approach ensures that the educational framework is not only consistent but also deeply embedded in the students' academic journey, promoting holistic development and alignment with broader educational objectives.

5. Conclusion

This paper explores the challenges and opportunities associated with integrating ideological and political education into the introductory lesson of "Introduction to Mechatronics Engineering." By constructing and implementing a "value-knowledge-ability" trinity teaching model, the study demonstrates how professional cognitive

initiation can be seamlessly combined with broader educational goals. The model employs "major national projects" as a narrative framework and utilizes a "four-stage progression" teaching path to ensure a structured and impactful learning experience. Teaching practice reveals that this approach effectively fosters freshmen's enthusiasm for their chosen field, cultivates a sense of national pride, and instills a strong sense of mission, thereby establishing a solid foundation for their academic journey. Furthermore, the universality and adaptability of this model make it highly applicable to similar engineering introductory courses, offering valuable insights for broader educational reforms. Future research could explore the long-term impacts of this teaching model on students' academic performance, professional development, and civic engagement. Additionally, further refinement of the model could focus on enhancing its scalability and adaptability across diverse disciplines and educational contexts, ensuring its continued relevance and effectiveness in addressing evolving educational needs.

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