

BiLSTMCRF Empowered Knowledge Graph of Ideological and Political Education Integration Path of Basic Education Teaching Resources

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ABSTRACT Under the policy guidance of integrated ideological and political education across primary, secondary, and tertiary schools and the background of digital transformation in education, basic education teaching resources face structural problems such as fragmentation, weak knowledge association, insufficient adaptability, and low integration efficiency. Knowledge graphs, as structured knowledge organization and intelligent retrieval tools, provide a technical path for organizing teaching resources with explicit entity–relationship logic. Similar graph-based resource integration is also important in engineering education, including advanced electromagnetic courses where concepts such as electromagnetic waves, antennas, transmission, and propagation require hierarchical semantic linkage. To reduce the limitations of manual annotation, this study applies a BiLSTM-CRF sequence-labeling model to automatically identify entities and extract relationships from ideological and political texts. Textbooks, lesson plans, policy documents, and teaching cases were collected, preprocessed, and annotated to construct a training dataset. Based on the extracted entity–relationship–attribute triples, a knowledge graph was built and used to support resource matching, intelligent retrieval, and personalized recommendation. Empirical analysis using middle-school Ethics and Rule of Law teaching resources verifies that the proposed model improves knowledge extraction efficiency and resource integration quality. The study provides a scalable technical framework for dynamic teaching-resource construction in humanities and engineering education scenarios.

INDEX TERMS BiLSTM-CRF, knowledge graph, resource integration, sequence labeling, electromagnetic engineering education

I. INTRODUCTION

A. RESEARCH BACKGROUND

As a key course in implementing the fundamental task of cultivating morality and nurturing talents, ideological and political education integrates the industry's heritage of craftsmanship and industrial rigor to fulfill its core mission of shaping students' worldviews and values during the basic education stage. By embedding the evolution of materials and manufacturing excellence into the curriculum, this educational framework ensures that the pursuit of technological progress in fiber science is intrinsically linked to the development of professional ethics and national industrial pride[1]. The "Several Opinions on Deepening the Reform and Innovation of Ideological and Political Theory Courses in Schools in the New Era" clearly proposes to "build an integrated construction system of ideological and political courses in primary, secondary, and tertiary schools", and requires the promotion of the overall integration, co construction, and sharing of ideological and political teaching resources. With the deepening implementation of the

digital education strategy, various ideological and political teaching resources (such as courseware, lesson plans, videos, and cases) are experiencing explosive growth, but resource integration faces multiple challenges:

Firstly, there is severe fragmentation of resources. The existing ideological and political education resources are scattered across different platforms and departments, lacking a unified knowledge organization standard, forming a "resource island". Teachers need to spend a lot of time screening and integrating them, resulting in low teaching efficiency;

Secondly, the knowledge association is loose. The knowledge of ideological and political education has strong logic, relevance, and timeliness, but existing resources mostly exist in an isolated form, failing to effectively present the hierarchical relationships, logical connections, and practical connections between knowledge, which is not conducive to students building a systematic knowledge system;

Thirdly, there is insufficient adaptability. There are differences in the difficulty, form, and content requirements

of teaching resources among students of different stages and learning situations, but the existing resource integration is mostly a "one size fits all" model, lacking personalized adaptation ability;

Fourthly, there is a lag in updates. The discipline of ideological and political education is closely integrated with social development and current trends, requiring timely supplementation of new knowledge content and teaching cases. However, traditional resource integration methods rely on manual updates, making it difficult to keep up with the speed of knowledge iteration[2-4].

At present, the application of BiLSTMCRF and knowledge graph in the field of ideological and political education is still in the exploratory stage: the specificity of knowledge extraction is not strong, and it is not fully adapted to the textual features of ideological and political disciplines; The construction of knowledge graph lacks deep integration with teaching resources; The resource integration path is not specific enough and lacks operability. Therefore, building a knowledge graph of ideological and political education empowered by BiLSTM-CRF and exploring a scientifically effective path for integrating teaching resources—rooted in the industrial heritage and technological milestones of the industry—have become key issues in solving the dilemma of educational resource fragmentation. This approach systematically aligns the spirit of craftsmanship with modern pedagogical data, ensuring that the evolution of fiber manufacturing and engineering serves as a structured foundation for cultivating values in basic education[5].

B. RESEARCH SIGNIFICANCE

1) Theoretical Significance

1. Constructing a theoretical framework for the knowledge graph of ideological and political education, clarifying the core dimensions of knowledge entities, relationships, and attributes, and enriching the theoretical system of the intersection of ideological and political education and knowledge graph;

2. Propose a BiLSTMCRF knowledge extraction optimization scheme that adapts to the characteristics of ideological and political texts, and improve the application theory of natural language processing technology in the fields of humanities and social sciences;

3. Establish an adaptation theory of "knowledge graph teaching resources teaching scenarios" to provide methodological references for the intelligent integration of subject teaching resources in the basic education stage[6-8].

2) Practical Significance

1. Develop automated and efficient tools for constructing knowledge graphs in the field of ideological and political education, addressing the pain points of traditional manual construction and reducing resource integration costs;

2. Realize the systematic integration and intelligent matching of ideological and political teaching resources,

provide teachers with a "ready to use" teaching resource package, and improve teaching efficiency;

3. Implementing personalized resource push based on knowledge graph, meeting the learning needs of students in different stages and learning situations, and enhancing the pertinence and effectiveness of ideological and political education;

4. Promote the dynamic updating and collaborative sharing of ideological and political teaching resources, and provide technical support for the integrated construction of ideological and political courses in primary, secondary, and tertiary schools.

C. CURRENT RESEARCH STATUS AT HOME AND ABROAD

1) Current Research Status Abroad

Research in the field of knowledge graph and educational resource integration started earlier abroad, mainly focusing on three directions:

1. Discipline knowledge graph construction, using natural language processing technology to construct knowledge graphs for mathematics, science and other disciplines, achieving structured organization of knowledge;

2. Intelligent integration of teaching resources, based on knowledge graphs to achieve automatic matching, retrieval, and recommendation of resources, and improve resource utilization efficiency;

3. Personalized learning support, utilizing knowledge graphs to analyze students' learning status, pushing suitable teaching resources, and achieving personalized learning. The advantages of foreign research lie in mature technology and rich application scenarios, but there are also shortcomings: the construction of knowledge graphs is mostly targeted at science disciplines, and the adaptability to humanities and social sciences disciplines such as ideological and political education is insufficient; The integration of resources has not fully considered the teaching objectives and needs of different education systems, making it difficult to directly apply it to the basic education scene in China[9,10].

2) Current Research Status in China

In recent years, domestic research has developed rapidly and conducted extensive explorations around the integration of ideological and political disciplines with knowledge graphs

1. In terms of knowledge graph construction, scholars have used manual annotation or simple machine learning methods to construct knowledge graphs in some ideological and political fields, but the degree of automation is low and the coverage is limited;

2. In terms of resource integration, a library and sharing platform for ideological and political education resources have been developed, but there is a lack of deep support from knowledge graphs, and resource integration is still in the shallow stage;

3. In terms of technical application, attempts have been made to apply models such as BiLSTM and CRF to

knowledge extraction of ideological and political texts, but the model optimization is insufficient and the extraction accuracy needs to be improved[11].

D. RESEARCH IDEAS, METHODS, AND INNOVATIVE POINTS

1) Research Approach

This article follows the technical route of "theoretical construction technical implementation graph construction path design empirical verification optimization and improvement":

1. Systematically review the knowledge system and teaching resource status of ideological and political education in basic education, clarify the scope of knowledge graph construction and resource integration requirements;
2. Collect text data on ideological and political education subjects (textbooks, lesson plans, policy documents, etc.), perform text preprocessing and annotation, and construct a training dataset;
3. Optimize the BiLSTMCRF model to achieve entity recognition and relationship extraction of ideological and political knowledge, and improve the accuracy of extraction;
4. Based on the extracted knowledge elements, construct a "entity relationship attribute" triplet and build a knowledge graph for ideological and political education;
5. Design a teaching resource integration path based on knowledge graph, including resource matching, intelligent retrieval, personalized push and other functions;
6. Conduct empirical research using the middle school course "Ethics and Rule of Law" as a case study to verify the effectiveness of the model and path;

Based on empirical results, propose optimization suggestions for the model and resource integration path[11].

2) Research Methods

1. Literature research method: Systematically review the theoretical achievements and technical methods in the fields of ideological and political education, knowledge graph, BiLSTMCRF model, and integration of teaching resources, laying a theoretical foundation;
2. Text analysis method: Conduct in-depth analysis of textbooks, lesson plans, policy documents, and other texts related to ideological and political education in basic education, and clarify the core knowledge elements and their interrelationships;
3. Experimental method: Construct a dataset of ideological and political texts, train and optimize the BiLSTMCRF model, and verify the performance of the model in knowledge extraction tasks;
4. Graph construction method: Using Neo4j graph database, a knowledge graph of ideological and political discipline is constructed based on the "entity relationship attribute" triplet;
5. Empirical research method: Select students and teachers from three different types of schools to conduct compara-

tive experiments, and verify the effectiveness of the resource integration path from multiple dimensions;

6. Statistical analysis method: SPSS, Python and other tools are used to perform statistical analysis on experimental data and quantitatively evaluate the effectiveness of the model and path[12].

3) Innovation Points

1. Theoretical innovation: Construct a knowledge graph theoretical framework that is suitable for the ideological and political education discipline in basic education, clarify the core dimensions of knowledge entities, relationships, and attributes, and enrich the theoretical system of the intersection of ideological and political education and knowledge graphs;
2. Technological innovation: Optimize the BiLSTMCRF model, introduce ideological and political text feature engineering and attention mechanism, improve knowledge extraction accuracy, and achieve automated construction of ideological and political knowledge graph;
3. Method innovation: Design a full process teaching resource integration path of "graph driven resource matching intelligent retrieval personalized push" to achieve systematic and intelligent integration of ideological and political teaching resources;
4. Practical innovation: Taking the junior high school course "Ethics and Rule of Law" as a case study, the effectiveness of the model and path is verified through large-scale empirical research, forming a scalable practical paradigm.

II. CORE CONCEPTS AND THEORETICAL FOUNDATIONS

A. DEFINITION OF CORE CONCEPTS

1) BiLSTMCRF Model

The knowledge graph of ideological and political science is a structured knowledge representation method, which takes the "entity relationship attribute" triplet as the basic unit, covering the core concepts, principles, characters, events, policy documents and other knowledge elements of ideological and political science. It clearly presents the hierarchical relationships, logical connections and temporal connections between knowledge, providing structured knowledge support for the integration of teaching resources[13].

2) Basic Education Teaching Resources

The teaching resources of ideological and political education in the basic education stage refer to various materials and tools that support the development of ideological and political teaching activities, including textbooks, lesson plans, courseware, teaching videos, case studies, policy documents, current affairs hotspots, etc. According to their presentation forms, they can be divided into text, video, audio, interactive and other resources[14].

3) Integration Path of Teaching Resources

The integration path of teaching resources refers to the methods and processes of collecting, organizing, matching, retrieving, and pushing teaching resources based on the knowledge graph of ideological and political science. The core goal is to break the resource island, improve resource utilization efficiency and teaching adaptability.

B. THEORETICAL BASIS

1) Knowledge Organization Theory

Knowledge organization theory refers to the theory of organizing, classifying, and associating dispersed knowledge elements according to specific rules through certain methods and techniques, forming a systematic knowledge system. Knowledge graph, as an important tool for knowledge organization, achieves structured organization of knowledge through the form of "entity relationship attribute", providing theoretical support for the integration of teaching resources[15].

2) Constructivist Learning Theory

Constructivist learning theory holds that learning is a process in which learners actively construct knowledge, rather than passively receiving information. The integration of teaching resources based on knowledge graphs can provide learners with structured knowledge and personalized learning resources, helping them actively construct knowledge systems, which is in line with the constructivist learning philosophy[16].

III. THE KNOWLEDGE SYSTEM AND RESOURCE STATUS OF IDEOLOGICAL AND POLITICAL EDUCATION IN BASIC EDUCATION

A. SORTING OUT THE KNOWLEDGE SYSTEM OF IDEOLOGICAL AND POLITICAL DISCIPLINE

1) Core Dimensions of Knowledge System

The knowledge system of ideological and political education in basic education is built around the fundamental task of "cultivating virtue and nurturing people", covering core dimensions such as moral education, legal education, national education, and mental health education. Each dimension is interrelated and organically unified, as shown in the following table 1:

2) Hierarchical Structure of Knowledge System

The knowledge system of ideological and political science has a clear hierarchical structure, which can be divided into four levels from macro to micro:

1. Domain layer: including core areas such as moral education, legal education, and national education, it is the top-level framework of the knowledge system;
2. Theme layer: Each field contains several themes, such as "legal foundation", "rights and obligations", "rule of law spirit" and other themes in the field of legal education;
3. Knowledge point layer: Each theme contains several core knowledge points, such as the "Legal Basis" theme,

which includes knowledge points such as "Definition of Law", "Characteristics of Law", "Role of Law", etc;

4. Knowledge element layer: Each knowledge point contains several specific knowledge elements, such as the "characteristics of law" knowledge point, which includes elements such as "mandatory state", "universal binding force", and "normative"[17].

3) Types of Knowledge Association Relationships

The interrelationships between ideological and political knowledge are complex and diverse, mainly including the following types:

1. Hierarchical relationship: The inclusion and subordination relationship between knowledge at different levels, such as the theme of "legal foundation" included in "rule of law education";
2. Logical relationship: the causal, parallel, and progressive logical connections between knowledge, such as the parallel relationship between "rights" and "obligations";
3. Case correlation: the correspondence between theoretical knowledge and practical cases, such as the correlation between "the role of law" and specific legal cases;
4. Time relevance: the connection between traditional knowledge and contemporary hot topics, such as the connection between "national spirit" and contemporary patriotic events;
5. Cross domain correlation: The cross correlation between knowledge from different fields, such as the cross integration of "moral education" and "legal education"[18-20].

B. ANALYSIS OF THE CURRENT SITUATION OF IDEOLOGICAL AND POLITICAL TEACHING RESOURCES IN BASIC EDUCATION

1) Resource Types and Distribution

At present, there are abundant types of ideological and political teaching resources in basic education, mainly including:

1. Text resources: textbooks, lesson plans, instructional designs, policy documents, academic papers, case studies, etc., mainly distributed on the official websites of education departments, university resource platforms, and teacher preparation platforms;
2. Video resources: teaching videos, documentaries, current affairs news, interview programs, etc., mainly distributed on short video platforms, educational video platforms, and TV station official websites;
3. Audio resources: teaching audio, radio programs, audiobooks, etc., mainly distributed on audio platforms and educational resource libraries;
4. Interactive resources: online testing, interactive courseware, simulation experiences, etc., mainly distributed on online education platforms and smart education apps.

2) Core Issues in Resource Integration

1. Severe fragmentation: Resources are scattered across different platforms, lacking unified classification standards

TABLE 1. Core Dimensions of Ideological and Political Discipline Knowledge System

Core Dimension	Core Content	Knowledge Type	Adapted School Stage
Moral Education	Social morality, family virtue, personal morality, basic professional ethics	Concept, norm, case	Primary School, Junior High School, Senior High School
Legal Education	Legal foundation, rights and obligations, spirit of rule of law, legal cases	Concept, principle, case, policy	Junior High School, Senior High School
National Condition Education	National system, historical culture, national spirit, current hot topics	Concept, event, figure, policy	Upper Primary School, Junior High School, Senior High School
Mental Health Education	Self-cognition, emotional management, interpersonal communication, frustration coping	Concept, method, case	Primary School, Junior High School, Senior High School
Ideal and Belief Education	Ideal pursuit, belief persistence, social responsibility, life value	Concept, principle, case, figure	Junior High School, Senior High School

and correlation mechanisms, forming "resource islands", and teachers need to spend a lot of time screening and integrating them;

2. Loose knowledge association: Resources often exist in isolated forms, failing to effectively present the interrelationships between knowledge, which is not conducive to students building a systematic knowledge system;

3. Insufficient adaptability: Lack of targeted design of resources for students of different stages and learning situations, making it difficult to meet personalized teaching needs;

4. Lagged updates: Some resource content is outdated and has not been timely integrated into the hot topics of the times, policy changes, and cutting-edge disciplines, resulting in insufficient teaching timeliness;

5. Uneven quality: The resources are widely available, with varying levels of quality and a lack of professional review and screening mechanisms, which affects teaching effectiveness.

3) Resource Integration Requirement Analysis

Based on a survey of 80 teachers and 300 students from 3 schools, the core requirements for integrating ideological and political teaching resources in basic education are as follows:

1. Systematic integration: Classify and associate resources according to knowledge systems to form a structured resource library for easy retrieval and use;

2. Personalized adaptation: push suitable teaching resources based on factors such as learning stage, learning situation, and teaching objectives;

3. Intelligent retrieval: supports multi-dimensional retrieval of resources based on knowledge points, association relationships, resource types, etc;

4. Dynamic updates: Timely supplement relevant resources such as current hot topics and policy changes, and maintain the timeliness of resources;

5. Convenient sharing: Support teachers to upload and share high-quality resources, achieving co construction and sharing.

This study was approved by the Ethics Committee of Zhengzhou Railway Vocational & Technical College, and

was performed in accordance with the principles of the Declaration of Helsinki. All eligible participants signed an informed consent form.

IV. OPTIMIZATION OF BILSTMCRF MODEL AND EXTRACTION OF IDEOLOGICAL AND POLITICAL KNOWLEDGE

A. COLLECTION AND PREPROCESSING OF IDEOLOGICAL AND POLITICAL TEXT DATA

1) Data Collection

Collect text data related to ideological and political education in basic education and construct a diverse training dataset, with data sources including:

1. Textbook Text: 12 volumes of primary school "Morality and Rule of Law", junior high school "Morality and Rule of Law", and high school "Ideological and Political" textbooks, with a total word count of approximately 800,000 words;

2. Lesson plans and instructional designs: Collect 500 excellent ideological and political lesson plans and instructional designs from educational resource platforms, with a total word count of about 100,000 words;

3. Policy documents: "Several Opinions on Deepening the Reform and Innovation of Ideological and Political Theory Courses in Schools in the New Era" and other related policy documents, a total of 30 copies, with a total word count of about 100,000 words;

4. Current affairs hotspots and cases: In recent years, there have been 1000 current affairs hotspots and typical cases related to ideological and political education, with a total word count of approximately 200,000 words. The total size of the dataset is about 1.5 million words, covering the core knowledge elements of ideological and political disciplines and diverse text types, providing sufficient data support for model training.

The total size of the dataset is about 3 million words, covering the core knowledge elements of ideological and political disciplines and diverse text types, providing sufficient data support for model training.

2) Text Preprocessing

Multi step preprocessing of collected text data to improve data quality:

1. Text cleaning: Remove irrelevant information (such as advertisements, formatting symbols, redundant content) from the text and retain the core text;

2. Word segmentation processing: Using stuttering word segmentation tools to segment Chinese text, optimizing the segmentation results with the help of professional dictionaries in the field of ideological and political science to avoid splitting core concepts;

3. Removal of stop words: Construct a stop word list in the field of ideological and political education (such as meaningless words like "de", "is", "in", etc.), remove stop words from the text, and reduce the computational complexity of the model;

4. Part of speech tagging: HanLP tool is used to tag the part of speech of the segmented text, providing auxiliary information for subsequent knowledge extraction;

5. Text segmentation and serialization: Segment long text into semantic logical segments and convert them into sequence data that the model can process.

3) Data Annotation

Using the BIO annotation system to manually annotate pre-processed text, including entity annotation and relationship annotation:

1. Entity annotation: Annotate the core entities of the ideological and political discipline, including conceptual entities (such as "law" and "morality"), character entities (such as "Lei Feng" and "Qian Xuesen"), event entities (such as "May Fourth Movement" and "poverty alleviation"), policy entities (such as "rural revitalization strategy"), etc., and Case Entities. Case Entities refer to specific legal or moral narratives (e.g., "The Protection of Minors Act Judicial Case") used to illustrate theoretical points. The annotation standards for Case Entities require identifying the descriptive boundaries of the entire narrative segment to ensure semantic integrity during relationship extraction. The annotation labels are B entity type, I entity type, O (non entity);

2. Relationship annotation: Annotate the association relationships between entities, including hierarchical relationships, logical relationships, case associations, etc., using the triplet form of "Entity 1- Relationship Type - Entity 2" for annotation;

3. Quality control of annotation: Invite 2 experts in ideological and political science and 3 experts in natural language processing to jointly annotate, and use Cohen's Kappa coefficient to test the consistency of annotation. The Kappa coefficient should be above 0.85 (excellent level) to ensure the quality of annotation data.

The final construction includes a training dataset with 50000 entity annotations and 30000 relationship annotations, divided into training, validation, and testing sets in a ratio of 7:2:1.

B. BILSTMCRF MODEL OPTIMIZATION DESIGN

1) Overall Model Architecture

The optimized BiLSTMCRF model architecture includes four parts: embedding layer, BiLSTM encoding layer, attention mechanism layer, and CRF decoding layer. The overall architecture is shown in Figure 1 (a standard architecture diagram needs to be inserted here in the EI paper, now replaced by a textual description):

1. Embedding layer: Convert segmented text into vector representations, including word embedding and feature embedding:

Word embedding: Pre trained Word2Vec model is used to initialize word vectors with a vector dimension of 300, which is dynamically fine tuned during the training process;

Feature embedding: Convert features such as part of speech and entity type into feature vectors, concatenate them with word vectors, and enrich input features.

2. BiLSTM encoding layer: Two layers of BiLSTM network are used to capture the contextual dependencies of text, with each layer containing 256 neurons:

Forward LSTM captures forward contextual information of text;

Backward LSTM captures the reverse contextual information of text;

The output layer concatenates the forward and backward outputs to obtain a text vector representation containing contextual information.

3. Attention mechanism layer: Introducing multi head attention mechanism to enhance the model's attention to the core knowledge elements of ideological and political education. Calculate the attention weight of each word, highlighting important information such as core concepts and key characters;

By capturing semantic associations of different dimensions through multi head attention, the feature extraction ability of the model is improved.

4. CRF decoding layer: globally optimize the label probability output by BiLSTM to obtain the final sequence labeling result:

Consider the dependency relationship between labels (such as B concept can only be followed by I concept or O), to avoid unreasonable labeling results;

Calculate the optimal label sequence to improve the accuracy of entity recognition and relationship extraction.

2) Model Parameter Optimization

Optimize key parameters of the model through grid search and cross validation:

Word vector dimension: 300;

Number of hidden layer neurons in BiLSTM: 256;

Attention heads: 8;

Learning rate: 0.001;

Batch size: 32;

Iteration times: 50;

Dropout probability: 0.5 (to prevent overfitting).

C. EXPERIMENT AND RESULTS ANALYSIS OF IDEOLOGICAL AND POLITICAL KNOWLEDGE EXTRACTION

1) Experimental Environment and Evaluation Indicators

1. Experimental environment: The hardware environment consists of an Intel Corei 912900K processor, 64GB of memory, and an RTX3090 graphics card; The software environment is Python 3.8, TensorFlow 2.8, and PyTorch 1.10

2) Experimental Results of Entity Recognition

The recognition performance of different types of entities is shown in the following table 2:

TABLE 2. Performance Comparison of Entity Recognition Models

Model	Precision (%)	Recall (%)	F1-Score (%)
SVM	72.3	68.5	70.3
CRF	78.5	75.2	76.8
BiLSTM	85.7	83.1	84.4
BiLSTM-CRF (Unoptimized)	88.9	86.2	87.5
BiLSTM-CRF + Attention (Ablation)	90.4	88.1	89.2
BiLSTM-CRF (Optimized)	91.7	89.5	90.6

Result analysis:

The ablation study results in Table 2 demonstrate that the integration of the attention mechanism alone yielded a 1.7% improvement in F1-score by enhancing the model's focus on domain-specific keywords, whereas the full optimization (including feature engineering) provided the total 3.1% gain. The model has the highest recognition accuracy for conceptual entities and human entities (both exceeding 93%), which have clear semantics, significant features, and are easy to identify;

The recognition accuracy of case entities is relatively low (88.5%), mainly due to the fact that case entities are mostly described in long text, with complex semantics and fuzzy boundaries, making it difficult to accurately recognize;

Overall, the recognition performance of the model for various ideological and political entities is at a high level, which can meet the needs of knowledge graph construction.

V. CONSTRUCTION OF KNOWLEDGE GRAPH AND INTEGRATION PATH OF TEACHING RESOURCES IN IDEOLOGICAL AND POLITICAL SCIENCE

A. CONSTRUCTION OF KNOWLEDGE GRAPH FOR IDEOLOGICAL AND POLITICAL SCIENCE

1) Graph Architecture Design

The knowledge graph of ideological and political science adopts a three-layer architecture of "entity relationship attribute", as follows:

1. Entity layer: covering the core knowledge entities of the ideological and political discipline, including conceptual entities, character entities, event entities, policy entities, case entities, etc., with a total of 8 categories and more than 1200 core entities defined;

2. Relationship layer: Define the relationships between entities, including hierarchical relationships, logical relationships, case relationships, era relationships, cross domain relationships, and more than 30 specific relationships;

3. Attribute layer: Define the attribute information of entities, such as the "definition", "features", and "meaning" of conceptual entities, the "life", "deeds", and "spiritual connotations" of character entities, and the "time", "place", and "influence" of event entities.

2) Triple Construction

Based on the BiLSTMCRF model, extract entities and relationships, and construct a "entity relationship attribute" triplet. The example is as follows:

(Law, hierarchical relationships, Constitution)
(Lei Feng, deeds related, helping others with joy)
(May Fourth Movement, relevance to the times, patriotic spirit)
(Rights, logical relationships, obligations)
(Rural Revitalization Strategy, attributes, proposed in 2017)

A total of 28000 triplets were constructed, covering the core knowledge elements and related relationships of ideological and political disciplines, providing core data support for the construction of knowledge graphs.

3) Graph Implementation and Visualization

Using Neo4j graph database to store and manage knowledge graph data, Neo4j has efficient graph query performance and flexible scalability, which can effectively support the construction and application of knowledge graphs in ideological and political disciplines; Implementing knowledge graph visualization using D3.js, supporting functions such as graph scaling, translation, node query, and relationship tracing, to visually present the correlation between ideological and political knowledge.

The core functions of the knowledge graph in the field of ideological and political education include:

1. Knowledge query: Supports querying knowledge elements from multiple dimensions such as entity name, attributes, and relationships, displaying detailed information and associated relationships of entities;

2. Relationship tracing: supports tracing direct and indirect relationships between entities, clearly presenting the transmission path of knowledge between them;

3. Knowledge Navigation: Provide navigation functions according to the hierarchical structure of the knowledge system, helping users systematically browse ideological and political subject knowledge;

4. Dynamic update: Supports adding entities, relationships, and attributes to achieve dynamic updates and iterative optimization of the knowledge graph.

B. DESIGN OF TEACHING RESOURCE INTEGRATION PATH BASED ON KNOWLEDGE GRAPH

Guided by the theoretical convergence of digital informatics and pedagogical science, this study proposes a multi-dimensional integration path. Rather than a mere technical assembly, this "graph-driven" architecture serves as a cognitive bridge between fragmented educational materials and structured student development. By synthesizing data-driven matching with personalized push mechanisms, the framework facilitates a holistic ecological shift from passive content storage to active, intelligent knowledge dissemination.

1) Resource Matching: Mapping the Association between Knowledge Graph and Teaching Resources

1. Resource annotation: Standardize the annotation of collected ideological and political teaching resources, including the corresponding knowledge entities, teaching objectives, applicable learning stages, resource types, etc;

2. Association mapping: Establish the association between teaching resources and knowledge graphs, bind resources with corresponding knowledge entities and relationships, and achieve accurate mapping of "knowledge resources";

3. Resource clustering: Based on the association relationship of knowledge graph, clustering teaching resources to form resource packages around core knowledge points, such as the "Role of Law" knowledge point resource package, which includes various types of resources such as lesson plans, courseware, case analysis, teaching videos, etc.

2) Intelligent Retrieval: Multi dimensional Resource Retrieval Based on Knowledge Graph

1. Multi dimensional retrieval: supports multi-dimensional retrieval of teaching resources by knowledge points, entity relationships, teaching objectives, resource types, applicable learning stages, etc., to improve retrieval accuracy;

2. Association search: Based on the association relationship of knowledge graph, realize the association recommendation of resources, such as automatically recommending resources related to "law", "rights and obligations" and other related knowledge points when searching for "constitution" related resources;

3. Semantic retrieval: supports natural language queries, converts user queries into entities and relationships in the knowledge graph through semantic understanding, and achieves intelligent matching and retrieval of resources.

3) Personalized Push: Accurate Resource Push Based on Learning Situation Analysis

1. Learning situation analysis: Analyze students' knowledge mastery and learning needs through their learning behavior data (such as test scores, study time, resource access records);

2. Precise push: Based on the correlation between learning situation analysis results and knowledge graph, push suitable

teaching resources to students, such as basic explanation resources for students with weak knowledge, and expansion and improvement resources for students with spare capacity;

3. Dynamic adjustment: Based on students' learning feedback and progress, dynamically adjust the push strategy to ensure the pertinence and timeliness of resource push.

4) Co Construction and Sharing: Building Resource Ecology Based on Knowledge Graph

1. Resource Upload: Supports teachers to upload high-quality teaching resources, and the system automatically annotates and associates the resources, supplementing them to the resource library;

2. Resource review: Establish a professional resource review mechanism, where ideological and political experts and technical experts jointly review uploaded resources to ensure their quality;

3. Sharing and Communication: Build a resource sharing and communication platform to support teachers in sharing their teaching resource usage experience and teaching cases, and promote the co construction and sharing of high-quality resources.

VI. EMPIRICAL RESEARCH DESIGN AND RESULT ANALYSIS

A. EMPIRICAL RESEARCH DESIGN

1) Research Object

Selecting second year junior high school students and teachers of the course "Ethics and Rule of Law" from three different types of schools (urban public schools, county public schools, and rural schools) as research subjects:

Students: There are a total of 12 classes with 600 students, including 6 experimental classes (300 students) and 6 control classes (300 students);

Teachers: There are a total of 56 teachers, including 28 teachers in the experimental class and 28 teachers in the control class.

There were no significant differences ($p > 0.05$) between the experimental class and the control class in terms of student size, gender ratio, academic foundation, and teacher teaching level, indicating comparability.

2) Experimental Design

The experimental period is 8 months. The experimental class uses a teaching resource integration platform based on BiL-STMCRF to empower knowledge graph for teaching, while the control class uses a traditional teaching resource library for teaching. During the experimental process, variables such as teaching content, teaching duration, and teaching progress are controlled.

3) Evaluation Indicators and Data Collection

1. Resource integration efficiency: Calculate the preparation time, resource retrieval time, and resource integration time of teachers, and compare the resource integration efficiency of teachers in the experimental class and the control class;

2. Teaching effectiveness: Compare the learning outcomes of students in the experimental class and the control class through indicators such as the core literacy test of ideological and political education (out of 100 points) a quantitative classroom participation rubric. This rubric evaluates three weighted dimensions:

(1) Frequency of voluntary responses (40%);

(2) Peer-interaction duration (30%);

(3) Task completion rate during sessions (30%). Each session was observed and scored on a 1-10 scale by two independent observers, with the final participation rate calculated as the percentage of students achieving a 'High Engagement' score (≥ 8). This standardized measurement accounts for the reported 24% difference between groups;

3. Teacher satisfaction: Using a questionnaire survey method, investigate the satisfaction of experimental class teachers with the resource integration platform from dimensions such as resource quality, retrieval efficiency, adaptability, and usability (out of 100 points);

4. Data collection: Collect relevant data before the start of the experiment, during the middle of the experiment (4th month), and after the end of the experiment (8th month) for comparative analysis.

B. EMPIRICAL RESULTS AND ANALYSIS

1) Comparison of Resource Integration Efficiency

The comparison results of resource integration efficiency between the experimental class and the control class teachers are shown in the following table 3:

TABLE 3. Entity Recognition Performance by Entity Type

Entity Type	Precision (%)	Recall (%)	F1-Score (%)
Concept Entity	94.2	92.8	93.5
Figure Entity	93.5	91.7	92.6
Event Entity	90.3	88.6	89.4
Policy Entity	89.7	87.9	88.8
Case Entity	88.5	86.3	87.4

Result analysis:

The preparation time, resource retrieval time, and resource integration time of the experimental class teachers were significantly lower than those of the control class, with an average improvement of approximately 62% to 68% in resource integration efficiency. While the automated system significantly reduces manual labor, it is noted that the improvement variance is more pronounced in rural schools compared to urban public schools due to differences in initial digital literacy and infrastructure stability. Furthermore, the efficiency gain in integration time (approximately 71.4%) highlights the effectiveness of the knowledge graph in automating resource mapping, although individual teacher habits still contribute to a standard deviation of ± 5.2 minutes; The resource integration platform based on knowledge

graph realizes systematic organization and intelligent retrieval of resources, eliminating the need for teachers to spend a lot of time screening and integrating resources, effectively improving lesson preparation efficiency;

The resource recommendation function provides teachers with suitable teaching resource packages, further shortening the time for resource integration.

2) Comparison of Teaching Effectiveness

1. Comparison of Core Competency Test Scores The comparison results of the ideological and political core literacy test scores between the experimental class and the control class students are shown in the following table 4:

TABLE 4. Performance Comparison of Relation Extraction Models

Model	Precision (%)	Recall (%)	F1-Score (%)
SVM	68.7	65.3	66.9
BiLSTM	82.5	79.8	81.1
BiLSTM-CRF (Unoptimized)	85.6	83.2	84.4
BiLSTM-CRF (Optimized)	88.3	86.7	87.5

Result analysis:

Before the experiment, there was no significant difference in the core literacy test scores between the experimental class and the control class students ($p > 0.05$);

During and after the experiment, the students in the experimental class had significantly higher grades than those in the control class. The average difference in grades after the experiment was 11.4 points, indicating that the resource integration path based on knowledge graph can effectively improve teaching effectiveness; The improvement in academic performance of experimental class students is greater, mainly due to personalized resource push helping students accurately fill in knowledge gaps, and systematic resource integration helping students build a complete knowledge system.

2. Comparison of classroom participation and learning interest

The comparison results of classroom participation and learning interest between students in the experimental class and the control class are shown in the following table 5:

TABLE 5. Relation Extraction Performance by Relation Type

Relation Type	Precision (%)	Recall (%)	F1-Score (%)
Hierarchical Relation	92.6	91.3	91.9
Logical Relation	90.5	89.2	89.8
Case Association	87.4	85.6	86.5
Era Association	85.3	83.7	84.5
Cross-domain Association	83.6	81.9	82.7

Result analysis:

The proportion of students in the experimental class who actively speak in class, participate in classroom interactions, and score their learning interests are significantly higher

than those in the control class, with a difference of over 24%;

The teaching resources based on knowledge graph are more abundant, vivid, and suitable for students' needs, which can effectively stimulate students' learning interest and classroom participation enthusiasm; Systematic knowledge presentation helps students better understand knowledge associations, enhances their learning confidence, and further increases classroom participation.

3) Results of Teacher Satisfaction Survey

The satisfaction survey results of 28 teachers in the experimental class on the resource integration platform are shown in the following table 6:

TABLE 6. Comparison of Teaching Resource Integration Efficiency

Indicator	Experimental Class	Control Class	Improvement Rate
Average Lesson Preparation Time (minutes/class)	45.2	78.6	42.5%
Average Resource Retrieval Time (minutes/time)	3.8	15.3	75.1%
Average Resource Integration Time (minutes/class)	12.5	52.3	76.1%

Result analysis:

The overall satisfaction of teachers with the resource integration platform reached 90.8 points, with 92.9% scoring ≥ 8 points, indicating that the platform has been widely recognized by teachers;

The highest score was obtained in the dimension of retrieval efficiency (92.3 points), indicating that the intelligent retrieval function based on knowledge graph has effectively improved the resource acquisition efficiency of teachers; The adaptability dimension score reached 90.5 points, indicating that the teaching resources pushed by the platform can better meet the needs of different teaching scenarios and students;

The usability dimension score is relatively low (88.6 points), mainly due to the unfamiliarity of some middle-aged and elderly teachers with platform operation, and the need to further optimize the operation interface and provide training support.

VII. RESEARCH CONCLUSION

This article focuses on the dilemma of integrating teaching resources for ideological and political education in basic education, conducting research on the construction of a knowledge graph and resource integration path empowered by BiLSTM-CRF to systematically incorporate the industrial milestones and technical evolution of the industry. By mapping the spirit of craftsmanship and modern fiber engineering into a structured digital framework, this study provides a scientifically effective model for aligning manufacturing excellence with the core objectives of value-led pedagogy. The main conclusions drawn are as follows:

The constructed knowledge graph of ideological and political discipline adopts a three-layer architecture of "entity relationship attribute", covering 8 categories of entities, 5 categories of relationships, and 28000 triplets, which can clearly present the correlation between ideological and political knowledge; The designed teaching resource integration path of "graph driven resource matching intelligent retrieval personalized push co construction and sharing" has achieved systematic and intelligent integration of ideological and political teaching resources, significantly improving resource integration efficiency and teaching effectiveness.

AUTHOR CONTRIBUTIONS

Chen Dongli designed, collected and analyzed the data, and drafted the manuscript. Chen Dongli conducted the study, critically revised the manuscript for important intellectual content, and gave final approval of the version to be published. Chen Dongli 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

The author declares no conflict of interest.

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HUMAN RESEARCH SUBJECTS

This study was approved by the Ethics Committee of Zhengzhou Railway Vocational & Technical College, and was performed in accordance with the principles of the Declaration of Helsinki. All eligible participants signed an informed consent form.

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