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Research on the Multi-agent Collaborative Cultivation Model of German Female Scientific and Technological Talents and Its Enlightenment to China

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Abstract. "Accelerating the construction of a strong country in science and technology" is an inevitable requirement of the times. Building a strong scientific and technological country requires solid support from scientific and technological talents. However, in China's current situation, the supply of high-end scientific and technological talents cannot meet the target demand for China to take the lead in the scientific and technological track, and the problem of brain drain is serious. Therefore, strengthening the construction of the team of female scientific and technological talents has become a necessary choice for China's strategy of building a strong scientific and technological country. Taking Germany as an example, this paper aims to provide reference for the cultivation of female scientific and technological talents in China by analyzing the roles of different subjects in Germany's multi-agent collaborative cultivation model of female scientific and technological talents, introducing the effectiveness of this cultivation model, and evaluating its advantages and disadvantages, and put forward corresponding suggestions for cultivating female scientific and technological talents in China from multiple perspectives.

Keywords: Germany, cultivation of scientific and technological talents, women, multi-agent collaboration

1. Introduction

Scientific and technological innovation is the core of China's overall development. China adheres to the strategies of rejuvenating the country through science and education and strengthening the country through talents, and has gradually formed a collaborative innovation system with technology-based enterprises, research institutes and universities as the main bodies. In the long history of scientific and technological development, women have played an immeasurable role in its progress. Although there are many precedents of women achieving accomplishments in the field of science and technology, the development of female scientific and technological talents is still restricted by traditional concepts. If we can build an education system and social atmosphere conducive to the development of female scientific and technological talents, and increase the proportion and discourse power of women in the high-tech field, it will not only make up for China's shortage of high-end scientific and technological talents, but also promote the formation of the

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concept of social gender equality. As a major scientific and technological country, Germany recognized the importance of achieving gender equality in the field of science and technology at an early stage. Since the end of World War II, the East German government has promoted women to enter production fields such as engineering and science and technology through a series of intervention policies. After several stages of development, Germany has formed a relatively mature policy system and practical methods for cultivating female scientific and technological talents. Through the cultivation model of multi-agent collaboration, the proportion of women in high-end scientific and technological fields has been increased [1]. The multi-agent collaborative innovation system is also the way for China to cultivate scientific and technological talents, so the study of Germany's case has important reference value for China to improve the multi-agent collaborative system. This paper adopts literature research and case analysis methods to provide reference for the cultivation of female scientific and technological talents in China.

2. The multi-agent collaborative cultivation model of german female scientific and technological talents

In the process of cultivating female scientific and technological talents, a single force in society cannot provide complete support, and multiple forces need to participate together, which requires the adoption of a multi-agent collaborative cultivation model. The multi-agent collaborative cultivation model is an educational training method involving multiple subjects such as universities, governments, enterprises, research institutions and the public. Its core characteristics include openness, diversified participation and resource sharing. The cultivation of talents in Germany not only needs to be guaranteed by the policy formulation of the national government, but also needs financial support from the government. For example, technological research and development requires sophisticated experimental equipment, engineering technology, and high-quality data set support, and these resources are mainly concentrated in enterprises and research institutions; at the same time, universities must provide a solid theoretical foundation and disciplinary knowledge for reserve talents, and create a positive environment and academic cultural atmosphere for them [2]. On the basis of a profound understanding of this point, Germany has gradually formed a multi-agent collaborative cultivation model after years of development. Among them, the government, enterprises, research institutions and universities are the major participating subjects.

2.1. The role of the German government in the collaborative cultivation model

The German government mainly plays the roles of policy guidance, financial support, and building collaborative platforms in this model.

In 2008, the German federal government and the states jointly launched the "Female Professor Program", whose objectives are: first, to increase the proportion of women in professor positions; second, to break gender segregation in disciplines; third, to build a family-friendly academic environment. To achieve these goals, the German government has given priority to supporting female scholars in the MINT fields and implemented a one-on-one mentorship system to provide guidance for female doctors in the education field. The content includes not only planning the direction of future career development and providing guidance for research work, but also mediating family relations. In addition, to guide more female talents in the scientific field to develop in depth, the government has implemented family-friendly policies, providing extended funding periods for parental leave and childcare subsidies. The Humboldt Foundation subsidizes the family members of female scholars, such as providing subsidies for the language training course fees of the families of

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foreign female scholars. In addition, the federal government has also invested funds in phases for support. The first phase invested 150 million euros, and an effectiveness evaluation was conducted in the last year of the phase. Universities that passed the evaluation could receive an annual subsidy of 150 billion euros [3]. During the implementation of the entire policy, the government also built a multi-agent collaboration platform. Specifically, on the one hand, the federal government mobilizes social forces, such as the allowances from the Humboldt Foundation and entrusting the "Center for Excellent Women and Science" to evaluate the implementation results of the policies; on the other hand, the government mobilizes universities and enterprises, and through university-enterprise linkage, provides internship opportunities for female scholars in the scientific field. Through the orderly assistance of multiple subjects and strong financial support, the program has achieved remarkable results.

Today, the policy formulation of the German government is more comprehensive and in-depth, such as focusing on enlightenment education and attaching importance to long-term development to fundamentally stimulate girls' interest in science. In 2022, the Federal Ministry of Education and Research (BMBF), a subordinate department of the German federal government, launched the "STEM Action Plan 2.0", which covers from kindergarten to university and continuing education. BMBF has institutionalized early interest and promoted the extension of STEM education to preschool education. For example, the "Little Scientists' Home" project targets children aged 3-10. By encouraging kindergartens, primary schools and after-school centers to use inquiry-based learning methods to carry out daily inquiry activities and inquiry experiments, it stimulates children's interest and exploratory desire in science [4]. This plan has greatly stimulated girls' early interest in the field of science and technology, fundamentally increased women's interest in science, and significantly improved the participation rate of women in the scientific field.

2.2. The role of German enterprises and research institutions in the collaborative cultivation model

German enterprises and research institutions mainly play the roles of providing practical opportunities and advanced technologies in this model. In 2001, the German Federal Ministry for Family Affairs, Senior Citizens, Women and Youth, in conjunction with German trade unions, launched "Girls' Future Day", targeting female students in grades 5 to 10 (11-16 years old). It aims to broaden girls' career choices through activities such as Corporate Open Days, stimulate their interest in science and technology, and encourage girls to engage in careers in the scientific and technological field. The Corporate Open Day is on the fourth Thursday of April every year. On this day, thousands of enterprises, universities and research institutions open their doors to the public, allowing visitors to tour their workplaces and laboratories, and provide practical opportunities for them. Girls have the opportunity to come into contact with advanced cutting-edge technologies [5], such as operating mechanical equipment (such as paint production, automobile maintenance), participating in programming, experimental design and other technical work. For example, in 2021, the Berlin Energy Agency provided an activity of "acting as a one-day energy consultant" in the Electrical Club. Girls searched for high-power-consuming electrical appliances in a department store building in the local area, and then provided merchants with solutions related to energy conservation and environmental protection using the energy-saving knowledge they had learned before; Busch Vacuum Solutions organized girls aged 11-14 to visit the assembly workshop and the vacuum pump installation process in groups at its headquarters in Maulburg, Germany, conducted vacuum experiments, and assigned professional mentors [6]. The German nanotechnology research institute AMO GmbH invited female students to enter the clean room, operate high-precision equipment, and

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transform abstract scientific research into interesting experiments such as "destructive material testing" [7]. Under the policy framework of the "STEM Action Plan 2.0", the government has established MINT industrial clusters, and through financial guidance and platform design, enterprises and research institutions have deeply participated. NETZSCH in Germany provides factory internships for female engineering students, where female researchers personally operate industrial equipment and participate in R&D meetings. Those who perform outstandingly will be funded by NETZSCH to continue their doctoral studies.

2.3. The role of German universities in the collaborative cultivation model

Different from enterprises and research institutions, universities mainly play the role of providing a theoretical foundation in this model. In addition, the role of universities is similar to that of the government to a certain extent, that is, to guide more women to enter the scientific field, create a good cultural atmosphere for female talents, and break traditional gender concepts.

In 2006, the German School Award was jointly founded by the Robert Bosch Foundation and the Heidelberg Fund, aiming to promote innovative teaching concepts to the field of basic education. This award recognizes schools that have achieved outstanding results in basic education and effectively stimulated students' potential. By 2020, a total of 85 schools had been selected for this award, of which 14 schools won the highest award of "Best School". Among them, many schools have been highly praised for their efforts to promote the education of women in mathematics. For example, the Anne Frank Municipal Experimental Secondary School, which won the German Best School Award in 2014, as a girls' school, not only actively promotes the academic development of women (especially in mathematics and science), but also focuses on integrating scientific knowledge with daily life. The school abolished the traditional class system, implemented a disciplinary system centered on natural sciences, social sciences and language sciences, advocated comprehensive autonomous learning, and changed the previous teacher-centered teaching model. The school broke the restrictions of grades and disciplinary directions, established autonomous learning centers, and carried out group collaborative learning. In addition, the Schul siblings Gymnasium is also committed to promoting women's learning in mathematics and science, especially building a successful personalized cultivation model according to the characteristics of different students, and adjusting the curriculum content and teaching materials according to students' needs [5].

University cultivation also focuses on "industry-academia integration". That is, integrating with enterprises, continuously adjusting teaching policies according to national strategic needs, providing a theoretical foundation for students to enter the high-tech industry, and improving the employment connection degree. For example, Degendorf University of Applied Sciences in Germany combines engineering theoretical courses with enterprise practical projects through the "Technology Campus" model to ensure that students master core knowledge in fields such as mechanical engineering and artificial intelligence [8]; Osnabrück University of Applied Sciences in Germany does not use fixed textbooks in classes, but uses handouts written by professors, and the content is constantly adjusted according to actual needs. In addition to imparting basic knowledge, professors mainly guide students and tell them what to do, while students need to explore independently how to solve the topics. Many of the assignments completed by students are real problems faced by enterprises. When students try to complete these topics, they are equivalent to participating in the process of enterprises actually solving problems [9].

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2.4. Analysis of the multi-agent collaborative mechanism

In the entire process of multi-agent collaboration, each subject plays a different role, as shown in Figure 1:

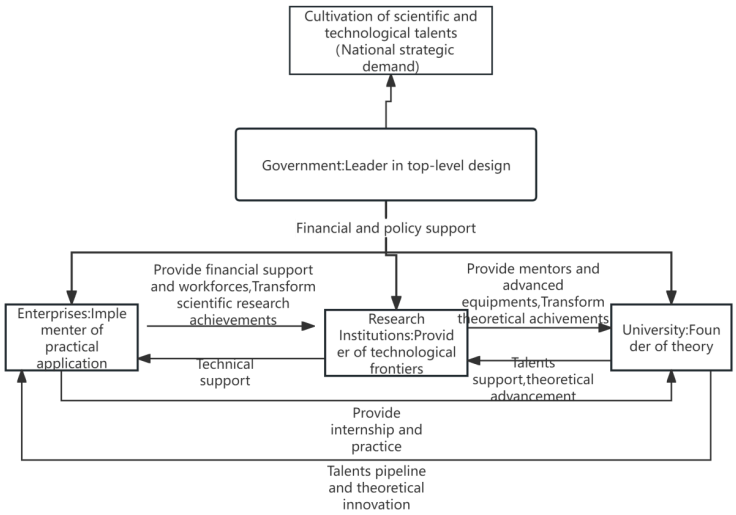

Figure 1. Analysis of the multi-agent collaborative mechanism

As shown in the figure above, the responsibilities next to each subject are at the macro level and play a direct role in the entire cultivation system, and the arrows between each subject show the interrelationship between subjects at the micro level. At the macro level, the government acts as the top-level designer, providing institutional guarantee for talent cultivation. Enterprises are the practical venues for talents, research institutions are pioneers in cutting-edge technological innovation, and universities are the foundation for theoretical education.

At the micro level, the government guides the orderly operation of the three subjects in this model through funds and policies; enterprises invest funds and talents to support research institutions in developing cutting-edge technologies, and transform their R&D achievements into practical applications. Research institutions feed back to enterprises by providing the technical equipment they need; research institutions and schools implement a joint supervisor system to guide students in scientific research, and provide equipment support for universities' theoretical research to facilitate the transformation of their theories into practice. Schools send doctoral students and other talents to research institutions, and support their continued scientific research with new breakthroughs in theoretical research; enterprises mainly provide internship opportunities for university talents, and correspondingly, universities also send outstanding talents to enterprises to ensure their permanent vitality. The behaviors of these subjects also uniformly serve the national talent cultivation strategy.

Among them, the actions of enterprises, research institutions and universities to cooperate with the implementation of government policies are not passive, but spontaneous actions based on shared interest goals with the government and the country, coupled with the corresponding financial incentives provided by the government. Enterprises and research institutions need a steady stream of high-tech talents to improve their existing products, continuously innovate ideas, and put them into practice to develop higher-end technical products, so as to obtain more profits, enhance their competitiveness, and extend the lifespan of their enterprises and institutions. Therefore, there is a

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mutually beneficial and win-win cooperative relationship among several subjects, and individual interests are unified under the overall national interests.

3. Effectiveness of Germany's collaborative cultivation model

For the effectiveness analysis of this model, this paper will present it in the form of a SWOT table. The SWOT (Strengths, Weaknesses, Opportunities, Threats) framework is a strategic planning tool, which is conducive to providing reference for China's talent cultivation and development strategy. Moreover, this system can study the internal capabilities and external environment of the research object, and has the characteristics of structure, dialectics and action orientation. Germany's cultivation model has diverse and complex subjects and strong dynamic evolution, and the SWOT framework can structure its complex problems, so the SWOT framework is suitable for evaluating this model.

3.1. Advantage analysis of the collaborative cultivation model

3.1.1. S-strengths analysis

First, close integration of theory and practice. By building a collaborative education system closely linking the industrial and educational circles, the practicality and career adaptability of scientific and technological talent cultivation are effectively strengthened. Cases such as "Girls' Future Day", "Technology Campus" and Osnabrück University of Applied Sciences in Germany clearly reflect this point.

Second, a sound legal supervision and guarantee system. Through these legal frameworks and social supervision forces, sustainable implementation guarantees have been invested in the cultivation of female scientific and technological talents. The federal government revised the Higher Education Act in 1985, focusing on the issue of inequality for women in higher education; in the "Female Professor Program", the federal government entrusted the "Center for Excellent Women and Science" to evaluate the implementation results of the policy to ensure the operation of the "Female Professor Program".

Third, systematic cultivation of social atmosphere. In the "Female Professor Program", family subsidies and maternity subsidies for female members are set up to pay attention to the real needs of women and the unique challenges brought to women by society [3]; the "Little Scientists' Home" is committed to the early enlightenment of children, making girls think that science and technology are not far away from them, stimulating their interest in science from an early age, and cultivating their scientific thinking [4]. From the perspective of women's internal psychological factors, this cultivation model makes them develop an interest in the field of science and technology from an early age; from the perspective of external environmental factors, these collaborative measures make them not have to worry about the impact of external factors, fundamentally promoting the sustainable development of female scientific and technological talents and creating a good atmosphere conducive to women entering the field of science and technology.

Fourth, regional cluster effect. As mentioned above, the German government has established MINT industrial clusters, using regional proximity to complete the coherent process of theoretical foundation, scientific research and internship. Regional clusters promote resource sharing and collaboration through geographical proximity and cultural homogeneity, greatly improving the operational efficiency of the collaborative cultivation model, and forming a replicable regional demonstration model, laying a good foundation for promoting the model at the national level.

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3.1.2. O-opportunities analysis

First, continuous policy upgrading. In 2022, the German federal government and the states jointly invested 320 million euros in the "2030 Female Professor Program", extended the program cycle to 2030, relaxed the participation threshold for small and medium-sized universities, and expanded the coverage through inter-university cooperation to accelerate the upgrading of the "2030 Female Professor Program" [10].

Second, global digital transformation. Global digital transformation is conducive to breaking boundaries, promoting the integration of resources from all parties, and facilitating the exchange of research results and international cooperation among multiple parties. All participating subjects share data information and research resources through big data networks. For example, small and medium-sized enterprises can obtain R&D opinions provided by scientific research experts through artificial intelligence communication service platforms [11]; enterprises and research institutions jointly develop low-threshold competition platforms (such as Alibaba Cloud Tianchi "Evolution on the Cloud" AI Biopharmaceutical Competition), provide basic codes and online training, and attract female developers from around the world to participate in cutting-edge technological research. Such platforms not only provide data resources, but also connect top mentor networks such as academicians and enterprise experts, integrating high-quality resources from various countries to support talent development [12].

Third, accelerated international collaboration. The "Erasmus+" program, which has been funded by the EU, aims to strengthen European academic exchanges and international cooperation. Through cross-border university-enterprise exchange internships and course training, it provides cross-border internship and employment channels for university students around the world, broadens their horizons, and promotes the circulation of talents, knowledge and technology [13]. In addition, with the financial support of the EU, the "Horizon Europe" program provides targeted funding for German women's STEM projects, complementing Germany's local policies and strengthening resource supply [1].

3.2. Disadvantage analysis of the collaborative cultivation model

3.2.1. W-weaknesses analysis

First, the problem of gender imbalance in the scientific research field still exists. According to a survey report released by the German Science and Humanities Council on November 2, 2022, the proportion of female scholars in the scientific research field has increased, but the growth rate is still limited. From 2010 to 2020, the proportion of female new students in Germany increased from 49.5% to 52.5%, the proportion of female graduates increased from 51.8% to 52.1%, the proportion of female doctoral students increased from 44.1% to 45.1%, and the proportion of women who completed their habilitation theses increased from 24.9% to 35.1%; the proportion of women among W1-level professors in German universities was 47.6%, 27.1% among C3/W2-level professors, and only 22.0% among C4/W3-level professors [14]. This also shows that some women's development is still hindered by traditional concepts, and corresponding policies need to be further formulated to improve this situation.

Second, insufficient participation of small and medium-sized enterprises (SMEs). SMEs have high instability. Due to financial constraints and the lack of legal constraints, SMEs often participate less in university-enterprise cooperation due to negative experiences of hiring interns in the past,

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unbalanced training input and output, economic downturn, and their own structural transformation. In addition, due to the scale of SMEs, their demand for trainees is small [15].

Third, poor communication and inadequate arrangements between universities and enterprises. A systematic study by the University of Paderborn in Germany found that there are problems in communication and arrangement in the cooperation between universities and enterprises. Communication between schools, enterprises and cross-enterprise vocational education institutions is usually problem and event-oriented, rather than continuous. Their communication often only occurs when problems such as student absenteeism or poor student performance arise. Although there are teaching syllabuses and training plans, the content and schedule are often poorly coordinated, leading to repetition or discontinuity in students' learning process, and the effectiveness of collaboration is highly dependent on the personal initiative of participants [16]. At the same time, due to the unreasonable arrangement of tasks between universities and enterprises, and the high difficulty of theoretical learning in the high-tech field itself, balancing academic courses and professional responsibilities is highly demanding for students participating in university-enterprise joint training. Some students may have a sense of fear due to excessive workload and miss various opportunities [17].

3.2.2. T-threats analysis

First, decentralized governance leading to reduced efficiency. Germany is a federal country, and each federal state is equivalent to an "independent country" with a high degree of autonomy. This may lead to reduced efficiency, uneven resource allocation and unbalanced regional development due to disagreements between the states and the federal government. According to Ludger Wößmann's interview with Wirtschaftswoche: "On the school digital agreement project, the federal government discussed the issue of fund provision for ten years. From the federal government to the states, then to local authorities, and then to schools, all participating units must reach an agreement, then write and process the application, and it will take several years to receive the funds [18]."

Second, teacher shortage. The German Teachers' Association calculates that the current shortage of teachers is about 40,000. The methods of calculating the actual shortage of teachers vary, but this is not the most important thing. No state government has been able to plan and formulate scientific policies to train enough teachers. There has been no such forward-looking prediction for many years, and the demand for teachers is still increasing due to the influx of immigrants [18].

Third, population crisis. The Rhineland-Palatinate STEM Report: Extended and Updated Research 2024 points out that changes in population structure will bring great pressure to the future labor market. It is estimated that by 2034, nearly a quarter of STEM practitioners may reach retirement age. Faced with such a severe situation, multiple subjects must adopt more effective talent training plans, increase cooperation and improve cooperation efficiency to consolidate the talent foundation of the entire education chain [19].

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3.3. Effectiveness evaluation of the collaborative cultivation model

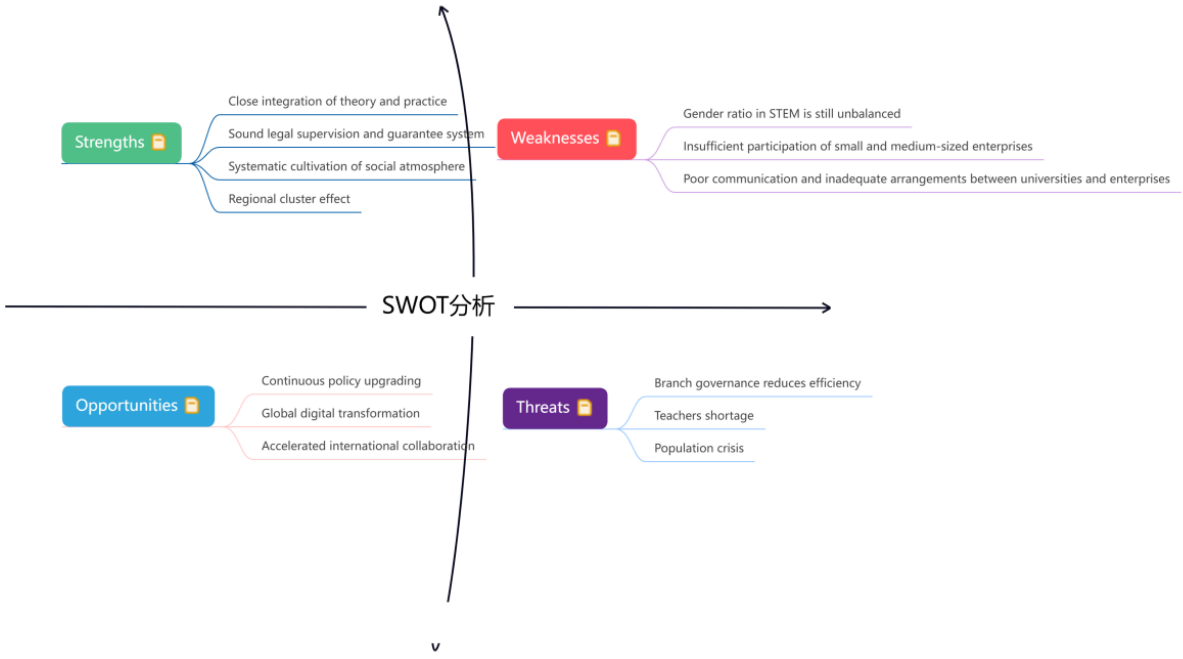

Figure 2. SWOT analysis of cultivation effectiveness

4. Enlightenment of German experience to the cultivation of Chinese female scientific and technological talents

4.1. Improving the multi-channel guarantee system

First, in terms of policies, attention should be paid to the inclination towards women. When formulating policies, subjects such as the government should pay more attention to the difficulties faced by women in society. The German Female Professor Program sets up maternity subsidies to allow female scholars to engage in scientific research without scruples. Germany's STEM education policy New STEM Action Plan: Moving towards the Future in STEM Education includes gender equality clauses, which change the male-dominated concept in the STEM field and attract more young women to study STEM disciplines through education in mathematics, information science, natural science and technology (MINT) for women; in addition, policies should attach importance to long-term development and cover multiple age groups. According to the characteristics of different age groups, formulate personalized policies and advocate lifelong learning. For example, enlightenment education for female groups of younger ages should focus on stimulating girls' interest in the scientific field, with emphasis on fun and experience, such as Germany's "Little Scientists" project; in addition, China can learn from Germany's "Girls' Future Day" and other policies to introduce policy activities targeting female groups. Second, legal supervision and guarantee: a multi-dimensional legal supervision and guarantee system needs to be constructed. First, improve the detailed legal provisions on gender equality, and clarify the definition and punishment standards for gender discrimination behaviors in the scientific and technological field. Units or individuals that reject women due to gender factors in scientific research project

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applications and workplace promotions shall be held accountable in accordance with the law. Second, set up a special supervision agency to regularly inspect the results of women-related projects. The Chinese government can link forces from all sectors of society to carry out regular inspections. Finally, financial guarantee. Building a diversified and stable funding support system is the foundation for ensuring sustainable talent cultivation. For example, actively expand funding sources; pay attention to the inclination of fund allocation; strengthen the fund incentive mechanism, etc.

4.2. Promoting the integration of the education system

The integration of the education system can be carried out from the following three aspects. First, deepen the integration of industry and education: enterprise training departments regularly organize career experience activities, learn from Germany's "Technology Campus" and "Girls' Future Day" to build a bridge for students to perceive the charm of occupations at close range. The organizers make good use of funds from all parties to build training bases with colleges and universities, and build a comprehensive and multi-level industry-education integration ecosystem [20]; schools actively cooperate with enterprises to carry out practical activities, adjust teaching syllabuses and schedules in a timely manner according to enterprise needs, compile real problems faced by enterprises into teaching materials, continuously update teaching materials according to the development of existing technologies, and give rewards and punishments to students based on their performance feedback from enterprises. At the same time, schools do a good job in the training and incentives for teachers. Improve the regular teacher assessment mechanism, improve the assessment content, improve the teacher incentive mechanism, enhance the comprehensive quality and ability of the teaching team, and ensure the teaching staff. Special departments should be established between universities and enterprises to coordinate and arrange the overall plan and follow up the progress regularly. Second, promote the development of an interdisciplinary and cross-field talent cultivation system: build an interdisciplinary and cross-field key emerging talent cultivation system in response to the urgent talent demand for the development of key emerging technologies. By building an interdisciplinary collaborative network, establishing special projects for interdisciplinary and cross-field talent training, carrying out customized education and technical training, accelerate the circulation and sharing of innovative resources. Improve the diversified evaluation mechanism, attach importance to students' innovation ability, interdisciplinary integration ability, practical application efficiency and team cooperation level, and use multiple methods such as project evaluation, peer review and practical assessment to comprehensively and systematically evaluate students' comprehensive abilities, ensuring that the quality of talent training adapts to the pace of emerging technology development [2]. Third, pay attention to the inclination towards women in the process of integrating the education system. Optimize textbook compilation and curriculum design, increase cases of female scientists in textbooks, broaden girls' career choices ideologically, and eliminate invisible gender prejudice. Focus on supporting women to participate in enterprise practical training and technological R&D, increase girls' practical opportunities, and set up practical projects and training plans exclusively for girls. Strengthen the construction of the female education evaluation system, and girls should give real feedback in a timely manner during the integration of the education system.

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4.3. Improving the cluster cultivation of high-skilled talents

The cluster cultivation of high-skilled talents provides key support for China's multi-agent collaborative cultivation model of scientific and technological talents to break barriers, optimize resources and improve efficiency. Improving the cluster cultivation of high-skilled talents can be carried out from the following aspects: first, strengthen the industry-education integration mechanism. Taking advantage of regional proximity and cultural homogeneity, connect the links of theoretical learning, scientific research and internship, build a "university-enterprise-research institution" linkage model, and form a "revolving door" mechanism. After accumulating practical experience and achieving R&D results, female postdoctoral fellows can apply for tenured faculty positions in universities based on their achievements, realizing the flow of talents among scientific research, enterprises and universities.

China can learn from this logic to build a regional industry-education joint community. For example, in Hunan, Jiangxi and other places, adjust majors according to industrial needs, accurately connect with key industries such as advanced manufacturing, deeply embed vocational education into the industrial development ecosystem, and replicate the collaborative efficiency of the MINT cluster's "integration of industry, university, research and application" and the "revolving door" talent flow. Second, improve the continuous growth system of talents in industrial clusters. Relying on multiple subjects in the cluster, continuously provide skill upgrading support for talents. China can learn from this idea to build a "revolving door" mechanism for the continuous training of talents. Drawing on German experience, integrate training resources from universities, research institutions, enterprises and other parties to build a "talent training-employment-re-training" system, allowing talents to continuously update their theoretical and practical skills, making talents flow among multiple subjects and forming a virtuous circle. In this process, attention should be paid to policy guidance and digital empowerment to promote resource integration and sharing, so that scientific and technological talents can achieve lifelong growth, adapting to the current era of rapid development and constant changes.

References

[1] Wu, M. H. Cultivation and development of female STEM talents in Germany from the perspective of the Theory of Planned Behavior [J/OL]. Journal of Comparative Education.
[2] Wang, S. M., Ge, C. L., & Zhang, Q. J. (2025). Multi-subject collaboration: Experiences and enlightenment of key emerging technology talent cultivation in the United States and Germany. Bulletin of the Chinese Academy of Sciences, 40(2), 250–259.
[3] Shao, P. X., & Zhou, X. L. (2019). Safeguarding the academic careers of female scholars in colleges and universities: An analysis based on the funding programs for female scholars in German colleges and universities. Journal of China Women's University, (4), 57–63.
[4] Xu, D. Y., & Wang, X. H. (2021). Philosophy, operation mechanism and enlightenment of Germany's "House of Young Scientists" program. World Education Information, (3).
[5] Li, Z., & Li, X. H. (2024). Motivation, countermeasures of female scientific and technological talent cultivation in Germany and enlightenment for China. Science and Technology Management Research, (18).
[6] Busch Vacuum. (2024, January 30). The first Girls' Day at ATELIERS BUSCH. https: //www.buschvacuum.com
[7] AMO GmbH. (2024, April 26). Girls' and Boys' Day at AMO GmbH: 11 girls and 1 boy. https: //www.graphene.tv.com
[8] Wu, Y. X. (2025, February 26). Delegation led by the president of Deggendorf Institute of Applied Sciences (Germany) visited our university. https: //gjc.sues.edu.cn
[9] Xinhua News Agency. (2015, May 14). Overview of Germany's "dual system" education. https: //www.news.cn
[10] Gemeinsamer Wissenschaftsrat (GWK). (2022, November 4). Auf dem Weg zur Parität von Frauen und MÃnnern in der Wissenschaft [On the way to parity between women and men in science]. https: //www.gwk-bonn.de.com

DOI: 10.54254/2753-7048/2026.HT30754

[11] Federal and state governments agree on the Professorinnenprogramm 2030 [Female Professor Program 2030].
[12] Wu, R., & Chen, Z. (2023). German universities boosting the national artificial intelligence strategy: Goals, missions and action measures. Journal of Higher Education Management, 17(5), 90–98.
[13] Alibaba Cloud. (2023, March 18). Outstanding female AI developers. https: //www.developer.aliyun.com
[14] Erasmus+. (2025, June 26). Traineeships abroad for students. EU programme for education, training, youth and sport. https: //erasmus-plus.ec.europa.eu/fr/opportunities/opportunities-for-individuals/students/erasmus-mundus-joint-masters-scholarships
[15] Education Office of the Embassy of the People's Republic of China in the Federal Republic of Germany. (2022). Dynamic information on German education (Issue 11).
[16] Mao, X. H. (2017). How does Germany enhance the attractiveness of vocational education in the face of student loss? Northwest Vocational Education, (3), 40–42.
[17] Universität Paderborn. (2025, March 19). Duale Ausbildung: Herausforderungen und Lösungsansätze [Dual vocational training: Challenges and solutions]. https: //bildungsklick.de/aus-und-weiterbildung/detail/duale-ausbildung-herausforderungen-und-loesungsansätze
[18] BARRAZA. (2023, June 9). 10 advantages and disadvantages of dual studies. Professional Development, Study in Germany.
[19] Xinyonghu 82864681. (2023, December 6). The lack of basic education in Germany is serious, and the backward reality is shocking. https: //www.360doc.com
[20] Shiguang Yiqu. (2025, April 12). STEM report of Rhineland-Palatinate (Germany): Women and immigrants drive a 2% growth. https: //www.m.sohu.com
[21] Zhao, C. H. (2025, February 12). Integration of industry and education: From "one-sided enthusiasm" to "mutual benefits" — Enlightenment of Germany's dual education system on the development of industry-education integration in China. China Teacher's Daily, (15).