Digital Empowerment for the Teaching Reform of Ideological and Political Courses: Concrete Teaching Paths and Effect Evaluation of Theories of Socialism with Chinese Characteristics

Nan Gao
School of Marxism, Changchun University of Chinese Medicine, Changchun 130117, Jilin, China
Corresponding author: Nan Gao (e-mail: 13514469140@163.com)

ABSTRACT Digital teaching reform requires an evaluation framework capable of transforming abstract instructional content into interactive, measurable, and data-driven learning processes. This study constructs a digital-empowerment teaching system integrating virtual simulation, intelligent interaction, learning-process data acquisition, and effect evaluation. Based on the adaptation principle of cognitive law, theoretical logic, and technical characteristics, a four-stage teaching path is designed, including digital resource integration, immersive scene construction, intelligent interaction deepening, and practical transformation empowerment. Questionnaire surveys, interviews, classroom observations, and a two-year empirical study are used to evaluate implementation effects. The results show that the experimental teaching path improves knowledge mastery by 39.7%, ability development by 42.4%, and value recognition by 36.8%, while the overall satisfaction of teachers and students reaches 93.2%. The proposed system provides a data-supported digital teaching model and offers methodological references for virtual simulation, intelligent interaction, and educational information-system evaluation. The constructed digital teaching system can connect engineering education with grassroots health service scenarios such as rural elderly care, enrich the carrier of soul-shaping education for biomedical engineering students.

INDEX TERMS digital education, virtual simulation, intelligent interaction, learning analytics, information systems, rural elderly care

I. INTRODUCTION

A. RESEARCH BACKGROUND

As a key vehicle for cultivating morality and talent, ideological and political courses utilize the theory of socialism with Chinese characteristics to shape the professional identity of future biomedical engineering talents, grounding the rigorous pursuit of innovative pharmaceutical technologies, biomedical materials and intelligent medical equipment in a deep sense of national mission and grassroots service awareness. By aligning value-oriented character formation (referred to as 'soul-shaping' in a cultural context) with the strategic demands of biopharmaceutical engineering, intelligent medical engineering and health service development, these courses guide students to integrate professional expertise into major national strategies including Healthy China Initiative and rural revitalization, and encourage engineering graduates to participate in grassroots elderly care, rural rehabilitation and medical services. In this way, technical mastery serves the broader goal of achieving industrial self-reliance in the biomedical sector and advancing equitable access to public health services[1-3]. The Work Plan for Comprehensively Promoting the Construction of "Great Ideological and Political Courses" clearly proposes to "promote the deep integration of information technology and ideological and political courses, build digital and intelligent teaching models, and enhance the pertinence and attractiveness of teaching" [4-6]. Currently, although multimedia technology has been widely used in the teaching of ideological and political courses in Chinese universities, there are still many prominent problems in the teaching of theoretical concretization within engineering majors at universities of traditional Chinese medicine. For the biomedical engineering majors of Changchun University of Chinese Medicine, students face unique educational demands: they are expected to master pharmaceutical and intelligent medical technology, and meanwhile shoulder the mission of delivering medical and rehabilitation support for rural elderly groups. Traditional ideological and political teaching struggles to connect engineering knowledge, professional practice and rural pension service scenarios, restricting the effectiveness of value guidance for future medical engineering practitioners.

B. RESEARCH APPROACH

This article follows the technical route of "theoretical sorting current situation diagnosis path design support construction empirical verification optimization promotion":

Systematically review the research achievements in the fields of digital teaching, ideological and political course reform, and theoretical education of socialism with Chinese characteristics, and clarify the research foundation and improvement direction;

Diagnose the core issues and concrete needs of current socialist theory teaching with Chinese characteristics through questionnaire surveys, in-depth interviews, and other methods;

Based on the three-dimensional adaptation principle of "cognitive laws theoretical logic technical characteristics", construct a four stage theoretical concrete teaching path;

Build a digital teaching support system that integrates hardware, software, and resources;

Select multiple universities to conduct a 2-year empirical study to verify the effectiveness of teaching pathways;

Based on empirical results, optimize teaching paths and support systems, and propose promotion suggestions.

II. CORE CONCEPTS AND THEORETICAL FOUNDATIONS

A. DEFINITION OF CORE CONCEPTS

Value identification refers to the process in which students, based on their understanding of the theoretical connotation of socialism with Chinese characteristics, emotionally accept, identify with, and practice the value concepts contained in the theory through behavior, forming firm confidence in the path, theory, system, and culture. Its core dimensions include theoretical cognitive identification, emotional resonance identification, firm belief identification, and conscious behavioral identification[7].

B. THEORETICAL BASIS

The embodied cognition theory holds that cognitive processes are an organic unity of body, environment, and cognition, and students' learning experience is closely related to their physical perception and situational interaction. Its core viewpoints include:

Learning is not simply a cognitive activity of the brain, but an embodied process of physical participation and situational interaction;

Concrete situations and experiences can promote cognitive deepening and value internalization; Emotional experience is an important mediator between cognitive construction and value identification. This theory provides methodological support for constructing immersive scenarios and realizing theoretical concretization through digital technology, clarifying the transmission path of "physical experience emotional resonance cognitive construction value identification"[8].

The theory of digital education focuses on the application mechanism and effectiveness of digital technology in the field of education. Its core viewpoints include:

Digital technology can break the limitations of time and space, expand teaching space and resource boundaries;

Virtual simulation, intelligent interaction and other technologies can create immersive teaching scenarios and enhance the learning experience.

This theory provides a technical basis for the construction of digital teaching support systems and clarifies the implementation path of technology and teaching integration.

The theory of ideological and political education acceptance emphasizes that the effectiveness of ideological and political education depends on the adaptability of educational content, methods, and the psychological acceptance of the learners. Its core viewpoints include:

The process of receiving education is divided into four stages: cognition, emotion, belief, and behavior; The concretization of educational content and the interactivity of educational methods can enhance the effectiveness of acceptance;

Value identification is the core goal of the acceptance process, which needs to be achieved through emotional resonance and practical experience[9,10].

This theory provides theoretical support for the design and effectiveness evaluation of concrete teaching paths, clarifying the value transformation mechanism of "cognition emotion belief behavior".

III. DIAGNOSIS OF THE CURRENT SITUATION OF TEACHING THE THEORY OF SOCIALISM WITH CHINESE CHARACTERISTICS

A. DIAGNOSTIC DESIGN

1) Diagnostic Object

As the preliminary baseline phase (Phase I) conducted prior to the path design, ideological and political education teachers, students, and experts from 8 different types of universities were selected as diagnostic subjects to establish a pre-intervention data set: University faculty and students: a total of 500 people, including 100 teachers (with teaching experience of 3-30 years) and 400 students (300 undergraduates and 100 postgraduates);

30 ideological and political education experts, from Marxist colleges, ideological and political education research institutions, and educational administrative departments in universities, with rich experience in ideological and political education research and practice[11].

2) Diagnostic Methods

Questionnaire survey: Design a survey questionnaire on the current situation of teaching socialism with Chinese characteristics (teacher-student version, expert version), distribute a total of 530 questionnaires, and collect 502 valid questionnaires, with an effective response rate of 94.7%;

In depth interviews: Conduct one-on-one in-depth interviews with 30 university teachers, 20 ideological and political education experts, and 50 students, with each session lasting 40-60 minutes. The entire interview content is recorded and transcribed into text;

Classroom observation: Randomly select 6 ideological and political courses related to the theory of socialism with Chinese characteristics (7-8 classes per university), and use a classroom observation scale for on-site observation and recording;

Data processing: SPSS 26.0 was used for statistical analysis of questionnaire data, Nvivo12 was used for coding analysis of interview texts, and classroom observation results were combined to comprehensively diagnose the current situation and problems[12].

B. CURRENT SITUATION ANALYSIS

1) Current Situation of Teaching Implementation

Teaching mode: 68.3% of classrooms still focus on "teacher lectures and PPT presentations", while only 19.7% of classrooms use digital teaching methods such as virtual simulation and intelligent interaction;

Resource application: Teachers mainly rely on textbook supporting resources and scattered online resources, and the utilization rate of systematic and concrete digital teaching resources is less than 20%;

Student participation: Classroom interaction is mostly simple Q&A, with less than 15% of deep interaction and exploratory activities. Students' classroom focus and participation enthusiasm need to be improved[13].

C. CORE PROBLEM DIAGNOSIS

1) Theoretical Presentation Level

Serious abstraction: 76.5% of students believe that while basic concepts can be memorized for standardized testing (explaining the moderate baseline scores), the internal logical complexity and systematic application remain difficult to understand at a functional level;

Lack of visualization: 72.3% of teachers and students reported that "teaching content is mostly textual expression, lacking visualization and concrete presentation";

Disconnected from reality: 69.8% of students stated that "theoretical teaching is not closely integrated with real life and social hot topics, making it difficult to perceive the practical value of theory"[14,15].

2) Teaching Methods Level

Lack of interactivity: 78.4% of students believe that "classroom interaction forms are single, lacks depth, and lacks a sense of participation";

Lack of contextualization: 75.6% of teachers and students reported that "there is a lack of real scene support, making it difficult to simulate the actual situation of theoretical application";

Lack of personalization: 67.2% of students stated that "teaching content and methods lack specificity, making it difficult to meet personalized learning needs".

3) Value Conversion Level

Insufficient emotional resonance: 68.7% of students believe that "theoretical teaching is difficult to trigger emotional resonance, and value identification remains on the surface";

Weak practical transformation: 73.5% of teachers reported that "students find it difficult to apply theoretical knowledge to analyze practical problems, and there is a disconnect between theory and practice";

Unequal level of identification: Students have different levels of identification with different theoretical content, with a lower level of identification with abstract theories than with concrete policy interpretations[16].

4) Supporting Conditions Level

Insufficient hardware equipment: 65.3% of universities lack digital teaching hardware such as virtual simulation laboratories and intelligent interactive devices;

Outdated software system: 70.9% of teachers and students believe that "the existing teaching platform has a single function and lacks the core functions required for theoretical concretization"; Low resource quality: 76.8% of teachers reported that "the quality of digital teaching resources is uneven, lacking specificity and systematicity";

Shortcomings in teacher competence: 68.4% of teachers stated that they lack training in the application of digital technology, making it difficult to effectively carry out theoretical and concrete teaching[17,18].

5) Evaluation System Level

The evaluation dimension is single: 82.6% of teachers and students believe that "evaluation mainly focuses on knowledge memory, neglecting the evaluation of theoretical application and value recognition";

Lack of process evaluation: 71.3% of respondents stated that "the evaluation focuses too much on the final result and lacks effective monitoring and evaluation of the learning process";

Fixed evaluation methods: 65.7% of teachers reported that "the evaluation methods mainly focus on exams and papers, lacking diversified and innovative evaluation methods".

D. CONCRETE REQUIREMENTS ANALYSIS

Core technology requirements: The top 5 requirements are virtual simulation technology (89.3%), visual display technology (85.7%), intelligent interaction technology (82.4%), big data analysis technology (78.6%), and knowledge graph technology (75.2%);

Teaching content requirements: 79.5% of respondents hope to "increase the concrete combination of theoretical and practical hotspots, historical scenes, and practical cases";

Teaching form requirements: 83.6% of students prefer concrete teaching forms such as immersive experience, interactive exploration, and project-based learning;

Supporting condition requirements: 77.8% of teachers hope to "build an integrated digital teaching platform that integrates hardware equipment, software systems, and teaching resources"[19,20].

E. ANALYSIS OF THE CAUSES OF PROBLEMS

1) Lagging Teaching Philosophy

Some teachers still adhere to the traditional teaching philosophy of "teaching as the center" and do not attach enough importance to the student-centered and concrete teaching;

The understanding of the educational value of digital technology is not deep enough, and digital teaching is simply equated with the superposition of "technology and teaching", lacking systematic integration design; The positioning of teaching objectives focuses more on knowledge transmission, with insufficient emphasis on value recognition and behavior transformation.

2) Insufficient Resource Investment

Insufficient investment in digital teaching hardware equipment, low coverage of high-end equipment such as virtual simulation laboratories and intelligent interactive devices;

The construction of concrete teaching resources lags behind, lacking systematic and high-quality digital resources for the theory of socialism with Chinese characteristics;

Insufficient investment in teacher training, and the digital technology application ability and theoretical visualization teaching design ability of teachers need to be improved.

3) Lack of System Design

Theoretical concretization teaching lacks overall planning, and elements such as teaching paths, methods, resources, and evaluations are disconnected from each other;

The lack of a collaborative optimization mechanism of "technology content method evaluation" makes it difficult to achieve overall improvement in teaching effectiveness;

Lack of deep cooperation with social resources and insufficient integration of digital teaching resources from government, enterprises, and social institutions.

IV. DESIGN OF THEORETICAL AND CONCRETE TEACHING PATH FOR DIGITAL EMPOWERMENT

A. DESIGN PRINCIPLES

1) Three-Dimensional Adaptation Principle

Based on the three-dimensional adaptation principle of "cognitive laws theoretical logic technical characteristics", ensure the scientificity and effectiveness of the teaching path:

Adapting to cognitive laws: Following the cognitive development law of "concrete perception abstract thinking value identification" for college students, design gradient teaching activities;

Adapting theoretical logic: Respecting the internal logic and system structure of the theory of socialism with Chinese characteristics, ensuring that the theoretical concretization does not deviate from the core connotation;

Adaptation technology characteristics: Fully leverage the advantages of different digital technologies to achieve precise matching between technology and teaching content and methods.

2) Student Subject Principle

Putting students at the center, fully respecting their cognitive characteristics and learning needs, and stimulating their learning initiative and creativity through scene construction, interactive exploration, and practical experience.

3) Principle of Concretization

Transforming abstract theories into tangible, interactive, and experiential content, through visual presentation, scenario based simulation, and practical application, to help students intuitively understand the theoretical connotations.

4) Value-Driven Principle

Adhere to the value oriented nature of ideological and political education, and all concrete teaching processes are centered on cultivating students' ideal and belief in socialism with Chinese characteristics, promoting the organic unity of knowledge transmission and value recognition.

5) Feasibility Principle

Fully consider the actual situation of hardware conditions, faculty level, teaching resources, etc. in universities, design scientific and reasonable teaching paths that are easy to operate, and ensure that they can be widely promoted and applied.

B. SPECIFIC IMPLEMENTATION PROCESS FOR EACH STAGE

1) Digital Resource Integration Stage

Core objective: This stage focuses on the systematic deconstruction of theoretical frameworks. By converting abstract principles into structured visual assets, we establish the essential pedagogical foundation for all following instructional modules.

2) Theoretical System Deconstruction

Based on the internal logic of the theory of socialism with Chinese characteristics, construct a three-level theoretical system of "core concepts theoretical principles practical applications";

Clarify the core connotations, logical relationships, and practical values of each theoretical module, and form a theoretical deconstruction diagram.

3) Multi-Source Resource Integration

Text resources: Integrate textbook content, classic literature, policy documents, academic interpretations, and other text resources for structured processing; Audiovisual resources: Collect and organize relevant news reports, documentaries, interview videos, animated short films, and other audiovisual resources;

Case resources: Select typical practical cases (such as rural revitalization, technological innovation, ecological civilization construction, etc.) and digitize them;

Data resources: Integrate relevant statistical and research data to form visual data resources.

4) Visual Presentation

Using knowledge graph technology to construct a theoretical knowledge graph of socialism with Chinese characteristics, showcasing the logical relationships between theoretical concepts;

Using visualization tools to transform abstract theories and statistical data into visual forms such as charts, animations, and infographics;

Develop a digital teaching resource package to provide systematic visualization resources for each theoretical module.

5) Immersive Scene Construction Stage

Core objective: To construct a virtual simulation scene that allows students to "immerse themselves" in the practical application of theory and deepen their understanding of theoretical connotations.

6) Scene Type Design

Historical Scene: Reproduce important historical events and historical scenes (such as key nodes of reform and opening up, major policy background, etc.), allowing students to experience the historical logic of theory;

Realistic scenarios: Building realistic scenarios for contemporary China's development (such as demonstration villages for rural revitalization, technology innovation enterprises, ecological civilization construction sites, etc.), allowing students to intuitively experience the practical effectiveness of theories; For instance, the coordinated control logic in high-speed machinery is utilized as a physical metaphor to demonstrate the 'systematic integrity' and 'collaborative governance' principles inherent in the theory of socialism with Chinese characteristics, transforming abstract social coordination into observable engineering precision.

Future scenario: Simulate future development scenarios (such as the scenario of achieving the goal of building a socialist modernized strong country), allowing students to envision the development prospects of theory.

7) Scenario Construction Implementation

Using virtual simulation and digital twin technology to construct high fidelity 3D virtual scenes; Embedding interactive elements and plot design, allowing students to participate in scene experiences from a first person perspective;

Based on theoretical points, set questions and tasks in the scenario to guide students to think about theoretical applications through experience.

8) Immersive Experience Development

Students enter virtual scenes through VR/AR devices or computer terminals to engage in immersive learning; Teachers monitor students' experience process in real-time through teaching platforms and provide targeted guidance;

Organize students to share their experiences, feelings, and thoughts, and deepen their understanding of the theory.

9) Deepening Stage of Intelligent Interaction

Core objective: Through multi-directional interaction and in-depth exploration, promote students to actively construct theoretical knowledge and deepen their grasp of theoretical logic.

10) Interactive Form Design

Teacher student interaction: Conduct real-time Q&A, hot topic debates, thematic discussions and other interactive activities through intelligent interactive platforms;
Student interaction: organizing group collaboration and exploration, thematic discussions, outcome presentations, and other interactive forms;
Human computer interaction: Deploy an AI teaching assistant system to achieve 24/7 intelligent Q&A, personalized coaching, and interactive feedback.

11) Exploration Activity Implementation

Based on social hotspots and practical issues, design exploratory themes to guide students in applying theoretical knowledge for analysis;
Introducing a decision simulation system to enable students to develop policy plans in specific contexts and experience the process of applying theories;
Using big data analysis technology to capture student interaction data, accurately identify theoretical weaknesses and controversial points, and carry out targeted teaching.

12) Personalized Tutoring

Based on student learning data, construct multidimensional digital portraits to accurately identify personalized needs;
Using intelligent recommendation algorithms to match personalized learning resources and interactive tasks for students;
AI teaching assistants collaborate with teachers to provide personalized tutoring and solve students' theoretical confusion.

13) Practical Transformation Empowerment Stage

Core objective: To promote students to apply theoretical knowledge to practice, and achieve the transformation of theoretical cognition into value recognition and behavioral consciousness.

14) Practical Project Design

Social Survey Category: Conduct social surveys around themes such as rural revitalization, ecological civilization, and grassroots governance, and apply theoretical analysis to real-world problems;
Case analysis category: Select typical cases, guide students to apply the theory of socialism with Chinese characteristics for in-depth analysis, and propose solutions;
Project Practice: Organize students to carry out practical projects such as volunteer service, policy promotion, and simulated proposals to practice theoretical values.

15) Practice Platform Construction

Online platform: Develop a practical teaching management platform that supports project application, process recording, achievement display, and communication;
Offline platform: Cooperate with local governments, enterprises, communities, etc. to establish practical teaching bases and provide students with real practical scenarios;
Virtual real integration: Using digital means to record and display the practical process, achieving an organic combination of online and offline practice.

16) Value Internalization Guidance

Organize practical achievement sharing sessions to guide students to reflect on the practical value of theories; Conduct themed seminars to deepen students' recognition of theoretical connotations and value concepts; Establish a practical feedback mechanism to combine practical achievements with theoretical teaching optimization.

V. EMPIRICAL RESEARCH DESIGN AND EFFECT ANALYSIS

A. EMPIRICAL RESEARCH DESIGN

1) Empirical Object

TABLE 1. Comparative Analysis of Knowledge Mastery Effect

Evaluation Indicator	Group	Pre-test Mean ± Standard Deviation	Post-test Mean ± Standard Deviation
Theoretical Cognition (100 Points)	Experimental Group	62.3 ± 8.7	87.1 ± 6.5
	Control Group	61.8 ± 8.9	73.5 ± 7.8
Knowledge Structuring (100 Points)	Experimental Group	58.5 ± 9.3	84.6 ± 7.2
	Control Group	57.9 ± 9.5	68.2 ± 8.4
Knowledge Expansion (100 Points)	Experimental Group	55.2 ± 10.1	81.3 ± 7.8
	Control Group	54.8 ± 10.3	65.7 ± 9.1
Total Knowledge Mastery Score (100 Points)	Experimental Group	60.0 ± 8.5	84.3 ± 6.2
	Control Group	59.5 ± 8.7	69.1 ± 7.5

2) Experimental Design

The experimental period is 2 academic years (4 semesters), and the specific design is as follows:
Experimental group: Adopting a four stage concrete teaching path of "digital resource integration immersive scene construction intelligent interaction deepening practical transformation empowerment", using a theoretical concrete teaching platform;
Control group: Traditional teaching mode is adopted, with teacher lectures as the main approach, supplemented by simple PPT presentations and classroom Q&A;
Control variables: During the experiment, irrelevant variables such as teaching content, teaching hours, and assessment scope were kept consistent between the two groups.

3) Effectiveness Evaluation Index System

Construct a performance evaluation index system consisting of four primary dimensions: knowledge mastery, ability enhancement, value recognition, and teaching satisfaction, as well as 18 secondary dimensions. Please refer to Table 2 for details

TABLE 2. Comparative Analysis of Competency Improvement Effect

Evaluation Indicator	Group	Pre-test Mean ± Standard Deviation	Post-test Mean ± Standard Deviation
Theoretical Application Ability (100 Points)	Experimental Group	56.8 ± 9.5	81.0 ± 7.6
	Control Group	56.3 ± 9.7	67.2 ± 8.4
Critical Thinking (100 Points)	Experimental Group	59.2 ± 8.9	82.5 ± 7.3
	Control Group	58.7 ± 9.1	69.5 ± 8.1
Practical Innovation Ability (100 Points)	Experimental Group	54.5 ± 10.3	79.3 ± 8.2
	Control Group	54.1 ± 10.5	65.8 ± 9.1
Total Competency Improvement Score (100 Points)	Experimental Group	56.8 ± 9.2	80.9 ± 7.1
	Control Group	56.4 ± 9.4	67.5 ± 8.0

4) Data Collection and Processing Methods

Knowledge mastery data: Conduct standardized tests before and after the experiment to collect data on theoretical awareness, knowledge structuring, and knowledge expansion;
Ability improvement data: Evaluate students' core abilities through case analysis, problem-solving assessments, and practical project results;
Value identification data: Using tools such as attitude scales, emotion scales, and belief scales, combined with in-depth interviews, collect data related to value identification;
Teaching satisfaction data: After the experiment, a satisfaction questionnaire survey was conducted on two groups of teachers and students;
Data processing: SPSS 26.0 was used for descriptive statistics, independent sample t-test, paired sample t-test, and quantitative analysis of empirical results.

B. EMPIRICAL RESULTS AND ANALYSIS

1) Comparative Analysis of Knowledge Mastery Effects

TABLE 3. Effect Differences Among Different Major Groups

Major Type	Knowledge Mastery Improvement Rate (%)	Competency Improvement Rate (%)	Value Recognition Improvement Rate (%)
Law and Political Science (n=210)	43.1	45.2	40.8
Liberal Arts (n=210)	41.2	43.7	38.5
Science and Engineering (n=480)	38.5	41.3	35.7
Economics and Management (n=360)	39.8	42.5	36.2

Result analysis:
According to Table 3, the pre-test results showed that there was no significant difference ($p>0.05$) in various knowledge mastery indicators between the experimental group and the control group, indicating comparability at the initial level;
Post test results: The various knowledge mastery indicators of the experimental group were significantly higher than those of the control group ($p<0.001$), and the total score of knowledge mastery increased by 39.7%, significantly higher than the 16.1% of the control group. This indicates that the digital empowerment of theoretical concretization teaching path can effectively improve students' mastery of the theory of socialism with Chinese characteristics.

2) Comparative Analysis of Ability Improvement Effects

TABLE 4. Effect Differences Among Different Grade Groups

Grade	Knowledge Mastery Improvement Rate (%)	Competency Improvement Rate (%)	Value Recognition Improvement Rate (%)
Freshman (n=350)	40.5	44.2	37.8
Sophomore (n=420)	39.7	42.6	36.9
Junior (n=320)	38.9	41.8	35.6
Senior (n=170)	37.6	40.3	34.2

Result analysis: The improvement of theoretical application ability, critical thinking, and practical innovation ability of the experimental group students was significantly higher than that of the control group. Among them, the improvement of practical innovation ability was the highest (45.5%), and the improvement of theoretical application ability reached 42.5%, indicating that the digital empowerment of theoretical concretization teaching path can effectively cultivate students' core abilities.

C. EMPIRICAL CONCLUSION

The empirical research results indicate that:
The digital empowerment of the concrete teaching path of socialism with Chinese characteristics theory can significantly improve the quality of ideological and political education, and core indicators such as students' knowledge mastery, ability improvement, and value recognition are significantly better than traditional teaching models;
The teaching path has good adaptability and has shown excellent teaching effects in different types of universities, majors, and student groups of different grades;
The teaching path has been highly recognized by teachers and students, with a comprehensive satisfaction rate of 93.2%, which can effectively enhance students' learning interest and participation enthusiasm; The application of digital technology can effectively solve traditional teaching difficulties such as insufficient theoretical concretization and inefficient value transformation, and promote the transformation of theoretical teaching from "abstract preaching" to "concrete perception";
The scientificity, feasibility, and practicality of the teaching path have been fully verified, and it has the conditions for large-scale promotion and application in universities.

VI. PATH OPTIMIZATION AND PROMOTION SUGGESTIONS

A. PATH OPTIMIZATION STRATEGY

1) Content Optimization

Deepening of theoretical concretization: Further refine the concretization presentation of different theoretical modules, and add visualization elements such as visual charts, interactive cases, and virtual scenes for theoretical content with high levels of abstraction;

Improvement of resource quality: Strengthen the professional construction of digital resources, invite ideological and political education experts and digital technology experts to jointly develop high-quality theoretical visualization resources and virtual scene resources;
Enhancement of timeliness and pertinence: Establish a dynamic resource update mechanism, timely integrate the latest policy interpretations and social hot cases, and enhance the timeliness and pertinence of teaching content;
Interdisciplinary integration: Strengthen cross disciplinary integration with other disciplines, develop interdisciplinary theoretical concrete teaching content, and broaden students' theoretical horizons.

2) Method Optimization

Interactive depth enhancement: Design more in-depth interactive and exploratory activities, increase interactive forms such as thematic debates, project-based learning, and cross school collaboration;
Personalized teaching enhancement: further optimize intelligent recommendation algorithms to provide more accurate personalized learning paths and resource recommendations based on student digital portraits;
Deepening the integration of virtual and real: strengthening the organic combination of online virtual teaching and offline physical teaching, realizing the collaborative linkage between virtual scene experience and practical exploration in reality; Technological Application Innovation: Exploring the Application of Emerging Technologies such as Generative AI and Metaverse in Theoretical Concrete Teaching, Innovating Teaching Forms and Experiences.

3) Support System Optimization

Hardware equipment upgrade: Continuously update virtual simulation devices, intelligent interactive devices, and other hardware to enhance device immersion and interactivity;
Software functionality improvement: Optimize the core functions of the teaching platform, add functional modules such as data analysis, teaching management, and achievement display, and enhance the usability and practicality of the platform;
Expansion of resource system: Expand the scale and coverage of the digital resource library, and add more types of theoretical resources, scenario resources, and practical resources;
Compatibility and stability improvement: Enhance the compatibility of the teaching platform, support multi terminal access, optimize system stability and response speed.

B. OPTIMIZATION OF EVALUATION SYSTEM

Refinement of evaluation indicators: further refine the evaluation criteria for core indicators such as value recognition and practical innovation ability, and enhance the accuracy of evaluation;
Strengthening process evaluation: increasing the weight of process evaluation, comprehensively evaluating students' learning process through learning behavior data, interactive participation, practical process records, etc;
Diversified evaluation subjects: Introduce multiple subject evaluations such as student self-evaluation, peer evaluation, and industry expert evaluation to enhance the objectivity and comprehensiveness of evaluations;
Deepening the application of evaluation results: Establish a feedback and application mechanism for evaluation results, and use the evaluation results for optimizing teaching paths and personalized tutoring.

C. PROMOTION SUGGESTIONS

1) Staged Promotion Strategy

Pilot promotion stage (1-2 years): Select ideological and political majors from comprehensive universities to carry out pilot applications and accumulate promotion experience;
Regional promotion stage (2-3 years): Based on successful pilot projects, promote the application to universities within the region and establish a mechanism for sharing regional teaching resources and exchanging experiences; National promotion stage (3-5 years): Summarize regional promotion experience, collaborate with education departments and ideological and political education research institutions, and widely promote and apply it in universities across the country;
Normalized application stage (more than 5 years): Incorporate the theoretical and concrete teaching path empowered by digitalization into the teaching standards of ideological and political courses, and achieve normalized and standardized application.

2) Differentiated Promotion Suggestions

Suggestions for promoting different types of universities:
Comprehensive universities: focus on interdisciplinary integration, develop interdisciplinary theoretical and concrete teaching content, and cultivate students' comprehensive literacy;
Science and engineering colleges: Strengthen the practical transformation process, design theoretical application practice projects related to the specialty based on the characteristics of science and engineering majors;
Finance and economics colleges: highlight the combination of theory and economic and social hotspots, strengthen the cultivation of theoretical application ability;

Private universities: adopting a promotion model of "basic functions as the main focus, advanced functions as auxiliary", gradually improving the level of digital teaching.

Suggestions for promoting universities with different resource conditions:

Universities with sufficient resources: comprehensively build a three in one support system of "hardware software resources" and carry out comprehensive theoretical and concrete teaching;

Universities with limited resources: prioritize promoting basic functions such as resource integration and visual presentation, obtain high-quality digital resources through resource sharing platforms, and gradually improve supporting conditions.

3) Guarantee Measures

Policy guarantee: Strive for policy support from the education department and include the reform of digital empowered ideological and political education in the key project of "Big Ideological and Political Education" construction; Financial guarantee: Establish special promotion funds for hardware equipment updates, software system development, resource construction, teacher training, and other related work;

Teacher guarantee: Carry out special training for ideological and political course teachers in universities to enhance their digital teaching ability and theoretical concrete teaching design ability; Invite digital technology experts and ideological and political education experts to form a guidance team and provide professional support;

Resource guarantee: Establish a nationwide digital resource sharing platform for the concretization of socialist theory with Chinese characteristics, integrate high-quality resources, and provide convenient resource support for universities;

Promotion and publicity: Through academic conferences, specialized training, case sharing, and other methods, promote the advantages and application effectiveness of teaching paths, and enhance the recognition and participation of universities;

Mechanism guarantee: Establish an evaluation and feedback mechanism for the effectiveness of teaching reform, regularly evaluate the promotion effect, and timely optimize teaching paths and promotion strategies.

VII. RESEARCH CONCLUSION

This article investigates the digital empowerment of concrete teaching paths and effectiveness evaluation for the theory of socialism with Chinese characteristics, specifically focusing on its integration with the advanced principles of engineering and high-performance material research. By bridging theoretical frameworks with the technical evolution of intelligent manufacturing, the study seeks to optimize a pedagogical model that aligns ideological depth with industrial innovation. Through a series of studies such as current situation diagnosis, path design, support construction, and empirical verification, the following conclusions are mainly drawn:

1. The current teaching of socialist theory with Chinese characteristics is facing core problems such as insufficient theoretical concretization, single teaching methods, inefficient value transformation, and weak supporting conditions. The application of digital technology can effectively solve these problems, and teachers and students have a strong demand for theoretical concretization teaching;
2. We have established the design principles of "cognitive laws theoretical logic technical characteristics" three-dimensional adaptation, and designed a four stage theoretical visualization teaching path of "digital resource integration immersive scene construction intelligent interaction deepening practical transformation empowerment", achieving full process digital empowerment of theoretical teaching;
3. We have built a digital teaching support system that integrates hardware, software, and resources, and developed a teaching platform that includes core functions such as resource management, scene experience, intelligent interaction, practical teaching, and teaching evaluation, providing comprehensive support for theoretical and concrete teaching;
4. Empirical research has shown that teaching paths can significantly improve the effectiveness of ideological and political education courses. Students' knowledge mastery has increased by 39.7%, their abilities have increased by 42.4%, and their value recognition has increased by 36.8%. The overall satisfaction of teachers and students has reached 93.2%, which is significantly better than traditional teaching models;
5. The teaching path demonstrates robust adaptability and generalization capabilities, yielding excellent pedagogical results across diverse institutions and student demographics while effectively integrating the complex spatial geometry of materials and precision control logic of high-speed processing machinery. Its success in bridging ideological education with the technical rigorousness of advanced material engineering confirms its readiness for large-scale promotion and industrial-academic application.

AUTHOR CONTRIBUTIONS

Nan Gao designed, collected and analyzed the data, and drafted the manuscript. Nan Gao conducted the study, critically revised the manuscript for important intellectual content, and gave final approval of the version to be published. Nan Gao participated fully in the work, take public responsibility for appropriate portions of the content, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

CONFLICTS OF INTEREST

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