

Visual Analysis of Ideological and Political Education in Optics Curriculum Based on CiteSpace Knowledge Graph

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Abstract: The construction of Curriculum-based Ideological and Political Education (CIE) serves as a strategic measure to implement the fundamental task of fostering virtue through education, with professional courses acting as the fundamental carrier for its advancement. Optics, a pivotal branch of physics and an interdisciplinary field linked to optical engineering technology, is a highly applied core professional course that integrates classic theories with modern technologies. Thus, it is imperative to explore the synergistic development of professional education for applied physics majors and CIE in the optics curriculum. In recent years, universities offering optics courses have accumulated certain practical experience in CIE, yet prominent issues such as unbalanced development, inadequate exploration and homogenization still persist. Based on this, this study adopts the knowledge graph analysis method, taking 187 Chinese journal papers from the China National Knowledge Infrastructure (CNKI) database during 2019-2025 as research samples. With the aid of the CiteSpace analysis tool, a visual bibliometric analysis of the sample literatures is conducted to trace and explore the knowledge evolution and logical context of CIE research in China's optics curriculum, aiming to reveal the cutting-edge hotspots and research trends in this field. The findings indicate that since the formal proposal of the CIE concept in 2019, the number of relevant research papers has increased at an average annual rate of 156.3%, marking the entry into a stage of rapid development. In terms of research content, the themes extend multidimensionally with CIE as the core, covering ideological and political education, CIE cases, CIE elements and other related contents. In terms of research subjects, the current research is relatively scattered, and a complete collaborative network has not yet been formed among research institutions and authors. Overall, under the background of fostering virtue through education in the new era, CIE research in the optics curriculum exhibits a strong policy-driven characteristic. In the future, China's CIE research in the optics curriculum should strengthen inter-regional, inter-university and inter-team cooperation, deepen the synergistic integration of CIE cases and educational practice, further highlight problem orientation, and respond to the mission of the times.

Keywords: Curriculum-based Ideological and Political Education; Optics; CiteSpace; Knowledge Graph; Visual Analysis.

1. Introduction

Curriculum-based Ideological and Political Education (CIE) represents a conceptual and practical innovation for universities to implement the fundamental task of fostering virtue through education and shape the soul of higher education. On May 28, 2020, the Ministry of Education of the People's Republic of China issued the Guidelines for the Construction of Curriculum-based Ideological and Political Education in Higher Education Institutions, which aims to integrate ideological and political education into the entire process of talent cultivation and comprehensively promote the construction of CIE in universities.^[1] The integration of CIE is an innovative measure and important approach for the ideological and political education of college students in the new era, with professional courses serving as the basic carrier for its construction.

Optics is one of the earliest developed natural sciences, which is inseparable from human life and closely linked to the development of natural sciences. As a time-honored discipline that constantly rejuvenates itself, the establishment of the modern physics system in the early 20th century originated from breakthroughs in optical research.^[2] It is a basic science that investigates the fundamental laws of the nature, generation, propagation, reception of light and its interaction with matter. As an important

branch of physics, optics plays a crucial role in university education. Optical knowledge is widely applied in various industries and acts as the foundation for numerous fields of natural science and engineering technology. In addition, optics courses not only impart professional knowledge, but also cultivate students' scientific thinking, experimental skills and problem-solving abilities. Therefore, the synergistic and in-depth integration of optics courses and ideological and political education is an essential requirement for implementing the fundamental educational task of fostering virtue through education, reflecting the progressive characteristics of talent cultivation and the high-quality development of education. Strengthening research on the construction of CIE in the optics curriculum is also an inevitable demand of the times.

At present, research on CIE in the optics curriculum has carried out effective exploration and practice from various aspects, including value adherence,^[3,4] excavation of CIE elements,^[5,6] construction of CIE cases^[7,8] and reconstruction of curriculum assessment methods,^[9,10] and has achieved a series of research results. However, there is a lack of systematic sorting and regular summary of the massive granular research results in this field, as well as structured and visual presentation methods. This disconnects the correlation between the contents of CIE in the optics curriculum, leading to the prominent phenomena of unbalanced development, inadequate exploration and homogenization, which hinders the three-dimensional and multidimensional in-depth expansion of CIE construction in the optics curriculum.

Based on this, this study takes the literatures on CIE in the optics curriculum included in the CNKI database as research data and the CiteSpace software as the analysis tool. Through visual methods such as co-occurrence graph, clustering graph, burst detection graph and time-zone spectrum, the cutting-edge hotspots and research trends in the field of CIE in the optics curriculum are revealed in the form of knowledge graphs and table matrices. This study aims to grasp the research dynamics of this field from a macro perspective, which is conducive to expanding the research field in depth, scientifically grasping the research direction, and providing reference for cultivating intelligent new-type applied optical talents with value guidance, competency orientation and problem-solving capabilities.

2. Research Methods and Data Sources

2.1 Research Methods and analysis Tool

This study adopts bibliometric research method and knowledge graph visualization method to analyze the literature data. Bibliometrics is a quantitative and objective analysis method commonly used to organize the evolving information in a specific research field. It uses visual analysis software to conduct statistics on references based on keywords, authors, journals or institutions of the research content, so as to further feed back information on the potential research trends.

The literature statistical analysis tool used in this study is CiteSpace 6.4.2 (64-bit). Also known as Citation Space, CiteSpace is a citation visualization analysis software developed gradually against the background of scient metrics and data visualization, which focuses on analyzing the knowledge contained in scientific literatures.^[11,12] In this study, the original data in CNKI were converted into the Reworks format readable by CiteSpace, encoded and created as projects in the software. After simplifying and merging the data slice network and conducting operation adjustment, the visual graphs for analysis in this study were obtained.

2.2 Data Sources

The research data were retrieved from the journal database of CNKI, with the search theme set as "Optics" and the secondary search term as "Ideological and Politics" in the retrieved results. The journal source categories include SCI source journals, Peking University Core Journals, CSSCI and CSCD. The deadline for publication was set as December, 2025, and a total of 187 relevant articles were initially retrieved.

3. Results and Discussion

3.1 General Situation of Research Literatures

A total of 103 valid papers related to CIE in the optics curriculum were retrieved from the CNKI database, the results are shown in Figure 1. Quantitative analysis of annual publication output shows that

the number of papers in 2019 was relatively low (only 3 papers), while it increased rapidly to 15 in 2020 (a threefold increase compared with 2019). Subsequently, the number of papers grew at an average annual rate of 156.3%, reaching a peak of 39 in 2023. From the development trend, there is still considerable room for further growth in the future. This indicates that CIE research in the optics curriculum has attracted increasing attention from researchers and academic institutions in China.

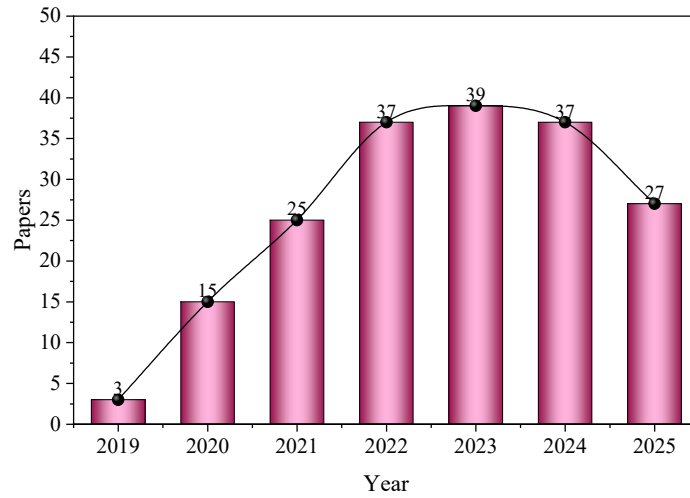


Figure 1 Trend of publication articles on ideological and political education in optics courses over time.

3.2 Keyword Clustering Analysis

The module value (Q value) and average silhouette value (S value) of keyword clustering were used to evaluate the rationality and credibility of the clustering results. A Q value > 0.3 indicates a significant clustering structure, an S value > 0.5 means a reasonable clustering structure, and an S value > 0.7 represents a highly credible clustering result. The smaller the cluster number, the larger the scale of the research cluster. As shown in Figure 2, a total of 6 research modules were obtained through keyword clustering analysis. The analysis results show that the Q value is 0.5419 (> 0.3), indicating a significant clustering module structure, and the S value is 0.8548 (> 0.7), which verifies that the clustering result is highly credible and the analysis conclusion is persuasive. The top three research clusters in terms of scale are Curriculum-based Ideological and Political Education, Cultural Confidence and Ideological and Political Elements respectively.

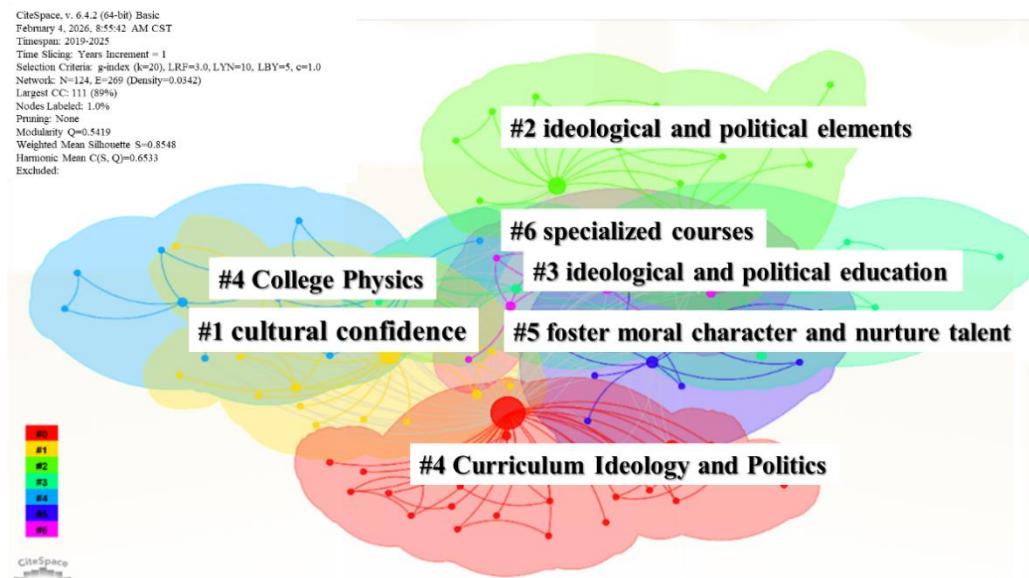


Figure 2 Keyword clustering analysis of ideological and political education in optics courses.

The detailed information of keyword clustering analysis is shown in Table 1. It can be seen from the table that the clustering results involve 6 main research directions in this field, including Cluster #0 Curriculum-based Ideological and Political Education, #1 Cultural Confidence, #2 Ideological and Political Elements, #3 Ideological and Political Education, #4 College Physics, #5 Fostering Virtue through Education and #6 Professional Courses. The core keywords of Cluster #0 include "Curriculum-based Ideological and Political Education" and "Reform and Innovation", which indicates that CIE is an important research topic in the field of optics curriculum reform, and this cluster mainly focuses on the output-oriented cultivation of optical talents and the reform and innovation of learning through practice; Cluster #1 focuses on cultivating students' cultural confidence and value identity in the process of CIE implementation, including the introduction methods and implementation paths of CIE in the optics curriculum; Cluster #2 centers on the integration of ideological and political elements into the optics curriculum, including the reform of teaching modes, teaching design and teaching methods; the core keywords of Cluster #3 are "Ideological and Political Education" and "Core Literacy", which mainly involves the teaching reform of optics courses driven by CIE; Cluster #4 focuses on the integration of teaching content and traditional culture, including the design of flipped classroom and micro-course, and the formulation of targeted teaching measures, aiming to achieve the educational effect of CIE that makes students "hold light in heart and illuminate the world"; Cluster #5 takes the educational essence of fostering virtue through education as the core, focusing on the excavation of ideological and political elements and the construction of typical CIE cases in the optics curriculum; the core keywords of Cluster #6 are professional courses and teaching design, including the teaching practice of applying basic optical knowledge to marine optics education.

Table 1 Information of keyword clustering analysis

No.	Cluster size	Sub-cluster silhouette value	Year	LSI log-likelihood rateables and keywords
0	27	0.908	2021	Curriculum-based Ideological and Political Education; Physical Optics; Output Orientation; Learning through Practice; Undergraduate Education; Nonlinear Optics; Reform and Innovation
1	20	0.724	2024	Cultural Confidence; Value Identity; Implementation Path; Student-centered; Curriculum Construction; Introduction Method; Scientific Literacy
2	19	0.904	2022	Ideological and Political Elements; Teaching Mode; Optical Module; Teaching Design; Teaching Method; Curriculum Integration; Patriotism Rooted in Heart
3	13	0.823	2020	Ideological and Political Education; Core Literacy; Optics Curriculum; Undergraduate Teaching Reform; Higher Education
4	13	0.866	2025	Teaching Content; Traditional Culture; Flipped Classroom; Micro-course Design; Teaching Measure; Illuminate the World; Hold Light in Heart
5	10	0.867	2023	Fostering Virtue through Education; Ideological and Political Elements; CIE Cases; Applied Optics; Teaching Reform
6	9	0.9	2023	Professional Course; Teaching Design; Optical Basics; Teaching Objective; Marine Optics; Teaching Practice

3.3 Institutional Collaboration Network

Statistical analysis of research institutions in optics courses helps to understand the research activities of various institutions and can serve as a reference for evaluating their research influence. By setting the node type to ****Institution**** in CiteSpace and running the analysis, a knowledge map of research institutions is obtained, and the top 20 institutions in terms of publication volume are sorted out (see Table 2). In the domestic research field of ideological and political education in optics courses, universities, as core research institutions, show high publication activity. With profound disciplinary accumulation and innovative exploration capabilities, these academic universities play a key role in grasping cutting-edge teaching trends and steadily advancing ideological and political education in optics courses, gradually becoming the backbone driving the development of relevant research. The main research forces on ideological and political education in optics courses in China are concentrated in engineering colleges of universities. Among them, the ****School of Network and Communication Engineering, Jinling Institute of Technology****, the ****School of Optical Science and Engineering, Soochow University****, and the ****School of Instrument Science and Opto-electronics Engineering, Beihang University**** are the central players. Other schools of physics and electronics are also actively engaging in this field.

Table 2 Top 20 Research Institutions in Ideological and Political Education in Optics Courses

No.	Research institution	Papers	No.	Research institution	Papers
1	School of Network and Communication Engineering, Jinling Institute of Technology	3	11	Wenzheng College, Soochow University	2
2	School of Optical Science and Engineering, Soochow University	3	12	School of Automation and Electrical Engineering, Tianjin University of Technology and Education	2
3	School of Instrument Science and Opto-electronics Engineering, Beihang University	3	13	College of Optical and Electronic Technology, China Jiliang University	2
4	College of Physical Science and Technology, Guangxi Normal University	2	14	College of Physical Science and Technology, Central China Normal University	2
5	School of Physics and Electronic Engineering, Xianyang Normal University	2	15	College of Physical Science and Technology, Hebei University	2
6	School of Marine Science and Technology, Tianjin University	2	16	School of Electronic and Optical Engineering, Nanjing University of Posts and Telecommunications	2
7	School of Optical-Electrical and Computer Engineering, University of Shanghai for Science and Technology	2	17	School of Physics and Kuang Yaming Honors School, Nanjing University	1
8	Jiangsu University of Science and Technology	2	18	College of Biological and Food Engineering, Suzhou University	1
9	School of Physics and Electronic Engineering, Zhengzhou University of Light Industry	2	19	National Teaching Seminar on Optics for Higher Education	1
10	School of Physics and Electronic Information, Dezhou University	2	20	Inner Mongolia Normal University	1

4. Conclusions and Prospects

Based on the visual analysis results of CiteSpace, the curriculum reform driven by CIE with fostering virtue through education as the core is a research hotspot in the current higher education field in China. From the perspective of keyword co-occurrence and clustering, a relatively complete optics curriculum construction system has basically formed, with "Curriculum-based Ideological and Political Education" as the core, and closely linked with "Ideological and Political Elements", "CIE Cases" and the reform of teaching methods and modes. From the perspective of published authors and research institutions, the current CIE research in the optics curriculum is relatively scattered with insufficient cooperative research, and no cohesive core research team has been formed yet, and the research also lacks long-term sustainability. Through the continuous exploration and construction of researchers in the past five years, the CIE research in the optics curriculum has presented a gradual and phased in-depth development trend, formed a number of constructive research methods and achievements, and initiated new ideas for the CIE teaching practice of the optics curriculum in Chinese universities. However, it must be clearly recognized that the CIE reform of the optics curriculum is a systematic project that requires long-term and unremitting efforts, and it is necessary to further explore and improve the cultivation mode of new-type optical talents with both political integrity and professional competence.

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