Exploring the Construction Path of Top Disciplines under the Background of "Double First-Class" Decentralization Reform — A Case Study of the Chemistry Discipline at a Leading Domestic University

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Abstract: Against the backdrop of the "Double First-Class" decentralization reform, in order to better understand the global standing of China's top chemistry disciplines, we evaluate their research outcomes by comparing them with those of chemistry departments at other world-class universities. Using the curriculum vitae analysis method, we analyze the quality of chemistry-related papers published over the past three years by top universities at home and abroad. The study finds that international top universities possess a clear advantage in the quality of scientific research outcomes in chemistry; two top Chinese universities maintain a leading position domestically and, to a certain extent, approach the level of international top universities, particularly with outstanding performance by young scholars; international top universities tend to publish their scientific results in journals with higher impact. Based on these findings, we suggest that in order to enhance the international influence of the chemistry discipline, it is necessary to further strengthen collaboration with world-class institutions; build research teams with international competitiveness and influence, and cultivate outstanding backbone talents; continuously promote interdisciplinary cooperation; and reinforce the development of top domestic academic journals.
***Keywords*:** Double First-Class, top disciplines, comparison of domestic and international universities, construction path

1. Research Background

The year 2022 marked the beginning of a new round of "Double First-Class" construction, an initiative aimed at further enhancing the international competitiveness of top universities and disciplines within China's higher education system. The Several Opinions on Further Promoting the Construction of World-Class Universities and First-Class Disciplines was issued. This document not only pointed out the direction for the development of higher education in China but also emphasized piloting the "Double First-Class" decentralization reform in selected universities. The pilot aims to explore a more flexible and efficient mechanism for teaching and research management, thereby promoting academic innovation and talent cultivation, and accelerating the construction and development of high-level disciplines.This paper takes the chemistry discipline of a leading domestic university as its subject. This discipline has consistently adhered to the principle of "based on fundamentals, oriented to national needs," achieving remarkable results in teaching and research. In recent years, the chemistry discipline of this university has not only gained a high reputation domestically but has also been increasingly recognized internationally.To better understand the global position of a top domestic chemistry discipline, we evaluate it by comparing its research outcomes with those of chemistry departments at other world-class universities. To accurately compare the differences between domestic chemistry disciplines and those of top universities worldwide, we adopt a method based on paper quality evaluation. This includes analyzing the quality of chemistry-related papers published over the past three years by various universities.Through a comparative study of this domestic chemistry discipline and the chemistry departments of top institutions such as Harvard University, Stanford University, the Massachusetts Institute of Technology (MIT), the California Institute of Technology, and the University of California, Berkeley, we find that although the chemistry discipline of this university has made great progress in recent years, certain gaps still exist. For instance, while its average citation rate is excellent, it remains lower than that of top universities like Harvard. However, it is noteworthy that with the advancement of the "Double First-Class" initiative, this chemistry discipline has recognized these issues and is taking steps to improve. For example, it has sought to enhance its strength through strengthening international cooperation and exchange, as well as improving the quality of graduate education. It is foreseeable that with the gradual implementation of these measures, the global standing of this university's chemistry discipline will be further consolidated.

2. Main Findings

First, through the curriculum vitae analysis method, we gained a preliminary understanding of the faculty composition of the chemistry discipline at the university compared with other institutions. Since the chemistry departments of the foreign

benchmark institutions are relatively small in size, resulting in an insufficient data sample, the five top institutions were combined into a single dataset for comparison, comprising 105 faculty members and 1,671 research outputs. The leading domestic university (Leading Domestic University 1) has 62 faculty members with 1,745 research outputs, while another top domestic university has 60 faculty members with 1,348 research outputs.For ease of analysis, we divided the samples into three generations: senior, middle-aged, and young. Figure 1 shows the generational distribution of the three groups. Considering that some members of the young group who joined after 1985 had relatively short tenure and their research outputs were not yet mature, we excluded them from the dataset. As can be seen, the three generations in the foreign benchmark group are relatively evenly distributed. In contrast, the domestic university shows a more pronounced generational gap. However, it is worth noting that more than ten faculty members born after 1985 were not included in the sample due to their short tenure; once included, their number would be comparable to that of the middle-aged group.

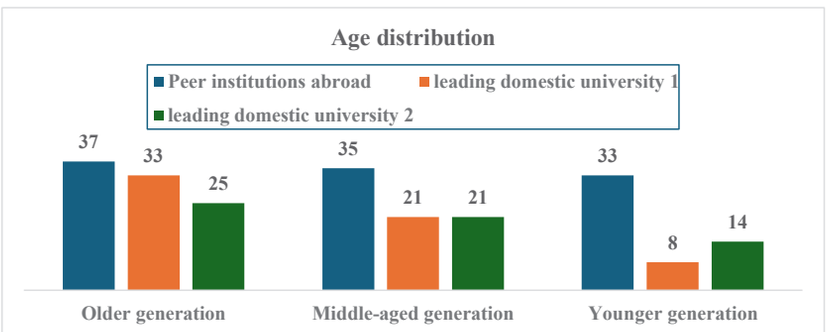

Figure 1. Age distribution of faculty at international benchmark universities, the target university, and domestic benchmark universities

Next, we conducted statistics on the research output of faculty members from different generations. Using the Web of Science database, we compiled the publication records of each faculty member from 2020 to 2022. Figure 2 presents a scatter plot showing the average quality of research outputs by year of birth. As shown in the figure, a small number of faculty members in the foreign benchmark sample perform exceptionally well, a situation not observed in the two domestic samples.

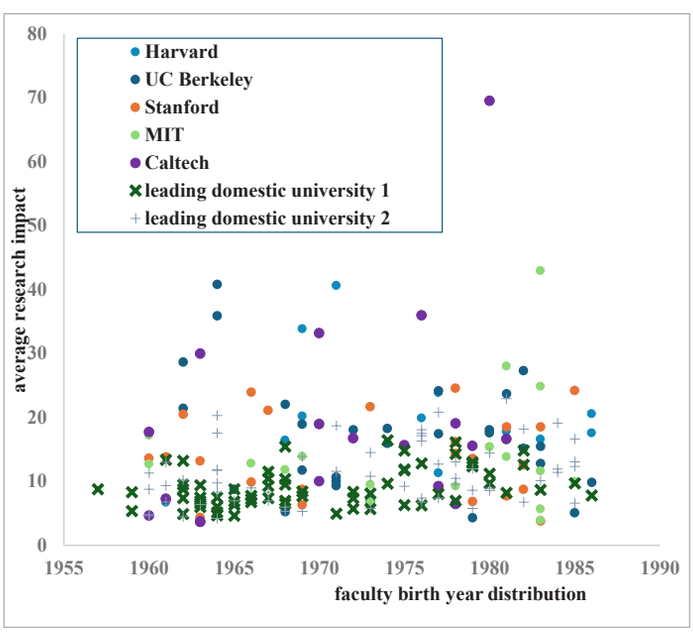

Figure 2. Variation in the average quality of research outputs across seven universities by faculty birth year

Using a two-way analysis of variance (ANOVA), we obtained the mean values of research output quality across generations and among different sample groups, as shown in Figure 3. It can be seen that there are certain differences among the three sample groups, but the data are relatively scattered, making it difficult to draw conclusions based on a single average value. Therefore, we applied the t-test method to compare the research output quality across different generations in

order to determine whether differences exist between institutions.

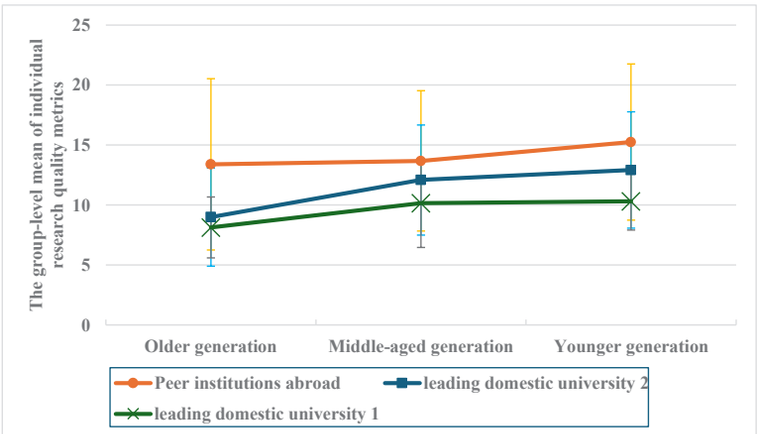

Figure 3. Comparison of average research output quality among three groups across three generations

Table 1 presents the mean values and variances of research output quality across different generations for the three sample groups, along with the p-values of the t-tests comparing the other two groups with the leading domestic university. It can be seen that, compared with the foreign benchmark group, there are significant differences in the senior and middle-aged groups, while no significant difference exists in the young group; compared with the domestic benchmark, no significant differences are observed across all three generations.

Table 1. Comparison of Mean Research Output Quality across Three Generations between Benchmark Institutions and the Leading Domestic University (Chemistry)

	Foreign Benchmark (n=105)	Leading Domestic University(n=62)	Domestic Benchmark(n=60)	Foreign Benchmark vs. Leading Domestic University t-test p-value	Domestic Benchmark vs. Leading Domestic University t-test p-value
Senior	15.29±9.46 (n=37)	8.13±2.54 (n=33)	8.99±4.09 (n=25)	0.000**	0.36
Middle-aged	15.64±8.62 (n=35)	10.15±3.69 (n=21)	12.08±4.59 (n=21)	0.002**	0.141
Young	17.73±12.22 (n=33)	10.31±2.40 (n=8)	12.92±4.85 (n=14)	0.098	0.173

Note:* p<0.05; ** p<0.01

Based on the data analysis, we arrived at the following main findings:

(1) International top universities such as Harvard University, Stanford University, the Massachusetts Institute of Technology (MIT), the University of California, Berkeley, and the California Institute of Technology hold a clear advantage in the quality of scientific research outputs in the field of chemistry.

(2) The two domestic universities occupy leading positions within China and, to a certain extent, approach the level of international top universities, with scholars born in the 1980s performing particularly well.

(3) International top universities such as Harvard University, Stanford University, the Massachusetts Institute of Technology (MIT), the University of California, Berkeley, and the California Institute of Technology tend to publish their research outputs in journals with higher impact.

3. Cause Analysis

Based on the analysis results, we can infer the following reasons:

(1) International top universities possess a longer history of modern scientific research, a wealth of academic accumulation, sound management mechanisms, greater resources, and larger funding investments, enabling them to attract more outstanding researchers and research teams, thereby producing more high-level papers. The foreign benchmark group includes researchers with exceptionally high average and total research output quality—academic masters—whereas domestic institutions still require further accumulation in comparison.

(2) The development of domestic journals in China remains insufficient, and the discourse power in the scientific community is still largely held by developed Western countries.

(3) In recent years, China's top universities have increased their support for scientific research and attracted a group of outstanding researchers, leading to significant progress in the field of chemistry. Most members of the young group joined the university after the implementation of the "Hundred Talents Program." The "Hundred Talents Program" was launched at the end of 2005 as an important talent initiative focused on recruiting outstanding young scholars. Open to all departments of the university, the program aims to recruit a group of young scholars who meet the requirements of building a world-class university and have the potential to become future academic leaders.The implementation of the "Hundred Talents Program" not only enabled the university to seize the opportunity to recruit a large number of excellent young scholars but also explored a pathway for building its future academic workforce. As the university's first youth talent recruitment program open to all departments, it introduced a challenging yet competitive mechanism, including quality review for recruitment, mid-term performance evaluations, and final international assessments. These measures continuously improved the talent evaluation system and assessment methods, enriched the academic workforce in practice, and brought substantial benefits to the chemistry discipline.

(4) Compared with the domestic benchmark university, there is a certain difference in the mean quality of research outputs, though not significant at present. From the curriculum vitae analysis, the domestic benchmark university has introduced a considerable number of academic leaders from other institutions in China, rapidly strengthening its research teams and improving faculty composition. The leading domestic university, however, mainly relies on cultivating talent from within, and its strength will take more time to manifest. Principal Investigators (PIs) who joined after 1985 were not included in the dataset due to their relatively short tenure, but their research capacity has already begun to show, with several important results published.

(5) In terms of research collaboration, compared with foreign institutions, the two domestic top universities show relatively limited internal cooperation. In most cases, publications are authored solely by faculty within the same research group, while joint outputs across different groups are less common. This may be related to the need for strengthening academic culture: academic culture is an important support for disciplinary development, yet shortcomings remain in this regard domestically. Excessive competition among faculty may hinder collaboration, resulting in a weaker cooperative atmosphere. Therefore, it is necessary to enhance communication and collaboration between faculty and students, and foster a positive, open, and inclusive academic culture.

The Impact of Decentralization Reform on the Construction of Top Disciplines

The impact of decentralization reform on the construction of top disciplines is multifaceted and can be analyzed from the following aspects:

(1) Enhancing autonomy in discipline development: Decentralization reform grants universities greater autonomy, enabling disciplines to allocate resources, formulate policies, and establish management mechanisms with more flexibility. In the construction of top disciplines, discipline leaders can make more independent decisions regarding development direction, talent recruitment, and training programs.

(2) Strengthening talent recruitment and cultivation: Through decentralization reform, disciplines gain more autonomy in selecting and recruiting outstanding faculty and researchers. Disciplines can formulate more attractive policies and incentives, providing excellent talents with better growth environments and development opportunities. At the same time, targeted training programs can be carried out to meet the needs of top discipline construction and improve the overall quality of the faculty team.

(3) Funding input and support: Decentralization reform provides disciplines with more channels and avenues to obtain financial support. Disciplines can secure additional research funding through independent project applications, collaborative research, and industry partnerships. This increases funding input for top discipline construction, provides better experimental equipment and research conditions, and promotes improvements in research standards.

(4) Promoting innovation and collaboration: Decentralization reform encourages universities to carry out innovative activities and collaborative research. Disciplines can independently establish cooperative mechanisms to strengthen collaboration among faculty members, between universities, and with external partners such as enterprises and research institutions. By conducting interdisciplinary research cooperation, cross-disciplinary integration and innovation in the construction of top disciplines can be advanced.

In general, decentralization reform has brought greater autonomy and flexibility to universities in the construction of top disciplines, as well as more resources and support. By strengthening talent recruitment and cultivation, increasing funding input and support, and promoting innovation and collaboration, the construction of top disciplines can achieve greater accomplishments.

4. Conclusions and Policy Recommendations

Based on the research findings and the analysis of underlying causes, the following conclusions and recommendations are proposed:

(1) Strengthening collaboration with world-class institutions to enhance the international influence of the discipline. Leading universities worldwide still maintain significant advantages in the field of chemistry. Strengthening cooperation and exchanges with these universities will help continuously improve the research capacity of the discipline. It is necessary to expand international cooperation networks, increase the enrollment of international students, optimize training programs, and attract outstanding high-level international scholars as well as young talents, thereby enhancing the degree of internationalization. Although the chemistry discipline of this university has actively engaged in international exchanges and cooperation, there is still room for improvement in terms of both the number and quality of collaborative projects compared with well-known international universities and research institutes. Therefore, more international joint projects and collaborative training programs should be actively pursued.

(2) Increasing research investment and advancing the development of first-class disciplines. China's top universities have already achieved notable progress in chemistry. However, further efforts are still required to strengthen funding support, faculty development, and the recruitment of outstanding talents, so as to ensure long-term, stable growth of world-class disciplines.

(3) Building high-level research teams and fostering an innovative academic environment. High-caliber research teams are the driving force behind the construction of first-class disciplines. It is essential to cultivate outstanding backbone researchers and provide long-term support for those engaged in fundamental research driven by free exploration. They should be granted sufficient autonomy and room for trial and error, in order to create a relaxed, open, and inclusive academic atmosphere and an innovative culture that enhances the overall competitiveness of the discipline.

(4) Interdisciplinary integration and collaboration as a key pathway to enhancing competitiveness. Interdisciplinary cooperation plays a vital role in the development of chemistry and should be further strengthened. Greater efforts should be made to foster exchanges and collaboration with related fields such as materials science, biology, and environmental science, thereby promoting cross-disciplinary integration, innovation, and breakthroughs.

(5) Improving academic evaluation mechanisms and safeguarding academic freedom. It is essential to refine evaluation systems and build incentive mechanisms that encourage faculty members to pursue innovative research and cross-disciplinary collaboration. Through the development of incentive frameworks and performance evaluation systems, academic vitality and innovation capacity can be stimulated. Moreover, strengthening mechanisms for teamwork is equally important: universities should promote communication and collaboration among faculty members, encourage them to launch joint research projects, and cultivate strong team cooperation skills.

(6) Strengthening the development of leading domestic academic journals. Efforts should be made to enhance the influence of China's top-tier academic journals, thereby expanding the voice and discourse power of the domestic academic community.

In summary, this study has drawn the above conclusions and recommendations. It is hoped that these findings can provide valuable references for universities in advancing the construction of world-class disciplines and contribute to the continuous improvement of higher education in China.

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