

An Empirical Study on Enhancing College Students' Labor Competence through the PDCA-based TPLEL Model

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Abstract

This study constructs and validates the TPLEL (Theory-Practice Bridging Labor Education Lectures) Model—a lecture-based intervention operationalized through the PDCA cycle—designed to address the theory-practice gap and enhance university students' labor competence. A pretest-posttest quasi-experimental design was employed with 206 first-year undergraduates. The intervention comprised five PDCA-driven lectures integrating theoretical instruction with practical activities. Labor competence was measured using the four-dimension scale developed by Wang Zhengqing et al. (2021), which assesses labor values, labor knowledge, labor skills, and innovative labor. Paired-sample t-tests revealed significant improvements in overall labor competence with a large effect size (Cohen's $d = 1.07, p < 0.001$). Notably, the knowledge-skills gap narrowed from 0.18 to 0.02, suggesting that the theory-practice disconnect was substantially alleviated. The TPLEL Model offers an actionable, replicable, and iterative pathway for bridging theory-practice gaps. Universities may benefit from adopting lecture-based bridging mechanisms integrated with PDCA cycles and establishing regular competency assessments using standardized scales to drive evidence-based curriculum improvement.

Keywords: PDCA cycle, TPLEL model, labor education, theory-practice integration, college students' labor competence

I. Introduction

Across the globe, the cultivation of students' labor skills and employment capabilities through higher education has become a pressing concern for policymakers and educators alike. According to the report “World Employment and Social Outlook: Trends 2025” released by the International Labour Organization (ILO), the global youth unemployment rate will reach as high as 12.6% in 2024, and a large number of young people are classified as “not employed, not receiving education or training” (NEET) (International Labour Organization, 2025). The World Economic Forum's “The Future of Jobs Report 2025” predicts that by 2030, 59% of the global workforce will need to undergo skills retraining (World Economic Forum, 2025). Collectively, these data suggest that the mere imparting of knowledge is no longer sufficient to address the evolving demands of the labor market; rather, education must more effectively integrate theoretical learning with practical training. Against this backdrop, the United Nations Educational, Scientific and Cultural Organization (UNESCO) through its 2022-2029 Strategy for Vocational Education and Training, is committed to promoting skills development to empower individuals and enhance employment capabilities (UNESCO, 2022); the Organization for Economic Cooperation and Development (OECD) in its “Skills Outlook 2023” report emphasizes that skills are crucial for building a resilient economy and society (OECD, 2023); the International Labour Organization (ILO) in its “Global Framework on Core Skills for Life and Work in the 21st Century” has proposed a core skills framework adapted to the 21st-century workplace (International Labour Organization, 2021). The convergence of these international policy frameworks suggests that bridging theoretical learning with practical training is key to strengthening youth employment resilience. Indeed, the disconnection between theory and practice has become a pervasive teaching problem in universities worldwide, and how to effectively cultivate students' labor skills and employment abilities through education remains a common challenge for global higher education.

In China, in 2020, the “Opinions of the Central Committee of the Communist Party of China and the State Council on Comprehensively Strengthening Labor Education in Primary, Secondary and Tertiary Schools in the New Era”-provided top-level policy direction for labor education in the new era. Subsequently, the Ministry of Education issued the “Guidelines for Labor Education in Primary, Secondary and Tertiary Schools (Trial)”, defining labor education as “utilizing the educational function of labor to conduct educational activities for students to appreciate labor and respect

the people who ~~do~~engage in labor” (Ministry of Education, 2020), and explicitly requiring that labor education be incorporated into the talent cultivation plans of universities. However, existing research has pointed out that current labor education in universities generally suffers from a disconnection between courses and practice, as well as a separation of content and major (Wu Xuefeng & Ma Yan, 2022). As Wang Huiying (2022) has characterized this phenomenon, current labor education is often marked by a “separation of knowledge and action” and a “division of labor and education.” Therefore, current labor education in universities faces a practical predicament - theoretical teaching often remains confined to classroom indoctrination, while the practical section is merely formal, and there is a lack of effective connection between the two, resulting in a “disconnection” between “knowledge” and “ability” for students, whose labor competence thus requires urgent improvement.

This predicament echoes the “theory-practice gap” proposed in the international education field on a cross-regional scale. Overseas scholars such as Greenway et al. (2019), Klafke et al. (2023), and Nyström et al. (2024) conducted similar studies on universities in Europe and America and Latin America, and confirmed that the lack of an “intermediary bridge” is the core cause of the disconnection between knowledge and action.

The PDCA cycle, as a mature continuous improvement methodology, offers a theoretical possibility for solving this problem - it can systematically integrate the four steps of “diagnosis - intervention - evaluation - improvement”, enabling each educational action to be based on the reflection of the previous round, thereby achieving iterative development over successive cycles. This study draws on the PDCA cycle and constructs the TPLEL model (Theory-Practice Bridging Labor Education Lectures Model for Enhancing University Students’ Labor Competence). It uses a series of lectures as a bridge connecting theory courses and practice courses. Through the lecture design principles of “one core issue, one identity exchange, one outcome production, and one linkage bridge”, each lecture addresses a specific problem in practice, and after the lecture, it translates understanding and answers into new practical activities, thereby connecting theory and practice courses and verifying the effectiveness of the model through empirical data.

2. Literature Review and Theoretical Foundation

2.1 Research on Labor Education

1) The Connotation and Conceptual Boundaries of Labor Education

Labor education is an important component of the socialist education system with Chinese characteristics. In 2020, the Ministry of Education defined labor education in the “Guidelines for Labor Education in Primary, Secondary, and Tertiary Schools (Trial)” as “utilizing the educational function of labor to conduct educational activities for students to develop a love for labor respect for those who engage in it.” Tan Chuanbao (2019) pointed out from the perspective of concept clarification that labor education is an educational activity aimed at promoting students’ formation of labor values and cultivating their labor competence. The concepts of labor and practice, activities, etc., have significantly different meanings in their general connotations and educational contexts. Ban Jianwu (2019) emphasized that labor education, as an important part of comprehensive development education, plays a significant role promoting students’ healthy growth and social progress.

Regarding the connotation of labor competence, Wang Quanquan et al. (2021) from the perspective of core literacy defined the structural dimensions of labor competence as three indispensable and interrelated key components: labor concepts, labor abilities, labor habits, and character. This definition provides a theoretical basis for the measurement and evaluation of labor competence. Liu Xiangbing (2019) systematically discussed in “An Outline on Labor Education in Universities in the New Era” the theoretical basis and practical paths for conducting labor education in universities, and pointed out that labor education ~~has~~ occupies a fundamental position in the educational system of universities.

In summary, the connotation of labor education has evolved from “labor skills training” to “cultivation of labor competence”, and the academic community’s understanding of its educational function has continuously deepened. However, there is still a problem of ambiguous conceptual boundaries at the specific operational level.

2) The Realistic Challenges of Labor Education in Universities

Although policymakers have placed high value on labor education, the implementation effect of labor education in universities is not satisfactory. Existing research has conducted a systematic diagnosis of the existing problems in current labor education in universities.

At the level of the curriculum system, researchers pointed out that labor education in medical colleges faces problems such as an incomplete curriculum system, a separation between theory and practice, limited implementers, and ambiguous evaluation standards (Hu Bing et al., 2023). Some studies further pointed out that current labor education in universities faces problems such as a single organizational form, a separation between theory and practice, a need for improved labor skills, and a lack of value exploration in labor education content (Li Ke et al., 2021). Additionally, some scholars discovered through questionnaire surveys and in-depth interviews that current labor education in universities has problems

such as students' weak mastery of labor knowledge and deviations in labor concepts (Wang Zhengqing et al., 2021). Ban Jianwu (2019) pointed out from the perspective of practical misunderstandings that the educational nature of current labor education in practice has not been fully demonstrated, and it has fallen into the pitfalls of form, resources, and evaluation, specifically manifested as replacing labor education design with labor itself.

International education research has summarized similar phenomena as "theory-practice gap". Greenway et al. (2019) conducted a systematic conceptual analysis of this concept and defined it as "the separation between theoretical knowledge and practice". Klafke et al. (2023) based on teaching reflections in universities in Brazil and Germany, described the gap between theory and practice as a deviation between academic learning expectations and systematic teaching obstacles in higher education. Nyström et al. (2024) through the analysis of literature on Work-Integrated Learning (WIL), extracted four dimensions of the gap between theory and practice: space, institution, epistemology, and pedagogy. Allen (2011) using Mid's "emergence" theory analyzed how the gap between theory and practice in higher education projects is jointly created and sustained. These international studies provide a reference framework for understanding the problem of theoretical and practical disconnection in labor education in Chinese universities.

In conclusion, the disconnection between theory and practice is a common predicament faced by current labor education in universities. However, existing research mostly remains at the level of problem diagnosis and lacks systematic solutions to the key issue of "how to effectively connect theory with practice".

3) Research on Assessment Tools for Labor Competence

Effective assessment tools are crucial for enhancing the labor competence of college students. In recent years, domestic scholars have made significant progress in the field of labor competence assessment. Wang Zhengqing et al. (2021) comprehensively utilized methods such as literature research, Delphi method, questionnaire survey, and structural equation model to construct a labor competence assessment model for college students, which includes four primary dimensions (labor values, labor knowledge, labor skills, and innovative labor) and 12 secondary indicators. This model is one of the most cited tools in the field of labor competence assessment in China (with 43 citations), and its reliability and validity have been rigorously tested, making it suitable for measuring the labor competence of general college students. In their empirical application of this model to assess the labor competence levels of college students in Chongqing, the authors revealed that the overall level of labor competence among college students is relatively high, but they have a deficiency in labor knowledge, and there are differences in gender, grade, and discipline. Cai Ruilin and Hua Wenfeng (2021) adopted a mixed research method to construct a labor competence evaluation index system consisting of five primary indicators (labor concepts, labor knowledge, labor ability, labor spirit, labor habits, and qualities). Additionally, Wang Quanquan et al. (2021) from the perspective of core literacy constructed a three-dimensional structure model of labor competence. Other scholars have conducted systematic discussions on the labor competence of contemporary college students from dimensions such as connotation, evaluation value, and evaluation indicators (Liu Xia et al., 2023).

Overall, domestic research on labor competence assessment has produced several measurement tools that have been empirically tested. Among them, the scale published by Wang Zhengqing et al. (2021) in the CSSCI journal "Modern Education Management" is most consistent with the research object in terms of dimension structure (4 dimensions), reliability and validity tests, and research sample (college students of ordinary universities), so this scale is selected as the measurement tool for this study.

2.2 Research on "Bridge Courses" in Higher Education

"Bridge courses" constitute a well-established concept in higher education, typically referring to courses that provide transitional learning experiences for students, aiming to bridge understanding gaps or promote the practice of basic skills (Villalta-Cerdas & Yildiz, 2022). In the field of higher education, researchers focus on how to bridge the gap between theory and practice through course design. As mentioned earlier, Allen (2011) and Nyström et al. (2024) respectively explored possible paths to bridge the gap between theory and practice from different perspectives.

In the research on labor education in China, scholars have also begun to pay attention to the design of the "bridging" mechanism. Some studies suggest that labor education can promote moral education, intellectual education, physical education, and aesthetic education in schools, serving as a bridge between school education and the production process (Liu Xiangbing, 2019). However, existing research mostly remains at the level of conceptual advocacy, lacking systematic operational frameworks and empirical verification on how to specifically design and implement "bridge courses" in labor education and how to connect labor education theory with practical courses through them. This research gap provides an entry point for this study.

2.3 PDCA Cycle Theory and Its Educational Application

1) Theoretical Underpinnings of PDCA Cycle

The PDCA cycle was proposed by American quality management expert W. Edwards Deming. It consists of four stages:

Plan (P) - analyze the current situation, set goals, and formulate plans; Do (D) - implement the plans; Check (C) - evaluate the results, identify problems; Act (A) - summarize experiences, formulate improvement measures. These four stages are connected end-to-end to form a continuous improvement loop. The core value of the PDCA cycle lies in "learning by doing, and improving through learning" - each cycle is a complete process of diagnosis, action, reflection, and optimization.

2) Application of PDCA in the Field of Education

The PDCA cycle theory has been widely applied in the field of education. In the aspect of cultivating students' abilities in higher education institutions, studies have introduced the connotation of the PDCA cycle theory, analyzed its necessity and feasibility in the field of cultivating students' abilities in higher education institutions, and discussed the implementation path (Guo Hong, 2018). In terms of curriculum teaching reform, researchers have improved the Database Principles and Applications Experimental Course based on the PDCA cycle theory, effectively enhancing students' practical abilities (Liu Lina et al., 2023). In the aspect of cultivating college students' vocational abilities, there are studies that apply the PDCA cycle to the vocational ability cultivation in higher education institutions, thereby improving the effectiveness of teaching work (Wang Yan et al., 2019).

In international research, Samuel and Farrer (2025) pointed out that the PDCA cycle, as a dynamic and stable management framework, can effectively convert assessment data into measurable organizational changes and cultivate a sustainable, data-driven continuous improvement culture in higher education. In addition, the PDCA cycle has also been applied to the construction of the curriculum teaching evaluation system, forming a closed-loop model of "teaching objectives - teaching implementation - teaching evaluation - teaching improvement" (Li Li et al., 2023).

However, existing studies that apply the PDCA cycle to the field of labor education, especially those addressing the issue of the separation between theory and practice, are still relatively few. This gap provides a theoretical application space for this research.

2.4 Literature Review

By systematically reviewing the above three pieces of literature, the following conclusions can be drawn:

First, the research on labor education has produced a relatively complete theoretical framework and assessment tool system. The academic community has conducted systematic research on the connotation of labor education, the structural dimensions of labor competence (Wang Quanquan et al., 2021; Wang Zhengqing et al., 2021), and assessment tools (Wang Zhengqing et al., 2021; Cai Ruilin and Hua Wenfeng, 2021), providing a theoretical basis and measurement tools for this study.

Second, the disconnection between theory and practice has been confirmed as the core dilemma of labor education in domestic and foreign universities. Multiple studies have pointed out that current labor education in universities exhibits problems of disconnection between theory and practice, and the differentiation between knowledge and action (Ban Jianwu, 2019; Wang Zhengqing et al., 2021; Klafke et al., 2023), and the concept of "the gap between theory and practice" in international education research (Greenway et al., 2019; Allen, 2011) also confirms the universality of this problem.

Third, there are obvious research gaps in the existing studies. Firstly, although some studies have pointed out the problem of "the disconnection between theory and practice" in university labor education, there is a lack of specific operational models that can effectively connect theoretical courses and practical courses. Secondly, the concept of "bridging courses" has been applied in other educational fields, but has not been systematically introduced to the field of labor education. Thirdly, the PDCA cycle has been successfully applied in enhancing students' abilities, but there is still a lack of intervention research in the field of labor education.

Based on these research gaps, this study addresses the following core questions: Can a series of lectures be used as an intermediary carrier and the PDCA cycle as the operational mechanism to construct an effective model that connects labor education theory courses and practical courses? Can this model significantly improve the labor competence of college students? This study will address these questions by constructing and verifying the TPLEL model (Theory-Practice Bridging Labor Education Lectures Model), with the aim of providing an operational, replicable, and iterative effective path for the reform of university labor education.

2.5 The Theoretical Framework of the TPLEL Model

The TPLEL model proposed in this study takes the "labor education lecture" as the core, the "bridging course" as the carrier, "connecting theory with practice" as the core function, "enhancing the labor quality of college students" as the core goal, and PDCA cycle as the core operating mechanism. The four-layer structure of the model is shown in Table 1 below:

Table 1. Hierarchical Structure of the TPLEL Model

PDCA stage	Element layer	Content	Corresponding stage/section
P (Plan)	Planning Layer	Based on the identified shortcomings in labor competence from the pre-test, the lecture script was designed following the four principles of lecture design.	Lecture Design
D (Do)	Carrier layer	Practical Labor Education Lecture (20-minute lecture, 30-minute activity)	Implementation of intervention
C (Check)	Target layer	After using standardized scales for measurement, the differences in labor knowledge and labor skills scores were quantitatively compared, and the effectiveness of improving college students' labor competence was examined.	Post-test evaluation
A (Act)	Enhancement Layer	Based on the post-test data, modify the lecture content and prepare for the iteration.	Improve quality and increase efficiency

The operation logic of the model is shown in Figure 1: The pre-test diagnoses the weak dimensions, and based on the “Four Ones” design principle, that is, one core issue, one identity swap, one outcome production, and one linkage bridge (the academic interpretation of the “Four Ones” principle: each lecture focuses on one real practical problem faced by students, sets up a teacher-student/student-student identity swap interaction session, produces visualized labor learning outcomes, and builds a stable linkage channel between classroom theory and extracurricular practice) designs the lecture content that connects theory and practice courses (P) → implements the lecture content (D) → post-test evaluates the improvement effect of college students’ labor competence (C) → summarizes and improves (A), forming a “diagnosis - operation - evaluation - improvement” closed-loop mechanism, with multiple iterations to enhance quality and efficiency.

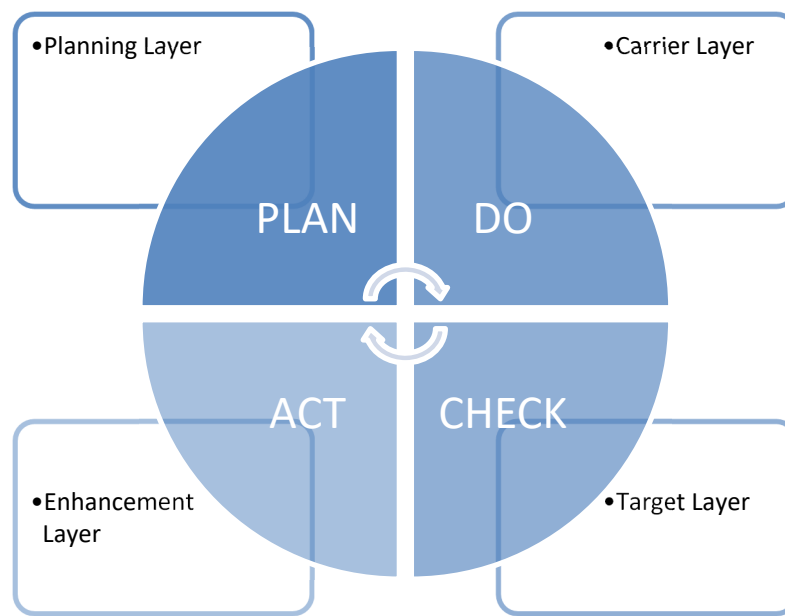


Figure 1. TPLEL Model Diagram

3. Research Design

3.1 Research Approach

This study adopts a single-group pretest-posttest quasi-experimental design. The same group of freshmen were measured on their labor competence before and after attending the labor education lecture. By comparing the pretest and posttest data, this study assesses whether the TPLEL model based on PDCA can effectively bridge the gap between labor education theory and practice and enhance the labor competence of college students. A complete PDCA cycle was implemented in this study.

3.2 Research Tools

1) labor competence Assessment Scale

This study uses the “New Era College Students’ labor competence Assessment Scale” developed by Wang Zhengqing et al. (2021). The scale consists of 4 primary dimensions: labor values, labor knowledge, labor skills, and innovative labor. The scale uses a Likert 5-point scoring system (1 = completely not matching, 5 = completely matching), and the higher

the score of each dimension, the higher the labor competence level of that dimension. “Labor knowledge” reflects students’ mastery of labor-related theories, and “labor skills” reflects students’ ability to apply knowledge in practice - the gap between the two can indirectly reflect the degree of disconnection between theory and practice.

2) Background Information Questionnaire

Before the labor competence assessment scale, a self-compiled background information questionnaire was developed to collect demographic information such as the students’ gender and educational category, for the purpose of describing the sample composition; there were no subjective measurement items.

3.3 Research Subjects and Samples

This study focused on the first-year students of the Class of 2025 at X University in Hefei City, Anhui Province. Using the cluster sampling method, 207 students from 5 classes were selected to participate in the research. Inclusion criteria: (1) Full-time first-year students; (2) Voluntary participation and signing of informed consent form; (3) Full participation in the pre-test, lecture intervention, and post-test. Finally, 206 valid questionnaires were collected, with a valid recovery rate of 99.5%. The composition of the sample is shown in Table 2.

Table 2. Demographic Characteristics of the Sample (N = 206)

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	98	47.6
	Female	108	52.4
Educational category	Undergraduate level	95	46.1
	Top-up Degree Program	111	53.9

3.4 Research Procedure (PDCA Four Phases)

Phase 1: Plan - Planning Layer: Pre-diagnosis and Lecture Design (Week 1 of March 2026)

Using Wang Zhengqing’s scale, a pre-test was conducted on 207 freshmen to obtain baseline data on labor competence, focusing on diagnosing the gap between “labor knowledge” and “labor skills”. The pre-test results showed that the score in the labor knowledge dimension was the lowest ($M = 2.98$), and the score in labor skills ($M = 3.14$) was also at a low level, indicating that students lacked systematic labor knowledge and the ability to convert theory into practice - the problem of disconnection between theory and practice was prominent.

Based on this, the core concept of the lecture design was determined as “Using lectures as a bridge to bridge the gap between theory courses and practical courses and enhance college students’ labor competence”. Each lecture was guided by a specific problem in students’ practice, including theoretical teaching (20 minutes) and student activities (30 minutes), ensuring that the lecture was student-centered and focused on students’ truly pressing issues, striving to solve one problem per lecture and apply and test the knowledge and insights learned in the practical section immediately. The specific content modules included: (1) Reconstructing cognition: “The First Lesson of Labor: The Handbook for Advancement from ‘Slacking Off’ to ‘Superstar’” (Theoretical Teaching, Debate Competition); (2) Tool thinking: “The Revealing of ‘Labor Tools’: The Hardcore Toolkit to Double Your Efficiency” (Theoretical Teaching, Case Analysis); (3) Creative labor: “Can Farming Also Go Viral on Weibo? - The Creative Formula to Make Labor Cool” (Theoretical Teaching, Practical Operation); (4) Value and dignity: “Salute to Ordinary Heroes! Discovering the Glitters in Everyday Life” (Theoretical Teaching, Group Discussion); (5) Connecting the future: “Up Your Resume! How to Make Your Labor Experience Your Most Outstanding Talking Point?” The lecture series consisted of 10 class hours divided into 5 sessions, to be completed once a week.

Phase 2: Do - Carrier Layer: Conducting Lectures (March - April 2026)

Carry out 5 labor education lectures strictly in accordance with the design plan. Each lecture must strictly follow the design principles. The first 20 minutes featured a systematic theoretical presentation, and the next 30 minutes included various student participation-oriented activity experience sessions that directly correspond to the theoretical content - enabling students to reflect after “acting”, immediately enter “acting” after “knowing”, and deepen “knowing” within “acting” to achieve the integration of knowledge and action. During the implementation process, we recorded students’ attendance, classroom participation, and completion of practical operations.

Phase 3: Check - Target Layer: Effect Evaluation (Week 4 of April 2026)

One week after the lecture series concluded, a post-test using the same Wang Zhengqing scale was conducted on the same group of students. The main focus was to examine whether labor knowledge and labor skills had significantly improved, whether the gap between the two had narrowed (that is, whether the disconnection issue had been alleviated), and to compare the changes in other dimensions, in order to prepare for the improvement of subsequent lectures.

Phase 4: Act - Enhancement Layer: Summary and Improvement (May 2026)

Based on the comparison and analysis of pre- and post-test data, we summarized the effective experiences and shortcomings of this PDCA cycle, with particular attention to the enhancement effect of integrating “theory and practice” design on the labor competence of college students, and proposed further optimized improvement directions for the next cycle.

3.5 Data Analysis Methods

Data analysis was conducted using SPSS 26.0: (1) Descriptive statistical analysis; (2) Paired sample *t*-test; (3) Effect size analysis (Cohen’s *d*); (4) Reliability analysis (Cronbach’s α). Statistical significance was determined by $p < 0.05$ indicating a significant difference, and $p < 0.001$ indicating an extremely significant difference; Cohen’s *d* criteria: $d < 0.2$ represents a small effect, $0.2 \leq d < 0.8$ represents a moderate effect, and $d \geq 0.8$ represents a large effect.

4. Research Results

4.1 Reliability Test of the Scale

Wang Zhengqing et al. (2021) reported in their scale development study that the Cronbach’s α coefficient of this scale was 0.93, and the Cronbach’s α coefficients of each dimension were 0.91, 0.86, 0.90, and 0.91 respectively, indicating that the scale has good reliability. Validity refers to the degree to which the scale can measure the level of college students’ labor competence, and is a key indicator for evaluating the quality of the scale. Wang Zhengqing et al. (2021) verified the structural validity of the scale through confirmatory factor analysis. In terms of convergent validity, the average variance extracted (*AVE*) of each dimension was greater than 0.5, and the composite reliability (*CR*) was between 0.86 and 0.92; in terms of discriminant validity, the square root of the *AVE* of each dimension was greater than its correlation coefficient with other dimensions. These indicators indicate that the scale has good structural validity. In the sample of this study, the Cronbach’s α coefficient of the total scale was 0.927, and the Cronbach’s α coefficients of each dimension were between 0.862 and 0.904, further verifying the applicability of the scale in this research group.

4.2 Pre-test Results of Labor Competence

The pre-test results showed that the overall average score of college students’ labor competence was 3.08 ($SD = 0.52$). The scores of each dimension from high to low were: labor values ($M = 3.42$, $SD = 0.62$), labor skills ($M = 3.05$, $SD = 0.58$), innovative labor ($M = 2.98$, $SD = 0.63$), and labor knowledge ($M = 2.87$, $SD = 0.67$). Among them, labor knowledge and labor skills were at the lower levels, indicating that students lacked both “understanding of labor principles” and “the ability to labor”, and the problem of the disconnection between theory and practice was prominent (see Table 3).

Table 3. Scores of Each Dimension of Labor Competence Before the Test (N = 206)

Dimension	Mean value (<i>M</i>)	Standard deviation (<i>SD</i>)	Sort
Labor values	3.42	0.62	1
Labor skills	3.05	0.58	2
Innovative labor	2.98	0.63	3
Labor knowledge	2.87	0.67	4
Total score	3.08	0.52	—

4.3 Post-test Results of Labor Competence

After a round of PDCA cycle intervention, the post-test results showed that the total average score of college students’ labor competence increased to 3.71 ($SD = 0.48$). The post-test scores of each dimension are shown in Table 4. There was a notable degree of improvement in all dimensions, among which the “labor knowledge” dimension rose from the fourth position in the original ranking to the third position.

Table 4. Scores of Each Dimension of Post-Test Labor Competence (N = 206)

Dimension	Mean value (<i>M</i>)	Standard deviation (<i>SD</i>)	Sort
Labor values	3.96	0.55	1
Labor skills	3.68	0.54	2
Labor knowledge	3.66	0.58	3
Innovative labor	3.52	0.61	4
Total score	3.71	0.48	—

4.4 Comparison Analysis of Pre- and Post-Tests

The paired sample *t*-test results (as shown in Table 5) indicate that the total score of college students’ labor competence and the scores of each dimension have significantly improved (all $p < 0.80$).

Table 5. Paired Sample T-test Results of Labor Competence Before and After (N = 206)

Dimension	Pre-test ($M \pm SD$)	Post-test ($M \pm SD$)	Deviation	t	p	Cohen's d
Labor values	3.42 ± 0.62	3.96 ± 0.55	0.54	13.01	<0.001	0.91
Labor knowledge	2.87 ± 0.67	3.66 ± 0.58	0.79	18.25	<0.001	1.27
Labor skills	3.05 ± 0.58	3.68 ± 0.54	0.63	15.98	<0.001	1.11
Innovative labor	2.98 ± 0.63	3.52 ± 0.61	0.54	11.24	<0.001	0.78
Total score	3.08 ± 0.52	3.71 ± 0.48	0.63	15.37	<0.001	1.07

From the data in Table 5, it can be seen that the labor knowledge representing the “theory” dimension (pre-test $M = 2.87 \rightarrow$ post-test $M = 3.66$, $d = 1.27$) and the labor skills representing the “practice” dimension (pre-test $M = 3.05 \rightarrow$ post-test $M = 3.68$, $d = 1.11$) both significantly improved, and the gap between them decreased from 0.18 points in the pre-test to 0.02 points in the post-test. This directly indicates that the problem of “theoretical and practical disconnection” has been effectively alleviated, and the total score (pre-test $M = 3.08 \rightarrow$ post-test $M = 3.71$, $d = 1.07$) significantly improved. These findings provide empirical support for the “linking theory and practice courses” function of the TPLEL model and its potential to enhance college students’ labor competence.

5. Discussion

5.1 The Alleviating Effect of the TPLEL Model on the “Disconnection Between Theory and Practice” Issue

The core finding of this study is that the TPLEL model appears to effectively mitigate aspects of the problem of the disconnection between theoretical courses and practical courses in university labor education. In the pre-test, students’ labor knowledge ($M=2.87$) and labor skills ($M=3.05$) were at the lower end of each dimension, and there was a notable gap (0.18 points) between the two, indicating that students lacked systematic labor knowledge and the ability to convert knowledge into practice - a “disconnection between ‘knowing’ and ‘doing’”. After one round of PDCA cycle intervention, labor knowledge increased to 3.66 ($d=1.27$) and labor skills increased to 3.68 ($d=1.11$), and the gap narrowed to 0.02 points. This result suggests that through the “bridging course” labor education lectures, students not only mastered labor knowledge, but also could apply and test what they had learned in the practical stage, moving toward the integration of “knowing” and “doing”.

It is worth noting that the pre-test score of labor knowledge was the lowest among all dimensions (2.87), but the post-test improvement was the largest (0.79, $d=1.27$), indicating that the precise intervention strategy targeting the weak dimension may be effective - this is precisely the core value of the PDCA cycle in the “planning” stage. At the same time, labor skills increased from 3.05 to 3.68 ($d=1.11$), approaching the post-test level of labor knowledge, indicating that the “problem-oriented, student-centered” design concept may have effectively facilitated the transformed knowledge into ability.

This finding provides preliminary support for the core hypothesis of the TPLEL model: lectures can become an effective intermediary carrier to connect theoretical courses and practical courses and potentially enhance college students’ labor competence. The key lies in that each lecture must include two sections: “theoretical lecture” and “practical experience”, and the two form direct correspondence in content - what is taught is used, and what is used is what is taught. The theoretical lecture begins with a problem in practice that confuses students, guiding them to participate in various activities to independently explore the answer to the problem and bring the answer to the next practical activity. This design breaks the traditional pattern where theoretical and practical courses operate separately, allowing students to complete the transformation and cycle from “knowing” to “doing” within the same teaching unit.

5.2 Analysis of the Differences in Dimensional Improvements

From the perspective of each dimension, the improvement in labor knowledge was the most significant ($d = 1.27$), with the greatest marginal effect. This might be because the labor knowledge education received by freshmen before enrollment was relatively scarce (pre-test score was only 2.87). The systematic knowledge lectures in the sessions did not rely on theoretical textbook knowledge but started from practical problems and taught the necessary knowledge to solve the problems. Students were more interested and learned faster. This finding is consistent with the assessment results of college students in Chongqing by Wang Zhengqing et al. (2021) - college students generally have a relatively poor grasp of labor knowledge, which is a weak link in the various dimensions of labor competence.

The improvement in labor skills was also significant ($d = 1.11$), and was almost on par with the post-test level of labor knowledge (3.66 vs. 3.68). This result indicates that when students acquire systematic theoretical knowledge, through the accompanying activity experience sections, the knowledge can be effectively transformed into practical hands-on abilities, thereby verifying the effectiveness of the “theory-practice” integrated design.

The improvement in labor values was by $d = 0.91$, at an above-average level. Although the labor values scored the highest in the pre-test (3.42), there is still significant room for improvement. This might be because the value guidance in the

lectures on Marxist labor views, the spirit of model workers, and the spirit of craftsmanship further strengthened students' identification with labor.

The improvement in innovative labor was relatively smaller ($d = 0.78$), although still at a moderately high effect level, it was significantly lower than other dimensions. This might be because the cultivation of innovative labor requires not only theoretical teaching and basic skill training, but also an open practical environment and the creation of a long-term innovative atmosphere. A single-round lecture intervention is may be difficult to bring about fundamental changes. This result suggests that the cultivation of innovative labor should be a key improvement direction in the subsequent PDCA cycle.

5.3 Theoretical and Practical Contributions of the TPLEL Model

1) Comparison with Domestic Research on Labor Education Integration: Existing studies mostly remain at the level of advocating concepts, lacking standardized and iterative lecture platforms. This study designs a complete series of five consecutive lectures, equipped with a PDCA cycle dynamic revision mechanism, to form a complete operational process that can be quantitatively evaluated.

2) Comparison with Overseas Bridge Course Research: Western bridge courses are mostly used for short-term transitions in engineering training and do not combine with the Chinese labor education policy background and continuous iterative loops. TPLEL embeds PDCA quality management into the lecture system, achieving a long-term educational improvement mechanism with one improvement per cycle, filling the gap of localized improvement.

3) Comparison with PDCA Education Application Literature: Past studies are mostly used for course management and the establishment of evaluation systems, rarely conducting quasi-experimental quantitative verification for labor education integration carriers. This paper adds empirical evidence in specific fields.

4) Value Innovation of the Model: First, at the structural level, the "theoretical lecture - activity experience" dual-loop design in each lecture ensures "frequency resonance" between theory and practice - starting from the problems discovered by students in practice, and then continuing with understanding and insights for the next practice, ensuring that students complete a complete learning loop from cognition to behavior within one teaching unit. In this study, the gap between labor knowledge and labor skills decreased from 0.18 points in the pre-test to 0.02 points in the post-test, directly verifying the effectiveness of this structural design. Second, at the content level, the content of the activity experience section directly corresponds to the theoretical lecture section, avoiding the separation of theory and practice. The five modules of the lecture content (reconstructing cognition, tool thinking, creative labor, connection with value and dignity for the future) all have corresponding activity sections to ensure that "what is taught is used, and what is used is taught". Third, at the mechanism level, the PDCA cycle ensures the continuous optimization of the model - diagnosing weak links in the pre-test (in this study, it was labor knowledge), implementing the design plan, testing the effect in the post-test (reducing the gap between knowledge and skills, improving students' labor competence), summarizing and refining the improvement direction. Each cycle can potentially achieve more precise narrowing of the gap between theory and practice on the basis of the previous cycle.

5.4 Research Limitations and Future Directions

Several limitations of this study should be acknowledged. 1) the study employed a single-group pretest-posttest design without a control group, which limits the strength of causal inferences that can be drawn from the findings. While the intervention effects were substantial and consistent across dimensions, it is possible that some portion of the observed improvements may be attributable to factors such as students' natural maturation during the university experience, exposure to other learning experiences during the study period, or testing effects associated with repeated measurement. The absence of a control group precludes the exclusion of these alternative explanations. Future research should consider incorporating a randomized controlled trial or a quasi-experimental design with parallel control classes to more rigorously evaluate the effectiveness of the TPLEL model and to isolate the specific contribution of the intervention from other confounding variables.

2) the sample was drawn from only one university in Hefei, Anhui Province, which may limit the generalizability of the findings to other institutional contexts. Students from different geographic regions, different types of universities (e.g., research-intensive vs. teaching-focused), and different academic disciplines may have varying baselines of labor competence and may respond differently to the intervention. Future studies should include multiple universities and diverse student populations to improve external validity and to assess the applicability of the TPLEL model across different educational contexts.

3) the intervention was relatively short in duration (five sessions over approximately one month), and no long-term follow-up assessments were conducted to evaluate the sustainability of the observed improvements. It remains unclear whether the gains in labor competence, particularly in the domains of labor knowledge and labor skills, would be maintained over

an extended period or whether they would diminish without continued intervention. Future research should incorporate longitudinal follow-up assessments at multiple time points (e.g., three months, six months, and one year post-intervention) to determine the persistence of effects and to identify the optimal intervention duration and frequency for maximum and sustained impact.

4) while the study provides preliminary evidence for the effectiveness of the TPLEL model, the absence of a control group limits the extent to which the findings can be attributed specifically to the model rather than to other concurrent factors. Future research with more rigorous experimental designs is needed to confirm the causal relationship between the TPLEL intervention and the observed improvements in labor competence.

Despite these limitations, the present study provides valuable preliminary evidence for the potential of the PDCA-based TPLEL model in enhancing college students' labor competence. The consistent pattern of improvements across all four dimensions, coupled with the substantial effect sizes, suggests that the model holds promise as a replicable and scalable approach for addressing the theory-practice gap in university labor education.

5.5 Insights from the Reform Practice of Labor Education in Universities

1) Establish a standardized transition lecture bridge: When conducting labor education in universities, it is not advisable to simply separate theoretical courses from practical activities. A series of connecting special lectures should be provided, adopting an integrated design of "theoretical explanation - immediate practice", to establish a clear channel for knowledge transfer.

2) Introduce the PDCA dynamic improvement mechanism: Regular pre- and post-tests based on the standardized labor competence scale should be conducted. Quantitative data can be used to diagnose students' shortfalls at different stages, and the lecture content can be revised accordingly to avoid the rigidity and formalism of the labor education course.

3) Set up hierarchical optimization priorities: The first round of PDCA should prioritize filling the gaps in students' labor theory. In subsequent rounds of the cycle, lectures related to innovative labor and creative practice should be gradually added, and students' comprehensive labor competence should be progressively enhanced through hierarchical progression.

6. Conclusion

Based on the PDCA cycle, this study investigated the issue of the disconnection between theoretical and practical courses in university labor education and the need for improving the labor competence of current college students. The TPLEL model (Theory-Practice Bridging Labor Education Lectures Model for Enhancing University Students' labor competence) was constructed and preliminarily validated. Using a pre-test and post-test quasi-experimental design, the following main conclusions can be drawn:

Firstly, the TPLEL model appears to effectively alleviate aspects of the problem of the disconnection between labor education theory and practice, and to be associated with significant gains in college students' labor competence. After one round of PDCA cycle intervention, all dimensions of students' labor competence showed significant improvement. Specifically, labor knowledge and labor skills significantly improved ($d = 1.27$, $d = 1.11$), and the gap between the pre-test and post-test decreased from 0.18 points to 0.02 points, indicating that the "knowledge-action gap" was substantially reduced.

Secondly, the integrated thematic lecture of "20 minutes of theoretical lecture and 30 minutes of supporting practice" may serve as a feasible connecting carrier suitable for labor education. Following the four standardized design principles, it can achieve the rapid transformation of theoretical knowledge into practical ability, providing low-cost and replicable teaching tools for universities in various countries. Within the same teaching unit, the transformation from "knowledge" to "action" can be realized, enabling students to identify problems in practice, enhance practice under theoretical guidance, and test theory in practice, forming a virtuous cycle. The effect sizes of each dimension (labor knowledge $1.27 >$ labor skills $1.11 >$ labor values $0.91 >$ innovative labor 0.78) further indicate that the dimensions directly related to the lecture content showed more significant improvement.

Thirdly, the PDCA cycle may provide a mechanism guarantee for continuously bridging the gap between theory and practice. The pre-test diagnosis identified the weak dimension (in this study, labor knowledge) and designed lecture content, execution steps for the experiment, inspection steps to quantify the effect, and handling steps to propose improvement directions - a four-stage cycle operation that can potentially ensure progressive improvement with each round.

Based on the above conclusions, this paper proposes the following suggestions: (1) University labor education should establish a theoretical and practical connection mechanism similar to the TPLEL model to prevent theoretical and practical courses from operating in silos and to facilitate their organic integration; (2) Labor education lectures should adhere to "one core issue, one identity exchange, one outcome production, one linkage bridge", ensuring the immediate

correspondence between theory and practice by coming from practice and returning to practice; (3) A regular assessment system based on standardized scales should be established to continuously monitor the changes in the “knowledge-skill” gap, using data-driven course improvement to form a multi-round PDCA evidence-based improvement loop.

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Author contributions

Dr. Tingting Zhang was responsible for the study design, data collection, and drafting the manuscript. Prof. A Komariah provided critical revisions to the initial draft. Dr. T C Kurniatun and Dr. S Sururi participated in data analysis and interpretation. All authors read and approved the final manuscript.

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