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Reform and Practice of Curriculum Ideological and Politics for Postgraduate Course of Forestry Robot Technology Based on the Three-Stage Transition

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Abstract

In the new era, advancing curriculum-based ideological and political education for postgraduate courses is imperative for moral education and high-quality postgraduate cultivation. This paper took the ideological and political education construction of the graduate course "ForestRobot Technology" as the object. The course had constructed a three-stage ideological and political teaching model of "frontier embedding - critical construction - innovative transfer". It adopted teaching strategies such as tracking academic frontiers, engineering ethics analysis, and innovative design challenges, and used the "motion analysis of forest industry robots" chapter as a typical case to demonstrate the differentiated design of ideological and political teaching at the graduate level. The practice showed that this model had achieved some results in stimulating academic interests, cultivating critical thinking, and enhancing the ability to solve complex problems, providing a reference for the ideological and political education of graduate professional courses.

Keywords

Graduate; Course ideological education; Robot; Innovation ability; High-level thinking.

1. Introduction

The National Conference on Ideological and Political Work in Colleges and Universities, held in December 2016, proposed integrating ideological and political work throughout the entire process of education and teaching, so as to achieve whole-process and all-round education[1]. Graduate education bears the core mission of cultivating high-level innovative talents for the nation[2]. In September 2020, the Ministry of Education and two other departments jointly issued the *Opinions on Accelerating the Reform and Development of Graduate Education in the New Era* [3], emphasizing the improvement of the "three-wide education" system and regarding ideological and political work as the primary task in building a high-level graduate education system. Compared with undergraduates, graduate students possess a more solid knowledge foundation, more mature thinking abilities, and a clearer research orientation, while also facing deeper value challenges such as academic ethics, professional ethics, and innovative courage. Therefore, as a unified whole of "educating people" and "cultivating talents"[4], graduate courses should enable curriculum-based ideological and political education to achieve a paradigm shift from "value guidance + knowledge impartation" to a trinity of "value shaping, higher-order thinking, and innovation capability."

The course *Forestry Robot Technology* is oriented toward the national strategic needs of forestry modernization and intelligent development, aiming to cultivate outstanding engineering talents who master cutting-edge robotics technologies, possess the ability to solve complex engineering problems, and demonstrate innovative spirit and academic integrity.

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Focusing on the positioning of graduate training, this paper explores pathways for developing curriculum-based ideological and political education from aspects such as the excavation of ideological and political resources, the integration pathways for higher-order abilities, and innovation in educational models.

2. Theoretical Positioning of Curriculum-Based Ideological and Political Education for Graduate Students and Construction of Its Teaching Model

2.1. Positioning of Curriculum-Based Ideological and Political Education for Graduate Students

As representatives of the core group of scientific research talent[5], graduate students possess stronger abstract and critical thinking abilities. Ideological and political education must meet the needs of talent cultivation in the new era and should shift from a "receptive" mode to a "dialogic" mode, strengthening innovative spirit and academic ethics, thereby enabling it to reach the realm of "adapting to specific situations, advancing with the times, and innovating in line with trends"[6].

2.2. Construction of a Three-Stage Progressive Ideological and Political Teaching Model

In accordance with the positioning of graduate education, the course constructs a three-stage progressive ideological and political teaching model, forming a three-dimensionally integrated teaching approach of "frontier tracking—academic discussion—innovative design," thereby highlighting its academic character and innovative orientation.

(1) Frontier-Embedding Stage: Ideological and political elements are embedded into frontier knowledge and technological advances of the discipline.

(2) Critical Construction Stage: Students' critical thinking abilities are cultivated through academic paper seminars, critical analysis of technical routes, and debriefing of engineering cases.

(3) Innovative Transfer Stage: Open-ended innovative design tasks are used as carriers to prompt students to transform internalized values into innovative action.

3. Excavation of Ideological and Political Resources

3.1. Distilling Innovation Patterns and Academic Character from the Historical Dimension

At the graduate level, the excavation of the historical dimension no longer remains confined to cultivating a sense of identification with "ancestral wisdom." Instead, it guides students to distill patterns of innovation from the history of technological evolution. In the introduction section, the course sets up a special topic entitled "Paradigm Shifts in Robotics Technology," systematically reviewing the technological transition path from industrial robots to service robots to special robots, and guiding students to reflect on key junctures in technological breakthroughs, the selection of technical routes, and related issues. Students not only broaden their perspective on the history of the discipline, but also subtly understand the innovative spirit of "daring to challenge the mainstream paradigm."

In the kinematic analysis section, the course introduces the academic development history of the proposal of the D-H method. When Denavit and Hartenberg published their paper in 1955, this method was not the only method for describing the workspace. Through case-based discussions on the academic history of how the D-H matrix became a classic method for robot

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kinematic equations, students are guided to reflect on the evaluation criteria and dissemination patterns of academic innovation, thereby cultivating the academic character of "pursuing excellence and striving for perfection."

3.2. Distilling Innovation Directions from the Practical Dimension

At the graduate level, ideological and political education in the practical dimension should not merely awaken a sense of crisis but guide students to translate "bottleneck" problems into concrete research topics. In the sensor system module, the course organizes a thematic seminar on "Application Potential and Technical Bottlenecks of the BeiDou System in Forestry Robots," requiring students to propose technical improvement approaches in connection with their own research directions. In the mechanical structure module, the course introduces the case of "the independent innovation journey of domestic forestry harvesters," analyzing the technological breakthrough path from surveying and imitation to forward design and then to partial leadership. This guides students to understand the hardships and strategies of independent innovation, and requires them to investigate after class the current status of domestic production of a certain type of forestry equipment and write a "Technical Breakthrough Proposal Report." Through the above teaching design, "serving the country through science and technology" is transformed from emotional resonance into research action.

3.3. Achieving a Conceptual Leap from Ecological Ethics to Philosophy of Technology in the Future Dimension

At the graduate level, ecological civilization education is elevated to a deeper reflection on the philosophy of technology[7]. The course organizes a thematic seminar on "Ethical Boundaries in the Development of Forestry Robots," with topics including: Will fully automated harvesting lead to the withdrawal of humans? Does the complexity of forest ecosystems determine that certain operations can never be fully automated? Through such discussions, students come to realize that technological innovation is not a purely technical issue but a matter of value choice—an understanding that is an essential quality for graduate students as future technological decision-makers. The course introduces the "Responsible Research and Innovation" framework and requires students to complete an "Ethical Impact Assessment Report" in the course's innovation design, thereby transforming ecological awareness into actionable design constraints.

3.4. Achieving Deep Integration of the Spirit of Scientists and Academic Norms from the Academic Dimension

Graduate students are at the starting point of their academic careers, which makes education in the spirit of science particularly important. The course refines the spirit of scientists into four core elements: truth-seeking, critical thinking, collaboration, and perseverance. In the dynamics and trajectory planning module, the course introduces the research stories of mathematicians such as Lagrange and Jacobi, shifting the focus of discussion from "the great contributions of scientists" to "how scientists confront failure and doubt," thereby enabling students to understand the true nature of academic exploration. Meanwhile, the course explicitly incorporates academic norm education into the assessment system, emphasizing data authenticity, citation standardization, and clarity of contribution statements in assignments, reports, innovative design, and other components, thus transforming academic integrity from an "institutional requirement" into a "professional instinct."

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4. Teaching Implementation: A Case Study of Robot Kinematic Analysis

4.1. Reconstruction of Teaching Objectives

Kinematic analysis is fundamental to robot design and analysis, and the D-H method is a commonly used method for establishing robot kinematic analysis. At the graduate level, the teaching requirement is to critically understand the assumptions and applicable boundaries of the D-H method, and to be able to improve or innovate upon the method according to unconventional configurations.

4.2. Implementing Frontier-Literature-Driven Independent Inquiry in the Pre-class Stage

Pre-class tasks are no longer simple concept previews but have shifted toward inquiry-based learning driven by frontier literature. The instructor releases a learning package on the course platform, including: (1) an excerpt from the original paper on the D-H method; (2) a recent research paper applying the D-H method to forestry machinery; and (3) an academic paper proposing an improvement to the D-H method. Students are required to comparatively analyze the core contributions and limitations of the three papers, submit a methodological review report as a group, and propose an academic question to be discussed.

The ideological and political objective at this stage is to cultivate academic reading ability, critical thinking, and norms of academic expression, enabling students to gradually understand that "knowledge is not static truth but a process of continuous construction," thereby laying a cognitive foundation for the cultivation of innovation capability.

4.3. Implementing Academic Discussion and Innovation Challenges in the In-Class Stage

4.3.1. Academic Discussion

The instructor distills typical questions raised by students before class, selects topics that are highly relevant to the discipline and both intellectually critical and exploratory, and organizes group debates. A typical discussion question is set: "For the kinematic modeling of forestry robots, is the D-H method still the optimal choice? If not, what are the advantages of alternative methods?" By employing academic seminar and argumentation methods, the course focuses on cultivating students' ability to analyze and differentiate professional methods and their academic judgment, enabling them to understand that "academic innovation is not about seeking novelty for its own sake, but about proposing better solutions on the basis of a deep understanding of the limitations of existing methods."

4.3.2. In-Depth Case Study

During instruction, comparative motion performance data between a certain domestically produced forestry harvester and its foreign competitors are presented. Students are required to work in groups to complete a "Gap Analysis Report," identify key bottlenecks, and propose at least one innovative improvement direction, thereby locating breakthrough points for innovation from technological gaps. This process adopts case-based analysis and problem-driven teaching methods, concretizing "bottleneck" problems into analyzable technical parameters and transforming "serving the country through science and technology" from emotional discourse into a research agenda. As students analyze the gaps, they raise the question "What can I do?", and their innovation motivation is thereby internalized.

4.3.3. Innovation Workshop

An open-ended design assignment titled "Design of a Kinematic Scheme for a Lightweight Forestry Robot for Steep-Slope Terrain" is released, with given constraints including an upper weight limit, number of degrees of freedom, workspace requirements, and ecological impact

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constraints. Students work in groups to complete scheme sketches and key parameters. "Consequence projection" is then conducted on each group's design scheme: if such robots were deployed on a large scale, what positive and negative social impacts might arise, and what measures could be taken to maximize positive impacts and minimize negative impacts? This process adopts teaching methods such as the ethical matrix and scenario-based reasoning. The inclusion of "ecological impact constraints" among the constraints enables students to consider both efficiency and ethics in technical decision-making, cultivating their engineering judgment and teamwork abilities. Students are guided to transcend "technical feasibility" thinking and enter "technological responsibility" thinking, making them aware that every design choice made by an engineer carries value consequences, and that innovation is about seeking the optimal solution within constraints.

4.4. Post-class Stage: Achieving Innovation Transfer and Continuous Research

Post-class assignments are divided into two levels. At the foundational level, students complete computational problems in kinematic analysis to consolidate core knowledge. At the innovation level, students complete a research report entitled "Kinematic Design of a Novel Forestry Robot for Complex Forest Terrain Scenarios," including scheme design, kinematic modeling, and ethical assessment. This stage achieves the leap from "learning" to "being capable of innovating," ensuring that value guidance ultimately translates into innovative action.

5. Teaching Effectiveness

The course *Forestry Robot Technology* has successively been recognized as a Graduate Excellent Course of Northeast Forestry University and an Outstanding Case of Curriculum-Based Ideological and Political Education for Graduate Courses in Heilongjiang Province, and won the Second Prize in the First National Excellent "Curriculum-Based Ideological and Political Education" Teaching Case Competition for Forestry Engineering Discipline. In terms of innovation capability, 85% of students proposed new approaches in their innovative designs, among which 8 designs have been transformed into graduate research topics and 4 are in the process of applying for invention patents. In terms of higher-order thinking, students' critical depth demonstrated in academic paper reviews has improved markedly, enabling them to identify methodological assumptions, point out flaws in argumentation, and propose directions for improvement. In terms of value internalization, the quality of ethical impact assessment reports has continued to improve, and students are able to proactively identify potential social and ecological impacts in technical schemes and propose specific design improvement measures.

6. Conclusions

The essence of curriculum-based ideological and political education for graduate students is to respond to the special developmental needs of graduate students as "quasi-knowledge producers" and to achieve a deep integration of value guidance and innovation capability cultivation. The three-stage model of "frontier embedding—critical construction—innovative transfer" constructed in the graduate course *Forestry Robot Technology* has been proven in practice: when ideological and political elements are embedded in academic frontiers, transformed into critical issues, and anchored in innovative design, ideological and political education is no longer an "add-on" to professional education but becomes a "catalyst" that stimulates academic interest and tempers innovation capability. When students learn to make judgments in academic discussions, locate directions in technological gaps, activate responsibility in ethical reasoning, and test capabilities in innovation challenges, ideological and political education is transformed from an external requirement into an internal driving

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force—this is where its deeper educational value lies. In subsequent course development, further exploration will be conducted on the support of intelligent teaching platforms for personalized learning diagnosis and on enabling the transformation of course outcomes through school-enterprise collaborative innovation platforms, so as to continuously enhance the educational effectiveness of curriculum-based ideological and political education for graduate students.

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