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From Shallow Cooperation to Deep Synergy: Triple Breakthroughs in Guangdong-Hong Kong-Macau Greater Bay Area's Higher Education Cluster Development

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Abstract: As an important carrier of national strategic development, the key task of Guangdong-Hong Kong-Macau Greater Bay Area construction is to build a scientific and technological innovation hub with international influence. Under this framework, promoting the coordinated evolution of higher education clusters has become a strategic supporting factor for regional development. The cultivation of international higher education clusters not only provides high-end intellectual resources and compound talent reserves for the construction of Greater Bay Area's science and technology innovation hub, but also creates a historic opportunity for universities in the region to break down barriers and deepen collaborative innovation mechanisms. By strengthening the strategic consensus of higher education cluster development, optimizing resource allocation and spatial layout, systematically exploring the coordinated development path of Guangdong-Hong Kong-Macau Greater Bay Area's higher education clusters, and then building an international higher education network system with distinct levels, gradient connection and close interaction, it will become an important engine driving the high-quality development of the world-class bay area.

Keywords: Cluster development; Higher education; Guangdong-Hong Kong-Macau Greater Bay Area

Guangdong-Hong Kong-Macau Greater Bay Area includes nine cities in the Hong Kong Special Administrative Region, Macau Special Administrative Region and the Pearl River Delta region of Guangdong Province, namely Guangzhou, Shenzhen, Zhuhai, Foshan, Huizhou, Dongguan, Zhongshan, Jiangmen and Zhaoqing. As the frontier region of China's opening up to the outside world and the economic vitality of China, it occupies a key strategic position in the overall development strategic layout of the country. The construction plan of this area is a major national development strategic decision personally drawn, deployed and promoted by , aiming at actively responding to the new situation, new tasks and new requirements faced by the development of the cause of the party and the state in the new era. Thoroughly implement the spirit of the 19th National Congress of the Communist Party of China, accurately implement the principle of "one country, two systems", fully mobilize the comprehensive advantages of Guangdong, Hong Kong and Macao, continuously deepen the pragmatic cooperation and exchanges between the mainland and Hong Kong and Macao, and further enhance Guangdong-Hong Kong-Macau Greater Bay Area's support and leading function in the national economic development and opening-up pattern. At the same time, we firmly support the integration of Hong Kong and Macao into the overall development of the country, safeguard the long-term prosperity and stability of Hong Kong and Macao, improve the well-being of Hong Kong and Macao compatriots, and urge Hong Kong and Macao compatriots and the people of the motherland to shoulder the historical mission of national rejuvenation and share the brilliant achievements brought by the prosperity and strength of the motherland. On February 18th, 2019, the Central Committee of the Communist Party of China and the State Council officially promulgated the Outline of Guangdong-Hong Kong-Macau Greater Bay Area

Development Plan, which clearly proposed to encourage universities in Guangdong, Hong Kong and Macao to carry out cooperative education projects, give full play to the platform effectiveness of the Guangdong-Hong Kong-Macao University Alliance, deepen the cooperation and exchange mechanism in the field of higher education in Guangdong, Hong Kong and Macao, and promote the free circulation and rational allocation of educational resources, especially talents, science and technology, information and other elements related to higher education, in Guangdong-Hong Kong-Macao Greater Bay Area. Under the grand background of Guangdong-Hong Kong-Macau Greater Bay Area construction, the orderly interaction and coordinated development of higher education in Guangdong, Hong Kong and Macao has become the key link and important supporting factor to promote the construction process of Greater Bay Area.

1.Clarify the development goals of Guangdong-Hong Kong-Macau Greater Bay Area's higher education clusters

As the landing text of the national strategy, the Outline of Guangdong-Hong Kong-Macau Greater Bay Area Development Plan marks the stage of regional coordinated development from policy design to institutional innovation. The promulgation of this programmatic document not only reconstructs the governance framework of cross-border factor flow, but also injects systematic kinetic energy into regional development through the top-level design of "collaborative innovation in education-strategic reserve of talents-ecological cultivation of science and technology innovation". Its core goal is to build an innovation ecosystem with deep integration of "education-science and technology-industry", and to build a scientific and technological innovation hub with global resource allocation capability through the linkage of higher education cluster development and international talent introduction and education mechanism.

1.1Deepen the development of education cooperation in the Greater Bay Area

Based on the concept of cross-border educational resource sharing, Guangdong, Hong Kong and Macao need to focus on building a multi-dimensional coordinated development framework. First, promote higher education institutions to establish a cross-regional joint education model, focusing on strategic discipline clusters such as artificial intelligence and biomedicine, and realize the integration of resource elements through the joint construction of joint laboratories and Industry-University-Research collaborative innovation platforms. Secondly, relying on the Guangdong-Hong Kong-Macao university alliance to build an institutional cooperation network, establish a regional curriculum mutual recognition standard system, implement a flexible chemical accumulation system, and explore the joint operation mechanism of cross-border scientific research data sharing and intellectual property rights. On the one hand, at the level of international education hub construction, it is suggested to implement the strategy of "double circulation". Promote the "double first-class" construction and quality improvement project internally, focusing on cultivating 5-7 disciplines with global competitiveness; Set up cross-border higher education special zones externally, and adopt the integration mode of "famous universities + production cities" to attract the top 50 universities in QS to set up regional research centers, forming an academic innovation pole with international visibility. On the other hand, in terms of optimizing talent training channels, it is necessary to establish a two-way flow system. We will implement the "Northward Schooling Support Program" for young people in Hong Kong and Macao, implement non-discriminatory policies in scholarship evaluation and vocational qualification certification, and simultaneously build a "vocational education industry-education integration corridor", and create a cluster of cross-administrative training centers in the fields of digital economy and intelligent manufacturing, forming a skilled talent training ecosystem of "secondary vocational-higher vocational-applied undergraduate".

1.2Building a talent highland in Guangdong-Hong Kong-Macau Greater Bay Area

Based on the theoretical framework of cross-border factor flow, it is necessary to build a multi-level talent strategy implementation system. First of all, promote the Pearl River Delta urban agglomeration to implement the strategy of "policy transplantation-localization improvement", learn from the flexible talent introduction mechanism of Hong Kong and Macao, and build differentiated competitive advantages in the fields of tax incentives

and cross-border practice. Focus on building a pilot zone for coordinated development of talents in Guangdong, Hong Kong and Macao, pilot the "all-in-one card" system for residence permits for international talents, and realize the cross-domain connection between work permits and social security. Secondly, build a "human resources service + data governance" integration platform, and establish a dynamic talent demand forecasting model relying on national human resources industry clusters. Through blockchain technology, the real-time update and accurate matching of the list of talents in short supply can be realized, a headhunting collaboration network covering RCEP member countries can be built, and a dual-track talent training system of "academic tutors + industry leaders" can be established. In view of Macao's special positioning, the construction project of "professional service talent hub" should be implemented, focusing on financial technology, Portuguese-speaking law and other characteristic fields, establishing a cross-border vocational qualification mutual recognition center, and setting up a special fund for talent structure optimization. Through the "Migratory Bird Project", top scholars such as Nobel Prize winners and IEEE fellows are attracted to form cross-border scientific research teams and build a full-chain intellectual support system of "basic research-application development-industrial transformation".

2.Enhance the awareness of Guangdong-Hong Kong-Macau Greater Bay Area's higher education cluster development

The construction of Guangdong-Hong Kong-Macau Greater Bay Area urgently needs to develop high-level higher education clusters to strengthen the weak links in the fields of regional education, science and technology and innovation. World-class university clusters are not only the base for cultivating innovative talents in Greater Bay Area, the source of scientific and technological innovation and the engine of industrial upgrading, but also double the value of higher education functions through resource agglomeration effect. Promoting the cluster development of colleges and universities is of strategic significance for comprehensively improving the core functions such as personnel training, scientific research, social services, cultural heritage and international exchanges. International experience shows that Tokyo Bay Area, new york Bay Area and San Francisco Bay Area rank among the world's first-class bay areas. The key lies in relying on export-oriented geographical endowments to form core competitiveness by building high-level university clusters. If Guangdong-Hong Kong-Macau Greater Bay Area wants to build a world-class bay area and a world-class urban agglomeration, it must deepen its understanding of the importance of the cluster development of higher education. At present, Greater Bay Area has gathered a number of internationally renowned universities and advantageous disciplines, and built a perfect higher education system, which has the characteristics of diverse types, strong complementarity and high industrial correlation. It is expected to form a significant "aggregation-radiation-spillover" effect in the fields of economy and culture, scientific and technological innovation and talent gathering. At the same time, the leading development of higher education in Greater Bay Area needs to have three characteristics. First, it is demand-driven, closely following the national strategy and regional economic and social development needs, focusing on the improvement of higher education quality and characteristic cultivation, enhancing social contribution and international influence, and promoting the deep connection of talent training, scientific research innovation and social services with industrial upgrading and technological frontier; Second, innovation-driven, deepening the comprehensive reform of higher education, optimizing system design, policy support and environmental construction, opening up resource circulation channels, building collaborative platforms, and comprehensively improving the overall efficiency of the higher education system; Third, sharing and collaboration, promoting the integration and mutual assistance of high-quality higher education resources inside and outside the Bay Area, building a cross-regional cooperative development mechanism, and ensuring that the higher education system is compatible with the construction of modern economic system and the new pattern of all-round opening up. In short, Guangdong-Hong Kong-Macau Greater Bay Area's universities build a complementary, interactive and competitive relationship, forming a mode of mutual openness, mutual cooperation, complementary advantages and common development among universities, which can realize the advantages of factor sharing, knowledge spillover, network collaboration and flexible specialization.

3.Bottlenecks encountered in the development of higher education clusters in Guangdong-Hong Kong-Macau Greater Bay Area

From the perspective of the connotation of higher education cluster development, comparing the data of Tokyo, new york and San Francisco Bay Areas, we can see that there are still obvious bottlenecks in the development of higher education clusters in Guangdong-Hong Kong-Macau Greater Bay Area at three levels: utensils, systems and ideas.

3.1Resource integration dimension: the breadth and depth of collaboration need to be broken through urgently

In the dimension of resource integration, Guangdong-Hong Kong-Macau Greater Bay Area's higher education coordination faces the dual constraints of weak material foundation and insufficient kinetic energy transformation. Although the three places share natural advantages such as geographical proximity, cultural affinity and institutional differences, the efficiency of factor flow and allocation in the educational field lags significantly behind that in the economic field. This contrast stems from the special attributes of educational cooperation. Compared with the quantifiable economic output of industrial cooperation, the benefits of educational cooperation are long-term and hidden, resulting in the imperfect dynamic mechanism of resource replacement. Deep-seated contradictions are reflected in three aspects. First, the educational field is naturally competitive, and colleges and universities have zero-sum games in academic ranking, scientific research resources, student quality and other dimensions. This exclusive competitive relationship restricts the generation space of deep collaboration. At present, the educational interaction between the three places mostly stays in superficial forms such as academic conferences and mutual visits between teachers and students, and has not yet formed a strategic coupling to support the construction of a global science and technology innovation center. Secondly, there is an asymmetric dilemma in the collaborative structure. Although Guangdong universities have the advantages of complete discipline system and large number of students, they still lag behind in the process of educational modernization and internationalization. Although colleges and universities in Hong Kong and Macao have international experience in running schools and advantages in characteristic disciplines, they are subject to space limitations and professional coverage limitations. This complementary resource fails to double the value through effective mechanisms, resulting in cross-border educational cooperation being trapped in the fragmented mode of "bilateral interaction" for a long time, and it is difficult to release the systematic synergy effect of the "Bay Area Education Community".

According to the summary of known data, first, the digital presentation of the material base gap shows that there is a significant gap between Guangdong-Hong Kong-Macau Greater Bay Area's investment in scientific research resources and the world's first-class bay areas. The per capita scientific research funding in Guangdong, Hong Kong and Macao is 240,000 yuan lower than that in San Francisco Bay Area, and the R&D investment intensity of universities is only 1/3 of that in San Francisco Bay Area. At the level of resource sharing, less than 30% of large-scale scientific research instruments in Guangdong universities are open to Hong Kong and Macao, and cross-border use requires an average approval process of 45 days, resulting in equipment utilization rate of less than 20%. For example, although the National Supercomputing Guangzhou Center of Sun Yat-sen University is open to Hong Kong and Macao, due to restrictions on cross-border data transmission, the actual computing power call of Hong Kong and Macao teams in 2023 will only account for 5% of the total resources. Second, the form of collaboration is simplified and shallow. At present, the educational collaboration among the three places is mostly focused on short-term projects that are easy to operate, and the proportion of in-depth cooperation is relatively low. On the one hand, shallow collaboration leads the way. Data on activities among members of the Guangdong-Hong Kong-Macao University Alliance in 2024 show that academic conferences account for 42% and mutual visits between teachers and students account for 35%, while jointly built entity research institutions account for 8%, and joint degree projects account for 8%. In-depth cooperation such as 6% accounts for less than 20%. On the other hand, the progress of mutual recognition of credits is slow. Although HKUST (Guangzhou) and HKUST launched the "Red Bird

Project" to share 1,500 courses, the overall coverage rate of mutual recognition of credits in Greater Bay Area is only 18%, and the difference in conversion rules leads to 30% of cross-border course selection applications being rejected due to conflicts in credit conversion. Third, typical cases reveal the lack of resource replacement motivation. For example, the institutional friction of Industry-University-Research cooperation between Hong Kong University of Science and Technology (Guangzhou). Although the school signed an agreement with Dongguan Songshan Lake Robot Base to build a research and development platform, the scientific research funds from Hong Kong and Macao could not be directly allocated to the mainland across borders, and the matching funds of enterprises had to be audited by three parties, resulting in the stagnation of two of the first three cooperation projects due to the delay of capital circulation for more than half a year. Enterprise feedback shows that 73% of Bay Area enterprises tend to cooperate with local universities, believing that "compliance costs are higher than technical benefits" for cross-border projects. In addition, courses are misaligned with industrial needs. 52% of the 2023 engineering graduates in Guangdong Province believe that "the course content is impractical", which is significantly higher than that in the Beijing-Tianjin-Hebei (37%) and the Yangtze River Delta (38%). At the same time, companies such as BYD have reported that curriculum updates in the field of new energy batteries lag behind technology iterations by 2-3 years, and school-enterprise joint development courses only account for 12% of engineering courses. The root cause lies in the fact that the three places have not yet established an institutional guarantee system to support the free flow of educational elements. The cross-border allocation of educational resources not only involves technical problems such as mutual recognition of credits and mutual employment of teachers, but also needs to break through institutional barriers such as talent evaluation, scientific research funding and intellectual property rights. Only by establishing a deep cooperation logic beyond simple resource exchange can the educational coordination between Guangdong, Hong Kong and Macao be promoted from "physical superposition" to "chemical integration".

3.2Institutional obstacles: lack of cross-domain governance framework and collaboration mechanism

The advantages of Guangdong-Hong Kong-Macau Greater Bay Area's "one country, two systems" system and the differentiated characteristics of multiple customs territories not only constitute the unique endowment of regional development, but also form the institutional challenge of collaborative innovation in higher education. At present, the deep dilemma of cross-border educational cooperation lies in the fact that an institutional dialogue platform across administrative jurisdictions has not yet been established, resulting in the lack of systematic connection mechanism between the Pearl River Delta urban agglomeration and Hong Kong and Macao Special Administrative Regions in key areas such as overall planning of educational resources and mutual recognition of quality certification. Although the academic circles put forward the theoretical concept of coordinated development of higher education in Guangdong, Hong Kong and Macao as early as the end of last century, the practical level is still subject to three structural contradictions. First, the innovation of policy tools lags behind the actual needs, and the existing cooperation mostly stays at the level of project-based temporary agreements, lacking legal regional education conventions. On the one hand, the examination and approval mechanism of cooperative education is rigid, and Guangdong-Hong Kong-Macao cooperative education projects are still implemented with reference to the Regulations on Sino-foreign Cooperation in Running Schools, which require overseas universities to be the main body of running schools. As a result, Hong Kong and Macao universities have to go through the examination and approval of at least seven departments, including the Ministry of Education and the National Development and Reform Commission, to set up branch schools in the Mainland, which takes an average of 18-24 months. For example, the City University of Hong Kong (Dongguan) took three years (2020-2023) from signing the contract to being approved, far exceeding the establishment cycle of ordinary domestic universities. On the other hand, the cross-border flow of scientific research funds is blocked. According to the Measures for the Administration of National Scientific Research Funds, the cross-border use of scientific research funds in Hong Kong and Macao needs to be approved by the State Administration of Foreign Exchange, and a detailed audit report on the use of funds needs to be submitted for a single transaction exceeding 500,000 yuan. The "Joint Laboratory of Optoelectronic

Materials" jointly established by Sun Yat-sen University and Hong Kong Polytechnic University has been forced to postpone or cancel 40% of the joint projects in 2023 due to the complicated audit process of Hong Kong funds. Second, the boundaries of powers and responsibilities of governance subjects are blurred, and the collaborative decision-making mechanism among local governments, university alliances and international organizations has not yet taken shape. On the one hand, the functions of cross-domain governance institutions are blurred. Although the Outline of Guangdong-Hong Kong-Macau Greater Bay Area Development Plan proposes to establish the "Guangdong-Hong Kong-Macau Greater Bay Area Education Collaborative Development Committee", this institution is only a joint meeting and has no administrative decision-making power. Among the 32 cooperation initiatives of the Guangdong-Hong Kong-Macao University Alliance in 2023, only 9 have been implemented simultaneously by the governments of the three places, and the rest have been shelved due to unclear local financial powers and responsibilities. On the other hand, localized management leads to the fragmentation of resources. Guangdong provincial universities need to comply with the Government Procurement Law for equipment procurement, while Hong Kong and Macao universities follow international bidding rules. The "Joint Laboratory of Marine Engineering" jointly established by South China University of Technology and the University of Macau delayed the procurement of key deep-sea detectors for 14 months due to conflicts in equipment procurement standards, and the project progress lagged behind by 40%. Third, there is an institutional vacuum in the mutual recognition of standard systems, and the core links such as credit conversion and teacher evaluation and employment still face the fragmented operation mode of "one district, one policy". On the one hand, the mutual recognition system of credits is lacking, and the three places have not yet established a regional credit transfer framework, relying only on bilateral agreements between schools. According to statistics from the Guangdong Provincial Department of Education, the success rate of cross-border course selection in the Greater Bay Area in 2024 will be 63%, of which 30% of courses cannot be included in the graduation requirements due to conflicts in credit conversion rules. For example, in the "Digital Media Arts" project jointly organized by Shenzhen University and Hong Kong Baptist University, students need to take four additional bridging courses to make up for the credit difference. On the other hand, the coverage of mutual recognition of professional qualifications is insufficient. Currently, only 7 types of professional qualifications such as certified public accountants and physicians have achieved mutual recognition, while 12 types of qualifications in emerging fields such as artificial intelligence engineers and data compliance engineers have not been included. Tencent's 2023 survey shows that 68% of Hong Kong and Macao engineers refused to be transferred to Shenzhen Qianhai R&D Center due to restrictions on their qualifications in the mainland. The current situation of insufficient system supply has caused regional educational cooperation to fall into the circular dilemma of "suspension of agreements-decentralization of actions-marginalization of results" for a long time.

3.3Conceptual obstacles: differences in school-running ideas and challenges of cognitive integration

At the cognitive level, the coordinated development of higher education in Guangdong, Hong Kong and Macao faces deep conceptual obstacles. The idea of running schools in mainland colleges and universities is characterized by dynamic evolution, and its development track resonates with the social transformation and strategic adjustment in the process of national modernization. However, because of the long-term infiltration of the mature market economy environment and the western education system, the school-running ideas of Hong Kong and Macao universities show the characteristics of gradual development. This difference is particularly prominent on the issue of "double first-class" construction. Hong Kong education scholar Cheng Jieming once pointed out that although the "double first-class" construction in the mainland has a strategic framework, the connotation boundary and evaluation criteria are always in the process of dynamic adjustment. This state of "strategic clarity and operational ambiguity coexist" just forms a cognitive dislocation with the precise governance paradigm pursued by Hong Kong and Macao universities. The root cause is that the path dependence of higher education development between the two places is significantly different. Mainland universities have formed a "policy-driven" development model in

serving the national strategic needs, emphasizing top-level design and rapid response; Colleges and universities in Hong Kong and Macao continue the tradition of "academic autonomy" and pay attention to institutional stability and academic community consensus. This difference directly leads to the cognitive gap in cross-border educational cooperation, which is manifested in the differentiated interpretation of educational quality standards, the divergent cognition of scientific research evaluation system, and the diverse understanding of talent training objectives.

According to the data, first of all, there are differences in quality assessment standards. A joint survey of university administrators in Guangdong, Hong Kong and Macao in 2024 shows that 82% of universities in Hong Kong and Macao list "international peer review" as a core quality indicator, while 76% of universities in Guangdong are more concerned about "serving the country". Strategy contribution ". For example, Hong Kong universities are required to submit four representative achievements in the REF (Scientific Research Excellence Framework) evaluation and accept blind review by international experts, while the mainland's "double first-class" evaluation emphasizes "breaking the five only" and gives priority to social contributions such as "solving stuck technology". Secondly, there are differences in scientific research orientation. According to the data of the National Natural Science Foundation of China, 68% of the projects in Guangdong universities focus on applied research such as new energy batteries and artificial intelligence, while 57% of the projects in Hong Kong and Macao universities focus on basic theories such as quantum computing and genomics. Finally, different evaluation mechanisms directly restrict the depth of collaboration, and universities in Guangdong, Hong Kong and Macao are deeply trapped in "evaluation islands". For example, the clinical research project of Shenzhen Hospital of the University of Hong Kong aborted. Because the mainland assessment required "replacement of domestic equipment within three years", the Hong Kong side insisted on "following the five-year cycle of international multi-center trials", which eventually led to the withdrawal of 60 million funds. At the same time, the formation of scientific research teams is in dilemma. A survey conducted by the Guangdong-Hong Kong-Macao University Alliance in 2024 shows that 67% of cross-border teams disintegrated due to "differences in achievement ownership standards." When the Macau University of Science and Technology and South China University of Technology jointly built an artificial intelligence laboratory, the Australian side requested that the results be submitted to NeurIPS (Top Conference), and China insisted on applying for the "Chinese Artificial Intelligence Society Science and Technology Progress Award". In short, to break through this bottleneck, it is necessary to build a long-term dialogue mechanism, and gradually realize the mutual recognition and interoperability of educational concepts, academic standards and quality assurance systems on the basis of maintaining their respective characteristics through joint research, mutual visits of scholars and co-construction of courses, and finally form a "harmonious but different" higher education ecology in the Bay Area.

4.Strategies to promote the development of higher education clusters in Guangdong-Hong Kong-Macau Greater Bay Area

According to the strategic deployment of the Outline of Guangdong-Hong Kong-Macau Greater Bay Area Development Plan, it is necessary to drive regional economic and industrial upgrading based on the overall situation of national development, supported by strategic forward-looking vision and international resource allocation capabilities. In this process, the construction of higher education clusters should become the key engine. By deepening the coordination mechanism between economy and education, Greater Bay Area will be built into a core higher education hub in the Asia-Pacific region and an educational innovation highland with global influence, so as to serve the country's development goal of building a world-class urban agglomeration.

4.1Cultivating the cultural foundation of the Bay Area: building an open and inclusive value community

As an important window for China's opening to the outside world since modern times, Guangdong-Hong Kong-Macau Greater Bay Area's cultural genes are deeply embedded in regional geographical symbiosis, historical continuity and civilization integration and innovation. Since the late Qing Dynasty, this area has played the role of the source of institutional reform, which is not only the fertile ground for the germination of national capitalism, but also the incubation platform of modern reform thoughts and democratic revolution thoughts. After the reform and

opening up, Guangdong has continued to lead the practice of institutional innovation and opening to the outside world, while Hong Kong and Macao have long played the role of a hub for dialogue between eastern and western civilizations. This historical accumulation has shaped the cultural characteristics of "pluralistic symbiosis, openness and tolerance, and innovation-driven" in the Bay Area. At the same time, this unique cultural ecology has been deeply integrated into the value system of colleges and universities in the Bay Area. For example, the pragmatic spirit of Lingnan culture has been organically integrated with the international vision of Hong Kong and Macao, which has shaped the school-running philosophy of "based on the local area and facing the world" of higher education in the Bay Area, and the reform gene that dares to be the first since modern times has been transformed into the innovative kinetic energy of colleges and universities to serve the national strategy. The construction of cultural identity provides a spiritual bond for the development of higher education clusters, enables universities in the three places to form a value consensus in personnel training and scientific research cooperation, and lays a cultural foundation for building a regional educational community. This cultural leading role is not only reflected in the level of academic exchanges, but also transformed into soft power to promote the innovation and development of the Bay Area through alumni network, Industry-University-Research cooperation and other carriers. Specifically, the strategy can be promoted in layers. First, the basic level (1-3 years) is to establish a cultural security zone, which not only creates the "Bay Area Civilization Dialogue Season", but also focuses on non-sensitive common issues every year, such as Lingnan architectural conservation, Guangfu food application, archaeology of the Maritime Silk Road, etc.; We also developed a cultural decoding toolkit, compiled a comparative manual of educational terminology in Guangdong, Hong Kong and Macao, and resolved the misunderstanding of concepts such as "patriotism and national identity". Secondly, the middle level (3-5 years) cultivates the common divisor of values, not only implements the "two teachers and three courses" plan, but also mainland teachers and Hong Kong and Macao teachers jointly develop three kinds of integrated courses such as scientific and technological ethics such as AI governance, business civilization such as Guangdong business spirit, and ecological responsibility such as mangrove protection; A cultural integration laboratory was also set up, and the "One Country, Two Systems Education Museum" was piloted in Hengqin, Zhuhai, to display the history of the return of Hong Kong and Macao with immersive technology. Finally, the high-level (5 + years) builds a spiritual community, which not only launches the "Bay Area Scholar Citizen" program, but also grants special status to teachers who have worked in the three places for 10 years, and gives them the right to participate in and discuss state affairs across borders; An educational heritage activation fund was also established, such as transforming Chen Yinque's former residence (Guangzhou) and the site of Matteo Ricci College (Macao) into spiritual landmarks of academic community.

4.2Optimizing the allocation of higher education resources: building a gradient development system

According to the strategic deployment of the Outline of Guangdong-Hong Kong-Macau Greater Bay Area Development Plan, Guangdong-Hong Kong-Macau Greater Bay Area needs to take the construction of international education demonstration zones as the starting point, implement the strategic reorganization and systematic layout of higher education resources, base itself on the spatial pattern of world-class urban agglomerations, build a higher education development network with "core guidance, node support and global coordination", and form a university cluster in the Bay Area with distinct gradients and complementary functions. In terms of spatial layout, it is necessary to highlight the "dual-core drive" strategy, build Guangzhou, Shenzhen, Hong Kong and Macao into the world's top higher education hub urban agglomerations, focus on building world-class universities and scientific research institutions, gather Nobel Prize-level scientific research platforms, national major infrastructure and international academic organizations, and form the original source of innovation and the magnetic pole of high-end talents; At the same time, we will simultaneously promote the construction of regional higher education centers in Zhuhai, Foshan and Dongguan. By implementing the climbing plan of characteristic disciplines and the demonstration project of integration of production and education, we will cultivate application-oriented university clusters, focusing on serving the needs of strategic industries such as advanced manufacturing and digital economy.

In terms of resource allocation, it is necessary to follow the principle of "differentiated positioning and characteristic development". Colleges and universities in core urban agglomerations should focus on cutting-edge basic research and the construction of international academic discourse power to create a disciplinary peak; Colleges and universities in regional central cities focus on technological transformation and industrial service capacity building, forming a highland for training applied talents. By building a cross-regional credit mutual recognition system, a joint laboratory network and a collaborative innovation platform in Industry-University-Research, the cross-border free flow of educational resource elements can be realized, and finally the Bay Area educational innovation ecological chain of "basic research in core cities, technology application in node cities, and achievement transformation in the whole region" will be formed. Specifically, in order to solve the "siphon effect" of excessive concentration of higher education resources in core cities such as Guangzhou, Shenzhen and Hong Kong, the regulation mechanism of "counterpart support index" is rigidly implemented. For example, when Guangzhou, Shenzhen and Hong Kong add a new world-class university platform such as Nobel Prize Laboratory and QS Top 50 branches, it is necessary to simultaneously build no less than two applied technology transformation centers in Zhaoqing, Jiangmen and other development gradient cities, such as intelligent manufacturing training bases and industrial innovation colleges.

4.3Optimizing the layout of disciplines: building an innovative ecological chain integrating production and education

Guangdong-Hong Kong-Macau Greater Bay Area's complete industrial system and efficient supply chain network provide strategic support for the development of higher education clusters. To build a synergistic mechanism in which economic development and educational innovation resonate at the same frequency, it is necessary to strengthen the empowering role of educational chain in industrial chain and innovation chain through strategic adjustment of discipline and specialty structure. Specifically, we can promote the optimization of discipline layout from three aspects. First, focus on the needs of strategic emerging industries and build a new engineering discipline cluster. Focusing on "stuck neck" technical fields such as integrated circuits, artificial intelligence, and biomedicine, we will focus on building a science and engineering discipline system with Bay Area characteristics. By setting up an interdisciplinary platform, building a demonstration college for the integration of production and education, and implementing the "dual tutorial system" talent training mode, we will build a whole innovation chain from basic research to application transformation, and support the deep integration of advanced manufacturing and modern service industries in the Bay Area. Secondly, proactively lay out the future technology track and build a highland of marine engineering and intelligent manufacturing disciplines. Relying on the Bay Area's sea-related industrial foundation and equipment manufacturing advantages, we will cooperate with Hong Kong and Macao universities to jointly build characteristic disciplines such as ocean observation technology and deep-sea resource development, and create a marine engineering discipline cluster with international voice. Promote the construction of high-end equipment manufacturing disciplines such as industrial Internet and intelligent robots simultaneously, and form a discipline support system to serve the construction of the "Sea Bay Area" by setting up Guangdong-Hong Kong-Macao joint laboratory and setting up major special research plans. Finally, build a collaborative innovation network between government and Industry-University-Research, and improve the dynamic adjustment mechanism of disciplines. Establish a discipline construction alliance composed of universities, research institutes, leading enterprises and industry associations, and realize the accurate connection between discipline and specialty settings and industrial needs by compiling the industrial technology map of the Bay Area, publishing the catalogue of urgently needed disciplines, and implementing the system of "unveiling the list and taking charge". In particular, it is necessary to give full play to the institutional advantages of Hong Kong and Macao universities in the transformation of scientific and technological achievements and the operation of intellectual property rights, build a "Bay Area Technology Transfer Corridor", and form a closed loop of discipline-industrial innovation from laboratory to production line. For example, the Guangdong Provincial Department of Industry and Information Technology, the Hong Kong Productivity Council, and the Macao

Department of Economics and Finance jointly built an industrial map platform, released the "Bay Area Technology Maturity Curve" every quarter, and implemented red and yellow card grading warning for disciplines. For majors listed in the "elimination zone" for two consecutive years, such as the forced reduction of enrollment indicators by 30% in 2023, and the simultaneous construction of academic firewalls.

4.4Innovative talent training mode: building Guangdong-Hong Kong-Macau Greater Bay Area's international education system

As the core element of the construction of modern industrial system in Greater Bay Area, there is a deep coupling relationship between human resources strategy and the development of higher education. In the blueprint for the construction of a high-quality living circle that is livable, suitable for industry and tourism outlined in the Outline of Guangdong-Hong Kong-Macau Greater Bay Area Development Plan, a team of high-quality talents constitutes a strategic resource to support regional high-quality development. Greater Bay Area's talent cultivation system needs to be based on the value guidance of "four self-confidences", deeply integrate the reform and innovation of higher education into the overall development of the country, and earnestly fulfill the mission of educating people for the party and the country by building an education system that comprehensively cultivates morality, intelligence, physique, beauty and labor. Guangdong, Hong Kong and Macao should give full play to their complementary advantages. They should not only join hands to inherit Chinese excellent traditional culture, but also cultivate a new culture with Chinese characteristics in the new era of innovation, enhance Hong Kong and Macao's sense of national identity and national belonging, and cultivate innovative talents rooted in national culture. Guangdong, Hong Kong and Macao can rely on the international talent exchange platform to hold Bay Area Forum lectures, subject skills competitions, innovation and entrepreneurship challenges and other activities to enhance talent exchanges and interactions among the three places. Set up inter-school online courses and open courses, etc., promote mutual selection of courses, mutual recognition of credits and mutual employment of teachers among schools, support and encourage universities in the three places to carry out various short-term exchange students projects, and promote the joint training of talents in the three places. Introduce international-level education, training and services, formulate international licenses and teaching standards, qualification certification system, lifelong education qualification framework, etc. that are internationally recognized and fully applicable in Guangdong-Hong Kong-Macau Greater Bay Area, and improve the applicability and internationalization level of talents in Guangdong-Hong Kong-Macau Greater Bay Area universities. Specifically, the creation of "Bay Area Engineer" certification chapter, such as mutual recognition of 12 core courses, pilot the integration of Chinese, American and British medical qualifications in Shenzhen Hospital of HKU, and Tencent and DJI took the lead in releasing the "Emerging Vocational Ability Map" covering cutting-edge fields such as blockchain. Simultaneously build a three-dimensional system of credit bank, the first hard connection, and the blockchain credit deposit system realizes the automatic conversion of credits in the three places, such as 1 credit in Hong Kong school = 1.5 credit hours in the mainland; Second, soft connection, developing curriculum equivalent algorithms, such as Hong Kong National Education Curriculum equals the outline of modern history in the Mainland; The third strong supervision, the Cross-border Education Quality Bureau imposes regional joint fuse sanctions on illegal colleges and universities, forming a new education ecology of "barrier-free mutual recognition of qualifications, no time difference in credit conversion, and no dead ends in quality monitoring".

4.5Collaborative innovation between Guangdong, Hong Kong and Macao: building an open integrated platform for Industry-University-Research

Give full play to the advantages of Guangdong, Hong Kong and Macao in higher education, adopt the mode of co-construction of the three places, form joint efforts and common development, build an open innovation system that is market-oriented and combines Industry-University-Research, and provide strong support for building an international science and technology innovation center. By establishing an information platform for scientific research and academic exchange among universities in Guangdong, Hong Kong and Macao, we will promote the

information exchange and sharing of scientific research talents among universities in the three places, set up new laboratories or R&D teams across domains, carry out joint declaration, joint research, joint promotion and transformation of scientific research projects, and vigorously build cutting-edge science centers, major collaborative innovation centers and basic research and applied basic research centers. At the same time, we will implement the national policy of opening to Hong Kong and Macao, and promote smooth exchanges of innovative talents, convenient customs clearance of scientific research equipment, cross-border use of scientific research funds, synchronization of innovative resource information, and open sharing of scientific research infrastructure and instruments and equipment. The scientific and technological achievements produced by colleges and universities in Greater Bay Area should concentrate on the transformation of scientific research achievements and help colleges and universities speed up the transformation and industrialization of achievements. Specifically, in view of the barriers to the cross-border flow of scientific research funds, an "offshore scientific research fund" is established under the guidance of the central bank, such as Macao supporting + Shenzhen operating. Mainland institutions can obtain a single fund ⩽ 5 million through green foreign exchange channels without approval, while Hong Kong and Macao institutions apply scientific research FT accounts to realize cross-border allocation. At the same time, in order to solve the obstruction of equipment customs clearance, establish a white list system of scientific research equipment, including cryo-electron microscope and gene sequencer.

4.6Collaborative governance of Guangdong, Hong Kong and Macao: Building an institutional guarantee system for the development of higher education clusters

There is an important difference between the construction of Guangdong-Hong Kong-Macau Greater Bay Area under China's national conditions and other world-class bay areas, that is, it involves one country, two systems, three jurisdictions and customs territories, and three currencies circulate. Under this system, it is even more difficult to develop higher education clusters. It is necessary to comprehensively deepen institutional reform focusing on interconnection, interoperability, mutual learning and sharing, actively explore new models of cluster development in Guangdong-Hong Kong-Macau Greater Bay Area, and promote institutional and institutional innovation in major development regions and key cooperation areas, so as to drive all parties to deepen cooperation and release reform dividends. Therefore, it is necessary to deepen the comprehensive reform in the field of education, plan the innovation of higher education clusters, and promote the development of institutional mechanisms more fundamentally, lastingly and deeply with demand-driven and problem-oriented. Build a strong Greater Bay Area education policy formulation and implementation evaluation system, form a strategic, forward-looking, innovative, targeted and feasible Bay Area higher education policy system, and provide institutional guarantee for the development and sustainable development of higher education clusters. Specifically, the three-step promotion strategy of collaborative governance builds a gradual institutional breakthrough path of "authorization-convention-legislation". First of all, in the near future (2025-2027), the function of the Guangdong-Hong Kong-Macao University Alliance will be implemented, upgraded to a statutory body jointly authorized by the three places, and basic rules such as the "Guidelines for Mutual Recognition of Credits 1.0" and the "Negative List for Sharing Scientific Research Equipment" will be issued; Secondly, in the medium term (2028-2030), sign the Charter for Coordinated Development of Education with a dispute settlement mechanism, and establish a system of "small conventions" such as cross-border degree management and mutual recognition of vocational qualifications; Finally, in the long term (2031 +), the State Council will be promoted to approve the Regulations of Guangdong-Hong Kong-Macao Education Special Zone and establish the Bay Area Education High Court to provide ultimate legal guarantee.

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