

Research on the integration path of "curriculum ideology and politics" in medical laboratory technology specialty from the perspective of materialist dialectics: a case study of pathogenic biology and immunology

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Abstract: "Pathogenic Biology and Immunology" serves as a compulsory course for the Medical Laboratory Technology major in higher vocational colleges. However, the integration of ideological and political elements into its teaching process currently faces challenges such as fragmentation, formalism, and superficial labeling. Grounded in Marxist materialist dialectics, this paper explores the philosophical connotations embedded within the curriculum—specifically the unity of opposites, the transformation of quantity to quality, and causal relationships—to construct a three-stage integration model: "Philosophical Thinking Guidance – Professional Knowledge Application – Professional Ethics Sublimation". Through quasi-experimental research, questionnaire surveys, and comparative grade analysis, this study validates the effectiveness of the proposed model in enhancing student learning outcomes, fostering a rigorous scientific spirit, and cultivating the professional philosophy of "Life Supremacy", thereby effectively addressing the difficulties associated with integrating ideology and politics into the curriculum.

Keywords: materialist dialectics; medical laboratory technology; pathogenic biology and immunology; curriculum ideology and politics

1 Introduction

The talent cultivation for the Medical Laboratory Technology specialty in higher vocational education has long faced the practical problem of "valuing skills over responsibility and critical thinking". Firstly, traditional teaching models are often teacher-centered, utilizing large-class instruction and direct indoctrination. This results in insufficient opportunities for students to actively explore and solve problems, leading to weak innovative awareness. Furthermore, the curriculum and teaching methods lack systematic training in scientific research literacy; students fail to master basic research procedures and lack the ability to identify problems, analyze relevant factors, and design experiments. Additionally, the course content fails to keep pace with the automation and intelligent advancement of modern clinical laboratory technology, still focusing primarily on manual operations. Consequently, students struggle to interpret clinical data from test results and develop the comprehensive analytical clinical thinking required.

"Pathogenic Biology and Immunology" aims to study the biological properties of key human pathogenic

microorganisms, including bacteria and viruses, alongside the mechanisms whereby the human immune system recognizes and eliminates them. Its importance lies in the fact that this course serves as a cornerstone for learning about the mechanisms, diagnosis, and prevention of infectious diseases. By mastering this knowledge, students can develop a scientific understanding of diseases, overcome discrimination and fear towards patients, and thereby safeguard health with a more professional and responsible attitude. However, current practice of "curriculum ideology and politics" mostly relies on simple case accumulation and lacks theoretical support. Integrating Marxist philosophy into medical laboratory education is an inevitable pathway to break through the limitations of education and cultivate high-quality technical and skilled medical talents who integrate virtue with skill and possess patriotic feelings.

2 Theoretical basis

As a frontier discipline in the field of life sciences, the "Medical Laboratory Technology" specialty plays a pivotal role in disease diagnosis, treatment, disease progression monitoring, and prognosis evaluation [1]. "Pathogenic Biology and Immunology" is a compulsory course within this specialty; however, higher vocational students often prioritize rote memorization over understanding intrinsic connections during their study, resulting in a disconnect between knowledge and practical operation. This is a common drawback and misconception in the initial stage of skills learning; therefore, it is necessary to excavate the contradictory relationships and fundamental principles behind phenomena and knowledge points. In the teaching process, the Marxist view of medicine should be organically integrated, enabling medical students to possess both the professionalism of medical disciplines and the generality of ideological and political courses [2]. Integrating relevant Marxist theories into professional medical laboratory courses can effectively help medical students to use medical knowledge and theoretical insights as methodological tools to analyze and understand real-world situations. Integrating Marxist theory into teaching not only enhances the ideological nature of the course but also helps students establish the professional belief that "laboratory testing is responsibility", making it an inevitable choice for educational development.

2.1 The law of unity of opposites: the dialectical balance between pathogenic invasion and host immunity

Philosophy generally holds that contradictions exist within things themselves and between different things. When applying Marxism to objective realities, one must conduct contradiction analysis and master dynamic equilibrium.

Within the framework of Marxist philosophy, the "Law of Unity of Opposites" is regarded as the fundamental law governing the development of things [3]. The teaching of "Pathogenic Biology and Immunology" is replete with numerous contradictions that are both opposing and unified. Their mode of existence is never static, fixed, or stationary confrontation, but rather a state where they interdepend and transform into each other constantly under given conditions.

2.1.1 Antagonism and unity between pathogens and the immune system

The invasion of pathogens and the host's immune defense constitute a typical pair of contradictions within the body. The execution of laboratory testing is precisely the identification of the external manifestations of this contradiction (such as elevated white blood cell counts or the appearance of antibodies). Without the existence of pathogens, immune defense would lack an object; without an immune response, pathogens would proliferate indefinitely. The task of laboratory personnel is not merely to detect pathogens but to assess the balance of power between the two sides of the contradiction, observing the critical point of unity of opposites and the conditions for transformation.

2.1.2 Transformation between normal flora and opportunistic pathogens

Normal flora and opportunistic pathogens transform into each other depending on factors such as the level of host immunity. The breakthrough of this transformation threshold is precisely the key to pathogenesis. Therefore, teachers should guide students to adopt a comprehensive learning approach that combines the study of microbial species with the

contradictory movement of the environment.

By studying this conditional relationship—which appears opposite yet non-antagonistic, and is constantly evolving through mutual transformation—students can avoid rigid, either-or diagnostic logic.

2.2 The "Law of Quantity-Quality Transformation": the quantitative mechanism of microflora evolution and infection pathogenesis

The "Law of Quantity-Quality Transformation" is a crucial principle in dialectics; identifying the "connection point" for guided teaching can achieve excellent pedagogical outcomes [4]. By studying this law within Marxist theory, students can more comprehensively understand the two states of development it reveals: quantitative change is gradual and inconspicuous, whereas qualitative change is fundamental and leap-like. When quantitative accumulation reaches a certain degree, it precipitates qualitative change, which subsequently opens the path for new quantitative changes. This law requires individuals to place importance on the accumulation of quantity while remaining sensitive to critical turning points.

2.2.1 Pathogen quantity: from latent infection to manifest disease

During the early stages, the human body may exhibit no symptoms, and test results might be negative or at a critical threshold. As pathogens proliferate and their quantity exceeds the "infection threshold", the disease undergoes a qualitative transformation, shifting from a latent infection to a manifest disease.

2.2.2 Operational errors in testing: the superposition of multiple minor errors leads to qualitative changes in results

By studying relevant Marxist content and mastering the "Law of Quantity-Quality Transformation", students can comprehend the significance of the "Zero Defect" requirement in practical laboratory courses: when it comes to life, the critical point where quantitative change turns into qualitative change is often unpredictable.

2.3 The view of universal connection: the holistic correlation between specimen testing and clinical diagnosis

Universal connection is one of the fundamental characteristics of materialist dialectics, permeating the entire process of movement, change, and development of all things, serving as the key to unlocking materialist dialectics [5]. Philosophy posits that the objective world inhabited by humans is material and dialectical; essentially, the world is a holistic whole characterized by universal connections, whereas isolated entities are unrealistic. Connections between all things possess objectivity, universality, and diversity.

For instance, all links from specimen collection, testing, clinical application to patient safety are closely interlinked. In reality, the quality of specimen collection influences laboratory data, which in turn affects clinical diagnosis, subsequently determining treatment plans. Educators must help students recognize that every test serves as a node within the clinical diagnosis network, requiring a heightened philosophical awareness throughout the testing process.

2.4 Materialist value orientation: the concept of "life supremacy" and professional ethics in laboratory testing

Laboratory results are never trivial; each specimen represents a life. "People Supremacy" is the core value concept of the Communist Party of China and a distinctive characteristic of the governance philosophy of the Party Central Committee with Xi Jinping at its core. The implementation of Xi Jinping's view of "People Supremacy" includes adhering to the principle of "Life Supremacy" and striving to ensure the safety and health of the people [6]. In the field of medical laboratory testing, this is manifested even more profoundly as the supremacy of human life. This requires that all medical laboratory staff adhere to Marxist principles across all institutional rules and technical procedures, truly upholding the principle of protecting life as the supreme. It emphasizes that technology must serve life. Although laboratory personnel may not directly face patients, every specimen in their hands corresponds to an individual life. This constitutes the philosophical basis for the maxim: "One specimen, one life."

3 Analysis of the current teaching status for medical laboratory technology majors in higher vocational colleges

3.1 Subjects of analysis

Students from four classes of the 2025 cohort majoring in Medical Laboratory Technology at Shijiazhuang Engineering Vocational College were selected as the research subjects, totaling 200.

3.2 Research methods

3.2.1 Student questionnaire survey

Aligned with professional training objectives and addressing the common disconnect between higher vocational medical education and clinical practice, an anonymous survey was administered via the Questionnaire Star platform. This approach ensured student privacy while assessing learning attitudes. The instrument encompasses students' professional cognition and motivation, classroom engagement, challenges in practical operations, professional identity and satisfaction, as well as their understanding of materialist dialectics.

3.2.2 Survey scale for scientific spirit and rigor

Centered on scientific spirit and professional rigor, and tailored to the characteristics of teaching in the Medical Laboratory Technology major, the "Survey Scale for Scientific Spirit and Rigor among Higher Vocational Medical Laboratory Technology Students" was developed. The scale encompasses cognition of scientific spirit, rigor in professional learning, rigor in practical training, and the application of scientific thinking, aligning with the requirements of professional teaching and talent cultivation. This scale employs a 5-point Likert scoring method: 1 = Completely Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Completely Agree. It aims to comprehensively understand the current students' scientific literacy and professional rigor, as well as to deeply explore issues within the scientific teaching process, thereby providing data support for this experiment.

3.2.3 Medical ethics and professional identity scale

Centered on medical ethics and professional identity, this scale was designed around five key dimensions: cognition of medical ethics, professional emotion, professional behavior, professional value identity, and professional responsibility. It employs a 5-point Likert scoring method. The scale covers students' understanding of the basic principles of medical ethics, adherence to professional norms during learning, passion for the profession, and sense of professional responsibility and accountability.

3.3 Results and analysis

The integrated survey results indicate that while students possess a certain level of cognition regarding theoretical learning and basic medical ethics, there are obvious shortcomings in four dimensions: the construction of systematic thinking, the rigor of practical training operations, the internalization of professional responsibility, and resonance with ideological and political education.

3.3.1 Absence of systematic thinking

When faced with complex medical ethics cases, students' thinking predominantly exhibits "single-point" or "linear" characteristics. Over 65% of students focused solely on isolated ethical provisions, failing to integrate multidimensional information spanning medical, social, ethical, and psychological aspects. The average score for the reverse-scored item regarding "systematically solving complex medical problems" was merely 2.1 (out of a maximum of 5). This reflects that students struggle to analyze problems in a coordinated manner from a perspective that combines both macroscopic and microscopic viewpoints.

3.3.2 Utilitarian attitude towards practical training

In the practical training sessions, over 80% of students viewed the experimental objectives merely as "completing a task", neglecting "accuracy"—the core competency of medical experimentation. Furthermore, 43% of students failed to repeat experiments when obtaining inaccurate results. Instead, they chose to directly manipulate data, which deviates from the truth-seeking and rigorous attitude required in medical research.

3.3.3 Insufficient sense of professional responsibility

Students' perception of professional image tends to be idealized, and their understanding of "professional responsibility and accountability" remains vague. In the module concerning the "spirit of accountability when facing potential medical risks", only 15% of students expressed a willingness to take initiative, while over 50% opted for self-protection. This reflects a lack of reverence for the dignity of life among students and exposes a serious deficiency in education regarding professional spirit.

3.3.4 Rigid integration of ideological and political education

Currently, there is a distinct "two skins" phenomenon in the classroom regarding the connection between ideological-political education and professional knowledge. The delivery of ideological content is overly didactic, failing to elicit emotional resonance from students; consequently, they cannot deeply understand its connotation, which deviates from the teaching objectives. The average score for "the attractiveness of classroom ideological education" was merely 2.3, with over 70% of students responding that "ideological content is disconnected from professional knowledge, feeling rigid and boring".

4 Instructional design based on Marxism

4.1 Based on the law of unity of opposites: achieving precise understanding of pathogens and immunity

The law of unity of opposites reveals the fundamental content of universal interconnection and the driving force of eternal development in things [7], permeating other laws and categories. The teaching focus of "Pathogen Biology and Immunology" is to enable students to master the dynamic equilibrium between pathogenic biological invasion and immune system defense. Bacterial infection involves the pathogen's invasion, growth, reproduction, and release of chemical substances, causing varying degrees of pathological manifestations; it is a process of mutual restriction between pathogens and the immune system, reflecting the coexistence and interpenetration of the unity and struggle of contradictions. Teaching should not only cultivate students' ability to perform precise testing but also enhance their capacity for holistic thinking.

4.2 Integrating the law of quantitative-qualitative transformation into practical operations: rigorous argumentation and continuous improvement of experimental results

The law of mutual transformation of quality and quantity reveals the form and state of development in things, where quantitative change is the accumulation of continuous operations, and reaching a critical "degree" triggers qualitative change. In practical operations, the quantitative changes in operational details ultimately feedback into experimental results, biological traits, and immune reaction outcomes. Pipetting, timing, concentration, and frequency are all accumulations of quantitative change; the presence or absence of colonies, staining outcomes, and pathogenicity represent the qualitative change occurring after quantitative change reaches a critical point. Standardized operation, precise volume control, and strict time management constitute mastering the "degree" of change in things; this not only drives experimental success but also embodies the professional qualities of aseptic technique, precise medication, and infection prevention. Adhering to the principle of moderation and valuing the accumulation of quantity should serve as the core ideological benchmark for experimental operations.

4.3 Adhering to the view of universal connection in job roles: patient-centered approach

Materialist dialectics emphasizes the objectivity, universality, and diversity of connections. As a key hub in the hospital diagnosis and treatment chain, the laboratory department links clinical practice, patients, laboratory instruments, quality control management, and infection prevention and control. Comprehensive Quality Management (CQM) is an important guarantee for obtaining accurate experimental results in the laboratory, while pre-analytical quality management is a necessary and indispensable part of quality control. Only by strengthening communication and connection between the laboratory and clinical departments, standardizing specimen collection and processing, and minimizing factors affecting test results can we ensure the accuracy of testing and provide authentic experimental basis for clinical diagnosis [8][9][10][11]. The standardization of test results runs through the entire process of specimen collection, transportation, reception, testing, reporting, and retesting. Establishing a holistic, interactive, and systematic work mode allows for grasping the internal connections and mutual influences of each link, while closely adhering to the patient-centered philosophy to comprehensively protect patients' health rights and interests.

4.4 Establishing the awareness of life supremacy: cultivating the original aspiration for professional value

The Marxist outlook on life takes human existence as its realistic starting point and aims for the free and comprehensive development of humanity. Proceeding from the reality of material production practices, it scientifically answers a series of questions regarding the essence, value, and process of human life, thereby forming a comprehensive and scientific understanding of human life. The laboratory department serves as a critical gateway in the healthcare system for safeguarding the lives and health of the people; therefore, the core of professional ethics shall always revolve around life. Every specimen and every set of data is linked to a patient's health and a family's happiness. Teaching work must emphasize respecting the value of every life, equally protecting the life and health rights of the populace, and placing the maintenance of public safety as the top professional priority.

5 Implementation of the teaching model

Students from Classes 1 and 2 of Medical Laboratory Technology were selected as the control group (totaling 100 students) and were taught via the traditional teaching model. Students from Classes 3 and 4 (totaling 100 students) were selected as the experimental group and were taught via the model integrating ideological and political education with Marxist philosophy. Both groups used the same textbooks and instructional hours. Based on the teaching model for the experimental group, the instructional process was divided into three parts: pre-class, in-class, and post-class evaluation, ensuring that each step was closely connected.

5.1 Pre-class preparation

One day in advance, the instructor publishes philosophy-themed short videos on the Xuexitong platform, requiring students to study and comprehend the content in combination with medical laboratory science to establish an ideological foundation. Additionally, the instructor uploads a 5–10 minute self-recorded video containing one philosophical concept, one professional knowledge point, and one ideological elevation. Students are required to watch, learn, and submit screenshots for attendance tracking.

5.2 In-class tasks

Group seminars are conducted with clinical PBL (Problem-Based Learning) cases as the vehicle, guiding students to independently analyze diagnostic approaches for pathogen testing. Philosophical concepts such as materialist dialectics and the view of life are integrated into the actual case scenarios to provide precise guidance. For instance, a case of "long-term antibiotic abuse inducing diarrhea" are presented. Students are organized to analyze the etiology, identify suspected pathogens, and sort out changes in immune response. The case is adopted to introduce the law of mutual transformation between quality and quantity and the view of universal connection: slight imbalance of gut flora represents quantitative

change, while severe imbalance triggering opportunistic infection represents qualitative change; bacterial resistance mutation is closely related to drug dosage. Subsequently, practical operations for fecal specimen smear staining are conducted to observe the morphology of flora and opportunistic pathogens, cultivating awareness of aseptic techniques and achieving a deep integration of case analysis, philosophical speculation, and microbiological laboratory practice.

5.3 Post-class evaluation

Assign post-class tasks via the Xuexitong platform, requiring students to share their ideological insights combining course content with job roles, and upload these as short essays to the platform. Students shall organize experimental data, complete paper-based lab reports, and submit them uniformly.

6 Evaluation of the effectiveness of ideological and political teaching in the course

6.1 Results survey

6.1.1 Course performance

Final grades were derived from a dual assessment comprising theoretical knowledge of basic medicine and practical performance, including procedural steps and experimental outcomes, culminating in a comprehensive end-of-term evaluation. The results indicate that the experimental group significantly outperformed the control group in both theoretical and practical domains, with a notably higher excellence rate.

6.1.2 Questionnaire survey

Anonymous questionnaires were distributed to students via the Xuexitong platform to gauge their satisfaction and opinions regarding the implementation of the new teaching model. Students in the experimental group indicated that their interest in learning had improved, their thinking had gradually shifted towards dialectical thinking, and their sense of professional responsibility had been significantly enhanced.

6.1.3 Student interviews

A sampling survey was conducted among students in the experimental class: 2-3 high-achieving students, 2-3 average-performing students, and 1-2 students with a weak academic foundation were selected. Semi-structured face-to-face interviews were utilized to record on-site student feedback, followed by the organization of transcripts for later analysis.

6.1.4 Statistical analysis

Data analysis was performed using SPSS 21.0 software. Measurement data are expressed as mean \pm standard deviation ($\bar{x} \pm SD$), and comparisons between groups were conducted using the independent samples t-test [12]. Count data are expressed as frequency (percentage) [n(%)], analyzed using the chi-square test. A P-value < 0.05 indicated that the difference was statistically significant.

6.2 Results analysis

6.2.1 Analysis of final exam scores

Table 1. Analysis of final exam scores

Group	Final Theory Average Score	Final Practice Average Score	Excellence Rate (%)	Pass Rate (%)
Experimental Group	81.5 \pm 8.6	84.2 \pm 7.6	42	95
Control Group	72.3 \pm 10	75.2 \pm 9.4	25	82
P-value	<0.05	<0.05	<0.05	<0.05

The average scores for both final theory and practice in the experimental group were higher than those in the control group, as were the excellence and pass rates (See Table 1). These differences were statistically significant ($P < 0.05$).

6.2.2 Analysis of questionnaire and interview results

The survey on course learning effectiveness revealed that the new teaching model effectively enhanced students' interest in professional learning and their mastery of knowledge. Students were able to skillfully apply philosophical principles such as the unity of opposites and the mutual transformation of quality and quantity to understand the professional logic of pathogens and immunity. Furthermore, experimental rigor was significantly strengthened, and awareness of professional responsibility was notably improved.

The organization of student interview transcripts indicates that students are able to subconsciously utilize philosophical principles to clarify the internal logic between pathogen invasion and immune defense, as well as between flora imbalance and infectious disease. For instance, one student stated, "Previously, I only knew how to memorize knowledge points; now I understand that bacterial pathogenicity is an accumulation of quantity leading to a qualitative change, so I won't casually tamper with data in experiments anymore." The majority of students expressed approval of the new teaching model, believing that the integration of ideological and political elements moved away from "sticker-style" preaching, stimulated learning interest, deepened the understanding of professional responsibility, and better aligned with clinical needs.

7 Problems and reflections

This study has preliminarily verified the positive role of the "curriculum ideology and politics" integration model based on materialist dialectics in improving students' professional grades, dialectical thinking, and professional identity. However, regarding implementation and evaluation, we anticipate that deep-seated problems will still arise in the future long-term development of this professional field, which are worthy of vigilance and reflection.

7.1 Insufficient philosophical attainment among teachers limits the depth of integration

The implementation of the new model imposes higher requirements on instructors, demanding that they not only master the professional knowledge of pathogenic biology and immunology but also possess the ability to "seamlessly connect" relevant principles of materialist dialectics (such as the unity of opposites and the transformation of quality and quantity) with specific clinical cases and experimental procedures. During the practical process, few instructors possess sound philosophical attainment and professional knowledge. Consequently, some classes still exhibited a rigid juxtaposition of "philosophical principles plus professional indoctrination", failing to achieve the ideal effect. This indicates that some teachers have a weak philosophical theoretical foundation. They also lack the ability to integrate philosophical connotations with professional phenomena and only attach philosophical labels mechanically. Therefore, systematically enhancing professional teachers' theoretical literacy in Marxism is a prerequisite for implementing the proposed model.

7.2 Long-term educational effects require further tracking and verification

The evaluation of teaching effectiveness in this study is currently based on end-of-semester grades, immediate questionnaire surveys, and short-term interviews. While the results indicate a significant improvement in students' experimental rigor and perception of professional responsibility, the sustainability of this philosophy-led shift in professional values remains uncertain. For instance, when students encounter real-world risks and conflicts of interest during internships or in their future careers, will their philosophy of "life first" withstand practical pressures? Can the habit of "zero-defect" operation be successfully transferred from the classroom to daily clinical testing? Due to the absence of long-term data, such as graduate tracking surveys and feedback from employers, the research presented in this paper is relatively limited.

8 Conclusion

Using Marxist materialist dialectics as a theoretical tool, and addressing the current tendency of ideological and political integration to be "fragmented", "superficial" and "disconnected"—where educational effectiveness is difficult to evaluate systematically [13][14]—this study constructed and implemented a three-stage integrated teaching model for the vocational course "Pathogenic Biology and Immunology". This model is defined as "Philosophical Thinking Guidance – Professional Knowledge Implementation – Professional Quality Sublimation".

The main conclusions are as follows: First, the integration of philosophical laws such as the unity of opposites, the mutual transformation of quality and quantity, and universal connection into teaching significantly improved students' theoretical scores and practical rigor. Second, by embedding the Marxist people-centered philosophy into the professional norms of medical laboratory technology, the study effectively awakened vocational medical students' sense of professional reverence and the responsibility awareness required for learning laboratory courses. Third, the instructional design, which organically integrates philosophy with practical skills, successfully addresses the problem of rigid imposition of ideological elements. It transformed "curriculum ideology and politics" from empty preaching into a thinking tool that is tangible, rational and applicable, thereby significantly enhancing students' learning interest and emotional resonance.

This study reveals the intrinsic connection between Marxism and professional education in medical technology. Introducing materialist dialectics into medical laboratory teaching is not an externally imposed political task, but rather an inherent requirement for cultivating high-quality medical technical talents who possess a rigorous scientific spirit, systematic clinical thinking, and lofty professional sentiment.

Conflicts of interest

The author declares no conflicts of interest regarding the publication of this paper.

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