Talent Cultivation Model for Big Data Management and Application Major in the Context of New Liberal Arts: Postprint

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Abstract

[Purpose/Significance] By investigating the demands of the big data industry under the new liberal arts background and analyzing the talent cultivation models for big data management and application programs in domestic and foreign universities, this study proposes a construction model for China's big data management and application programs under the new liberal arts background, thereby promoting reforms in talent cultivation models for undergraduate program education in Chinese universities to meet industry demands for talent in the new era. [Method/Process] Using research methods including web surveys, web scraping, and comparative analysis, 18 typical domestic and foreign universities were selected as samples to conduct a comparative analysis of the theoretical curriculum system and practical teaching components of newly established big data management and application programs, identifying the key points, difficulties, and pain points in current new program construction. [Result/Conclusion] This study proposes a talent cultivation model for undergraduate big data management and application programs under the new liberal arts background, with interdisciplinary joint cultivation as the foundation, multi-level hybrid education as the method, new liberal arts laboratory construction as the means, and industry-academia collaborative cultivation as the orientation, aiming to shape technical, applied, and business-oriented undergraduate talents in big data management and application that meet the requirements of new liberal arts construction.

Full Text

Preamble

Big Data Management and Application Talent Training Model Under the New Liberal Arts Background

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Abstract:
[Purpose/Significance] By investigating the demand of the big data industry under the new liberal arts background and analyzing talent training models for Big Data Management and Application programs in domestic and foreign universities, this study proposes a construction model for China's Big Data Management and Application specialty under the new liberal arts background, promoting reform in talent training models for undergraduate professional education to meet industry talent demands in the new era. [Method/Process] Using web surveys, web crawlers, and comparative analysis, 18 typical universities at home and abroad were selected as samples to conduct comparative analysis of theoretical curriculum systems and practical teaching components for newly established Big Data Management and Application programs, identifying key priorities, difficulties, and pain points in current new specialty construction. [Result/Conclusion] This paper proposes a talent training model for undergraduate Big Data Management and Application professionals under the new liberal arts background, rooted in cross-disciplinary joint training, employing multi-level hybrid education as the method, utilizing new liberal arts laboratory construction as the means, and guided by industry-academia collaborative education. This model aims to cultivate technical, application-oriented, and business-oriented Big Data Management and Application professionals that meet new liberal arts construction requirements.

Keywords: Big Data Management and Application specialty; new liberal arts; talent training; model innovation
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The development of new technologies such as big data and artificial intelligence has profoundly impacted the development of library and information science disciplines and education in China. Following the new engineering initiative, new liberal arts construction represents another major measure to comprehensively deepen higher education teaching reform. In his report at the 2020 New Liberal Arts Construction Work Conference [1], Wu Yan, Director of the Higher Education Department of the Ministry of Education, emphasized the need to build momentum, accumulate strength, and strategize, while recognizing, responding to, and pursuing changes to comprehensively promote new liberal arts construction. The three fundamental drivers of new liberal arts construction are "specialty optimization, curriculum quality improvement, and model innovation," with particular emphasis on promoting interdisciplinary integration. In the construction of "science + liberal arts" interdisciplinary programs, institutions should focus on cultivating talent with backgrounds in computational law,

big data management and application, and fintech. New liberal arts construction emphasizes interdisciplinary integration and the fusion of liberal arts and sciences, reflecting new trends in disciplinary development and talent cultivation.

According to the "2019 China Big Data Industry Research Report," the global big data market size in 2020 was approximately $210 billion, while China's big data industry scale reached about 600 billion yuan [2]. Data from the China Commercial Federation Data Analysis Professional Committee indicate that China will need 1.8 million big data professionals in the next 3-5 years, but currently has only nearly 300,000 big data practitioners. As a typical interdisciplinary discipline and a critically needed specialty for social development, Big Data Management and Application has been listed as a top priority for specialty optimization and disciplinary construction by numerous universities' library, information, and archival science programs since its approval in 2019.

Domestic research on Big Data Management and Application specialty construction has gradually become a hot topic. Foreign data science programs do not emphasize a liberal arts background but focus on data literacy development [3-4], often pairing data science construction with library and information science programs [5-6], though research on data specialty construction within a liberal arts context remains limited. Domestic research primarily concentrates on curriculum design [7-8], curriculum system improvement [9], and transformation of talent training objectives [10-11] for Big Data Management and Application programs within liberal arts backgrounds. Notable scholars such as Ma Feicheng [12] have analyzed the applications and challenges of library and information science specialty construction under the new liberal arts background; Ke Ping [13] and colleagues have examined the development direction of the library, information, and archival science first-level discipline under new liberal arts construction; Sun Jianjun [14] and colleagues have proposed innovative ideas for teaching "Information Resource Management" courses under the new liberal arts background; and Cao Wenzhen [15] has analyzed the evolution of undergraduate education in top American iSchool information science programs. Existing research shows that studies on talent training models for Big Data Management and Application under the new liberal arts background are relatively limited. This research attempts to address three questions: (1) What are the practical demands of social development for Big Data Management and Application talent training under the new liberal arts background? (2) What is the current state of curriculum system construction for Big Data Management and Application programs in domestic and foreign universities? (3) How can talent training models for Big Data Management and Application in China achieve innovation under the new liberal arts background?

This paper analyzes the positions and capabilities required by society and industry development for Big Data Management and Application professionals under the new liberal arts background, examines theoretical curriculum systems and practical teaching components of domestic and foreign programs using web

surveys and social survey analysis methods, and proposes an innovative talent training model for China's Big Data Management and Application specialty by integrating the practical demands and characteristics of the new liberal arts construction era. This study provides reference and guidance for curriculum system construction and talent training for Big Data Management and Application programs under the new liberal arts background.

2. Talent Demand of the Big Data Industry Under the New Liberal Arts Background

2.1 Sample Selection and Research Methods

To understand the capability demands of the domestic big data industry for talent under the new liberal arts background, web surveys and web crawler methods were employed to obtain position data from domestic and international big data companies. Based on the "Global Top 50 Big Data Companies" list published in the U.S. Big Data Quarterly [16] and the "2020 China Big Data Industry Development White Paper" [17], target enterprises were identified, yielding recruitment information from 20 foreign company websites and 5,000 recruitment postings for "Big Data Management and Application" professionals from Zhaopin.com in China. After comprehensive comparison, ten companies were selected for detailed introduction and analysis of their offered positions to determine specific enterprise talent demands.

2.2 Analysis of Position Categories

The talent demand situation in domestic and foreign big data industries for new liberal arts background data professionals is shown in Table 1 and Table 2 . Through collation and analysis, positions can be categorized into three types: technical talent, application-oriented talent, and business-oriented talent. Technical talent requires data engineers to conduct cutting-edge technology research, algorithm development, and product information processing in the big data mining field, as well as related work progress planning. Application-oriented talent emphasizes using technology and platforms to process and analyze data, 挖掘其潜在价值, providing decision-making basis for operations management, enabling enterprises to clearly understand internal development status and external competitive environment, and thereby providing data support for business risk assessment and related decisions. Business-oriented talent is primarily responsible for coordinating and managing business data to ensure data integrity and accuracy across systems, and making business decisions based on data analysis results combined with multi-domain knowledge. The integration of business-oriented talent with big data technology represents the most direct and extensive transformation link in big data technology application.

Word clouds of new liberal arts background big data talent demand positions are shown in Figure 1 and Figure 2 [Figure 2: see original paper]. Analysis reveals that domestic and foreign big data industries have different emphases in posi-

tion demands. Foreign enterprises focus on positions such as data scientist, data analyst, and data engineer, emphasizing the use of scientific methods and data mining tools for digital visualization and data mining analysis of complex massive data. They also emphasize combining business for data insight and direction control of data analysis, distinguishing it from simple data analysis and statistics. Domestic enterprises place greater emphasis on data analysts, data mining engineers, and solution architects, with stronger focus on data development capabilities and platform architecture capabilities. There are gaps in development stages and speeds between domestic and foreign data industry companies. China remains in the core development stage of data platform construction and data analysis and utilization, while foreign demand for platform construction and data analysis has basically stabilized in the data decision-making and early warning stages.

2.3 Competency Requirements for Related Positions

Analysis of talent position demands from domestic and foreign big data companies reveals that industry requirements for talent can be divided into three levels: hard technical requirements, soft knowledge literacy, and cross-boundary integrated knowledge needs.

Under the new liberal arts background, Big Data Management and Application programs cultivate what can more accurately be described as applied liberal arts talent, with greater emphasis on skill training, as hard technical requirements constitute market entry conditions. In terms of technical breadth, talents with experience in databases, data warehouses, SQL, Tableau, R, Python, platforms such as Hive, Hadoop, Spark, basic machine learning algorithms, and deep learning frameworks including Caffe, TensorFlow, Torch, Theano, and MXNet are favored by enterprises.

Enterprise demands for talent are not limited to single technical applications but require macro-level integration of technical capabilities to serve specific positions. For example, Baidu's senior data analysts and operations managers need to master two or more analytical tools. Beyond individual technical and application capabilities, new liberal arts background Big Data Management and Application programs also require team communication and collaboration skills, stress resistance, and foreign language proficiency. Professional literacy emphasizes the ability to solve practical industry problems, such as data insight, logical thinking, and analytical summarization skills, requiring strong data sensitivity. Educational requirements also reflect talent's soft knowledge literacy from the perspective of academic levels. Different positions have varying degrees of requirements for big data capabilities. For instance, Amazon's data center operations manager position requires a master's degree in a data-related background and fluency in both spoken and written English; SAP's data platform developer, intelligent data and analysis, and data governance positions require fluent English and good German skills; Alibaba's business data analysis positions and Huawei's e-commerce data analysis product expert positions require CET-6 or

IELTS language certificates.

From a global development trend, talent demand in the big data field shows obvious cross-boundary integration, with interdisciplinary composite talent being the cutting-edge decision-making talent needed by industry. Intel's data scientist position requires mastery of data collection, mathematical algorithms, mathematical software, data analysis and prediction, and market application and decision analysis skills. Industry demand for talent is not merely about data processing capabilities but requires higher-level ability to combine relevant domain knowledge for big data mining and analysis. Tencent's data analysts and Apple's data analysts, in addition to requiring data analysis experience and proficiency in database languages such as SQL and Python programming capabilities, also require certain financial or financial professional knowledge backgrounds and professional qualifications such as equity investment and financial auditing to fully understand business requirements and develop technical solutions. Intel's product data lead position, besides requiring corresponding data analysis capabilities, also demands marketing and sales experience and the ability to master product data lifecycle to ensure data resource quality.

3. Current Situation and Dilemma Analysis of Big Data Management and Application Talent Training

3.1 Sample Selection and Research Methods

The authors collected and analyzed undergraduate training programs from domestic and foreign institutions offering "Big Data Management and Application" programs, ultimately selecting 10 foreign universities and 8 domestic institutions for investigation. Foreign Big Data Management and Application programs were benchmarked against "Data Science" programs [11], with particular focus on iSchools alliance members to better understand trends and priorities in foreign library and information science discipline and data science program pairing construction. The survey results are shown in Table 3 . Domestic institution selection was based on the "2020 National 81 Universities Big Data Management and Application" ranking list published by the "University Big Data and Artificial Intelligence Promotion Alliance" [18], selecting institutions with earlier program establishment and publicly available training programs for analysis. The survey results are shown in Table 4 . The research methodology primarily employed web surveys and comparative analysis to collect training programs and analyze the current talent training situation and construction dilemmas for domestic and foreign Big Data Management and Application programs from both curriculum system and practical components perspectives.

3.2 Curriculum System Analysis

Diversified curriculum systems are reflected in multi-type thinking cultivation and multi-directional career training. The survey shows that current domestic and foreign Big Data Management and Application program curricula have cer-

tain modular characteristics, with course types divisible into information management modules, data analysis modules, and mathematics/computer science modules. These correspond to the thinking ability cultivation and disciplinary knowledge training needed for business-oriented, application-oriented, and technical talent demanded by enterprises.

The information management module consists of foundational information courses focusing on constructing students' knowledge structure in information management, with main courses including information retrieval, information storage, information organization, and management. The data analysis module focuses on cultivating students' data application and analysis capabilities, training them to collect data and conduct auxiliary decision analysis through analysis and processing training, with main courses including data science fundamentals, web data visualization analysis, machine learning, and data mining. The mathematics/computer science module serves as the technical support module for liberal arts Big Data Management and Application programs to meet enterprise demand for technical talent, training students in mathematical model construction and computer language programming capabilities. Mathematics courses mainly include calculus, linear algebra, and statistics, while computer language programming primarily includes Python, object-oriented programming, R language, and natural language processing techniques, with courses such as artificial intelligence overview, machine learning, deep learning, and natural language processing.

Comparison reveals that similarities in domestic and foreign curriculum system construction lie in modular, structured course pattern settings. iSchools alliance curricula abroad exhibit certain hierarchical and gradient characteristics, setting courses of varying difficulty for different student levels. Simultaneously, curriculum design emphasizes the continuity and gradient of 贯通式 talent training. For example, the University of California, Berkeley's School of Information offers a data science course series limited to master's students, while adjusting to slightly less difficult new courses for lower-grade learning needs; the University of Washington's progression from undergraduate "Data Science for Informatics" to doctoral "Data Science" also sets courses step-by-step to achieve continuous education. Gradient-based scientific teaching methods benefit students' progressive knowledge absorption and consolidation, promoting the expansion of theoretical understanding and practical capabilities in data management [19]. Moreover, foreign curriculum system construction places greater emphasis on training in underlying data technology implementation [20], focusing on learning analysis and processing techniques with data as the object. Domestic curriculum system construction places more emphasis on disciplinary foundations and economics/management backgrounds, with most institutions situating Big Data Management and Application program construction within existing economics and management or information management programs, combining with the economic, management engineering, or library and information science characteristics of the hosting schools or departments, and focusing on learning from data application scenarios and knowledge transformation links.

3.3 Practical Teaching Component Analysis

Based on training programs for domestic and foreign Big Data Management and Application programs and scholars' research findings, practical teaching components mainly include three aspects: practical class hours and courses, practical seminars and projects, and practical application and internships.

Currently, domestic universities primarily use increased practical class hours and additional practical courses to improve practical teaching [39]. New liberal arts background Big Data Management and Application program construction mainly starts from the content of the practical teaching system, increasing practical class hours on one hand, organizing various thematic research and survey activities, and guiding students to participate in supervisors' research projects; on the other hand, offering thematic data analysis practical courses that allow students to practice in data companies to familiarize themselves with specific processes such as data cleaning and data mining [40]. By constructing new liberal arts laboratories and adopting project-driven methods to introduce the CDIO engineering education model based on project design, relevant teaching work helps students better connect and understand specific theories [41].

Practical seminars and project-based teaching can promote mutual exchange and cooperation among students, enhancing their comprehensive use and understanding of multiple technologies and methods to improve data literacy [42]. Tsinghua University established one of the first domestic big data research institutions where the core course is "Big Data Practice." This practical course differs from traditional teaching models by combining enterprise mentors, top academicians, and industry experts, allowing students from different disciplinary backgrounds to form interdisciplinary research teams, applying real industry data to practical teaching and solving real-world problems. The course requires students to collaborate through seminars and conduct final project defenses. During research, students gradually acquire practical skills for specific applications. Seminar components are unique to doctoral talent training in foreign iSchools and constitute crucial teaching components for enhancing doctoral students' scientific research capabilities, professional literacy, and expression abilities.

Adding internship and enterprise project practice components can help students comprehensively learn various theories and technical methods, improving their practical application capabilities through specific applications. Cornell University's Information Science program, when training talent for data science directions under the new liberal arts background, adds enterprise-collaborated practical projects beyond core courses, pairing program students with business school students to conduct industry-sponsored projects with partner companies such as Google, Amazon, McKinsey, Common Bond, P&G, IBM, and Salesforce. During this period, weekly meetings are held with industry guest lecturers to discuss technical and information science business and management content and plan subsequent practical internships. Simultaneously, students freely choose internships, continuously improving and supplementing the practical teaching

training system for Big Data Management and Application programs through practical class hours and courses, practical seminars and projects, and practical application and internships.

3.4 Dilemma Analysis of Current Big Data Management and Application Talent Training

Since 2018, China has approved 81 universities to establish Big Data Management and Application programs. Although program construction has been approved for three years, many universities have not yet formed mature talent training systems. Domestic professional education concentrates at the undergraduate level, while foreign data science program training focuses on master's and doctoral levels, particularly professional master's programs. The current market urgently needs high-quality data science talent, but high-quality talent training cannot be separated from a relatively complete and systematic talent training system. Most domestic institutions have relatively hierarchical professional curriculum systems, but at the application level, they mostly simply retain characteristic courses from original programs, with phenomena of copying traditional statistics and computer science courses [43-44], lacking course types that combine engineering courses with liberal arts disciplinary characteristics. Meanwhile, existing disciplinary resource construction, whether in faculty team building, curriculum system support, or practical teaching components, cannot fully support Big Data Management and Application program construction needs and urgently requires targeted improvement and optimization to meet new liberal arts construction requirements.

Regarding talent training orientation in new liberal arts specialty construction, traditional liberal arts construction shows characteristics of emphasizing theory over application, with more theoretical courses and fewer practical training components in specialty construction. New liberal arts background specialty construction should place greater emphasis on cross-boundary concepts such as computational thinking to intersect and integrate with liberal arts thinking paradigms, reconstructing students' data thinking systems and improving their data analysis and application capabilities to better solve specific big data technology and application problems in practice [45]. New liberal arts Big Data Management and Application program construction and talent training should emphasize not only disciplinary theoretical curriculum innovation but also improvement in talent practical components and application capabilities. As the world faces unprecedented changes in a century and China's development during the "14th Five-Year Plan" period remains in an important strategic opportunity period, new specialty construction aims not only to meet social development demands but also to cultivate composite professional talent that meets national development strategic needs, which has become a key focus in new specialty construction.

Regarding curriculum systems in new liberal arts specialty construction, new specialty construction should not merely chase trends and hotspots in data tal-

ent training under the Western discourse system but should cultivate new liberal arts leadership talent suitable for China's new era development characteristics and national strategic needs [46]. Only by cultivating proactive talent that supports national digital economy and digital China development construction based on national big data strategy, cultural revitalization strategy, and technology powerhouse strategy can the era characteristics of China's new liberal arts Big Data Management and Application talent training be highlighted. On one hand, in the era where "data and information become national strategic resources," as a discipline studying data management and utilization, it should leverage disciplinary advantages, continue innovation and development, and provide decision support for major national strategic decisions such as big data strategy and digital economy. On the other hand, in China's digital economy and digital China construction process, students' data literacy should be comprehensively improved to eliminate cultural poverty and digital divides, further combining respective disciplinary advantages and characteristics in new technology development. However, how to better construct interdisciplinary curriculum systems that cater to social strategic development remains a difficulty in new specialty construction.

Regarding practical components in new liberal arts specialty construction, Big Data Management and Application program construction should be rooted in the professional characteristics and advantages of humanities disciplines, combining big data and artificial intelligence technologies and methods in new technology development to timely and organically integrate cutting-edge industry knowledge into practical components of specialty construction, improving the era orientation and targeting of talent practical application capability cultivation. Meanwhile, the concurrent innovation of "three news"—new technologies, new tools, and new methods—cannot be separated from ultimate implementation at the practical level [47]. As a basic research basis for new liberal arts construction development, humanities and social sciences research paradigms have undergone significant changes with the emergence and application of new technologies. How to train students to combine technologies, methods, and tools such as artificial intelligence, semantic analysis, machine learning, and data visualization to serve the big data industry, build practical laboratories for Big Data Management and Application programs under the new liberal arts background, better apply big data theoretical courses and tools, and enable trained professionals to better meet social development practical demands constitutes a pain point in new specialty construction.

4. Talent Training Model for Big Data Management and Application Under the New Liberal Arts Background

Although training objectives for Big Data Management and Application programs under the new liberal arts background vary according to school or program characteristics, the design principle should meet digital China construction development needs based on the national "Four Orientations" strategy, en-

abling graduates to possess comprehensive capabilities in understanding, applying, managing, and researching data, and mastering relevant theories, methods, and technologies for efficient data collection, analysis, processing, governance, data privacy, and security. To address dilemmas in talent training for Big Data Management and Application under the new liberal arts background and cultivate professionals meeting national strategic needs and industry development requirements, this paper proposes four talent training models for undergraduate-level new liberal arts Big Data Management and Application programs, as shown in Figure 3 [Figure 3: see original paper].

4.1 Cross-Disciplinary Joint Training Model

New liberal arts emphasizes computational thinking, collaborative thinking, interdisciplinary thinking, and relational thinking—new thinking modes that require better collaborative construction through interdisciplinary integration [11]. Currently, many institutions at home and abroad have launched interdisciplinary talent training models based on big data technology, such as the University of Washington's focus on interdisciplinary cooperation between mathematics and statistics to jointly cultivate data science master's students; Fudan University's Big Data College launching four "Data Science and Big Data Technology 2+X" interdisciplinary talent training programs for mathematics, economics and management, technology, and natural sciences; and Beijing University of Chinese Medicine, as a medical university currently offering Big Data Management and Application programs, aiming to cultivate talent "familiar with data characteristics in the medical and health field, especially traditional Chinese medicine, and systematically mastering traditional Chinese medicine big data management technologies and methods." Although the degree of interdisciplinary integration varies, interdisciplinary integration and joint training across departments represent an inevitable trend in future talent training. Cross-disciplinary joint training can promote not only cross-boundary integration within universities but also inter-university cross-disciplinary joint degree training programs. Therefore, future construction should enable universities to conduct specialty construction and talent training based on their own characteristics in professional development, enhancing cross-disciplinary integration in talent training.

4.2 Multi-Level Hybrid Education Model

For social science students under the new liberal arts background, Big Data Management and Application program training objectives focus on enabling such students to conduct routine data acquisition, cleaning, processing, and transformation in practical work and research, and to conduct problem-oriented modeling and analysis [48]. This paper proposes a "three-three-three" multi-level hybrid education curriculum model to meet specific learning needs at different stages. This training model divides Big Data Management and Application courses into three levels: big data general education courses, Big Data Management

and Application foundational courses, and Big Data Management and Application core courses. Course modules are divided into three categories: knowledge cultivation, capability training, and professional quality. Course content implements three integrations: intra-course integration, inter-course integration, and inter-disciplinary integration. Intra-course integration, such as for the "User Profiling and Precision Detection" course, achieves gradient evolution course category settings for undergraduate, master's, and doctoral levels, dividing "User Profiling and Precision Detection" into Level 1, Level 2, and Level 3 courses. Inter-course integration, such as "Patent Information Mining" and "Technology Forecasting and Innovation," achieves cross-course integration where prerequisite courses provide relevant learning foundations and methods for subsequent courses. Inter-disciplinary integration involves using this discipline's research methods to process research problems or data in other disciplinary fields to promote mutual integration and innovation among different disciplines under the new liberal arts background, such as medical big data and legal big data. Different knowledge and skills are supported by corresponding course modules, with specific credit arrangements set according to different application specialty characteristics and existing curriculum systems combined with professional practical demands.

For Big Data Management and Application programs established within library and information science disciplines, based on reference to existing library and information science curriculum system construction methods and content, some general education courses and certain computer and mathematics-related courses are selected and integrated to form a curriculum system suitable for undergraduate specialty understanding and basic technical learning, providing undergraduate student sources for library and information science graduate training. The designed multi-level hybrid education model is shown in Figure 4 [Figure 4: see original paper].

4.3 New Liberal Arts Laboratory Construction Model

Big Data Management and Application programs under the new liberal arts background should be distinguished from engineering specialties oriented toward technical implementation and application practice, placing greater emphasis on balancing theoretical learning and practical construction. With "application-practice-innovation" as the main principle, programs should maintain the essential characteristics of humanities disciplines while meeting social employment demands of the era, achieving collaborative talent cultivation between theoretical learning and practical application [49], ultimately reaching knowledge innovation and application capability training for Big Data Management and Application professionals [50]. Based on current university specialty construction situations, practical course types should be reasonably supplemented by adding specific components such as seminars, project group teaching, and dual-mentor project teaching to comprehensively shape application-oriented Big Data Management and Application professionals [51]. Additionally, new liberal arts

laboratory construction for Big Data Management and Application programs should be actively promoted. The "Key Points of the Ministry of Education's Social Science Department 2020 Work" proposes to "focus on supporting the construction of a batch of liberal arts laboratories to promote research method and disciplinary cross-integration, leading academic development [52]." New liberal arts background Big Data Management and Application program construction should reduce repetitive, verification, and observational experimental internships, and increase design-oriented, innovative experiments and participatory internships [53] to further improve the practical teaching system. New liberal arts laboratory construction should eliminate the approach of copying science and engineering disciplines, highlighting new liberal arts characteristics and using liberal arts demands as the development basis. New liberal arts laboratories should serve not only research but also teaching and social services, achieving "1+1>2" collaborative teaching by absorbing professionals from different research backgrounds.

4.4 Industry-Academia Collaborative Education Model

Currently, big data industry demand for new liberal arts background talent can be summarized as demand for "three types of talent": technical, application-oriented, and business-oriented. Universities should adopt "industry-education integration, collaborative talent cultivation" as the talent training philosophy, introducing industry-academia collaborative education models to develop "three-type" big data talent construction. The industry-academia collaborative education model can be divided into three stages: establishing school-enterprise collaborative mechanisms, jointly formulating talent training programs, and implementing joint school-enterprise evaluation mechanisms, as shown in Figure 5 [Figure 5: see original paper]. The industry-academia collaborative education model emphasizes industry-academia integration and mutual benefit [54]. First, based on tripartite consensus on "school-enterprise-student" needs, integration points should be identified to gradually establish school-enterprise collaborative education mechanisms, including jointly building big data application innovation platforms, teachers entering enterprises for training or engineers entering schools for teaching, undergraduate school-enterprise dual-mentor systems, combining internships with graduation design, and enterprise engineer compensation distribution mechanisms based on the credit system. Second, schools should conduct joint formulation of training programs based on established school-enterprise collaborative mechanisms, with the key being dynamic adjustment according to demands. During joint training, through cooperation with typical survey companies (such as MyCOS surveys) and social surveys, training programs should be periodically updated and adjusted to better meet industry development and talent development needs. Based on established joint training mechanisms and talent training programs, school-enterprise joint evaluation mechanisms should be adopted to assess talent training effectiveness. Students' professional capabilities and qualities are jointly represented by internship courses and theoretical course grades, with evaluation standards for

course grades jointly formulated by in-school mentors and enterprise mentors. After the training period, enterprises and universities can jointly issue talent training certification to confirm the specialization and cooperation of talent training.

5. Research Conclusions

Facing unprecedented global changes in a century, social transformation brought by new technologies, and increasingly complex and changeable national economic construction and social development environments, new liberal arts Big Data Management and Application programs need to clarify disciplinary positioning, accurately anchor specialty construction development orientation, maintain integrity and innovate in responding to and pursuing changes, and achieve specialty construction with era characteristics in the construction of scientific spirit and humanistic care. This study begins with analyzing the capabilities required by domestic and foreign big data industries for Big Data Management and Application professionals under the new liberal arts background, examines curriculum systems and practical components of domestic and foreign programs, and proposes four models for future new liberal arts Big Data Management and Application program construction.

Survey results indicate that talent types needed by domestic and foreign big data industries can be divided into technical, application-oriented, and business-oriented talent, with curriculum systems including information management modules, data analysis modules, and mathematics/computer science modules, and practical components including practical class hours and courses, practical seminars and projects, and practical application and internships. Currently, cultivating interdisciplinary big data talent has become a priority in new liberal arts Big Data Management and Application program construction, constructing interdisciplinary curriculum systems catering to social development is a difficulty, and enabling trained professionals to better meet social development practical demands is a pain point. To address these dilemmas, this study proposes a talent training model rooted in cross-disciplinary joint training, employing multi-level hybrid education as the method, utilizing new liberal arts laboratory construction as the means, and guided by industry-academia collaborative education, hoping to provide reference for current domestic new liberal arts Big Data Management and Application talent training construction. Additionally, compared with talent training characteristics of mathematics, computer science, and management engineering-related data science and big data technology programs, Big Data Management and Application programs established within library, information, and archival science disciplines place greater emphasis on data management and application capabilities under different scenarios and domain backgrounds, emphasizing the use of big data technology to solve comprehensive theories, methods, and technologies for data collection, analysis, processing, governance, data privacy, and security in different application scenarios, better leveraging the application of intelligence analysis and collection

processing in different fields under the big data environment.

This study has certain limitations. This paper only conducted in-depth text analysis of publicly available training programs; subsequent research will conduct expert interviews on samples of domestic new liberal arts Big Data Management and Application program construction training programs. Additionally, as new liberal arts Big Data Management and Application program construction remains in its initial stage, follow-up surveys can be adopted after the first cohort of graduates to evaluate talent training effectiveness and provide guidance for program reform.

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Author Contributions:

Wang Xiwei: Proposed research questions, research framework, and revised the paper;
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Jia Ruonan: Responsible for sample data collection and analysis;
Meng Ying: Responsible for survey data collection.

Note: Figure translations are in progress. See original paper for figures.