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Visual Analysis Of Project-Based Teaching In China's Application-Oriented Universities

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Abstract

Through the visual analysis of the literature related to project-based teaching in China in the past 20 years, this paper aims to provide a reference for the deepening practice of project-based teaching and curriculum construction. Based on the main core journals included in the CNKI database from 2007 to 2025, the author uses CiteSpace software to visualize and analyze 622 valid literatures, systematically sort out the research hotspots and development contexts, etc., and construct the annual publication trend of national project-based teaching in the past 20 years, the context of research scholars and network cooperation, keyword frequency and co-occurrence map. It is found that the annual number of papers on project-based teaching has increased in stages, reaching a peak in 2019, and policy promotion is related to research enthusiasm. The research focuses on keywords such as "teaching reform", "applied talent training" and "industry-education integration", forming a multi-dimensional research pattern with practice orientation as the core. On the whole, project-based teaching research has formed a policy-driven and practice-oriented development path. In the future, it is necessary to strengthen micro-level exploration, build a comprehensive evaluation system, and promote scholar cooperation to deepen the innovation of teaching models and the cultivation of applied talents.

Keywords

Project-Based Teaching, Citespace Software, Visual Analytics.

1. Statement of the Problem

Project-based teaching is a teaching model that emphasizes student-centered teaching, which plays a very important role in promoting students' deep learning and promoting the realization of the core literacy goals of the subject[1]。 As a student-centered teaching model that drives learning through real situations and tasks, project-based teaching has been highly valued in the field of education in recent years. General Secretary Xi Jinping emphasized that "it is necessary to deepen the reform of education and teaching and strengthen practical education", and project-based teaching is an important path to promote the implementation of this concept. The Fifth Plenary Session of the 19th Central Committee of the Communist Party of China clearly proposed to build a high-quality education system and pay attention to cultivating students' innovative spirit and practical ability. Through the setting of comprehensive and open learning projects, project-based teaching not only promotes students' knowledge integration and ability transfer, but also helps to improve the ability of cooperative inquiry and problem-solving, which is a powerful starting point for realizing core literacy-oriented curriculum reform.

With the advancement of teaching reform, classroom teaching has gradually changed from "teacher-oriented" and "knowledge-based" to "student-oriented" and "quality-oriented"。 With the deepening of educational reform, project-based teaching has been incorporated into

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the multidisciplinary curriculum system and has become a hot area of teaching research. Systematic sorting and visual analysis of research results related to project-based teaching is not only a practical need to promote the widespread application of this teaching model, but also an inherent requirement for optimizing teaching design and improving teaching effectiveness. In order to promote the continuous deepening of education reform, this paper uses CiteSpace software to visualize and analyze the literature related to project-based teaching in China in the past 20 years, and systematically sorts out the research hotspots and development contexts, in order to provide a reference for the deepening practice and curriculum construction of project-based teaching.

2. Data Sources and Research Methods

2.1 Data Sources

The research data in this paper are derived from the main core journals in the CNKI database, and the search topics are "project-based teaching" and "application-oriented", the time range is selected from January 1, 2007 to October 30, 2025. In this study, in order to ensure that the research data is more reliable and authoritative, a total of 755 related documents were obtained from the main core journals of SCI, EI, Peking University Core, CSSCI and CSCD selected from all data sources, and the search results that were obviously inconsistent or irrelevant to the main keywords were manually eliminated, and finally 622 valid documents were retained as the final search data.

2.2 Research Methods

In this paper, CiteSpace software is used to visualize and analyze the retrieved final data, and the results of annual publication trends, research scholars and network cooperative relationships, keyword frequency, and co-occurrence maps are formed, and the research hotspots and trends in this field in different time periods are analyzed, which is helpful for scholars to grasp and predict future research hotspots.

3. Literature Visualization Analysis

3.1 Statistics of the Number of Annual Literature

From 1993 to 2022, the annual publication trend of project-based teaching research in our country's universities is shown in Figure 1. From Figure 1, it can be seen that the research on project-based teaching in our country began in 2007, but the research results in 2019 were the most significant, with a total of 100 papers, while the research results from 2007 to 2010 were significantly less, with an average annual number of 15 papers. From 2011 to 2018, project-based teaching was in a stage of stable development, and the society began to pay attention to matters related to project-based teaching and related theoretical research, with an average annual publication of 44 articles, and the number of articles increased significantly. From 2020 to 2025, the research popularity has declined, of which the data for 2025 is incomplete statistics (January to October), which is only for trend reference.

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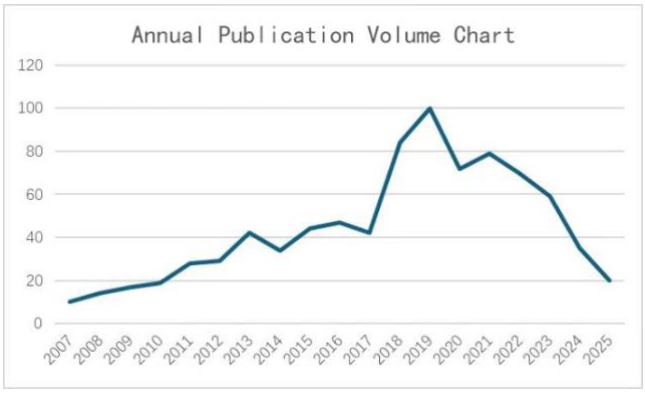

Figure 1: Trend chart of the annual publication volume of project-based teaching research in major core journals from 2007 to 2025

At the same time, the development and evolution of project-based teaching are closely linked to the major policies of national education reform in the corresponding period, and the promulgation and implementation of various education policy documents during this period are significantly positively correlated with the changes in the number of research results related to project-based teaching. In 2001, the Ministry of Education issued the "Outline of Basic Education Curriculum Reform (Trial)", which clearly stated that "students are encouraged to actively participate, be willing to explore, and be diligent in hands-on", which provides policy guidance for the initial exploration of project-based teaching. In 2010, the Outline of the National Medium and Long-term Education Reform and Development Plan (2010-2020) emphasized "innovative talent training models" and promoted the extension of project-based teaching from basic education to higher education and vocational education. In 2016, the Ministry of Education issued the "13th Five-Year Plan for Education Informatization", which proposed to "encourage project-based learning and inquiry-based learning", which accelerated the deep integration of project-based teaching and information technology. In 2019, the "China Education Modernization 2035" required "building an education system for the comprehensive training of moral, intellectual, physical, aesthetic, and labor", and superimposed the provisions of the new vocational education law on "implementing teaching modes such as project teaching and case teaching", which promoted the number of articles published in 2019 to a sharp peak; Although there have been slight fluctuations after 2020, the Ministry of Education's "Opinions on Strengthening Science Education in Primary and Secondary Schools in the New Era" in 2023 emphasized "promoting project-based learning and other teaching methods", which once again triggered a research boom; The 2025 "Vocational Education Professional Teaching Standards (2024 Edition)" will include project-based teaching as the core teaching model into the requirements of professional courses, but the number of publications has shown a downward trend since then, which still reflects the strong role of the policy in promoting project-based teaching and research as a whole.

3.2 Keyword Analysis

Through CiteSpace software, the co-occurrence graph of the main keywords of major core journals in the field of project-based teaching from 2007 to 2022 was analyzed. From the perspective of graph parameters, there are many keywords and several connection lines, and the network density can be inferred from the software data. From the visual presentation of the graph, the size of the graph intuitively reflects the frequency of keywords, that is, the larger the graph, the higher the attention and frequency of keywords in this field. The hierarchical richness of color represents the duration of the study, and the more diverse the color, the longer the research span. The more and denser the connection, the closer the research connection between the keywords. At the same time, the year in which the keywords appear corresponds

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to the color of the lines, which can clearly trace the year in which the keywords appeared and the degree of close research connection between them.

Figure 2: Keyword clustering map of project-based teaching

Specifically, from the content analysis of Figure 2, the module value Modularity Q, the higher the Q value, the stronger the independence between different clusters, the clearer the theme distinction, Q=0.8519 in the figure indicates that the clustering differentiation is very good, and the boundary between different theme clusters such as "education reform" and "integration of industry and education" is very clear, and there will be no theme confusion. The closer the profile value Silhouette S, S is to 1, the higher the keyword association in the same cluster, and the S = 0.9697 in the figure indicates that the keywords within each cluster are extremely homogeneous - for example, keywords in the same cluster such as "project-based" and "practical teaching" are often discussed at the same time in research, and the topic focus is very high. In addition, first of all, from the perspective of cluster scale, "educational reform" is the largest cluster with the longest time span in the figure, which runs through almost all research stages, indicating that teaching reform has always been the core topic in the field of project-based teaching research. Its dense nodes and rich cross-year connections reflect the continuous attention of researchers on how to promote classroom paradigm transformation, curriculum structure reshaping, and talent training model optimization through project-based teaching in the context of education reform. Secondly, clusters such as "practical teaching" and "project-based" show a continuous and stable distribution on the timeline, indicating that with the promotion of project-based teaching, the concepts of "application-oriented" and "practice" have been deepened, and have gradually become the key starting point of domestic teaching reform. The number of related keyword nodes has increased significantly since 2013, indicating that researchers have begun to shift from simple concept discussions to substantive issues such as operation process, task design, and classroom implementation mechanism of project-based teaching. Third, the clustering of "industry-education integration" and "school-enterprise cooperation" is mainly concentrated after 2016, with high node density and obvious brightness, reflecting that it is a hot spot in recent years. With the continuous advancement of vocational education reform, new engineering construction and the transformation policy of application-oriented universities, project-based teaching has gradually moved from the classroom to industrial scenarios, and the research theme has extended from curriculum reform to practical fields such as cross-border collaborative education, industrial project introduction into the classroom, and school-enterprise co-construction of courses. This change reflects the shift in research focus from "internal reform of teaching" to "deep coupling between education and industry". In addition, clusters such as "application-oriented" and "application-oriented" show

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a latecomer growth trend, highlighting the high compatibility between project-based teaching and application-oriented talent training. Relevant research focuses on the development of students' comprehensive ability, the improvement of interdisciplinary integration ability, and the formation of problem-solving ability in real situations, which further shows that project-based teaching has become an important part of the talent training system of application-oriented universities. At the same time, the clustering of "curriculum reform" and "innovation and entrepreneurship" is closely related to the main line clustering of "project-based teaching", indicating that in the context of new curriculum reform and "entrepreneurship and entrepreneurship education", the educational value of project-based learning, the path of curriculum ideological and political integration, and the synergistic relationship with innovation and entrepreneurship education have gradually become the focus of researchers. In recent years, a large number of studies have focused on the construction of project-based curriculum system, cross-curriculum project design, and the application of comprehensive projects in multi-professional collaborative teaching, which has further promoted the expansion of project-based teaching from single course implementation to curriculum system integration. In general, the timeline diagram reveals the characteristics of the three stages of project-based teaching research: (1) 2007-2012 is the embryonic period, and the research themes are scattered, mainly focusing on the discussion of teaching reform concepts; (2) From 2013 to 2019, the topics of project-based teaching, practical teaching, and applied talent training heated up rapidly, reaching the peak of research in 2019. (3) From 2020 to 2025, as a period of deepening development, project-based teaching research has formed a knowledge network with "teaching reform" as the core and multi-theme coordinated development, and shows a trend of continuous advancement from macro concept discussion to practice deepening and professional application.

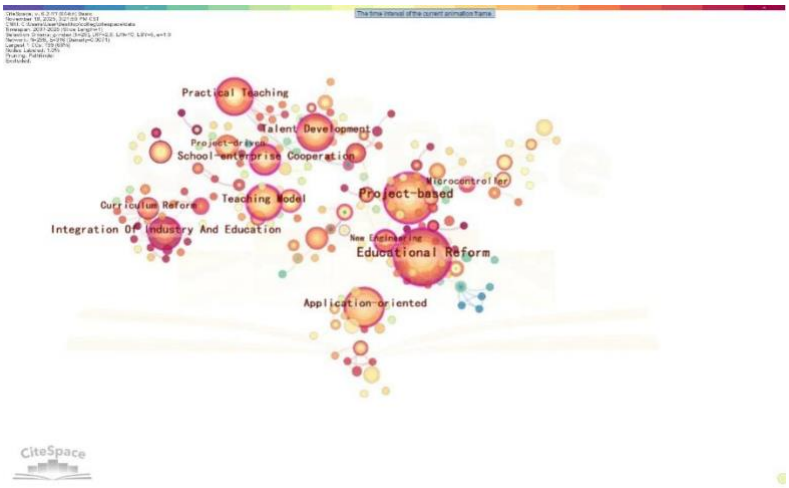

Figure 3: Keyword co-occurrence network diagram of project-based teaching

Figure 3 shows the network diagram of keyword co-occurrence in domestic project-based teaching research from 2007 to 2025. Through the size, color and connection relationship between nodes, the figure presents the frequency, prominence and closeness of keywords and their correlation with each other, so as to reveal the knowledge structure and core topics of project-based teaching research. Among them, the keywords of frequency and high intermediary centrality can reflect the hot spots and trends in the field of project-based teaching. Intermediary centrality refers to the number of times a node acts as a bridge between the shortest path between two other nodes, and the more times a keyword node acts as an intermediary, that is, the more connections with other keywords, the higher the intermediary centrality. The table lists the keywords with high frequency and high mediation centrality in this field.

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Both "project-based" and "teaching reform" have the largest nodes, indicating that project-based teaching, as an important path of teaching reform, is the focus of general attention of researchers. The dense connection between nodes reflects that the research focuses on the role of project-based teaching in classroom reform, curriculum restructuring, and teaching concept update. The close gathering of nodes such as "practical teaching", "application-oriented" and "application ability" indicates that research increasingly emphasizes the role of project-based teaching in promoting students' ability training. In particular, the two keywords "application" and "application ability" appear at a high frequency, reflecting that project-based teaching has become an important starting point for application-oriented universities to improve the quality of talent training. The "industry-education integration" and "school-enterprise cooperation" on the left side of the map present medium and large nodes, and are closely connected with the central keywords, showing that these themes have heated up rapidly in recent years, reflecting the general concern of researchers to introduce classrooms through real projects, school-enterprise collaborative design tasks, industrial resources to support teaching, etc., so as to promote the expansion of project-based teaching from the classroom level to the industrial level, and realize the docking of education and industrial needs. The words "innovation and entrepreneurship" and "curriculum reform" also form a relatively clear local cluster, indicating that with the advancement of "entrepreneurship and entrepreneurship education" and new curriculum reform, research has gradually expanded from traditional project-based learning to new directions such as interdisciplinary comprehensive projects and innovative project-driven learning, indicating that the application scenarios and practical depth of project-based teaching are constantly increasing. The color of the nodes in the figure shows a gradient from cold to warm, representing the changes in research hotspots in different years. The warmer nodes are concentrated on keywords such as "projectization", "teaching reform" and "integration of industry and education", indicating that these themes have received special attention in recent years. the cooler nodes are mostly related to basic and continuous themes, such as "teaching methods" and "curriculum system", which represent the long-term stable concerns of research.

In general, the co-occurrence diagram clearly reflects the current project-based teaching research theme from teaching reform to project-based practice to ability training. The research perspective expands from internal classroom reform to industrial collaborative education; The research focuses on macro concepts to micro levels such as project task design and practice path construction.

3.3 Analysis of the Main Publishers and Cooperation Networks

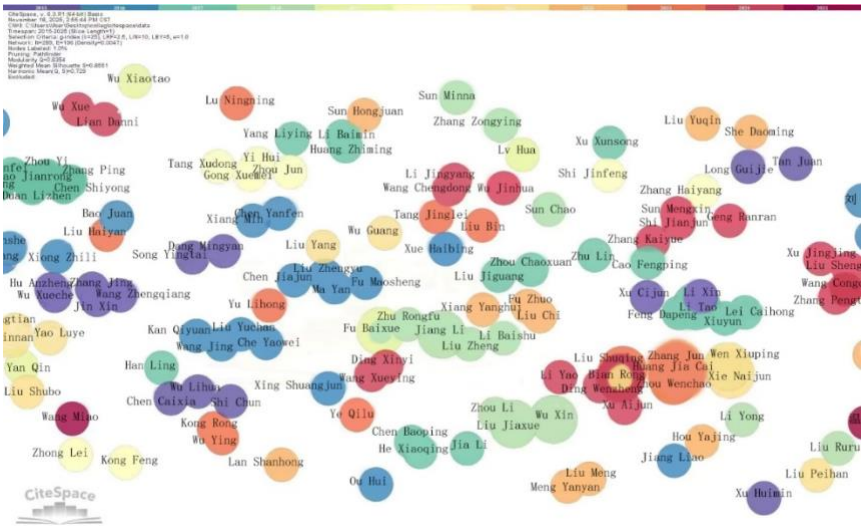

Figure 4: Distribution of core authors of project-based teaching research in major core journals from 2007 to 2025

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The main authors and associations of major core journals in the field of project-based teaching and research from 2007 to 2025 were analyzed by CiteSpace software, and the distribution of core authors is shown in Figure 4. Figure 4 clearly shows the relationship between the core authors, in which the size of the thick circle of the name intuitively represents the number of publications of the scholar, and the connection between the names clearly reflects the cooperative network relationship between scholars.

Regarding the main publishers, first of all, Fu Baihua, Jiang Li, Wu Xin, Liu Jiaxue, from the significant size of their names in the picture, it can be judged that the number of articles is large, and they are the core publishing force with important influence in this field; followed by scholars such as Liu Shuqing, Zhang Juncai, Zhou Wenchao, and Xie Naijun, whose names are presented on a scale that also shows that their publications in this field are more prominent. In addition, scholars such as Li Yong, Hou Yajing, and Meng Yan have also made certain contributions in this field. Regarding the cooperative network relationship between scholars, it can be inferred from the distribution of connections and the overall network density in the figure that the connection between scholars is not close, and the vast majority of authors are in a relatively scattered research state, forming fewer large-scale cooperation teams, and the cohesion of professional research forces is obviously insufficient. Except for a few scholars who have a relatively clear connection, other scholars basically carry out research work in the form of solo work.

4. Conclusion and enlightenment

4.1 Research Conclusion

If you follow the “checklist” your paper will conform to the requirements of the publisher and facilitate a problem-free publication process.

A series of reform documents in the field of education emphasize deepening the integration of industry and education, improving the quality of application-oriented talent training, and placing innovative teaching models and promoting the coordinated development of education and industry in an important position. Moreover, in recent years, with the continuous deepening of project-based teaching research and the visual analysis of the duration of related research, it can be seen that the current research direction of experts and scholars is gradually moving towards project-based teaching innovation in the context of new engineering, the project-driven model of deep integration of industry and education, and the construction of an interdisciplinary project-based curriculum system for the cultivation of application-oriented talents. Scholars' research results on the topic of project-based teaching are generally at the level of high-quality development, which also indirectly shows that the research on project-based teaching has become a key research direction for scholars in this field. From the perspective of scholars' research topic associations, although the network connection between core keywords is focused, there is still room for improvement in the overall cooperation density, the scale of professional research teams is insufficient, and some studies are still relatively scattered.

4.2 Research enlightenment

This paper uses CiteSpace software to visualize and analyze project-based teaching, and puts forward some suggestions on the existing problems in project-based teaching and common social problems, in order to promote the reform and have room for further improvement.

There is an obvious disconnect between engineering graduates and industrial demand, and there are problems in the process of education, such as students' lack of necessary engineering experience and professional practice ability, scattered and unsystematic project-based teaching, old curriculum projects, and prominent contradictions between assessment and

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evaluation and traditional mechanisms [2]。 It can be seen from the retrieved relevant core journal literature that most of the research of experts and scholars is mostly at the macro level, focusing on macro issues such as teaching model construction, policy-oriented interpretation, and overall implementation framework design, and has not yet fully penetrated into the specific scenarios and details of teaching practice. In the process of promoting project-based teaching, grassroots colleges and universities face more complex and arduous practical problems - such as the differentiated design of project-based courses of different majors, the precise dismantling and dynamic regulation of project tasks in the classroom, the balance and adaptation of individual student differences and teamwork, and the difficulties in the implementation and connection of school-enterprise collaborative projects. Local application-oriented colleges and universities can implement project-based teaching, build a progressive curriculum system of "foundation-integration-testing", lay a solid foundation of knowledge through professional basic project courses, achieve interdisciplinary integration through comprehensive design project courses, and test the effectiveness of education in graduation design project courses, so as to solve the dilemma of "disconnection between learning and application" [3]。 These micro links directly affect the implementation effect of project-based teaching and the quality of talent training, and are the key to determining whether teaching reform can truly take root. Therefore, on the basis of continuously deepening macro-level research, it is necessary to further strengthen the in-depth excavation of micro-aspects, focus on specific scenarios, operation processes, crux of problems and optimization paths in teaching practice, and provide more practical and refined theoretical guidance and practical reference for grassroots teaching practitioners.

Enhance cooperation and exchanges between experts and scholars in the field of project-based teaching. Universities can cooperate with leading enterprises in the industry to build industrial colleges and training platforms to transform the real technical pain points of enterprises into teaching projects, so that students can improve their engineering practice ability and career adaptability in "learning by doing" [4]。 Through the above visual analysis, it is not difficult to see that the academic connection between experts and scholars in this field is not close, and most of them are still in a state of independent research, and there is a lack of collaborative exploration across universities and disciplines. Therefore, it is necessary to further build a normalized academic cooperation platform, encourage the formation of cross-unit and cross-field research teams, and carry out in-depth academic exchanges around the core topics, practical difficulties, and innovation paths of project-based teaching. Major universities, scientific research institutes and industry enterprises should strengthen linkage and cooperation, integrate teaching resources, scientific research forces and industrial needs, and jointly tackle key issues in the implementation of project-based teaching, so as to better implement the national education reform policy and explore more practical teaching methods and practical paths.

At present, there is still a certain disconnect between higher education and social needs, and the training of application-oriented talents is still stuck in the one-sided cognition that "hands-on is application-oriented", ignoring the importance of comprehensive quality and sustainable development [5]。 With the continuous upgrading of the industrial structure, emerging fields have put forward higher requirements for talents, not only need to have solid practical ability, but also need to have cross-border integration, innovative thinking and the ability to quickly adapt to the environment. In response to these new needs, colleges and universities need to build a more diversified and open teaching system. On the one hand, by introducing the enterprise mentor mechanism, we should set up positions such as "industrial professor" and "enterprise mentor" to promote teachers to practice regularly in enterprises and strengthen their engineering application ability and industrial understanding. On the other hand, through the joint construction of industrial colleges and research institutes between schools and

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enterprises, the collaborative education model of "talent training, technology research and development, and social services" is explored [6].In terms of talent training methods, it is necessary to establish a multi-evaluation system that combines process and comprehensiveness, and replace the traditional single written test assessment through the dimensions of project display, process record, teamwork performance and innovation ability, so as to more comprehensively reflect the learning quality and professionalism of students. At the same time, the sustainable development ability and general ability training system should be incorporated into project-based teaching, and critical thinking, innovation and entrepreneurship ability, and cross-cultural communication ability should be integrated into the whole teaching process as core elements, so as to build an educational ecology of "learning and application". In general, by deepening school-enterprise cooperation, optimizing the faculty structure and reforming the evaluation system, it will help promote the transformation of the application-oriented talent training model from "skill-oriented" to "comprehensive ability and innovation-driven", and realize the positive response of higher education to industrial development and social needs.

5. Research limitations and prospects

Although this study systematically presents the overall picture of project-based teaching in China, there are still certain limitations: firstly, the scope of literature is mainly based on Chinese core journals, and can be expanded to international databases in the future to enhance the comparative horizon; Secondly, the analysis at this stage is more biased towards macro trends, and in the future, it should be combined with the teaching cases of typical universities and typical majors to conduct empirical verification at the micro level to enrich the application path of project-based teaching. With the rapid development of artificial intelligence, AIGC, and virtual simulation technology, the digital, intelligent, and interdisciplinary characteristics of project-based teaching will become more prominent, and the evaluation system of "AI+project-based teaching" will be explored[7], the synergy mechanism and the project task generation logic will become an important growth point in the next stage of research.

In short, through the systematic combing and visual analysis of the literature related to project-based teaching in the past 17 years, it can be found that project-based teaching has formed a relatively clear development context in teaching reform and application-oriented talent training, which has important theoretical value and practical significance for the promotion and deepening of project-based teachingIt also provides rich ideas and methods for the innovation of applied talent training mode. With the deepening of the construction of an educational power, project-based teaching will play a key role in industrial collaborative education and students' comprehensive ability training, project-based teaching should closely combine the education policy and industrial development needs of the new era, explore scientific and efficient teaching reform plans, continuously accumulate experience and optimize the path in practice, and embark on the road of project-based teaching development with Chinese characteristics [8], in order to improve the quality of higher education talent training, Promote the high-quality development of applied education and make greater contributions.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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