



Research on the evaluation index system of academic papers for double first-class disciplines based on bibliometrics



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ABSTRACT

Briefly, the term double first-class refers to the construction of world-class and first-class universities with world-class and first-class disciplines. The Central Committee of the Communist Party of China and the State Council of the People's Republic of China made the important strategic decision to build world-class and first-class universities with world-class and first-class disciplines. Based on what we learn from an evaluation system of the discipline construction of world-class and first-class universities abroad and the analyses of the strategic plan of Chinese double first-class universities and disciplines, we propose four first-level evaluation index systems that combine eight second-level evaluation indexes to evaluate academic papers according to the SCIE/SSCI and CSSCI/CSCD databases using bibliometrics. The CSSCI/CSCD databases, which are used to collect the papers published in excellent domestic journals, are introduced as an important index that promotes the construction of the academic paper index system for "double" world-class and first-class in domestic universities. We construct double first-class universities in order to serve our country, the people and our economic construction. In addition, we encourage Chinese researchers to publish their excellent research achievements in China.

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INTRODUCTION

Since 2015, the Chinese government has indicated that it desires a number of Chinese universities to reach double first-class status by 2050, which means the creation of world-class and first-class universities that support first-class disciplines (Chinese State Council, 2018). Chinese authorities released a selected list of universities and colleges that will participate in the country's construction plan of world-class and first-class universities with first-class disciplines on September 21, 2017 (Ministry of Education, 2017). The plan, also known as the "Double

First Class" initiative, aims to ultimately build a number of world-class and first-class universities and disciplines by the end of 2050 in an effort to make China an international higher education power.

Double first-class, in short, means building world-class and first-class universities with world-class and first-class disciplines. Building world-class and first-class universities with first-class disciplines is an important strategic decision made by the Central Committee of the Communist Party of China and the State Council of the People's Republic of China. It is also another national strategy in the field of higher education in China following the "211 Project" and "985 Project", and the strategy is conducive to enhancing the comprehensive strength and international competitiveness of Chinese higher education and

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achieving the goals and objectives of "two hundred years". The Chinese dream of the great rejuvenation of the Chinese nation provides strong support (News, Department of Education and training, Australian, 2019a; News, Department of Education and training, Australian, 2019b).

The construction of first-class universities focuses on the overall first-class disciplines in the universities and comprehensively improves the level of personnel training and innovation ability for students. A total of 42 first-class universities (36 Class A schools and 6 Class B schools) were created on the basis of the original 39 985 Project Anonymous. Without world-class and first-class disciplines, it is impossible to become a world-class and first-class university (Yang, 2009). The key point of double first-class construction is the construction of world-class and first-class disciplines. Therefore, it is particularly important to establish and improve the academic evaluation and academic standard system of philosophy and social sciences with Chinese characteristics, Chinese style and a Chinese air (Chinese State Council, 2018) and to construct a disciplinary evaluation system serving "double" world-class and first-class universities and disciplines.

Bibliometrics is a cross-discipline that uses mathematical and statistical methods to quantitatively analyze all knowledge carriers. It is a comprehensive knowledge system that integrates mathematics, statistics and philology and conducts quantification. Its main measurement objects are the following: the number of documents (various publications, esp. articles and citations), the number of authors (individual, collectives or groups), and the number of vocabulary words (various document markers, most of which are narratives) (Lutz and Werner, 2018). The most essential characteristic of bibliometrics is that its output must be a "quantity". Bibliometrics is widely used in resources, health, industrial production and other fields (Hailin and Cuihong, 2018; Richard and Lutz, 2016) and has been applied in discipline construction (Yao-Hua et al., 2019).

Overview of the university ranking index system and academic evaluation index system

Summary of the ranking index systems

Among the global university ranking and academic evaluation systems, there are currently four recognized global university ranking systems, namely, the Best Global Universities (BGU) of the United States, the Times Higher Education World University Ranking (THEWUR) of the United Kingdom, the Quacquarelli Symonds World University Rank (QSWUR) of the United Kingdom, and the Academic Ranking of World Universities (ARWU) of

Shanghai Jiaotong University, China (Li, 2017).

BGU was ranked by US News & World Report Rank based on the data provided by the original Thomson Reuters (now Clarivate Analytics) as the only bibliometric data source (<https://www.usnews.com/best-colleges/rankings/universities>). It calculates and releases university rankings according to the five-year academic reputation data provided by InCites research and analysis solutions and the five-year Web of Science academic paper data. The first-level evaluation indexes consist of academic reputation (25%), bibliometric indexes (65%) and school-level indexes (10%). Among these indexes, bibliometric indexes are divided into six secondary-level evaluation indexes including the number of papers (12.5%), the impact of normalized citations (10%), total citations (10%), the number of highly cited papers (12.5%), the percentage of highly cited papers (10%) and international cooperation (10%).

THEWUR is the annual ranking of the Thames Higher Education magazine published by Thomson Reuters (now Clarivate Analytics), which provides data as the only bibliometric data source (<https://www.timeshighereducation.com/world-university-rankings>). It calculates and releases university rankings according to the degree of internationalization, teaching quality, paper output and other data of universities. Its first-level evaluation indexes consist of economic activities and innovation (2.5%), internationalization (5%), teaching and students (30%), research indexes (30%) and the impact of academic papers (32.5%). Among the indexes, the indexes related to bibliometrics are the number of published academic papers (4.5%) and the citation rate of academic papers (32.5%).

QSWUR is developed by Quacquarelli Symonds, a British educational organization. The rank data are provided by the Elsevier Publishing Group as the sole source of bibliometric data (<https://www.topuniversities.com/university-rankings/world-university-rankings>). The organization calculates and releases the annual ranking of universities based on employer evaluations, paper output, teacher-student data and other data. Its first-level indexes are academic peer evaluations (40%), global employer evaluations (10%), number of cited papers (20%), teacher/student ratio (20%), international student ratio (5%) and international teacher ratio (5%).

ARWU is an annual ranking by the World-Class and First-class University Research Center of Shanghai Jiaotong University (now Shanghai Soft Science Company) (<http://www.shanghairanking.com>). It uses Nature, Science, SCIE, and CSSI as the bibliometric data sources and synthetically calculates and publishes an annual ranking based on Nobel Prize and Fields Prize data, highly cited researchers and the paper outputs of universities. The first-level indexes are the number of alumni who have won a Nobel Prize or Field Prize (10%),

Table 1. Data sources and data intervals of the mainstream academic paper evaluation index systems in China.

Academic evaluation index system	Measurement data	Measurement intervals	Calculated object	Discipline classifications
ESI	SCIE and SSCI	Approximately 10 years	total citations	22 disciplines
NIR	68 top journals	Annual papers	Numbers of papers	4 disciplines
ARWU	Articles collected by InCites	Approximately 5 years	Numbers of papers in CNKI	72 disciplines
QS	Scopus database	Approximately 5 years	Citation rate and h index	56 disciplines

the number of faculty members (20%) who have won a Nobel Prize or Fields Prize, the number of scientists who have received the highest number of citations in various academic fields (20%), the number of papers published in Nature and Science (20%), the number of papers included in the SCIE and SSCI (20%) and the average score of the above indexes (10%).

Except for THEWUR, the proportion of bibliometrics in the four global university ranking index systems mentioned above is more than 60%. This shows that bibliometrics has become an important evaluation index in university academic ranking and evaluation (Yin, 2017).

International mainstream academic evaluation index systems

At present, the generally accepted mainstream academic evaluation systems are the Basic Scientific Index Database of the United States (ESI), the Nature Index of the United Kingdom (NI) (Fang et al., 2017), the top ranking of soft sciences in the world of Shanghai Jiaotong University (ARWU) and the Discipline Ranking of World Universities (QS), as shown in Table 1.

To measure the performance of scientific research and track the trend of scientific development, the Institute of Science and Technology Information (ISI) of the United States builds the Database of Basic Scientific Indexes (Du, 2016). The SCIE/SSCI papers of Thomson Reuters (now Clarivate Analytics) in the last 10 years are used as the bibliometric data sources. The threshold of measuring research performance is determined according to the frequency of citations. The top 1% of research institutions, scientists and research papers in the world; the top 50% of the world's countries/regions and the top 0.1% of the hot papers are listed.

The UK Natural Publishing Group builds the Natural Index Rankings (NIR) (Zhao and Zhao, 2013) according to 68 top journals in the world as its bibliometric data source, and the index uses the contributions of the countries and scientific research institutions that have published approximately 60,000 high-quality scientific research

papers annually as the calculation basis. The NIR measures the annual index of scientific research institutions through three measurement methods: counting papers, fractional measurement and weighted fractional measurement.

The Research Center of the World-Class and First-Class University of Shanghai Jiaotong University (now Shanghai Soft Science) has developed the Ranking of the World-Class and First-Class Disciplines in Soft Science based on the paper data collected by Thomson Reuters (now Clarivate Analytics) SCIE/SSCI in the InCites database in the last five years as its bibliometric data source. Through the comprehensive calculation of the total number of papers, the influence of papers, the proportion of international cooperation papers, the number of papers in top journals and the number of authoritative awards, the Ranking of the World-Class and First-Class Disciplines in Soft Science ranks the disciplines of scientific research institutions.

The QS World University Discipline Ranking is a ranking published by the British Educational Organization, which uses the paper data from the Scopus database of the Elsevier Publishing Group in the past five years as its bibliometric data source. Through a comprehensive calculation based on peer academic reputation, employer evaluations of students' employment reputation, the citation rate of papers, the h index and other evaluation indicators, it ranks the disciplines of various scientific research institutions. From the above contents, we can see that the total number of papers and the citations of papers in a certain period of time are important indicators of academic evaluations in the process of scientific research institutions by the mainstream academic evaluation index systems evaluating the subjects of scientific research institutions.

Thoughts on China's Academic Paper Evaluation Index System

The content of the global university ranking and academic evaluation index systems show that the bibliometrics of the

number of citations and the publications of universities and scientific research institutions in a certain period of time have become the main bases for the evaluation index systems of universities and disciplines, but these evaluation indexes also have some common problems. First, the bibliometric data sources are relatively singular, and the weights of non-English bibliometric data sources are not enough to objectively reflect the level of academic research of non-English language regions or our country scientific research institutions. Second, the bibliometric intervals are relatively scattered, and the weighting of the interval change curve is insufficient, which cannot objectively reflect the rapid development of science and technology in developing countries or innovative countries. Third, the detailed classification of disciplines is relatively vague, and the customization function of discipline classification is imperfect, which cannot objectively reflect discipline classifications and academic focuses at the country level. Therefore, the author believes that the current mainstream evaluation index systems from abroad should not be blindly copied, but rather we should form a new evaluation index system combined with the actual situation of domestic university discipline construction and development (Liu et al., 2008; Wang and Zhou, 2008; Zhang and Zhang, 2007). The new evaluation index system for the academic papers published from authoritative academic journals both at home and abroad is constructed using the number of papers, impact factors, citation frequency, h index, research value, international exchanges and cooperation, research hotspots, etc.

Establishment of an evaluation index system based on bibliometrics

The indexes in China's double first-class discipline construction mainly include teaching level, teaching achievements, personnel training, teacher introductions, academic papers, international and domestic awards, domestic and foreign patents, social service ability and other indicators. Among the indexes, the proportion of academic papers is 15%, which makes it an important index because of its great weight.

Previously, peer review is used to evaluate papers. When evaluating papers, foreign papers used the SCI and EI databases as the measurement bases while domestic papers used core journals and noncore journals as the measurement basis. They conducted only simple classification and weighting. An average score was obtained by many experts scoring the evaluation results. With the advent of the information age, the number of papers is growing exponentially. Peer review is unable to meet paper evaluation needs. People continue to explore some objective evaluation indexes and methods to accurately evaluate papers.

As an important branch of science, bibliometrics takes

scientific literature as its research object. Through the comprehensive use of statistical analysis, social network analysis and mathematical modeling, bibliometrics can quantify the characteristics of researchers and scientific literature and their relationship. Bibliometrics provides theoretical and methodological support to reliably evaluate the scientific research productivity, academic influence and scientific frontier progress of researchers, research teams, research institutions, countries, regions, or a certain discipline field and scientific frontier progress. It also provides a quantitative scientific basis for national scientific research management, scientific decision making and the utilization of scientific funds (Wen, 2007; Yang, 2014; Fu, 1982; Qiu, 2007). Considering the feasibility, scientificity and objectivity of this method, bibliometrics is becoming a new way for thinkers to effectively manage science and technology under a new environment (Pang, 2018).

At present, China adopts the bibliometric method combining the foreign SCI/SSCI paper database with the domestic CSCD/CSSCI paper database. The impact factor, citation frequency, other citation times, citation depth, adoption rate of government departments and enterprises and social influence are taken as the important evaluation indexes. This method significantly improves the breadth and depth of the evaluation, which makes the level of grading of papers clearer and highlights the importance of high-level academic papers.

Construction principles

The evaluation index system of double first-class disciplines is constructed according to the published papers in the SCIE/SSCI and CSSCI/CSCD databases as the bibliometric source, the internationally known evaluation indexes of "Publication Papers and Citation Efficiency", and the first-class discipline classification issued by the Ministry of Education. The evaluation index system conforms with the following four principles (Li et al., 2018; Pan Jian et al., 2018), as shown in Figure 1.

Guiding principle: While correctly evaluating the achievements of double first-class discipline construction, we should pay attention to the construction of high-level academic journals in China and gradually guide scientific researchers to publish academic papers in domestic high-level academic journals.

Systematic principle: In the design process of the discipline evaluation index, we should correctly address the following relationships: scientific research accumulation and technology innovation, paper quantity and paper quality, citation quantity and citation effect, and natural science and social science.

Scientific principle: In the process of constructing the

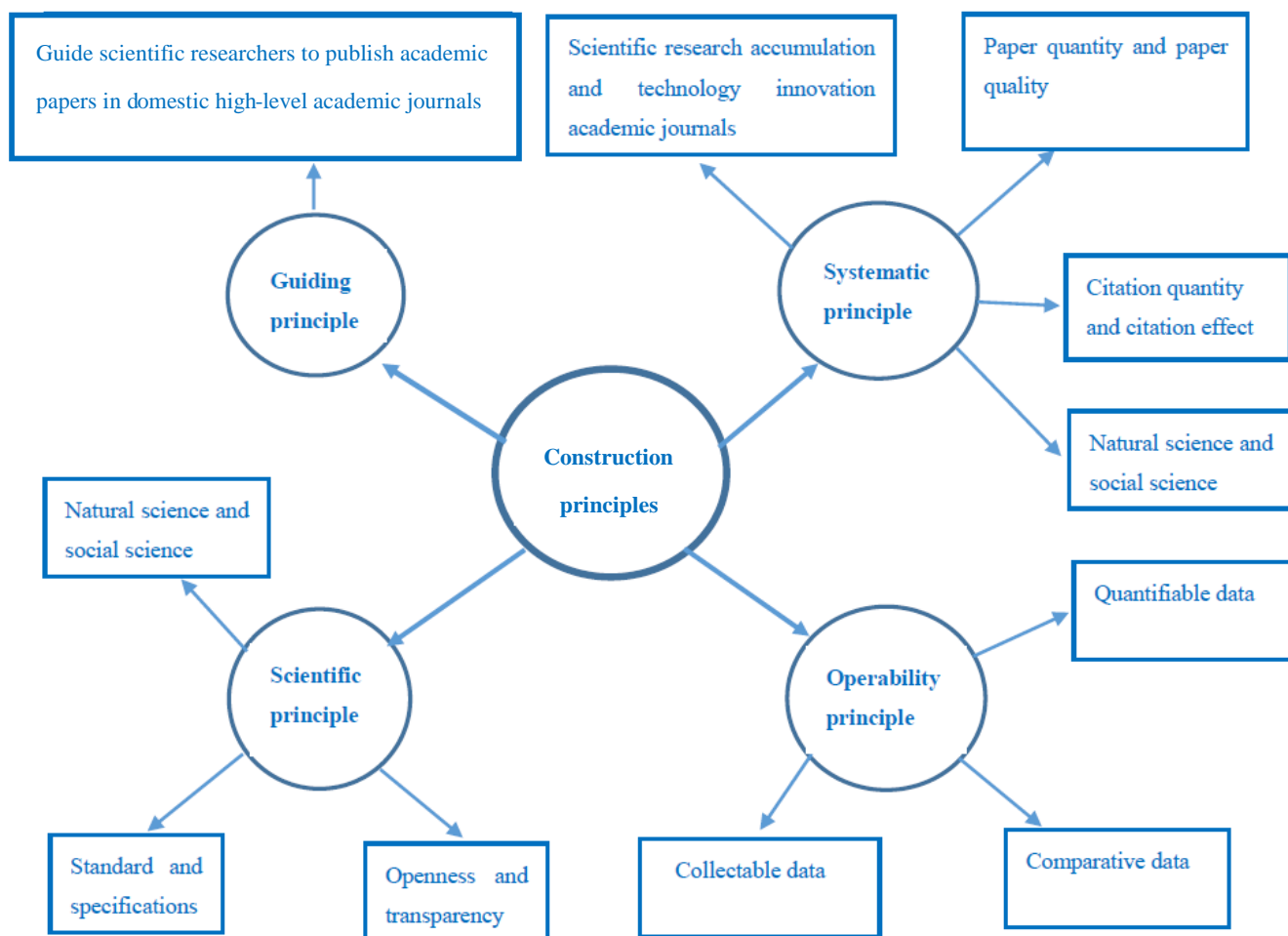


Figure 1. Construction principles of the evaluation index system.

discipline evaluation system, we should promote its standards and specifications, science and reasonability, and openness and transparency so that it conforms to our country's double first-class construction and can guide scientific research. In addition, the discipline evaluation system should be able to withstand the tests of history and reality.

Operability principle: In the acquisition process of the discipline evaluation data, it is required that the evaluation index be easy to quantify, the quantitative data are easy to collect, and the evaluation data are easy to compare and analyze.

Construction ideas

The main purposes of constructing a bibliometric evaluation index system for double first-class disciplines is to gradually weaken the absolute position of SCIE/SSCI papers in our country's academic evaluation, guide

scientific researchers to publish academic papers in domestic high-level academic journals, and steadily enhance the weighting of the "discipline system, academic system and achievement system" in international universities and discipline evaluation systems (Liu, 2020; Su et al., 2012; Du, 2019). The main ideas for the construction of the disciplinary evaluation system are described in Figure 2.

Literature sources: Taking the academic papers collected in the SCIE/SSCI databases and CSSCI/CSCD databases as the bibliometric data sources, the data sources are quantitatively analyzed using evaluation indexes such as the total number of papers, the citation efficiency, the number high-level papers, the number of highly cited papers and international cooperation to objectively assess the achievements and level of discipline construction of universities.

Discipline classification: Taking the discipline classifica-

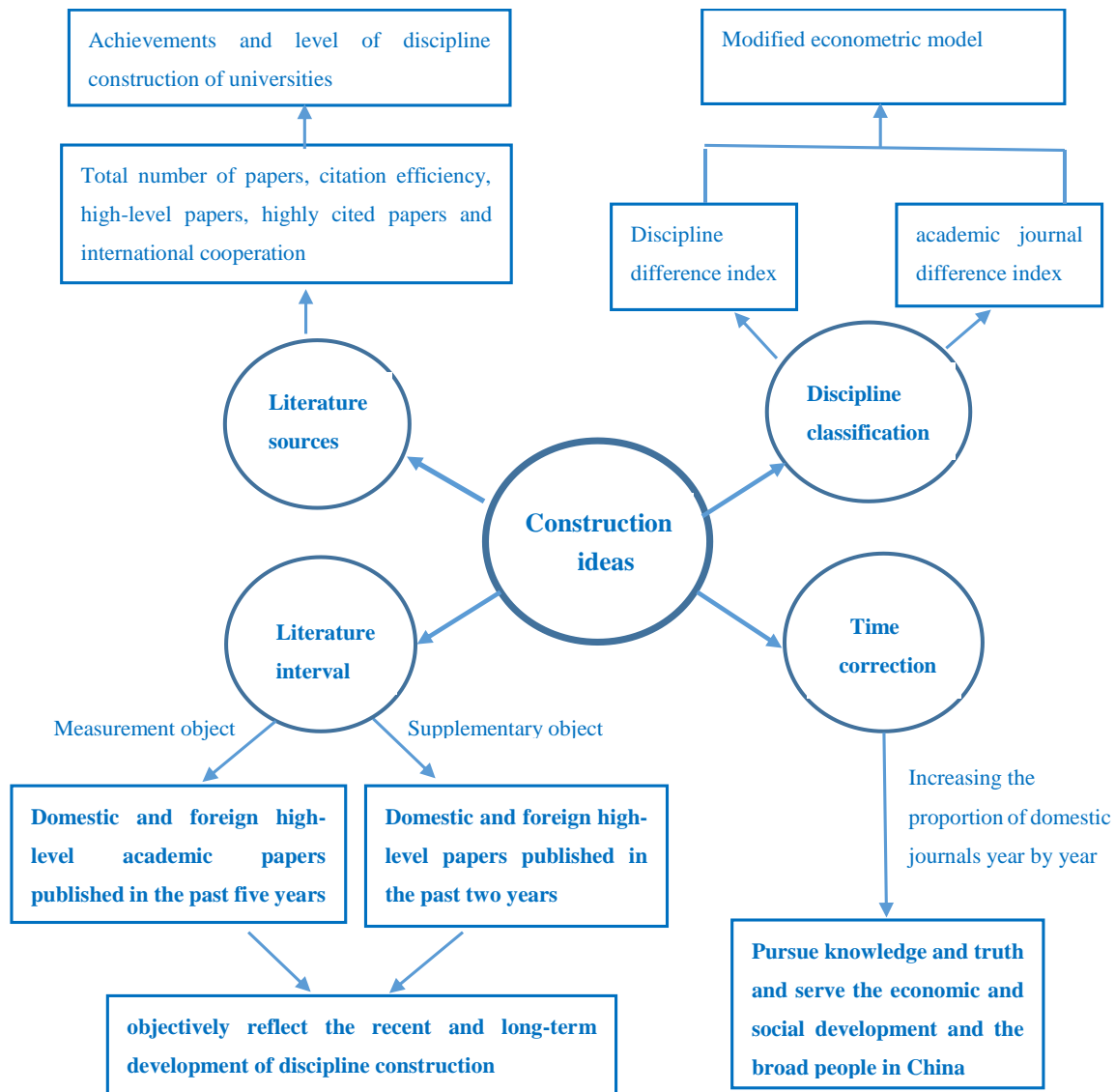


Figure 2. Construction ideas of the evaluation index system of academic papers.

tion criteria of the Ministry of Education as the object of discipline classification evaluation, on the basis of the discrepancies existing in foreign discipline classification, the discipline difference index and academic journal difference index are determined by expert scoring and questionnaire surveys, and the measurement objects of disciplines and academic journals involved in channels are corrected and/or processed.

Literature interval: To objectively reflect the recent and long-term development of discipline construction in universities and scientific research institutes, the data of domestic and foreign high-level academic papers published in the past five years are taken as the main evaluation objects and measurement objects. Then, the

data of the domestic and foreign high-level papers published in the past two years are taken as the supplementary measurement objects of universities and scientific research institutions. Furthermore, the ratio of domestic to foreign high-level academic papers is 3:7, which conforms to the literature research, expert evaluation and empirical analysis. With the development of China's economy, science and technology, this ratio will also increase. Its main purpose is to objectively reflect the recent and long-term development of discipline construction in universities and scientific research institutions.

Time correction: Taking the published foreign high-level academic papers (70%) as the starting point and domestic

Table 2. Evaluation index system and weighting of academic papers for double first-class disciplines based on bibliometrics.

First-level indexes	Weighting	Secondary-level indexes	Weighting	Notes
Total number of papers	0.3	SCIE/SSCI	0.21 - λ	Decrease by 2% per year
		CSSCI/CSCD	0.09 + λ	Increase by 2% per year
Citation efficiency	0.3	Total number of citations	0.2	ESI
		Average number of citations per paper	0.1	Average number of citations per article
High-level papers	0.2	Highly cited papers	0.1	The top 1% of ESI
		Top journal papers	0.1	Top papers at home and abroad
International cooperation	0.2	Foreign papers	0.1	Cooperative papers published at abroad
		Domestic papers	0.1	Cooperative papers published in China

high-level academic papers (30%) as the supplement of the evaluation, the proportion of domestic and foreign academic journals is gradually revised by the paper balance index (2%). During the 10-year revision, the proportion of SCIE/SSCI and CSSCI/CSCD journals was 5:5. Scientific research not only pursues knowledge and truth, but it also serves economic and social development and the people as a whole. The vast number of scientific and technological workers should write scientific papers on China and apply scientific and technological achievements to realize the great cause of modernization (Qi, 2016).

Index design and weight

On the basis of the comprehensive ranking and discipline evaluation of famous institutions at home and abroad, the system introduces CSSCI/CSCD academic papers as a reasonable supplement to the discipline evaluation. The bibliometrics of discipline construction in universities is conducted using four first-level indexes (total number of papers, citation efficiency, high-level papers and international cooperation). Eight secondary-level indexes (the number of SCIE/SSCI papers, the number of CSSCI/CSCD papers, total number of citations, average number of citations per paper, number of highly cited papers, number of top journal papers, number of international cooperation papers published at home and number of international cooperation papers published abroad) are included in four first-level indexes, as shown in Table 2.

Index analysis and explanation

The scientific research output of universities is mainly measured using the total number of papers using two secondary-level indexes: the number of papers collected from the SCIE/SSCI and the number of papers collected from the CSSCI/CSCD. In general, the total number of

papers published in the SCIE/SSCI and CSSCI/CSCD in the last five years is taken as the main research data. In order to affirm the effectiveness of recent discipline construction in universities, the total number of papers collected in the SCIE/SSCI and CSSCI/CSCD in the last two years is used as supplemental data. The specific calculation formula is as follows: the total number of papers = the total number of papers cited in the past five years \times 75% + the total number of papers cited in the past two years \times 25%. To further highlight the role of the number of papers collected in the CSSCI/CSCD in the evaluation system, the balance index of the annual number of published papers (λ) is introduced. The weighting of the number of papers collected in the CSSCI/CSCD is increased by 2% annually. Through 10 years of accumulation, the ratio of the number of papers collected by the SCIE/SSCI in various disciplines to the number of papers collected in the CSSCI/CSCD has reached 5:5, which has encouraged researchers to publish high-level papers in domestic journals.

The citation efficiency is mainly used to measure the research achievement of universities, and it is measured using two secondary-level indexes: the total number of citations (called total citations) and the average number of citations per paper (called citation impact). The total number of citations is the total number of SCIE/SSCI or CSSCI/CSCD papers cited by other academic papers in the SCIE/SSCI or CSSCI/CSCD systems in the past five years. The specific calculation formula is as follows: Total number of citations = total cited numbers of SCIE/SSCI in the past five years \times 50% + total cited numbers of CSSCI/CSCD in the past five years \times 50%.

The average number of citations per paper collected in the SCIE/SSCI and CSSCI/CSCD in the last five years is also calculated. The specific calculation formula is as follows: Average number of citations per paper = (total number of citations in the SCIE/SSCI in last five years + total number of citations in the CSSCI/CSCD in the last five years)/(total number of citations of SCIE/SSCI papers

Table 3. Evaluation index system and weighting of academic papers for certain double first-class disciplines in Western China based on bibliometrics.

First-level indexes	Secondary-level indexes	Weight	2017	2018	2019	2020
Total number of papers	SCIE/SSCI	0.21 -λ	0.165	0.171	0.176	0.181
	CSCD/CSCI	0.09 +λ	0.084	0.093	0.098	0.104
Citation efficiency	Total number of citations	0.2	0.136	0.145	0.154	0.163
	Average number of citations per paper	0.1	0.051	0.056	0.062	0.065
High-level papers	Highly cited papers	0.1	0.057	0.074	0.071	0.076
	Top journal papers	0.1	0.048	0.054	0.065	0.072
International cooperation	Foreign papers	0.1	0.072	0.082	0.088	0.081
	Domestic papers	0.1	0.073	0.082	0.091	0.092
Total	-	1.00	0.686	0.757	0.805	0.834
Average	-	1.00	0.771			

in the last five years + total number of citations of CSSCI/CSCD papers in the last five years).

High-level papers are mainly used to measure the high-level scientific research achievements of universities, and they are measured two secondary-level indexes: highly cited papers and top journal papers. Highly cited papers are measured as the total number of highly cited papers collected in the SCIE/SSCI and CSSCI/CSCD in the past five years. The specific calculation formula is as follows: the number of highly cited papers = the number of top 1% highly cited papers in the SCIE/SSCI in the last 5 years × 50% + the number of top 1% highly cited papers in the CSSCI/CSCD in the recent 5 years × 50%. The number of top journal papers is calculated as the total number of journal papers with the top 20% average impact factors collected in the SCIE/SSCI and CSSCI/CSCD in the past five years. The specific calculation formula is as follows: the number of top journal papers = the number of journal papers with a top 20% average impact factor in the SCIE/SSCI in the past five years × 50% + the number of journal papers with a top 20% average impact factor in the CSSCI/CSCD in the past five years × 50%.

International cooperation is mainly used to observe the international cooperation of the scientific research of colleges and universities, and it is measured using two secondary-level indexes: foreign papers (cooperative papers published abroad) and domestic papers (cooperative papers published domestically). Domestic papers are the total number of international cooperation papers in the CSSCI/CSCD in the last five years.

Considering the lower starting point of domestic papers and expanding the influence of domestic journals in international academic circles, the setting of weights is inclined to a certain extent. The weighting of domestic papers is set to 10%. The total number of international cooperation papers published in the SCIE/SSCI in the past five years is included in foreign published cooperative papers. Considering the objective factors of the

SCIE/SSCI published papers, the weighting setting is controlled to a certain extent, and the weighting value is set to 10%.

According to the above calculation formula, the academic papers of the SCIE/SSCI and the CSCD/CSSCI published from 2014-2017, 2015-2018, 2016-2019 and 2017-2020 (from Jan.-Oct. 2020) are used to calculate the academic paper achievement of a certain double first-class discipline in Western China in 2017, 2018, 2019 and 2020. It is known that the target value of the four-year evaluation period of the double first-class universities is 0.75. The indexes obtained from bibliometrics and the above calculation formula are shown in Table 3. Table 3 shows that the values of the SCIE/SSCI, CSSCI/CSCD, the total number of citations and the number of domestic papers increased rapidly from 2017 to 2020. The average number of citations per paper and highly cited papers should be elevated, which is the direction for improving double first-class construction in the future. The average forecast value during 2017-2020 is 0.771, which is greater than the target of 0.75. The results show that academic papers have reached the double first-class discipline level of the Ministry of Education. In October 2020, the Education Ministry of China organized more than ten academicians to evaluate the construction of Western China's double first-class disciplines in Chengdu. The evaluation results show that these disciplines have passed the assessment of double first-class construction. The average value of academic papers from 2017 to 2020 is 0.767, which is very close to the predicted value of 0.771, indicating that this prediction method is reliable.

CONCLUSION

According to international standards, world-class and first-class universities emphasize scientific research contributions and international academic standards (Zhou and Wu, 2016). In this study, we establish a bibliometric

evaluation index system for academic papers in double first-class discipline construction. The academic paper achievements of the double first-class discipline construction are evaluated by four indexes: the total number of papers, citation efficiency, high-level papers and international cooperation. In addition to learning from Western countries' SCI/SSCI as an important index, we also integrate Chinese elements, namely, the CSCD/CSCI, as useful supplementary materials. The number of Chinese elements will increase each year due to serving our own country, the people and the local areas, which will promote the construction of "double" world-class and first-class domestic universities. Universities and disciplines are not only the only institutions constructed into double first-class universities and disciplines. Important academic journals in China are also constructed into high-level academic journals. To construct first-class academic journals in China, we fully integrate the discipline evaluation index system, which truly reflects the achievements of double first-class construction and truly realizes the development goal of serving our country's double first-class strategy. The predicted value obtained from bibliometrics and the calculation formulas is close to the actual evaluation value, which indicates that this prediction method is reliable. Due to the dynamic change in the construction of double first-class disciplines, disciplines are eliminated in each evaluation. The four-year average index of academic papers of the evaluated discipline is relatively low; and if it is not improved in the later stage, it will face the risk of being eliminated.

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