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# Research on the Empowerment Mechanism and Teaching Model of Craftsmanship Spirit for Technological Independent Innovation

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**Abstract:** In the context of increasingly fierce global technological competition, China faces multiple “technology chokepoints” that severely restrict industrial autonomy. Breaking through these bottlenecks requires not only breakthroughs in cutting-edge technologies but also highly skilled technical personnel with a spirit of craftsmanship. Higher vocational education, as the main platform for cultivating technical skills, shoulders the important mission of sowing the seeds of talents for future technological breakthroughs. This study, based on the “mastering - optimizing - breaking through” three-stage progressive ability model, systematically explores how to build a talent cultivation system for technological independent innovation in higher vocational colleges through stepped training programs, long-term dedicated will cultivation, and cross-disciplinary project practices. The research proposes that through teaching strategies such as project-based learning, mentorship accompaniment, and phased goal management, the “ten years to hone a sword” spirit of persistence should be transformed into an operational and motivating teaching process, thereby cultivating innovative craftsmen who can master existing technologies proficiently, continuously optimize processes, and ultimately achieve breakthroughs in principles.

**Keywords:** Technological Independent Innovation; Craftsmanship Spirit; Empowerment Mechanism; Teaching Model; Higher Vocational Education

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## 1. Introduction

“Technology chokepoints” refer to core technologies in critical fields that are subject to control by others and severely restrict industrial autonomy. These technologies often have long research and development cycles, high integration, and complex processes. Their breakthroughs not only rely on the original innovation of research institutions but also require a large number of highly skilled technical personnel who can be meticulous, persistent in research, and pursue excellence. The spirit of craftsmanship emphasizes concentration, meticulousness, and the pursuit of excellence, which is precisely the core spiritual quality needed to overcome “technology chokepoints”.

However, in the current technical skills training in higher vocational colleges, they often focus on “mastering” existing technologies, lacking the ability to progress from “continuous optimization” to “principle breakthrough”, and rarely

systematically integrate the cultivation of the spirit of craftsmanship into the entire teaching process<sup>[1]</sup>. At the same time, the learning and innovation of complex technologies require long-term investment. How to cultivate students' resilience and the will to remain focused in the face of setbacks has become a pressing issue in vocational education. Moreover, modern engineering problems are increasingly characterized by high integration and cross-disciplinary nature, and single-position skills are no longer sufficient to solve systemic technological bottlenecks.

Therefore, this study focuses on the theme of "empowerment mechanism and teaching model of craftsmanship spirit for technological independent innovation", aiming to answer the following questions: How to construct a stepped ability model that meets the needs of technological breakthroughs? How to design teaching strategies to cultivate students' long-term focus and perseverance? How to expand students' horizons and collaboration skills through cross-disciplinary practices? The research results will provide theoretical references and practical paths for higher vocational colleges to deepen teaching reforms and cultivate the new generation of craftsmen supporting technological independent innovation.

## **2. Theoretical basis and analysis framework**

### **2.1. Core value of craftsmanship spirit in technological independent innovation**

The spirit of craftsmanship originated from traditional handicrafts but has been given new connotations in modern industry and technology. It not only reflects the mastery of skills but also the pursuit of excellence in quality, the continuous optimization of processes, and the courage to explore unknowns. In overcoming "technology chokepoints", this spirit is manifested as: in the "mastering" stage, one can deeply understand the details and limitations of existing technologies; in the "optimizing" stage, one can improve the stability and efficiency of the process through iterative experiments; in the "breaking through" stage, one can dare to question existing principles and explore new technical paths. Therefore, the spirit of craftsmanship is the spiritual bridge connecting skill learning and technological innovation.

### **2.2. Three-stage progressive ability model: "Mastering - Optimizing - Breaking Through"**

This study draws on the three-stage progressive logic of "mastering - optimizing - breaking through" in the flowchart to construct a capability development model for technical breakthrough talents:

**Mastering stage:** The goal is to proficiently and accurately reproduce existing technologies or processes, thereby developing solid basic skills and a sense of standardization.

**Optimization phase:** The goal is to, on the basis of proficient mastery, through analysis, experimentation and iteration, enhance the stability, efficiency or applicability of technical indicators, and cultivate the ability to make problem-oriented improvements.

**Breakthrough Phase:** The goal is to deeply understand the technical principles, identify the root causes of technical bottlenecks, and attempt to achieve innovation at the principle level through new ideas and methods.

These three phases are not linearly progressive; rather, in practice, they often cycle, interweave, and spiral upward, forming a complete chain for the growth of technical capabilities.

### **2.3. Theoretical support for the teaching model: situational learning, willpower cultivation, and interdisciplinary collaboration**

The Situational Learning Theory emphasizes learning in real or simulated task scenarios. Project-Based Learning (PBL) can effectively integrate the three stages of "mastering - optimizing - breaking through", enabling students to construct knowledge and develop abilities in the process of solving complex problems.

The theory of willpower cultivation suggests that the achievement of long-term goals requires transforming abstract willpower into specific, manageable tasks and continuously motivating through positive feedback. The mentor system and phased goal management are key strategies.

The interdisciplinary collaboration theory holds that modern engineering innovation often occurs in the intersection

of disciplines. Through cross-disciplinary project practices, it is necessary to cultivate students' systematic thinking, communication and collaboration, as well as integration abilities, as this is an inevitable requirement for addressing highly integrated technical challenges.

### **3. The enabling mechanism of craftsmanship spirit: From “Instrumental skills” to “Innovative character”**

The empowerment of craftsmanship spirit essentially involves internalizing external skill training into students' professional character and innovative qualities. Based on the three-level ability model, the enabling mechanism can be divided into the following three levels:

#### **3.1. Skill internalization mechanism: From “Knowing” to “Doing”**

In the “mastering stage”, through intense standardized training, repeated practical operations and immediate feedback, students transform operational steps, process parameters and other explicit knowledge into muscle memory and intuitive responses. This process emphasizes “slow is fast”, avoiding the pursuit of superficial speed while neglecting the accuracy and stability of the movements. Teachers should play the roles of “modeler” and “corrector” to help students establish a sense of reverence for technology and norms.

#### **3.2. Lean optimization mechanism: From “Doing” to “Doing well”**

Entering the “optimization stage”, the teaching focus shifts to cultivating students' abilities to discover, analyze and solve problems. Through the establishment of “technical improvement small projects”, students are guided to collect production data, analyze fluctuation causes, design experimental plans and evaluate optimization effects. During this process, students gradually develop sensitivity to details, rigor in data, and the relentless pursuit of “better”<sup>[2]</sup>. The core of this mechanism is to tolerate trial and error and encourage iteration, making the optimization process itself a learning goal.

#### **3.3. Principle innovation mechanism: From “Doing well” to “Breaking through”**

In the “breaking-through stage”, students are required to step out of the established technical framework, trace the technical principles, and think about “why it cannot be better/different”. Through modules such as “technical frontier discussions” and “reverse analysis of principles”, students are guided to read literature, disassemble classic cases, and conduct exploratory experiments. At this time, the role of the teacher should shift to “collaborator” and “inspirer”, creating an atmosphere that encourages questioning and tolerates failure. This mechanism aims to ignite students' curiosity and exploration spirit, planting the seeds of thinking for principle breakthroughs.

## **4. Teaching mode design: Three supporting strategies**

### **4.1 Staged project training system: A pathway for the cultivation of “Three Levels” of abilities**

Design a series of comprehensive projects that progress from simple to complex and are progressive. Each project includes the implicit requirements of “mastering - optimizing - breaking through”. For example, in the “Precision Component Processing” course:

Basic Project (Mastered): Students are required to complete the task according to the diagram, with a pass rate of 99%.

Advanced Project (Optimization): With the requirement of higher performance indicators (such as surface roughness and form tolerance), students are asked to adjust process parameters and optimize the tool path design to achieve the goal.

Challenging Project (Breakthrough): Propose processing demands that exceed the capabilities of existing equipment

(such as new materials, special structures), encourage students to research new processes (such as composite processing, additive manufacturing integration), or make simple modifications to the equipment.

The projects form a capability ladder, and students must pass the assessment of the previous stage before moving on to the next stage, ensuring a solid and progressive progression of capabilities.

#### **4.2. Long-term intensive willpower cultivation mechanism: Transform “Ten years of hard work for one sword” into the teaching process**

For complex skills or innovative projects that require long-term investment, design a teaching strategy of “long-term mentorship accompaniment + phased goal management”:

**Long-term project design:** Establish a “technical research topic” lasting for 1-2 semesters, such as “the development of domestic production processes for key components of a certain type of imported equipment”. The project itself is sufficiently complex and uncertain, requiring continuous commitment from the students.

**Phase-based goal breakdown:** Long-term projects are divided into multiple milestones such as “literature research - scheme design - test verification - iterative optimization - summary defense”, and for each milestone, there are clear and verifiable outputs and timeframes.

**Dual emotional and professional support from the mentor:** The mentor not only provides technical guidance but also pays attention to the students’ psychological fluctuations and changes in willpower. Through regular conversations, sharing of setbacks, celebration of small victories, etc., they help students establish a sense of rhythm and achievement during the “long-term battle”.

**Positive Incentive System:** Establish non-material incentives such as “Pursuit Medal” and “Breakthrough Commendation”, and incorporate process-based efforts into the evaluation system<sup>[3]</sup>. Record students’ “optimization iteration times” and “restart times after failure”, etc., as evaluation dimensions for willpower qualities.

#### **4.3. Cross-disciplinary collaborative practice platform: Cultivate systematic vision and collaboration skills**

Build “Cross-disciplinary Innovation Workshop” or “Virtual Project Center”, and design comprehensive practical projects around typical “critical technology bottlenecks” (such as high-end CNC machines, precision optical instruments, industrial software, etc.). The project teams consist of students from different disciplines such as mechanical, electronic, software, and materials, collaborating in real or highly simulated engineering scenarios. For example:

**Project task:** “Develop an intelligent detection device”, requiring mechanical engineering to design the structure, electronics engineering to handle the sensors and circuits, and software engineering to write the control and algorithms.

**Teaching process:** Emphasize the aspects such as requirement analysis, interface definition, system integration testing, and integration verification, so that students can understand their own roles and values within the overall system, and learn the communication language and collaboration norms across different disciplines.

**Evaluation Orientation:** Not only evaluate individual contributions, but also assess the efficiency of team collaboration and the final system performance. This guides students to go beyond single skills and establish a mindset of system thinking and mutual benefit among teams.

### **5. Practical pathways and guarantee system**

To ensure the effective implementation of the aforementioned empowerment mechanism and teaching model, higher vocational colleges need to carry out systematic reforms and construction:

#### **5.1. Curriculum system reconstruction**

Break through traditional disciplinary boundaries and build modular course groups centered around “technical fields”

rather than “professional subjects”. Each course group includes “basic mastery module”, “optimization advancement module” and “innovation exploration module”, supporting students’ personalized and progressive learning.

### **5.2. Teacher team transformation**

Teachers need to transform from “knowledge transmitters” to “project mentors” and “innovation partners”. Through methods such as dual recruitment with enterprises, technical research and practice, and specialized training in teaching methods, enhance teachers’ engineering experience, innovation literacy, and willpower cultivation capabilities.

### **5.3. Training platform upgrade**

Build an open training base integrating “basic training, optimization experiments, and innovation research”. Introduce equipment and processes close to industrial reality, while reserving interfaces for renovation and development, supporting students in conducting optimization and breakthrough practices.

### **5.4. Evaluation system reform**

Establish a multi-dimensional evaluation system of “process data + phased achievements + comprehensive literacy”. Utilize learning archives, project logs, and iterative records to track students’ growth trajectories, incorporating relevant manifestations of craftsmanship spirit (such as concentration, perseverance, and collaboration) into evaluation indicators<sup>[4]</sup>.

### **5.5. School-enterprise cultural integration**

Introduce real technical problems from industry leaders and hidden champion enterprises as sources for graduation projects or innovation projects. Invite enterprise artisans and technical experts to serve as off-campus mentors, directly bringing the lean culture and problem-solving spirit of the industry into the campus.

## **6. Conclusion and outlook**

Facing the national strategic demand for “key technology breakthroughs”, higher vocational education must go beyond the simple training of skills, and strive to cultivate innovative technical skills talents with a spirit of craftsmanship. The “mastering - optimizing - breaking through” three-stage progressive model proposed in this study, as well as the empowerment mechanism and teaching model built around this model, provide a feasible implementation framework for this goal.

Through step-by-step project training, students’ technical abilities can be systematically enhanced; through a long-term dedication spirit cultivation mechanism, the “ten-year-long refinement” spirit is transformed into a manageable and motivating teaching process; through cross-disciplinary collaborative practice, students develop a systematic perspective and collaboration ability to address complex engineering problems. The three elements complement each other, jointly shaping new era craftsmen who are rooted in skills yet daring to innovate, focusing on details yet having a broad vision.

Future research can further explore directions such as: the specific indicators and evaluation tools for the “three stages” of ability in different professional fields; the research on personalized teaching strategies for willpower cultivation; the conflict resolution and leadership training in cross-disciplinary team collaboration; and the long-term tracking and effect evaluation of the empowerment of craftsmanship spirit. Only by continuously deepening teaching reforms can we truly allow the spirit of craftsmanship to take root and thrive in the soil of vocational education, continuously providing the country with ideal, competent, and resilient breakthrough forces for technological innovation.

## **Disclosure statement**

The author declares no conflict of interest.

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