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Research and Practice of Government-Industry-Academia-Research Collaborative Educational Mechanism for the Integration of Economics and Management Majors with Big Data

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Abstract

The rapid development of Big Data and Artificial Intelligence has had an increasingly profound impact on society and the business sector, resulting in significant changes in the demand for talent in the market. Therefore, it is particularly important to explore the ability quality based on big data thinking and promote the deep integration of "professional thinking, professional judgment thinking, and big data thinking" in order to cultivate application-oriented and compound professionals. This paper analyzes the challenges and opportunities facing the cultivation of talents in economics and management under the background of big data and constructs the government-industry-academia-research collaborative educating mechanism for the fusion of economics and management majors with big data from the aspects of cultivation goal setting, curriculum system construction, teaching mode innovation, faculty construction, and practical training platform construction. The practical effect of the government-industry-academia-research collaborative education mechanism for the integration of economics and management majors with big data is evaluated through the quality and satisfaction of student cultivation, student employment, practical teaching, and student participation in disciplinary competitions. The results of the study show that by integrating big data and information technology into economics and management majors, graduates are able to meet the demand for talent in the era of the digital economy and realize the effective docking between talent cultivation and job demand.

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Keywords

Economics and Management Majors, Big Data Integration Teaching, Government-Industry-Academia-Research Mechanism, Collaborative Education Mechanism

1. Introduction

With the continuous advancement of globalization and informatization, data generation, storage, and processing abilities have achieved significant improvement. Big data has transcended the scope of technical fields, penetrated into multidisciplinary fields, and become a new driving force for economic and social development. In the field of economics and management, big data technology not only improves the accuracy and efficiency of data analysis, but also helps enterprises to make more scientific strategic decisions, optimize resource allocation, and strengthen market competitiveness (Mccarthy et al., 2006: pp. 221-235). The integration of big data and intelligence will reshape the future business model and have a profound impact on society (Goos et al., 2014: pp. 2509-2526). Therefore, economic management majors need to adapt to the requirements of the era of data and intelligence. Accordingly, it is necessary to break disciplinary boundaries, strengthen cross-fertilization, and explore the new liberal arts education model of "business-industry fusion" (Aoun, 2017) so as to cultivate economic and management talents with the ability to process and analyze big data, which is a key role in meeting the future market demand and promoting industrial upgrading.

Analyzing from the perspective of social demand for talents, data analysis constitutes the core competitiveness of enterprises, and the market needs talents with the concept of business intelligence, mastery of basic theories and common algorithms of data analysis, clear business processes, and the ability to accurately summarize and analyze demand, and skilled use of data analysis tools. According to McKinsey research, it is expected that by 2030, 400 million to 800 million global labor force will be replaced by automation, accounting for one-fifth of the current global labor force (Feng & Li, 2017). In view of this, economic management professional construction needs to keep pace with the times to meet the talent needs of the digital economy and intelligent era. Therefore, the training of talents in colleges and universities needs to integrate big data and cultivate data-based management thinking so that students can screen data and use analytical tools and econometric methods to provide decision-making support for managers (Xie, 2017). This goal is in line with the new liberal arts talent cultivation concept, which aims to make students have both management and data analysis abilities through four years of education and strengthen the practice to meet the market demand for talent.

However, the current integration of economics and management majors with big data still encounters multiple challenges. On the one hand, the teaching system of most economic and management data and statistics courses is plagued by the

deviation of teaching objectives and excessive theorization of teaching content. Traditional teaching emphasizes the cultivation of data and statistical analysis technology and neglects the transformation from traditional application to the composite transformation of the deep integration of mathematics, statistics, information technology, etc., with the profession. With a single training goal and the actual needs of the big data era of low degree of fit, it is difficult to meet the needs of students to use data analysis to solve the real problems of guidance. On the other hand, the faculty generally has the problem of strong academic ability but weak application ability. Young teachers especially have a good academic foundation in data analysis and information technology, but it is difficult to effectively integrate theoretical knowledge with big data technology, and there are deficiencies in cultivating students' practical ability.

In order to solve the above problems, the mechanism of collaborative education between government, industry, academia, and research has been constructed. This mechanism focuses on cooperation among the government, industry, schools, research institutes, and enterprises and promotes the innovation of talent cultivation modes by virtue of resource sharing and complementary advantages. Under the background of the integration of economics and management majors and big data, the government-industry-university-research collaborative education mechanism shows the following advantages: First, policy guidance and support: the government provides systematic guarantee and incentive mechanism for the cooperation between the industry-university-research institutes through the formulation of relevant laws, regulations and policy measures, which motivates all parties to devote themselves to the cultivation of talents. Second, industry demand-oriented: enterprises, as the main body of talent demand, participate in the planning and implementation of talent cultivation programs by providing practical platforms and technical assistance (Wang & Yang, 2018: pp. 32-33), so as to guarantee the close connection between talent cultivation and market demand. Third, the scientific research and innovation power of schools and research institutes: universities and research institutes, by virtue of their academic advantages, deepen the cutting-edge exploration of big data technology and economic and management theories and lay a solid theoretical foundation and technical backing for talent training. Finally, in-depth cooperation of multiple subjects: through the construction of a comprehensive system of government, industry, academia, and research collaborative education, all the subjects have clear responsibilities and work closely together in talent cultivation, and gather a strong synergy of talent cultivation.

To summarize, the government-industry-academia-research mechanism for the integration of economics and management majors with big data is an important way to adapt to the development needs of the times and cultivate innovative talents. Through in-depth collaboration among the government, industry, educational institutions, research institutes, and enterprises, this mechanism aims to effectively respond to the current challenges of talent cultivation and promote the transformation, upgrading and high-quality development of economics and

management professional education.

2. Challenges and Opportunities of Cultivating Economics and Management Talents in the Era of Big Data

2.1. Realistic Challenges of the Development of Digital Technology

2.1.1. The Aggravated Graduates' Structural Unemployment

In the era of big data, with the widespread popularization of digital technology, some jobs will be replaced by automation and intelligence, which will further intensify the structural unemployment problem faced by graduates. Against the backdrop of China's sustained economic and social development, labor costs continue to rise, and the rapid advancement of digital technology has made the cost advantages demonstrated by automation and intelligence increasingly significant, prompting enterprises to widely adopt big data and artificial intelligence technologies, shrinking human resource demand and thus increasing the employment challenges for graduates. For example, the current rise of smart finance signifies that enterprises are gradually moving towards digital and intelligent transformation. It is widely recognized that smart finance is a comprehensive embodiment of ABCR, which integrates the four core modules of AI (Artificial Intelligence), Bigdata, Cloud, and RPA (Process Robotics). Among them, Bigdata, Cloud, RPA, and other technologies have entered the stage of in-depth application, while AI technology is in the process of gradual advancement (Billett, 2020). However, some of the accounting courses in colleges and universities are still stuck in the traditional manual bookkeeping and other low-end level, and the gap with the actual needs of the industry is widening. Therefore, there is an urgent need to integrate information technology into teaching, covering data collection, cleaning, visualization, etc., to train students to form a process-oriented mindset of data generation, so that they can become data experts in the system design team. On the other hand, the development of smart finance has eliminated the positions of accountants engaged in low-end data processing, and has turned to a large demand for management accountants in the fields of management consulting, value analysis, investment decision-making, and budgetary decision-making. Management accountants need to rely on comprehensive automated reporting realized by AI artificial intelligence, financial robots, RPA, and other technologies to penetrate customers' businesses and participate in customers' management in order to create new value in financial control. With the wide application of big data and AI technology, employment conflicts are expected to become more prominent.

2.1.2. New Requirements for Cultivating Composite Talents

The pace of reforming the talent training system of economics and management has continued to move forward, and relevant experiences and achievements have been emerging. However, in the context of the big data era, the system will face more serious challenges. First, the era of big data puts forward new requirements for the training mode of economic and management talents (Frey & Osborne, 2017: pp. 254-280). Equal communication, sharing, and interaction have become

the significant features of the learning mode in this era, and knowledge dissemination mainly relies on interactive sharing and other mechanisms, and the traditional passive indoctrination education mode has been difficult to meet the needs of the cultivation of economic and management talents in the era of big data. Second, the emerging information media use big data mining technology to continuously adapt to the preferences of the new generation of young people and introduce easy-to-accept knowledge dissemination methods, resulting in the formation of path dependence, and the traditional teaching methods are difficult to stimulate their learning motivation, so that the cultivation of economic and managerial talents needs to be changed. Third, the rapid development of artificial intelligence technology, such as big data mining and data imaging, has provided a new way to comprehensively assess teaching and examining students (Lipko, 2016). However, how to use the new technology to promote the cultivation of economic and management talents from "mass production" to "personalized customization", further needs research.

Accompanied by the booming development of big data technology, the requirements for talent in the future society are increasing. Interdisciplinary, multidisciplinary, and comprehensive abilities and qualities are becoming more and more important, which poses new challenges to the cultivation of economic and management talents. Within the framework of existing institutions and mechanisms, there are still many hurdles to overcome in order to cultivate talents who are capable of innovative work and whose comprehensive qualities and skills are in line with the needs of the times, thus realizing an overall leap in the pattern of talent cultivation.

2.2. Big Data Technology Empowers the Cultivation of Economic and Management Talents

2.2.1. Big Data Technology Provides New Opportunities for Cultivation of Economics and Management Talents

Every industrial revolution experienced by human society has significantly contributed to the emancipation of productive forces and accelerated the progress of human civilization. Given the historical factors, there is still a gap between the overall level of industrialization in China and that of developed countries. Although the level of China's industrialization has risen dramatically and made remarkable achievements, the manufacturing industry has a huge volume but not strong strength, and there are still generational differences in some areas. However, in the new wave of technological innovation driven by digital technology, China is firmly at the forefront of the camp, and the research, development and application of some technology has led the world. The rise of big data technology has brought new opportunities for the development of professional education.

Big data technology realizes personalized training in talent cultivation. At the level of personalized teaching, big data technology supplies personalized learning resources and teaching programs based on students' learning characteristics and needs. For example, through big data technology to analyze students' learning

behavior and performance, the system can independently adjust the content and difficulty of teaching to ensure that each student can follow their own pace of learning. In the dimension of intelligent-assisted teaching, teachers can implement teaching design and curriculum planning with big data and artificial intelligence technologies, and capture students' learning insights through data analysis mechanisms to evaluate and adjust teaching. At the same time, we provide intelligent teaching tools, such as voice recognition software and handwriting recognition software, to help teachers instantly record students' responses and assignments, and provide timely feedback and guidance.

2.2.2. Big Data Technology Promotes Collaborative Education among Government, Industry, Academia, and Research Institutes

The rapid progress of big data technology provides an opportunity for the innovation of government-industry-university-research collaborative education model. Although the traditional industry-education integration model emphasizes cooperation and communication between universities and enterprises, it lacks in-depth cooperation mechanisms and resource integration (Zhang, 2018: pp. 127-129). However, under the big data environment, enterprises can realize information interoperability and resource integration with universities with the help of artificial intelligence technology, which can improve the efficiency and quality of collaborative education. For example, enterprises build big data platforms, promote data sharing and analysis with universities, and provide more accurate support and services for the government-industry-university-research collaborative education mechanism.

First of all, big data technology promotes the efficient integration and optimal allocation of educational resources. In the government-industry-university-research collaborative education mechanism, the integration of big data technology has led to the realization of more efficient and precise integration and utilization of educational resources. By intelligently analyzing students' learning needs, interest tendencies and effectiveness, the system can automatically match and recommend appropriate learning resources, such as courses, textbooks and cases, thus enhancing the purpose and effectiveness of learning. At the same time, big data technology can also realize intelligent deployment of educational resources to ensure that every student has access to adequate and appropriate learning resources.

Secondly, big data technology promotes the quality and efficiency of talent training. As one of the important optimization means of the government-industry-university-research collaborative education mechanism, big data technology significantly enhances the quality and efficiency of talent cultivation. Through in-depth analysis of students' learning data and performance, the system can accurately identify students' learning weaknesses and potentials and then customize personalized learning paths and tutoring strategies for them. This precise teaching strategy facilitates the implementation of tailor-made teaching to ensure that each student can progress at an appropriate learning pace. At the same time, big data

technology can also realize intelligent supervision and management of the teaching process to ensure the quality and effectiveness of teaching.

Thirdly, big data technology drives the promotion of the deep integration of government, industry, academia, and research, plus a policy that promotes the integration mechanism of industry and education in the realization of the deep integration of industry, academia, and research. By building a digital integration platform for industry-university-research, schools, enterprises and research institutes can share resources, exchange information, and collaborate in innovation more efficiently. This kind of cross-border cooperation model is conducive to breaking down industry barriers and accelerating the pace of technological innovation and industrial upgrading. At the same time, big data technology can also accurately match talent training and industrial demand, providing a solid talent guarantee for social and economic development.

2.2.3. The Collaborative Mechanism Addresses Potential Resource Disparities among Institutions

As shown in the prior discussion, the mechanism emphasizes resource sharing and complementary advantages and aims to cultivate compound talents with innovative abilities that are in line with the needs of society. In the context of the integration of economic and management majors with big data, the government-industry-academia-research cooperative education mechanism provides a broader platform and rich resources for talent cultivation by integrating the resources of all parties.

First, industry participation. Industry is an important force in resource allocation. In the mechanism of government-industry-academia-research collaboration in educating people, the industry can deeply integrate with the economics and management majors and the field of big data by investing funds, providing internship and practical training opportunities, and participating in the cultivation of talents. This kind of deep integration not only helps industries understand the demand and training direction of talents but also promotes industrial technological innovation and transformation and upgrading, thus promoting the optimal allocation of resources.

Second, schools and research institutions support. Schools and research institutions play an important role in resource allocation. They provide strong support for the integration of economic and management majors with big data by integrating teaching resources, scientific research equipment, and faculty. At the same time, schools and research institutions also promote the deep integration of industry, academia, and research by cooperating with enterprises in scientific research projects and building training bases together so as to realize the sharing and complementation of resources.

Third, building an information sharing platform. The information sharing platform is an important part of the mechanism of government-industry-university-research collaboration in educating people. By building an information sharing platform, all parties can understand the demand and supply of resources in a timely manner, and realize accurate matching and efficient utilization of resources. In

addition, the information sharing platform can also promote exchanges and cooperation among all parties, and promote the optimal allocation of resources and synergistic development.

Fourth, promoting discipline crossover and integration. The integration of economic and management majors with big data needs to break down the disciplinary barriers and promote disciplinary intersection and integration. Through the integration of computer science and technology, mathematics, mathematical statistics and other major support majors of artificial intelligence and big data, and the formation of the School of Data Science and Artificial Intelligence and other initiatives, the construction of cross-disciplinary direction of economic management and artificial intelligence and big data can be strengthened. This interdisciplinary intersection and integration not only helps to cultivate outstanding financial talents with composite knowledge, innovative abilities and comprehensive qualities, but also promotes the optimal allocation of resources and synergistic development.

3. The Construction of Government-Industry-Academia-Research Cooperative Education Mechanism for the Integration of Economic and Management Majors and Big Data

In the context of the digital economy, the application of big data technology in the field of economic management is expanding day by day. Enterprises are in urgent need of economic management talents with big data processing and analyzing skills to cope with the complexity and change of the market. Therefore, the education of economics and management majors must keep pace with the times, integrate big data technology into the curriculum system, and cultivate high-quality talents to meet the market demand.

Take Erasmus University Rotterdam in the Netherlands as an example, which has achieved remarkable results in the integration of economics and management education with big data. Erasmus University Rotterdam has established close partnerships with many well-known enterprises, government agencies and research institutions to jointly promote the deep integration of economics and management majors with big data technology. The university not only provides students with practical opportunities and internships, but also encourages them to participate in research projects and combine theoretical knowledge with practice. Through close cooperation with the industry, the school not only cultivates a large number of talents with big data analysis and economic management capabilities, but also provides intellectual support and solutions for enterprises. This mechanism of government-industry-university-research collaborative education has greatly improved the quality of talent cultivation and promoted the innovative development of economic and management education and big data technology.

With the reference of Erasmus University Rotterdam, the construction of a government-industry-academia-research collaborative education mechanism for the integration of economics and management majors with big data should be built with big data as the cornerstone, and from the internal and external linkage of

government-industry-academia-research and the integration of theory and practice at two levels. Relying on the concept of government-industry-academia-research collaborative education, the mechanism involves the innovation of course objectives, curriculum system, teaching mode, faculty and practice platform construction and other aspects. (Figure 1)

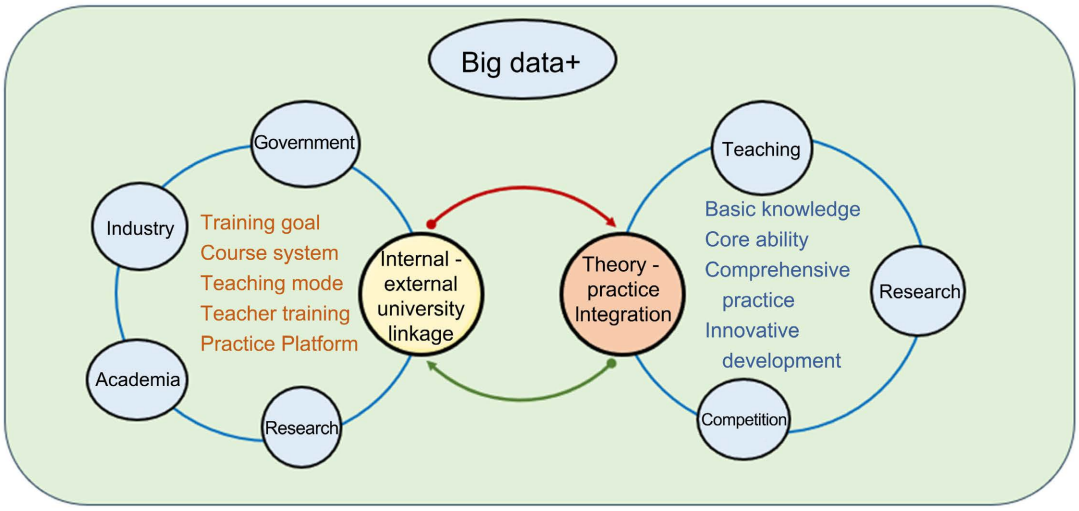

Figure 1. Logical foundation of government-industry-academia-research collaborative education mechanism.

3.1. Cultivation Goal Setting

The mechanism of government-industry-academia-research collaborative training mechanism provides strong support for the integration of economic and management majors with big data through the cooperation of government, enterprises, universities, and research institutions to realize resource sharing and complementary advantages. Under this mechanism, talent cultivation goal setting needs to fully consider the market demand, discipline characteristics, and development trends.

3.1.1. Principles of Training Objectives

In the context of big data, the following principles should be followed in setting the cultivation objectives of the industry-teaching integration and collaborative education mechanism for economics and management majors:

First, market demand-oriented. Talent cultivation objectives are closely centered on market demand, cultivate economic management talents with big data processing and analysis capabilities, and meet the needs of the government, industry and high-quality talents.

Secondly, disciplinary cross-fertilization. The integration of economic and management majors and big data needs to break the disciplinary barriers, realize disciplinary cross-fertilization and integration, and cultivate composite talents with multidisciplinary knowledge and skills.

Third, innovation ability cultivation. Innovation ability is an important characteristic of high-quality talents. Cultivate students' innovation consciousness and

innovation abilities and encourage students to participate in activities such as academic research, professional competitions and industry training.

Fourth, practical ability cultivation. Practical ability is one of the necessary abilities of economic management talents. The setting of cultivation objectives should emphasize the importance of practical teaching, and the setting of practical courses should account for no less than one quarter of the total courses.

3.1.2. Content of Training Objectives

Basic Knowledge and Skills: To train students to master solid basic theories of economics, management and statistics, and to become proficient in statistical data analysis skills and software operation. In addition, the cultivation of foreign language ability, mathematical and statistical computer application and other skills are strengthened.

Big Data Processing and Analysis Ability: Cultivate students to master the core skills of big data processing and analysis, covering data collection, data purification, data mining and data visualization. Through course study and practical exercises, students will be able to skillfully use big data technology and tools to solve practical problems in the field of economic management.

Innovative Thinking and Competitive Awareness: Support students in participating in academic research, professional competitions, industry training, and other practical activities to cultivate their innovative and competitive awareness. Based on teamwork and project management to enhance students' teamwork ability and leadership.

Professional Ethics and Social Responsibility: Cultivate students to have professional ethics and social responsibility and to be able to utilize data resources in a compliant and correct manner so as to provide solid support for the sound development of society and economy.

Lifelong Learning Ability: Cultivate students to develop awareness and ability to learn lifelong to ensure that they can continuously improve their business skills throughout their careers. Through the provision of continuous education and training resources, we help students cope with dynamic changes in the market environment and technological innovation.

3.2. Construction of Curriculum System

On the basis of clear cultivation objectives, it is necessary to build a curriculum system that meets the needs of talent cultivation for economics and management majors in the context of artificial intelligence. These courses should include data science and big data analysis, machine learning and deep learning, and other cutting-edge technology courses, as well as innovation and entrepreneurship, international education, and other practical courses. At the same time, it is also necessary to focus on the articulation and integration between courses to form a complete curriculum system. We focus on the following aspects:

First of all, deep cross-fusion of disciplines, the formation of cross-border integration mechanism, the cultivation of special direction courses of big data

integration in each specialty, and the creation of "gold courses". The curriculum is a micro-unit of talent training, but it solves the most fundamental problems of education. The establishment of a cross-teaching team integrating "engineering, science and information technology", and the overall design of teaching content, methodology, assessment and other aspects to realize the integration of content.

Secondly, around the special direction of big data integration of each major, we develop new content of practical courses both on and off campus to expand the breadth of school-enterprise cooperation in educating people.

Thirdly, the existing practice courses are focused on the content of the core professional courses, presenting traditional and single characteristics, and there is a large gap with the actual operation of enterprises, and it is necessary to return to the real application scenarios in order to cultivate students to form a digital, process-oriented and data-oriented mode of thinking. In the process of talent cultivation, the School of Economics and Management is committed to integrating new concepts, new thinking and new methods into the talent cultivation system in view of the new requirements for economic and management professionals in the new business era (including new manufacturing, new retail, new finance and new management). According to the current market demand for talent cultivation, we have taken the initiative to adjust and optimize the talent cultivation program, especially in the six mindsets emphasized in talent cultivation, data mindset has been fully emphasized and is reflected in the theoretical and practical curriculum of each major.

The talent cultivation courses of Big Data + Business include three categories: data thinking courses, data tools courses, and professional integration courses (i.e., Big Data + Business Professional Integration Courses), and the teaching objectives, core contents, and requirements for students' abilities of the specific courses are shown in Table 1:

Table 1. "Big Data+" talent training programs for economics and management.

Content	Data Thinking Course	Data Tools Course	Professional Integration Course (Big Data + Economics and Management)
Teaching goal	Training data thinking and improving data analysis skills	Mastery of specific tools	Big Data thinking in specialized areas
Core element	Theoretical Body of Knowledge and Operational Skills for Big Data Commonality	Tool-specific operations	Ideas and methods for solving big data problems in specialized areas
Impact on students' ability to work	Master data thinking, good at raising issues, analyzing issues, and solving problems from a higher level of business operation management	Strong hands-on skills, with applications based on mastery of data analytics tools and techniques	Ability to more effectively utilize big data to drive growth in their business and capabilities
Student employment	Acquisition of core Big Data knowledge and skills with a broader employment profile	Employment is more limited by mastering only specific big data tools	Composite positions in specialized fields
Students taking courses	Required course	Optional course	Required course

In the construction of the curriculum system, we emphasize the integration of theory and practice. The curriculum system must cover three modules: basic theory, professional skills and practical operation. The basic theory module focuses on the cultivation of basic knowledge such as mathematics and computers; the professional skills module analyzes the core technologies in the field of artificial intelligence in depth; and the practical operation module, with the help of experiments, projects and other means, prompts students to apply what they have learned to the process of solving practical problems. In addition, the integration of interdisciplinary. Secondly, interdisciplinary integration. Promote the interdisciplinary integration of big data technology with economics, finance, e-commerce, international logistics, etc., in order to broaden students' horizons and enrich their knowledge system, aiming at cultivating composite talents. Finally, the dynamic adjustment of the curriculum. Based on the industry development trend and technological innovation, the content of the curriculum is regularly changed to ensure the consistency of the teaching content with the market demand.

3.3. Innovations in Teaching Modes

Under the framework of the government-industry-university-research collaborative education mechanism, the innovation of teaching mode constitutes the key to realizing the deep integration of economics and management majors and big data. The "Three Realities" Teaching Mode is Proposed in the Process of Practice. In the practice of government-industry-academia-research collaborative mechanism, we adopt the following teaching modes:

The project-based learning mode: first, the project-based learning mode, which deeply integrates the learning content with actual projects, enables students to explore and apply big data knowledge in the process of project implementation. This aims to develop students' practical skills, teamwork skills, and problem-solving abilities. For example, projects such as market analysis and risk management covering the application of big data are designed to promote students' learning and growth in practice.

Case teaching: introducing real big data application cases. This approach aims to assist students to deeply understand the practical application of big data in the field of economic management, thus enhancing their practical perception ability and improving their learning interest and effectiveness.

School-enterprise cooperation practical training courses: in collaboration with enterprises in the big data industry, a practical training base is set up to create a practical learning environment that integrates enterprise culture. Students are able to work on actual projects in the base and gain insight into the cutting-edge application and development trend of big data technology.

Interdisciplinary integrated teaching: Economics and management majors need to implement interdisciplinary integration with science and engineering majors and jointly offer related courses aimed at enhancing students' comprehensive literacy and innovation ability. Interdisciplinary courses such as "Big Data and

Economics" and "Big Data and Finance" enable students to understand the basic principles of big data technology and its practical application while mastering economic management theory.

In the above teaching practice, we focus on the implementation of the "three realities" teaching mode: example analysis, real-world training and real-world testing. For the core courses, we use example analysis to implement interactive teaching and motivate students to learn independently; then, we deepen the application of knowledge through real-world training; and we complete the learning assessment and innovative application through real-world testing, in order to enable students to effectively master the strategies and methods of solving big data problems in their professional fields, and to more efficiently use big data to promote the development of their personal business and capabilities. For example, the cultivation of accounting process-oriented thinking has been relatively mature in the industry, and it is necessary to set up relevant courses to recover real scenarios and improve the quality of talent training. In contrast, data-based management thinking and big data auditing are still in the exploratory stage, and we need to actively promote them to achieve leapfrog progress in professional development.

During the operation of the cooperative education mechanism, we integrated and optimized teaching resources and teaching methods: Firstly, we built a high-quality teaching resource base. Integrate teaching resources related to big data, such as teaching videos, case banks, project sets, etc., aiming to provide teachers and students with diversified learning materials. Secondly, implement personalized teaching strategies. Second, implement personalized teaching strategies. With the help of big data technology, students' learning behaviors and performance data can be analyzed in detail, and then customized learning suggestions and tutoring programs can be provided. The aim is to meet different learning needs and promote the improvement of students' learning effectiveness. Promote the triad collaborative teaching model. By combining the strengths of professional teachers, technical experts and industry lecturers, we have built a teaching team with a "1 + 1 + 1 quality teacher" system. Through this collaborative teaching mechanism, we fill the gaps in students' knowledge and practical experience.

3.4. Teacher Training

In the implementation of a collaborative education mechanism teaching mode for the in-depth integration of economics and management majors with big data, the cultivation of dual-teacher teachers and exchange of teacher training are the core links to enhance the professionalism and practical ability of the teachers, and to cultivate high-quality talents with both big data skills and economic management ability to lay a solid foundation.

School of Economics and Management of Beijing University of Petrochemical Technology is committed to cultivating compound talents with the integration of data analysis skills and intelligent management. Its faculty construction is closely

centered on talent cultivation goals, and the first task is to strengthen the cultivation system of dual-teacher teachers, send teachers to go out for training, and deepen the faculty construction. Over the past three years, more than ten teachers have received professional training in data analysis. This "classroom to workplace" mechanism not only encourages teachers to gain an in-depth understanding of the practical application of big data technology in the field of economic management, but also motivates them to integrate cutting-edge industry dynamics and technological trends into classroom teaching to ensure that the teaching content is closely related to the market demand. Through in-depth cooperation with enterprises, teachers are able to participate in real-world projects and solve practical problems of enterprises, and then continue to improve their professional skills and comprehensive quality in practice.

On the other hand, this study takes the initiative to invite enterprise experts to teach on campus and share their practical experience and technical insights. With their rich practical experience and deep knowledge of the industry, these experts bring new vitality to the teaching of economic management majors. Through their courses, students can get in touch with the real-world cases of big data technology in enterprise operations, enhancing the practicality and goal orientation of learning. At the same time, the teaching of enterprise experts also ignites the students' desire for knowledge and drives them to actively explore the new field of combining big data and economic management.

3.5. Practical Education Platform Construction

Practice teaching, as a key link in the collaborative education mechanism of industry-teaching integration for economics and management majors, has become more and more important and urgent in the context of big data. In order to effectively integrate the professional knowledge of economics and management with big data technology, strengthening the design and implementation of practical teaching links has become an important way to cultivate talents with innovative spirit and practical ability.

Establishment of school-enterprise cooperation practical training base. In the context of big data, there is an urgent need to optimize the practical teaching system to ensure that students can keep abreast of the technological frontier and master practical skills. To this end, cooperation with enterprises to establish practical training bases has become a proven strategy. These training bases are not only equipped with advanced practical training equipment and simulation environment, but also integrated with the real workflow and business scenarios of enterprises, so that students can experience the practical application of big data in economic management in an immersive manner. Through close cooperation with enterprise instructors, students can participate in project practice and solve real problems, thus deepening their theoretical knowledge and improving their professional skills in practice.

Build an innovation and entrepreneurship platform. In order to stimulate

students' innovative thinking and entrepreneurial enthusiasm, it is necessary to build an innovation and entrepreneurship incubation platform in addition to the training base. On this platform, students not only have access to the latest research projects, but also can transform their ideas into actual entrepreneurial plans under the guidance of their mentors. By participating in entrepreneurial practice, students can learn how to use big data technology for market analysis, risk assessment and decision-making, thus developing a keen market insight and strong teamwork skills.

Participate in academic and professional competitions. Organizing students to participate in domestic discipline competitions and professional competitions is an important means to improve the comprehensive quality and competitiveness of students. By participating in these competitions, students not only improve their professional skills and practical operation ability, but also exercise their teamwork ability, problem-solving ability, and innovative thinking ability. Competitions including The China International "Internet Plus" Student Innovation and Entrepreneurship Competition Beijing Region, National University Students Energy Saving and Emission Reduction Social Practice and Technology Competition, The National College Students' E-commerce "Innovation, Creativity and Entrepreneurship" Challenge Competition, National Collegiate Business Elite Challenge, National University Students' Big Data Analytics Technical Skills Competition, Cross-border E-commerce Innovation and Practice Competition of National University Business Elite Challenge "Zhiqiao" Cup, National College Business Elite Challenge Marketing Simulation Decision Making Competition, and so forth. By participating in these activities, students expand their horizons, enhance their self-confidence, and lay a solid foundation for their future career development.

4. The Practical Effect of the Government-Industry-Academia-Research Collaborative Education Mechanism

4.1. Practice of Cultivation Objectives of the School of Economics and Management, Beijing University of Petrochemical Technology

The School of Economics and Management of Beijing Institute of Petrochemical Technology, in the construction of the government-industry-academia-research collaborative educating mechanism of big data integration, sets the cultivation objectives based on the principle of result orientation, aiming at cultivating applied and compound talents in the field of economic management. On the one hand, it increases the construction intensity of the specialty of data management and application. On the other hand, based on this specialization, it comprehensively penetrates big data thinking, analysis and application ability into all majors of the School of Economics and Management. We focus on promoting the in-depth integration of big data with the majors of e-commerce, marketing, accounting, logistics management, international economics, trade, etc. We have set up a big data featured course group at the college level and researched and developed integrated courses with the aim of cultivating business intelligence elites in various majors.

Based on the above cultivation objectives, the College of Economics and Management has revised the cultivation programs of all economics and management majors to realize the deep integration of university data and economics and management courses. Currently, the college initiatives are as follows: First, for the characteristics of each major, additional courses on big data analysis and methods, including Introduction to Big Data, Data Acquisition and Preprocessing, and Visualization of Big Data, have been set up to lay the foundation for the integration of each major with big data. Second, it strengthens the mutual support between majors and increases the cultivation of composite talents. Third, it promotes the intelligent upgrading of existing professional courses, such as the addition of robot bookkeeping and accounting automation to the accounting major to cultivate the direction.

In terms of guaranteeing the implementation of the cultivation objectives, the School of Economics and Management has set up an education quality monitoring and evaluation system for the integration of industry and education to ensure the implementation of the cultivation objectives. Specifically, the system includes clear teaching quality standards and evaluation criteria, according to which regular monitoring and evaluation of teaching quality is carried out; moreover, a student feedback mechanism has been established to collect and respond to students' opinions promptly and optimize the teaching quality continuously. In addition, the College has also set up a reward system and an achievement-sharing mechanism to ensure the successful realization of the training objectives. It encourages teachers and students to actively participate in the activities of industry-teaching integration by formulating appropriate incentives, including the establishment of scholarships and bursaries to recognize teachers and students with outstanding performance in industry-teaching integration; at the same time, it establishes a mechanism of results sharing, so that teachers and students can enjoy the results and benefits of the industry-teaching integration project together, and then mobilize the motivation and innovativeness of teachers and students.

Beginning in 2020, four consecutive years of training, tracking surveys have been conducted by the Mycos Data company, and feedback on the effect of government-industry-academia-research practice in terms of quality and satisfaction of talent training, satisfaction, employment, and practical teaching aspects. Majors involved in the school of economics and management include International Economy and Trade, Big Data, Electronic Business, Supply Chain, Accounting, and Marketing. The sample size for graduates in the year 2020 is 425, 433 in the year 2020, 465 in the year 2021, 532 in the year 2022, and 536 in the year 2023. Details are shown in Table 2.

4.1.1. Quality and Satisfaction of Student Training

As a core indicator for measuring the effectiveness of education, the quality and satisfaction of student cultivation has received more and more attention from academics in recent years with the deepening of education reform. According to Table 2, it can be seen that student teaching satisfaction has shown a stable and continuous upward trend in recent years.

Table 2. The data description of the survey.

Classification	Year of graduation	Male	Female	Total Number
Before the Mechanism	2019	193	232	425
After the mechanism	2020	202	231	433
	2021	196	269	465
	2022	254	278	532
	2023	264	272	536

Data source: The Mycos data annual evaluation report on the quality of graduates of Beijing Institute of Petrochemical Technology (2020-2024).

Specifically, in 2020, students' teaching satisfaction was as high as 95%, increasing by 2% compared with the year 2019, reflecting students' high affirmation of the quality of teaching at that time. Student satisfaction with teaching gradually increased and continued to grow in subsequent years, reaching 96.5% in 2022 and a record high of 97% in the latest data for 2023.

This series of growth figures highlight both the positive initiatives taken by providers to improve the quality of teaching and learning, as well as the positive feedback from students on improvement measures. The improvement in the quality of student training and the increase in satisfaction have complemented each other, forming a positive interaction mechanism. High-quality student training not only meets society's demand for talents, but also strengthens students' trust and sense of belonging to education, which in turn contributes to the sound development of the education sector. 21 years or 95

In summary, the teaching satisfaction of student training has shown a steady upward trend in recent years, and this good trend is the result of the unremitting efforts of educational institutions, as well as a concrete reflection of the positive feedback from students. In the future, it is necessary to continue to pay attention to the changes in students' needs and optimize teaching contents and methods, with a view to further improving the quality and satisfaction of student training. (**Figure 2**)

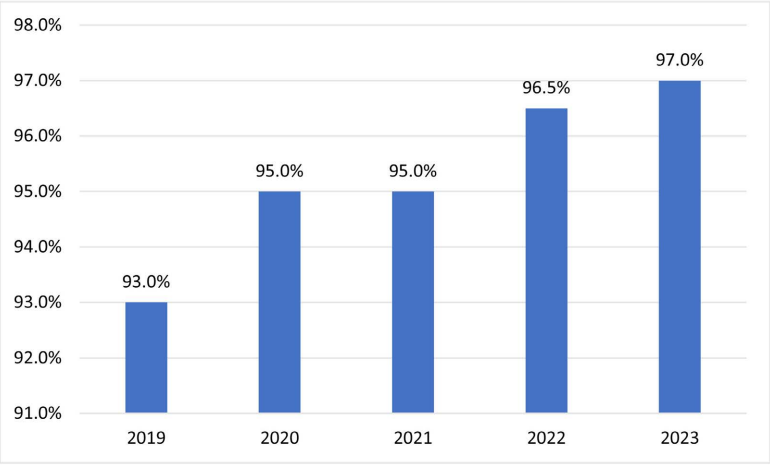

Figure 2. Students satisfaction with teaching (in %). Data sources: The Mycos Data annual evaluation report on the quality of graduates of Beijing Institute of Petrochemical Technology (2020-2024).

4.1.2. Student Employment Effect

Based on the data analysis in Figure 3, the employment rate of graduates has shown a continuous upward trend from 81.7% to 90% during the period from 2019 to 2023. This trend demonstrates the steady growth of students' employment success rate realized with the improvement of education level and the dynamic changes in the job market.

In contrast, students' employment satisfaction also shows an increasing trend year by year, from 78% in 2019 to 85% in 2023. It shows that students' expectations of employment positions are more in line with the actual situation, and the skills learned by students can meet the requirements of the job market and changes in the work environment.

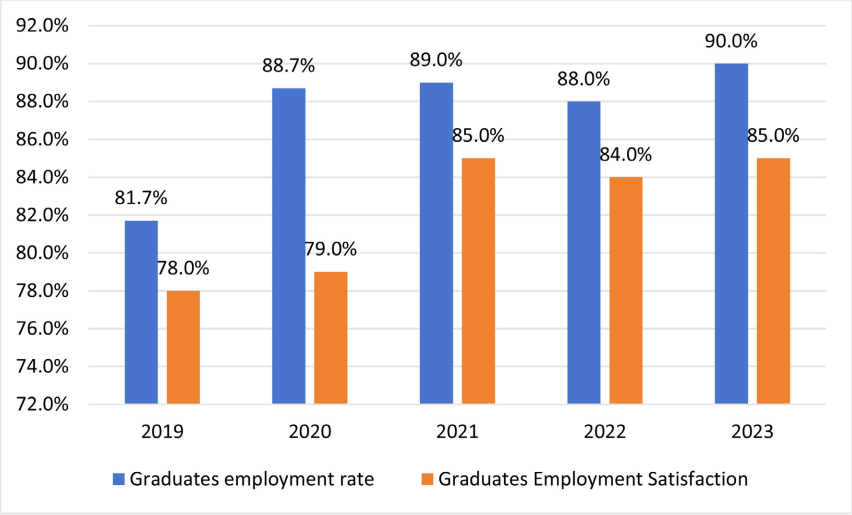

Figure 3. Employment rate and employment satisfaction of graduates (%). Data sources: The Mycos data annual evaluation report on the quality of graduates of Beijing Institute of Petrochemical Technology (2020-2024).

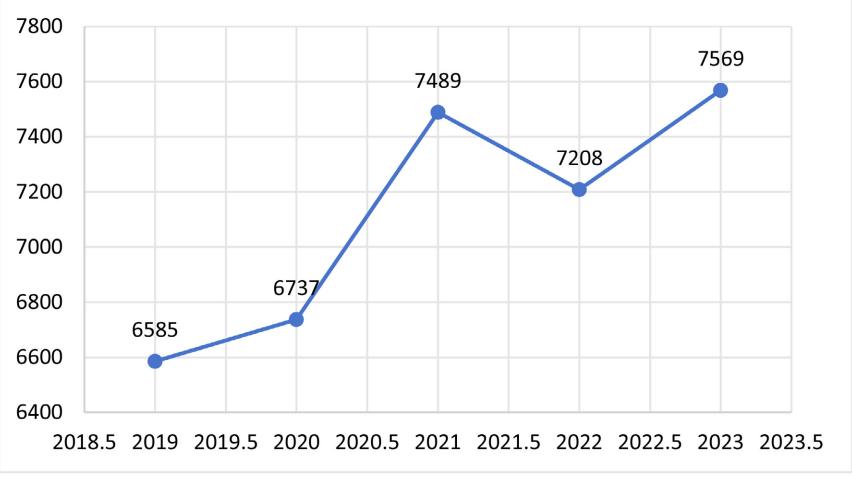

Figure 4. Graduate employment income (in RMB yuan). Data sources: The Mycos data annual evaluation report on the quality of graduates of Beijing Institute of Petrochemical Technology (2020-2024).

In terms of the employment income of graduates, the overall trend shows a year-on-year increase. It will increase from 6585 yuan in 2019 to 7569 yuan in 2023, which reflects the rapid development of the economy and society and the increasingly fierce competition in the labor market. At the same time, it also shows that the bargaining power of graduates in the job market is gradually increasing. (**Figure 4**)

4.1.3. Practical Teaching

The College of Economics and Management has excellent experimental conditions to strongly support the construction of new liberal arts and professional integration. The Experimental Center of the College covers a total area of about 1100 square meters, with assets totaling 8.6 million yuan, including 400 high-end computers, 10 servers, 49 sets of experimental and internship software systems, and 4 sets of teaching and research databases. The institute has built a sustainable system of cooperation between industry, academia and research with a number of enterprises, including: a big data school-enterprise cooperation training base with Beijing Jiuqi Software Company Limited and Beijing Qingdian Education Technology Company Limited; a strategic cooperation agreement with Beijing E-commerce Center District, Beiqai Group, Zhongke E-commerce Valley and other units to establish the Intelligent Business Industry College; and the establishment of the Intelligent Business Industry College with UFIDA Science and Technology Company Limited and Beijing Kangbang Science and Technology Company Limited, Ltd. and Beijing Kangbang Technology Co., Ltd. to establish a laboratory cooperation platform. In addition, by virtue of the off-campus talent training base of the Beijing Institute of Certified Public Accountants (BICPA), which is open to all the accounting firms in Beijing, it provides key support for talent cultivation in the field of big data auditing.

4.1.4. Students' Participation in Academic Competitions and Scientific Research Activities

At the university level, even though the number of participants has fluctuated in recent years, it has remained highly active overall, providing students with abundant opportunities for research practice. It is especially noteworthy that students' participation in research competitions has become increasingly diversified, extending from traditional basic competitions such as the China "Internet+" College Students' Innovation and Entrepreneurship Competition to more and more directions. As seen in **Figure 5**, since 2019-2023, students' participation in disciplinary competitions has been increasing year by year, and the types and levels of competitions have reached new heights.

While the level and types of participation continue to increase, the number of awards won in the competitions also continues to reach new heights. This trend can be seen from the increasing number of participants in national, provincial and university-level research competitions. As shown in **Figure 5**, the number of national awards in 2020 was only 3, and in 2023 it rose to 13; the number of provincial awards reached 49 in 2023, and the total number of awards rose from 46 in

2020 to 141 in 2023. This trend not only reflects students' eagerness for scientific research and innovation activities, but also reflects the positive results of the university's diversified exploration of scientific research and education in government, industry, academia, and research. By participating in diversified scientific research competitions, students have practiced their scientific research skills and innovative thinking ability, broadened their knowledge boundaries, and enhanced interdisciplinary communication and cooperation.

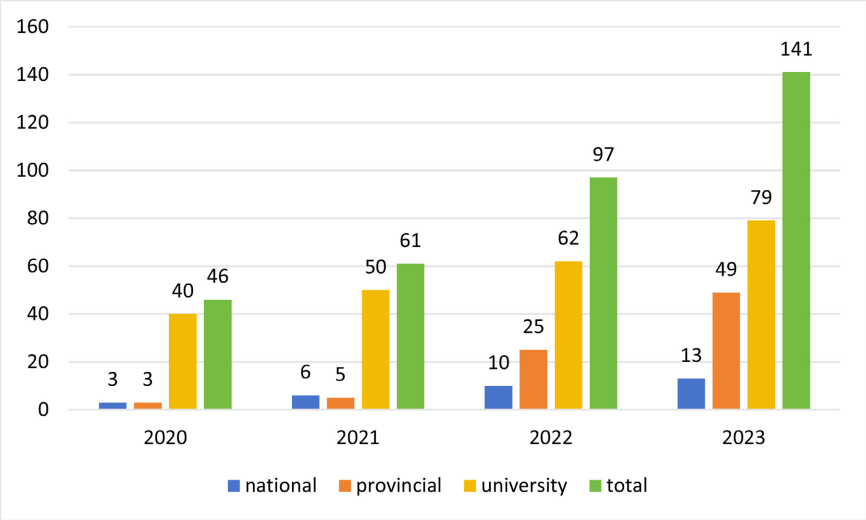

Figure 5. Students' participation in competitions and awards. Data sources: The Mycos data annual evaluation report on the quality of graduates of Beijing Institute of Petrochemical Technology (2020-2024).

With regard to students' participation in scientific research activities, students' participation in the Undergraduate Research Training Program (URT) has presented a significant upward trend. In 2020, the total number of URT projects was 18, including 3 national-level projects; in the year 2019, it increased to 19 with 4 national ones; while in the year 2022 and 2023, the number increased to 28 and 32, respectively, with 6 and 9 national ones respectively. Participation in the URT projects reflects the active exploration and practice of universities in research and innovation activities, which enhances students' interest in research and provides a good foundation for further study and research. In the future, there is an urgent need to strengthen the synergy and cooperation between research projects at all levels in order to optimize the allocation of research resources, thus promoting the sustainable development and progress of research and innovation activities.

5. Conclusion

With the rapid acceleration of globalization and informatization, big data has risen to become a new engine for economic and social development, exerting extensive and far-reaching influence on various fields. Especially in the education field of economics and management majors, the integration and application of big data technology not only reshapes the traditional teaching mode, but also opens

up unprecedented opportunities and challenges for the trajectory of talent cultivation. During the implementation of the mechanism, we have experienced many challenges, including the new curriculum implementation, for all the traditional courses have gone through the digital reform, and almost all the teaching methods, teaching mode, and course structure and contents have undergone dramatical reform, which poses a great challenge for all teachers and students. Through four years of exploration, we have drawn the following conclusions:

First, the integration of big data in economic management is an inevitable trend. The flourishing development of big data technology provides more accurate and efficient means of data analysis for the field of economic management, which helps enterprises establish a scientific strategic decision-making system, optimize the allocation of resources, and enhance the competitive advantage in the market. Therefore, the professional education of economic management must conform to this change, integrate big data technology into the curriculum system, and cultivate economic management talents with the ability of big data processing and analysis. Through school-enterprise cooperation, the establishment of practical training bases and the implementation of project-based learning and case teaching, students can deepen their theoretical understanding and improve their professional skills in practice, so as to better meet the market demand.

Secondly, establish the mechanism and new path of government-industry-university-research collaborative education. Based on the government-industry-university-research collaboration to help the integration of economics and management majors with big data. Strengthen the synergy of government, industry, education, scientific research and enterprises, and promote the innovation of talent cultivation mode through resource sharing and advantage integration. The government relies on policy guidance to build an institutional framework and incentive mechanism for industry-university-research cooperation; enterprises, as the main body of talent demand, participate in the planning and implementation of talent cultivation through practical platforms and technical support; educational institutions and scientific research institutes deepen the theoretical and practical research on big data and economics and management by virtue of their academic strengths, providing solid theoretical and technical support for talent cultivation. Through cross-border cooperation, we break the barriers between government, industry, academia and research, promote collaborative education between government, industry, academia and research, promote technological innovation and industrial upgrading, and cultivate high-quality, complex and innovative talents for economic and social development.

Thirdly, it builds a government-industry-university-research collaborative education system for the integration of big data in economics and management majors. We put forward the "three realities" teaching mode, and establish key links such as training objectives, curriculum system, teaching mode, faculty and training platform for the integration of specialties and big data. In the practice of "three realities" teaching mode, students are allowed to learn the application of big data

analytics in a simulated market environment by introducing real enterprise cases to enhance the sense of real-world combat. The practical classroom relies on the big data training platform to provide practical opportunities for data processing and analysis, so that students can master skills in hands-on practice. The practical classroom encourages students to participate in real projects, such as enterprise data analysis, market research, etc., and apply what they have learned to solve real problems. This teaching mode not only cultivates students' practical ability and innovative spirit, but also promotes the deep integration of economic and management majors with big data technology, laying a solid foundation for students' future career development. Through the operation of the "Three Realities" teaching mode, the teaching quality of the school's economics and management majors and the comprehensive quality of students have been significantly improved.

Talent cultivation objectives closely follow the market demand and cultivate economic management talents with big data processing and analyzing ability; build a cross-disciplinary curriculum system and form a professional curriculum with distinctive features integrated with big data; innovate the teaching mode by adopting project-based learning and case study teaching, etc., to strengthen students' practical and innovative ability; strengthen the introduction of dual-teacher teacher training and enhance the exchange of teachers' training, so as to improve the professional and practical ability; and enhance the practical training platform and enterprises' joint efforts. Practical training platform to build training bases with enterprises, create an innovation and entrepreneurship platform, encourage students to participate in domestic and international AI competitions and professional qualification certification, and comprehensively enhance students' comprehensive quality and competitiveness.

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Conflicts of Interest

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

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