The History and Current Situation of China's Undergraduate Major Evaluation and the Prospect of Intelligent Education Evaluation Based on Big Data Technology

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Abstract. The accreditation and evaluation of undergraduate majors is one of the most important elements in the monitoring of China's higher education quality. with the combination of quantitative and qualitative research methods, this paper illustrates the stages of development, problems of undergraduate majors operation in China, and proposes an evaluation framework for undergraduate majors from the fourth paradigm perspective. The development of undergraduate major evaluation in China are divided into four stages: the budding period (1985-1998), the rising period (1998-2009), and the booming period (2010-2022). The forms of evaluation are divided into major accreditation, major ranking and major assessment. Major evaluation mode includes independent evaluation mode, comprehensive evaluation mode and appraisal mode. Continuous collection of sample data, customized indicators, multiple fusion calculation analysis, visual feedback are the typical features of big- data-based intelligent education evaluation.

Keywords. Undergraduate Major Evaluation, History and Current Situation, Big Data

1. Introduction

The accreditation and evaluation of undergraduate majors is one of the most important elements in quality control of higher education in China. Why is it necessary to carry out undergraduate major assessment? Undergraduate major is the basic element in universities and the basic unit for universities to realize their functions. The pursuit of high-quality major education is a strong motivation in the development of major evaluation. With the deepening of reform in education sector and the loosening on major setting as well as approval restrictions, universities thus are more active in setting majors independently. Therefore, it is critical to ensure high level of major setting and

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management as well as high quality of education with professional standards and evaluation system. Majors of higher education link universities and society. However, the incompatibility between the supply of majors and the demand of economic and social development still prevails, and the contradiction between structural unemployment of graduates and enterprises' failure to find suitable talents is still to be solved. Therefore, it is necessary to form a mechanism for universities to develop mature schemes of self-building, self-development and self-improvement in major management through goal-oriented assessment. The quality of talents cultivation and their adaptation to social demands also need to be further improved. This paper systematically analyzes the theoretical and practical development and problems of undergraduate major evaluation in China, and proposes the theoretical prospects and practical strategies for the development of major evaluation in the future.

2. Study on the development stages of major evaluation in China

Adopting both quantitative and qualitative research methods, this paper takes references from the database of China Knowledge Network Literature (CNKI) and visual analysis on China's major evaluation research literature by the knowledge mapping analysis software Cite Space[3] and the CNKI's measurement and visualization function. Through a general study of the mapping of major evaluation research fields, the research results of major evaluation in China are unfolded in a holistic and multi-faceted manner in this paper, representing the theoretical development of major evaluation as a whole.

Johannes Kepler discovered the laws of planetary motion based on Tycho Brahe's systematic observations on celestial motions. Likewise, Li Jie also put up that the focus and paradigm of scientific research changes over time, sometimes slowly and sometimes dramatically. And the history of scientific development can be tracked from published literature [1]. Being inspired by these examples, the author applies to the date from literature, the number of published articles, keywords, co-citations, emergent terms, authors and institutions to outlining the panorama of major evaluation in depth and details.
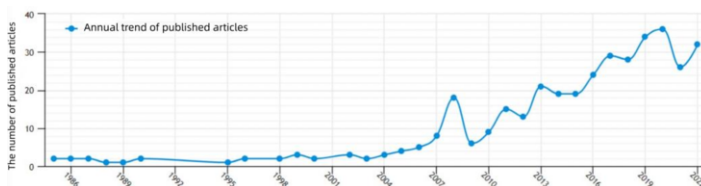

Figure 1. The trend of published journals about major evaluation and major assessment from 1985-2022

As what can be seen from Figure 1, research on major evaluation in China began in 1985. For more than 20 years after the first journal article on major evaluation was published, the number of relevant published journal articles has been remained at the level of about 1-5 per year, drawing few attentions from scholars who focus on the theoretical research of higher education. Overall, the development of research related to major evaluation can be divided into three periods: budding, rising and booming.

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[3] Cite Space (Citation Space) is a software for visualizing and analyzing trends and patterns in scientific literature. It is designed as a tool for dig out the clustering and distribution of knowledge in cited literature through analysis on citation from internet.

2.1. The first period: budding (1985-1998)

The issuing of *The Decision of the Central Committee of the Communist Party of China on the Reform in Education System* in May of 1985 marked China's education system reform beginning. With stronger attention to the quality of undergraduate education teaching and talent cultivation from central government, China launched education evaluation projects from nation, province and university level, when the exploration on major evaluation theory sprouted. However, the number of articles published at that time was still at a low level of 1-2 articles each year. At this period, related research topics mainly focus on the preliminary exploration of evaluation theory and practice, most of which are empirical articles.[2-4]

2.2. The second period: rising (1998-2009)

According to The Law on Higher Education promulgated at the fourth meeting of the Standing Committee of the 13th National People's Congress in August of 1998, the level and quality of education in universities and colleges have to be supervised and evaluated by educational administrative departments, offering legal support for educational evaluation's importance and normativity. What came after is the increasing of the theoretical research on major evaluation. During the same time, the number of published journals increased as a whole, though with occasional dropping in some years. 2008 saw the highest point of 18 journals published while a downturn occurred in 2009. At this period, the research and practice of major evaluation began to learn international experience[5-6], attach importance to evaluation methods[7-8] and the guidance of relevant theories.[9]

2.3. The third period: booming (2010-2022)

Generally speaking, the number of articles published during this period shows a wavy but upward trend. Derived by the issuing of *The Guidance on Accelerating the Implement of "Double First-class" Initiative in Higher Education Institutions* jointly formulated by the Ministry of Education, the Ministry of Finance and the National Development and Reform Commission in August of 2018 and The General Plan for Deepening the Education Evaluation Reform in the New Era issued by the Central Committee of the Communist Party of China and the State Council in October of 2020, the number of published journals peaked with 36 in 2020 alone. By 2022, the published journals on major evaluation in higher education disciplines has accumulated to 351. At this period, relevant research is constantly seeking how to improve major evaluation. [10]

On the University's Competitiveness and Evaluation of University's Specialty by Zhang Xiaodan from Wuhan University is the first dissertation on major evaluation. This dissertation proved the scientificity and practicality of major evaluation index system from the perspective of empirical evidence. The purpose of the research is to systematically elaborate major evaluation system and use its index system to promote the competitiveness of universities, with the establishment of various index systems and the study on evaluation system of major classification in universities at its core. [11] As can be seen from Figure 2, from 2004 to now, the dissertations with the title of major evaluation have reached 49. The highest number of 8 was in 2010 and the number has been maintained at about 4 in the past two years.
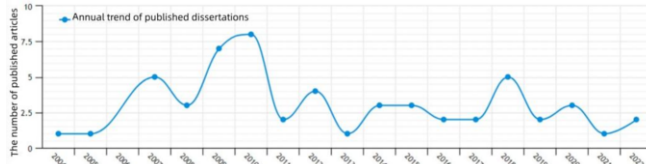
Figure 2. The trend of dissertations published with the title of major evaluation from 2004-2022

3. Current status of major evaluation practice

3.1. Forms of major evaluation

In recent years, the rapid and widespread development of higher education has drawn worldwide attention on higher education assessment. In terms of the form of major evaluation, there are currently three main types (As shown in Figure 3).

Figure 3. Forms of major evaluation in China

One is major accreditation, which is conducted by various associations. For example, the Washington Accord accreditation of engineering education majors.

The second is major ranking, which is implemented and published by media or independent institutions. For example, rankings published by the Alumni Association (As shown in Table 1).

Table 1. Alumni Association's 2017 ranking of undergraduate majors in Chinese universities - Guangdong Province

Ranking	University	Type	National Ranking	8 Star	7 Star	6 Star	5 Star	4 Star	3 Star	2 Star	1 Star	Sum
1	Sun Yat-sen University	Multiversity	17	0	5	10	28	59	16	0	0	118
2	South China University of Technology	Science and engineering university	45	0	1	4	11	41	33	7	0	97
3	South China Normal University	Normal university	91	0	0	3	5	13	34	20	0	81

The third is professional assessment, which is a comprehensive evaluation of undergraduate majors carried out by education administrative departments or universities in each province. As of 2022, Guangdong, Liaoning, Shanxi, Hubei and other administrative departments in education sector have carried out provincial undergraduate major evaluations.

3.2. Mode of major evaluation

When it comes to evaluation modes, they can be classified into three modes: independent evaluation mode, comprehensive evaluation mode and appraisal mode (As shown in Figure 4).
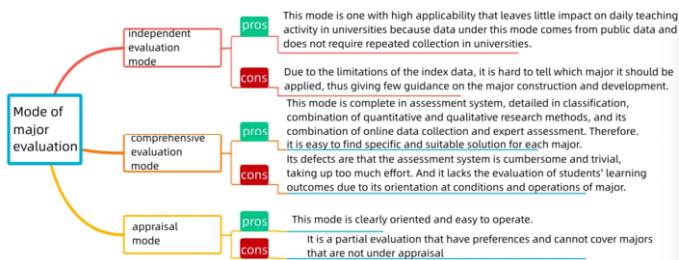
Figure 4. Analysis of the classification of major evaluation modes in China

The first is independent evaluation mode. Being commissioned by the Department of Higher Education of the Ministry of Education of the People's Republic of China, the project Analysis on the Evaluation and Star Distribution of the Disciplines and Majors of Project 985 Universities (National Key Universities) dominated by Professor Qiu Junping is an independent evaluation mode. This project studied the quality of the construction of majors in 985 Universities from 2012 to 2013. The raw data in this evaluation mainly come from official data documents (compilation, yearbook, report, etc.).

The second is comprehensive assessment mode. Taking provincial undergraduate program evaluation in Liaoning Province for example, there are six ground rules in their evaluation. The first is orientation. The practice of comprehensive evaluation of majors further promotes universities to take undergraduate teaching as fundamental work, so that dean's and faculty's focus, resource allocation and funding arrangement are all fixed on teaching. Such evaluation can also continuously strengthen major construction and reform, improve the level of major construction and talent quality, and advance majors to better serve for economic and social development in a faster step. The second is scientification. The design of the comprehensive major evaluation index system, the choice of evaluation methods and evaluation practice should follow the law of education and the law of professionals development, fully consider the inherent characteristics of major construction and talent training and effectively promote the comprehensive, coordinated and sustainable development of major. The third is objectivity. Through comprehensive evaluation of majors, representative and repeatable indicators are selected among indicators reflecting the state of major management. And a scientific and reasonable indicator system and evaluation function are designed to objectively reflect the real state of reform and construction of majors. The fourth is simplicity. The comprehensive major evaluation resorts to modern information technology means, which helps to collect, summarize and analyze data through internet, to simplify evaluation process and improve efficiency, instead of doing research in universities by experts themselves. The fifth is offering specific guidance for different majors. Comprehensive major evaluation is to evaluate the same majors offered by different schools. On the basis of not affecting normality of major management, the designing of index system and the application of evaluation results is used for providing specific guidance for each major to help them develop with their own characteristics. The sixth is the mixed quantitative and qualitative research methods. The comprehensive evaluation of majors adopts the quantitative analysis of data as the main focus and the qualitative judgment from experts as the supplement. While the former focuses on the objective evaluation of the current state, the latter highlights the subjective evaluation on potentials. The second is comprehensive assessment mode. Taking provincial undergraduate major evaluation began in Liaoning Province for example, there are six ground rules in their evaluation.

The first is orientation. The second rule is scientification. The third is objectivity. The fourth is simplicity. The fifth is offering specific guidance for different majors. The sixth is combining quantitative and qualitative research methods.

The third is appraisal mode. In 2016, the General Office of Shanxi Provincial Party Committee and the General Office of Shaanxi Provincial People's Government decided to launch the First-class Majors Initiative. Project management is used in the building of first-class majors. All undergraduate colleges and universities in the province are required to apply their majors to step into first-class major. The Shanxi Provincial Department of Education entrusted the Western China Higher Education Assessment Centre with the responsibility of accepting materials and auditing projects for undergraduates, and the Shanxi Higher Education Data Centre with the responsibility of data collection and technical support. Shanxi Vocational and Technical Education Society was entrusted by the Provincial Department of Education with the responsibility of accepting materials and auditing projects for higher education.

Based on what is analyzed above, it can be concluded that independent evaluation is one with high applicability that leaves little impact on daily teaching activity in universities because data under this mode comes from public data and does not require repeated collection in universities. However, at the same time, due to the limitations of the index data, it is hard to tell which major it should be applied, thus giving few guidance on the major construction and development. The comprehensive evaluation mode stands out with its completeness in assessment system, detailed in classification, combination of quantitative and qualitative research methods, and its combination of online data collection and expert assessment. Therefore, it is easy to find specific and suitable solution for each major. However, its defects are that the assessment system is cumbersome and trivial, taking up too much effort. And it lacks the evaluation of students' learning outcomes due to its orientation at conditions and operations of major. The appraisal mode, on the other hand, is clearly oriented and easy to operate, but it is an evaluation that only focus on majors that are under appraisal. So, it is a partial evaluation that have preferences and cannot cover majors that are not under appraisal.

The preceding analysis on these pros and cons of the three modes has inspired the author to make further step on the design of major evaluation. From the perspective of promoting evaluation discernment, major evaluation can put more emphasis on the orientation of indicators, strong data support, appropriate assessment scales and high universality in majors that are being evaluated. In terms of convenience, the data will be judged mathematically and processed with big data technology. This procedure ought to be responsible by an outstanding team, rather than be finished annually with qualitative assessment by a large number of experts, resulting in low efficiency due to different standards. In terms of orientation, this type of evaluation will cover as many majors as possible, giving the same attention on both students' learning outcomes and keeping characteristics of each major.

4. Analysis of the problems of major evaluation

In October 2020, the Central Committee of the Communist Party of China (CPC) and the State Council issued the General Plan for Deepening the Reform of Education Evaluation in a New Era, which calls for improving the institutional mechanism of moral education, reversing the unscientific orientation of education evaluation, and resolutely overcoming chronic problems of centering at higher scores better admissions, more paper,

higher career status. In practice, major evaluation has always been one of the difficulties in evaluating higher education and a headache for education administrators and evaluators. [12] It is of strategic importance to deepen the reform of education evaluation in the new era by innovating the concept of undergraduate major evaluation and constructing a new system and mode of major evaluation.

The big-data analysis on Chinese discipline major research based on the study of China's core journals reveals that China's major evaluation research on disciplines outweigh the research on majors. More vividly, Figure 5 illustrates the big data cloud map and knowledge map of specific research keywords. In-depth analysis have made it clear that China's higher education evaluation has gone through four stages: beginning, institutionalization, advancing and deepening. Since the reform of the education system in 1985, China has put more stress on the quality of undergraduate education teaching and major talent cultivation, and launched relevant evaluation projects at three levels: national, provincial and university. A system of higher education evaluation with Chinese characteristics have basically formed after 40 years' exploration and practice. In the new era, the Double First-class Initiative has been officially implemented, but major evaluation has not been adapted to it, and there are still problems such as putting more emphasis on macro evaluation than micro evaluation, obvious utilitarian orientation, more quantitative and result-oriented indicators but less qualitative and process-oriented indicators, lack of big data support for evaluation, convergence of evaluation indicators and lack of discipline and major characteristics. [13]
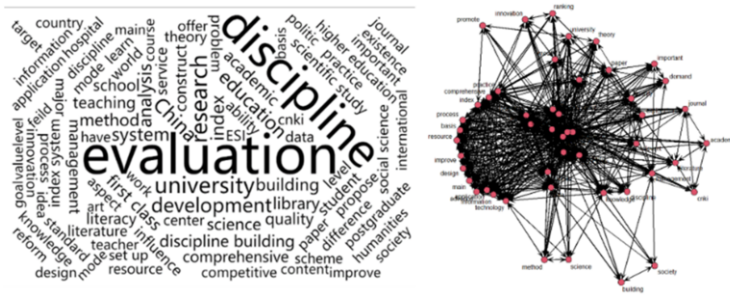

Figure 5. Big data cloud map and knowledge map of keywords for major evaluation research in Chinese disciplines

In summary, theoretical research on major evaluation in China began in 1985 with the reform of the national education system, and has gone through three stages: budding, rising and booming. Throughout the 37 years of theoretical development, the unswerving efforts of Chinese scholars in exploring major evaluation theory have also promoted the development of Chinese educational evaluation theory, provided theoretical support and paradigm for the practice of major evaluation in the field of higher education, and made theoretical contributions to the modernization of Chinese-style education. However, the number of publications and of representative research results is few, which needs to be further explored.

5. Prospects: A Framework for Undergraduate major Evaluation in the Fourth Paradigm Perspective - Smart Education Evaluation Based on Big Data Technology

The surging of the big data technology has unprecedentedly advanced things to be quantified and statistically analyzed, giving rise to the new progress on data-intensive knowledge and driving evaluation paradigm's evolution. According to Turing Award winner Jim Gray, scientific research can be divided into four paradigms: the Experimental Science paradigm for describing natural phenomena (Empirical Science), the Theoretical Science paradigm using modeling method and inductive method (Theoretical Science), the Computational Science paradigm for computer simulations of complex phenomena (Computational Science), and the data-intensive science paradigm (eScience), also known as the fourth paradigm, which combines theory, experiment and computational simulation. The fourth paradigm includes the usage of diverse tools for the continuous collection of scientific data, building system for managing the entire lifecycle of data, and the designing of tools and methods for data analysis and visualization customized for scientific research questions. [14] (As shown in Figure 6). There is no doubt that the advent of big data technology provides new methods and new perspectives for our cognition and scientific research. If this technology is applied in undergraduate major evaluation, a new paradigm of data-intensive evaluation will be invented and help undergraduate major evaluation to be conducted in an intelligent way. In other words, data mining and learning analysis based on full-sample, full-process and panoramic meta-education data will enable the evaluation of undergraduate majors to become intelligent.
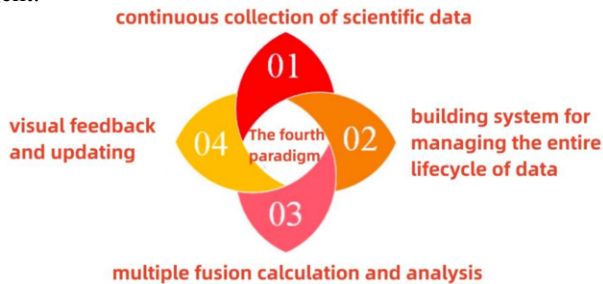

Figure 6. Main features of the fourth paradigm

To be specific, on account of applying big data technology to education research, education evaluation methods would see revolution, evolving into a data-intensive dynamic evaluation system that combines uninterrupted collection of sample data, personalized indicators, multiple fusion calculation and analysis, as well as visual feedback and updating together.

In the future, major evaluation will use the Internet of Things perception technology, video recording technology, image recognition technology and platform acquisition technology to continuously collect the multi-source, heterogeneous, multi-modal and incoherent semantic big data generated in real time in the process of education. major evaluation activities are no longer limited by presets and are not limited to the investigation of causality. Instead, specific algorithms are used to analyze "big data", so as to conclude the correlation and regularity behind the educational data. In the future major evaluation, big data technology can mine valuable information from the big data of education generated in real time through the real-time dynamic monitoring of

educational activities, and present the educational evaluation results in intuitive graphics and image information through visual tools, and personalized feedback the evaluation results to the evaluators. Big data technology has continuously improved the professional level of educational evaluation.

6. Summary

Focusing on the evaluation of undergraduate majors in China, this paper clears out three phases of undergraduate major development in China: budding, rising and booming, by employing quantitative and qualitative research methods. Besides, this paper also classifies the forms of major evaluation in China into major accreditation, major ranking and major assessment, and the major evaluation modes into independent evaluation mode, comprehensive evaluation mode and appraisal mode. Furthermore, the fourth paradigm of evaluation framework of undergraduate major is proposed in this paper, with a view to make up for the shortcomings of previous research methods and provide references for research and practice related to the innovation of undergraduate program evaluation system.

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