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Reflections on educational reform supporting build China into a world leader in science and technology

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ABSTRACT

Building a science and technology's world leader is an important goal for China by 2035, how to build a strong country in science and technology-high-level scientific talent is the fundamental supporting factor. Historically, Germany, the United States and Japan, three late-developing catching-up countries in the process of moving towards a scientific and technological power, have successfully implemented high-level scientific talent training initiatives, ultimately promoting the strong rise of science and technology. According to the experience of the three countries, the cultivation of high-level scientific talents is mainly achieved through major reforms in education, especially research-oriented education reform. At present, China is entering a new stage of development in building a scientific and technological power, the domestic and international development situation is more severe, and the law of science and technology itself is evolving at an accelerated pace, which puts forward new requirements for the cultivation of high-level scientific talents, and education reform is imperative. In comparison with the experience of Germany, the United States and Japan, China's current high-level research-oriented education still has many problems, it is difficult to support self-reliance and self-improvement in science and technology and build China into a world leader in science and technology. To sum up the history and face the reality, it is suggested that China should establish the concept of "integration of science and education" as soon as possible, promote education reform under the traction of scientific and technological needs, comprehensively sort out and reshape the positioning of universities, accelerate the reform of high-level research education, and increase the reform of primary and secondary education to prepare for the cultivation of high-level scientific talents in a comprehensive and systematic way.

Key words: world leader in science and technology, self-reliance and self-improvement, integration of science and education, educational reform, research oriented education

INTRODUCTION

A world leader in science and technology is a country with a high level of scientific and technological originality, a strong capacity for innovation and leadership, and a balanced field of development, and at the same time a strong economy, comprehensive national power and world influence, characterized by a strong scientific and technological capability and a strong capacity for innovation.[1] China has proposed the goal of becoming a world leader in science and technology by 2035, which is inextricably linked to the simultaneous promotion of education. According to history, there are five countries in the world that can be called scientific and technological world leaders, and the order of their establishment is: Britain, France, Germany, the United States and Japan. Among them, the United Kingdom and France because of the early

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scientific revolution and the establishment of the world's major scientific centers, thus becoming the first to lead the type of scientific and technological world leader, while Germany, the United States, Japan because of catching up with and beyond the United Kingdom and France to become a catch-up type of scientific and technological world leader.[2] The virtual economy in the academic world has two meanings: firstly, it refers to the decreasing creation of knowledge, and the repeated dissemination and even plagiarism of outdated knowledge in closed circles; The second refers to the serious detachment of knowledge production and dissemination activities from reality, and only "self circulation" in the academic circle.

Obviously, because China started late and has been in a state of catching up in science and technology, it is called a late-catching-up country, therefore, to build a strong science and technology country, we should focus on the experience of Germany, the United States and Japan.

Based on previous studies,[2] where the rise of science, must first emphasize education reform. The rise of science is also an indispensable condition for the establishment of a scientific and technological world leader, China has now reached the critical juncture of the need for the rise of science, whether or not to achieve scientific originality to enhance the world's major scientific centers, directly determines whether or not China can build the world's scientific and technological power. So, the history of Germany, the United States, Japan, three countries is how to realize the rise of science through education reform, what is the inspiration for China? What are the problems in the cultivation of high-level scientific talents in China, and what should be done? This paper will focus on these issues.

IMPORTANT PRACTICES OF RESEARCH-ORIENTED EDUCATION REFORMS IN GERMANY, THE UNITED STATES AND JAPAN

The German approach: targeting the development of pure scientists

Before the educational reforms, Germany lagged behind the pioneering countries Italy, France and Great Britain by about 200 years.[3] At that time, the world's mainstream direction was represented by the applied education of France and the gentleman's education of England. 1807, the Kingdom of Prussia was defeated in the Anti French Alliance War and was forced to cede all the territories west of the Elbe River to France, thus losing the famous Halle University. The Prussian nation was full of humiliation. The Prussian nation was full of humiliation, and the German national mood was volatile. In order to revitalize the country, Germany pointed to the solution of national education. Wise people (such as Fichte) believe that the future of Germany lies in education, and compulsory universal education must be provided to all. The King of Prussia also believed that "this country must compensate for the loss of its body with spiritual strength." [4] It was the inevitable choice of Prussia to change the spiritual world of the people through educational reforms in order to prepare for the re-emergence of Prussia and the realization of the unification of Germany. Therefore, Prussia introduced compulsory education while establishing new universities.

The University of Berlin (1810), which was born in this context, is a research university that is regarded as the mother of modern universities. Whether in terms of educational positioning, institutional models, teaching staff, or educational philosophy, they were at the highest level at that time, even surpassing England and France. It trained a large number of physicists, chemists, biologists, philosophers, *etc.*, and made a direct contribution to the second industrial revolution in Germany and the second scientific revolution in mankind. Compared with traditional universities, the University of Berlin has the following breakthroughs.

First, in terms of the positioning of the university, it focuses on pure scientific research. Universities represent the pinnacle of academic institutions, and the core of their operation lies in the training of scientists, engaging in pure academic exploration and the pursuit of truth, rather than meeting the needs of the Government and society.

Second, in terms of their status, universities maintain a high degree of independence. They are free from any form of State organization, teachers and students enjoy academic freedom, teachers' fields of study are free from any political, partisan and social opinion, and students are free to choose their teachers and subjects of study and to question and criticize authority.

Third, in dealing with knowledge, creating knowledge is more important than imparting knowledge. The College has set up lectures according to disciplines, with a full professor in charge and other scholars following his or her research, forming a school of thought and continuously exploring cutting-edge knowledge in the field. During lectures, teachers and students discuss common topics on an equal footing, question each other, inspire each other, and acquire new knowledge together.

Fourth, in the construction of academic disciplines, great importance is attached to the development of philosophy. Philosophy is considered to be the

knowledge that can unify all disciplines, and the Faculty of Philosophy has been put on a par with the Faculty of Law, the Faculty of Medicine and the Faculty of Theology, thus greatly contributing to the development of metaphysics and the natural sciences.

Fifth, in the training of students, we endeavor to cultivate their moral character. Before learning specialized knowledge, students must cultivate a broad vision and an independent mind, so that they can focus on their inner growth rather than being subordinate to external goals. In order to cultivate students' moral character, the cultivation of teachers is emphasized first and foremost.

Under the demonstration of the University of Berlin, other German universities also reformed, and together they promoted the development and progress of research university education in Germany, so that by the time of World War I, Germany was at the top of the world's science.

The United States approach: vigorously developing graduate education

Since the 19th century, the United States has been relying on the introduction and improvement of European technology to develop its domestic economy, and has gradually transformed itself from an agricultural country to an industrial country.[5] With the deepening development of industrialization and the westward movement, the domestic demand for scientific and technological talents is higher, the traditional "literacy" education has been difficult to meet the demand for high-level talents, and there are calls for the United States to establish a "real university". At the same time, the other side of the ocean, Germany's education reform has occurred for nearly half a century, giving rise to more and more scientific and technological achievements and basically triggered the second industrial revolution. When these achievements were introduced to the United States with new communication technologies and students returning from studying abroad, the United States became more aware of its serious shortcomings in science education and began to consider establishing a research-oriented university.

The earliest research university was Johns Hopkins University, founded in 1876, which, unlike the University of Berlin founded in Germany, was a private university. Although the United States tried to learn from the German research university model, but because of the explosive growth of knowledge, the United States is essentially facing the problem of German education "involution", new students want to learn knowledge while creating knowledge becomes unlikely. In order to solve this problem, Johns Hopkins University pioneered the division of university education into two stages, undergraduate and graduate, with undergraduates being used to learn knowledge and graduate students being used to create knowledge.

Specifically, Hopkins University has the following characteristics: firstly, it combines advanced concepts with local realities. On the one hand, Hopkins has fully absorbed the philosophy of the University of Berlin that "teaching must be combined with scientific research"; on the other hand, it has clarified the system of postgraduate education in the light of local needs, established doctoral degrees, and made postgraduate education the core of university education.[6]

Secondly, undergraduate education is effectively linked to graduate education. The purpose of undergraduate education is to provide talents for graduate education, and through the creation of the Graduate School, the rate of undergraduates going on to higher education and the proportion of doctoral degrees conferred are strictly controlled, so as to realize the principle of "strict entry, strict exit", and to ensure that every doctoral graduate becomes an academic elite through strict academic training.

Creation of a large number of vehicles for scholarly communication and knowledge dissemination.[7] Including high-level academic journals, university presses, professional societies/clubs, visiting professors, *etc*., the academic level of the journals created not only comparable to the leading journals in Europe, but also set off a wave of journals created by American universities; University publishers and professional associations have evolved into new academic institutions and modern academic organizations that influence the world's education model, respectively; Visiting professors also promote a strong academic atmosphere of mutual exchange between different universities.

Thanks to the many pioneering reforms at Johns Hopkins University, research-oriented education in the United States has ushered in a new situation, with the establishment of Clark University and the University of Chicago, and the opening of graduate schools at Harvard University and Yale University, among others, following suit,[8] emphasized graduate education and cultivated scientific talents, which led to the United States keeping up with the trend of the times in local education and eventually succeeding in catching up with Germany in the second half of the Second Industrial Revolution and becoming the new world science center.

The Japanese approach: promoting the spirit of scientific research in pursuit of excellence

The lessons and experiences of Japan's education reform

coexist. The establishment of the University of Tokyo in 1877 marked the beginning of Japan's modernization of university reform, but it was soon transformed into an Imperial University, followed by the establishment of six Imperial Universities. Although Imperial University is located at the core of higher education in Japan, with the mission of cultivating elite talents, its educational model is clearly constrained by the government's will: on the one hand, the setting of university majors must be based on national needs, and is subject to the will of the state; on the other hand, the appointment of university professors is determined by the government, government officials can be transferred to universities to teach and university professors can also serve as government officials, forming the identity of "both teachers and officials". University teachers have long been referred to as "teacher officials".[9]

Under this institutional arrangement, although the Imperial university was positioned as a research-oriented university and also offered graduate education and promoted research and academic freedom, its substantive discretion was very limited. The "direct responsibility of the university for the needs of the nation" was formalized as a system of schooling, and schooling was absolutely subordinate to the interests of the nation. Therefore, as Japan's national power grew, and as the ideology of Japanese militarism became prevalent, these imperial universities naturally became the most infiltrated, and scientific research was greatly hindered.

After the end of World War II, Japan reformed its indigenous higher education by adopting pacifist and democratic educational ideologies on the one hand, and by reorganizing all imperial universities into national universities to engage in high-level scientific research on the other. While still serving national objectives, there was a significant increase in the autonomy of operation and freedom of research.[10] On the other hand, the creation of private universities has been encouraged to develop mass higher education and to train specialized and technical personnel for society, while at the same time serving to guarantee equal opportunities in education.[11]

Most of the post-war Japanese university teachers had experienced World War II, were deeply impressed by the technological blows Japan suffered from the United States, and had a clear understanding of the cruelty of scientific and technological competition, so they had a strong desire to climbing to the pinnacle of science and seizing the commanding heights of science. Teachers do not aim to publish papers, but rather focus on solving the world's scientific and technological problems, and venture into the "no man's land" at the frontiers of science and technology. It has become the lifelong pursuit of these teachers to give Japan a place in the international arena, and a strong culture of "scientific research first" has spread through the universities. Driven by this spirit of pursuing excellence in scientific research, Japan has produced many world-class scientists and a number of Nobel Prize-winning research results in the last three decades of the 20th century.

EXPERIENCE AND ENLIGHTENMENT

We can see that Germany, the United States, Japan, three countries, in the rise of science or began to attach importance to scientific research before, have made a breakthrough reform of education, and if the direction of the reform is right, after a long period of accumulation will produce great results, on the contrary, if the direction of the reform is wrong, it will cause major losses. The successful experiences of these three countries can be basically categorized as follows.

First, they emphasize the ability to produce original knowledge. All three countries understand that original knowledge can truly support the rise of science and technology and the prosperity of the nation, and the University of Berlin in Germany has even made "exploring the unknown for mankind" its mission. The main practice of knowledge originality is to put scientific research in the most important position, to stimulate scientific research with generous treatment and respectable status, and to avoid consuming energy on fame, fortune and earning a living.

Second, the educational reforms were categorized. The reforms in all three countries clearly distinguish between research-oriented universities and vocational universities, with research-oriented universities only aimed at cultivating scientific talents and scientific spirit. In research-oriented universities, graduate students are given a higher priority than undergraduates, and undergraduates are trained as a reserve for graduate students rather than to meet the needs of society.

Thirdly, a free academic atmosphere should be established. To minimize the interference of political, partisan and social opinions, teachers are given full freedom to conduct scientific research, and students are given the right to study, criticize and think freely, believing that "the spirit of science can only be generated in freedom". The lesson of Japan's failure also confirms this from the opposite side.

Fourth, the role of mentors is emphasized. Research universities have chosen to employ academic experts in the field as professors in their various specialties and to train students with first-rate teachers. Mentors are defined as partners rather than "masters", and it is advocated that mentors and students communicate on

an equal footing and inspire each other. Mentors, with their own spirituality, have a profound influence on students' minds and research abilities, thus enabling them to grow into scientific talents.

These practices and experiences have the following implications for China's construction of a science and technology powerhouse and education reform.

First, the rise of science is first of all the rise of scientists and masters, and the reform of research-oriented education is the driving force of the rise of science and technology. In the early stage of scientific and technological development, we can rely on foreign technology and talent introduction to catch up quickly, but after a certain stage, we must rely on endogenous efforts to achieve self-reliance and self-improvement (this is more obvious in the United States and Japan). At the same time, in order to achieve self-reliance, it must be supported by high-level research-oriented education reform. For example, Germany first started research-oriented education and founded research universities in the world, and then trained large-scale world-class scientists and masters. The accumulation of these high-level talents enabled Germany to catch up with Britain and detonate the second industrial revolution [at the end of the 19th century. [2] From the beginning of the 19th century, the United States has been paying attention to introducing technology and talents from Europe and making certain technological improvements and inventions. However, after the outbreak of the second industrial revolution, it realized that its scientific level was seriously lagging behind, and it followed the example of Germany to establish research universities. Japan launched research-oriented education almost at the same time as the United States. Through long-term accumulation, research in microbiology, medicine and other fields has reached the world-class level,[12] after World War II, new scientific development was achieved through the reform of research-oriented education (transformation of Imperial University) again.

Second, the key to the success or failure of education reform lies in whether the system design is reasonable. The reform of education is bound to adopt new educational ideas, but only with the corresponding system can it lead to real success. A good institutional arrangement can not only create a good atmosphere, but also stimulate people's vitality and good thought. The system design of university orientation, college arrangement, teaching design, discipline construction and teachers' treatment is the key factor to determine the success or failure of the reform. When Germany established Berlin University, it ensured that teachers could create knowledge continuously and students could become talents through education, by giving the university independent status, attaching importance to the development of philosophy, guaranteeing the freedom of teaching and (or) Learning, and advocating the combination of teaching and scientific research. In order to cope with the explosive growth of knowledge, Hopkins University in the United States has designed a graduate education and graduate school system, and formed an academic exchange system by creating academic journals, professional societies/clubs, visiting professors and other knowledge dissemination carriers. When Japan studied Germany, although it adopted advanced educational ideas, it was too conservative in the system design of school status, specialty setting and teacher appointment, which made the university fully serve the will of the state and the government, thus losing academic freedom and eventually becoming an infected place of militarism. After World War II, Japan redesigned the system of Imperial University, adopted pacifist educational ideas, and promoted the autonomy and research freedom of the university, thus creating a strong academic atmosphere, which made the scientific level rise rapidly.

Third, the cultivation of scientists and masters must respect the laws of scientific research. Those who cultivate first-class scientists and masters have no one not to respect the laws of scientific research. Respecting the laws of scientific research means putting the research characteristics of science in the first place, giving full respect and support to researchers, especially reducing the interference of the government and society in scientific research in the field of exploring the frontier of science. This means that scientific research is more important than teaching, inspiring students to think independently is more important than imparting knowledge, and forming a scientific spirit is more important than obtaining a good job. Historically, the University of Berlin once took "exploring the unknown world for mankind" as its mission, giving teachers full free research space and students the right to study freely, criticize freely and think independently, believing that "scientific spirit can only be produced in freedom" and fully respecting the law of scientific development. The graduate education of Johns Hopkins University fully considers the relationship between learning knowledge and production knowledge, and cultivate undergraduate students (to learn knowledge) as reserves for graduate students (to create knowledge), rather than rushing to meet social needs. Imperial University in Japan has proved from the opposite side the harm caused by too much pursuit of utilitarian goals and ignoring the development law of science itself. Therefore, in order to cultivate diversified scientists and real masters, we must abandon the thinking of quick success and instant benefit and give full respect to scientific laws and researchers.

RE-UNDERSTANDING OF CHINA'S EDUCATION REFORM

At this point, it can be basically determined that

education reform should first focus on "what kind of people to train", and high-level research-oriented education reform is the precondition for the rise of science. Therefore, education reform needs to first understand the current situation and talent demand, so as to facilitate the formulation of programs/policies. Generally speaking, the current circumstance includes two aspects: On the one hand, from the domestic and international development situation. China has embarked on a new journey of building a socialist modernized country in an all-round way. The demand for science and technology is more urgent for economic and social development, and the demand for high-quality and high-quality scientific and technological talents is stronger than ever. At the same time, the international situation is not optimistic, the competition between China and the United States and the game between big countries are becoming increasingly fierce, and it is difficult to rely on technology introduction to open up the market. The lack of scientific and technological originality makes us subject to people. In the long run, if we can't master the original technology and original innovation ability, we can't really realize the rise of science and technology and build a world leader in science and technology. This situation means that the development of science and technology in China has reached a stage where it must rely on endogenous power. Only by cultivating high-quality scientific talents to provide the source power for the development of science and technology can we truly achieve self-reliance and self-improvement and become a world leader in science and technology. How to cultivate high-quality scientific talents is an important proposition of the times that we are facing at present.

On the other hand, from the development law of science and technology itself. The world is entering a period of accelerated evolution in a new round of scientific and technological revolution and industrial transformation, and new changes are taking place in scientific research paradigm and industrial production mode. Scientific and technological innovation no longer simply follows the linear development logic of "scientific discovery-technological invention-commercial application". On the contrary, the reverse interaction of "market demand-technological demand-scientific breakthrough" is more frequent, the trend of combining scientific research with industrial application is more obvious, and the scientific research paradigm is evolving from linear development to multi-point breakthrough.[13] At the same time, the logic of industrial production is no longer purely standardized assembly-line operation, but more shifted to mass customization and personalized production, to the human way of life and way of thinking to bring a profound impact. These changes mean: the traditional large-scale batch mode of personnel training is no longer adapted to the new scientific and technological and economic and social development needs, with the change of situation, education should be reformed accordingly, the indoctrination of knowledge and standardized education must be replaced by the creation of knowledge and innovative thinking.

However, over a long period of time, China's education reform has been continuously explored and deepened, and the large-scale basic talents of the industrialization era have been cultivated with a certain degree of success, but entering the new stage of development, China's supply of high-quality scientific talents still appears to be insufficient, and the relevant education still suffers from the following problems.

First, the form of teaching is not flexible enough to foster the spirit of exploration. Most education adopts a teacher-student teaching style, with teachers giving lectures and students listening. The status between teachers and students is not equal, lacks of interactive and heuristic learning likes the Berlin University. The lecture system often involves changing the teacher for each lecture in a "flowing" manner, without achieving the original essence. Academic research tutors are too authoritative, and there is little room for students to question and criticize, to make their own choices, and to give free play to their ideas.

Secondly, teachers face significant survival pressure and find it difficult to conduct pure scientific research. Forced by the title constraints and the pressure of life, university teachers are forced to spread their energies to make a living, exchange knowledge for profit, and thus emphasize the sale of knowledge over the creation of knowledge. Teachers generally lack the motivation to explore the no man's land at the frontier of science and technology and climb to the top of the scientific peak, which in the long run leads to the knowledge being too old and too slow to be updated, forming a "virtual economy" in the academic world.

Thirdly, there is a disconnect between graduate and undergraduate education, which makes it difficult to select academic talents. The status of graduate school in the university is not prominent, student management is limited to administrative nature, there is no scientific plan, implementation program and system to protect academics, and there is no long-term plan for undergraduates' selection. Because of the disconnection between undergraduate and postgraduate training, fewer undergraduates choose to go on to graduate school to pursue academic research, coupled with the lack of academic training in undergraduate education, most students need to re-cultivate their academic abilities in postgraduate school.

Fourthly, the evaluation of talents is too quantitative, submerging the value of academic research. The number of published papers is still the main basis for talent evaluation. The fierce competition for publication has led to a shortage of academic journals, resulting in many chaos such as spending money to buy papers, publishing to buy pages, and copying models mechanically for papers write. The long review cycle of journals, untimely feedback from expert reviews, and the emphasis on title and funding in paper evaluation have long existed. Academic journals have lost their original academic exchange significance, become tools for evaluating professional titles, and have also drowned out the true value of academic research.

Fifthly, there is insufficient education on student liberal education and premature limitations in innovative thinking. Since elementary school, there has been a problem of learning for quick success and instant benefits, focusing on pursuing external goals while neglecting internal cognitive enhancement. The "showing style" learning and "pursuit of perfection" educational methods prematurely mask students' talents. The "showing style" learning refers to only for the purpose of showing others, rather than being able to do what they truly want or are able to do on their own. The reason is that teachers and parents use their own expectations to force students to strive towards a certain goal, and students are not taught to form independent opinions and self-restraint. Therefore, their performance is only outstanding in specific situations (such as parent teacher meetings), and they cannot achieve autonomy and long-term success. The practice of distinguishing student levels solely based on scores makes students and parents tired of dealing with a mountain of homework and a variety of bonus points, lacking the energy to forge an independent personality and a free mind. The social environment and educational atmosphere have not been reversed for a long time.

The existence of these problems has led to the cultivation of scientific talents deviating from the high-level orientation, and the reserve of high-end talents is not strong enough, which in turn leads to the weak ability of knowledge creation and source innovation. From all the experiences and real problems, China's education reform has great potential, but in the long run, we should aim at the reform of high-level research-oriented education first, so as to lay a good foundation for the cultivation of high-level scientific talents for the future, and then we can involve in other aspects. Because research-oriented education reform requires a long period of time from its inception to its true effectiveness, for example, Germany from 1810, the founding of the University of Berlin, to the rise of chemistry and physics in the 1860 s, it took about 50 years, and then after about 20 years, in the 1880 s only to detonate the second industrial revolution; The United States from established Hopkins University and started graduate education at 1876, to exceeding Germany in the number of Nobel Prize in science at 1930 s, it taking about 60 years; Japan from the Second World War to carry out educational reform, to the 21st century Nobel Prize in science rise, it took more than 50 years. Therefore, if we don'*t* reform research-oriented education now, we will face greater pressure in the future.

SUGGESTIONS ON CHINA'S EDUCATION REFORM

In view of the experience, enlightenment and problems of the previous analysis, this paper puts forward the following schemes or suggestions.

First, promote the implementation of the concept and working mechanism of integration of science and education as soon as possible. This includes two aspects: at the macro level, increase the collaboration between the technology and education sectors, as well as the collaboration between the technology and education sectors, the working logic behind it is talent cultivation, utilization, and development; At the micro level, increasing the combination of scientific research activities and teaching activities, and unifying research work and education work, the work logic behind it is the creation, dissemination, and sharing of knowledge. It is suggested to launch the concept of "integration of science and education" as the core essence of the strategy of "revitalizing the country through science and education" in the new development stage, and implement the long-term project of "integration of science and education". Strengthening education reform under the demand for science and technology, coordinated by the two departments of science and education, focusing on reversing harmful academic styles, building a first-class scientific research/academic ecosystem, promoting talent evaluation reform, improving the talent introduction, retention, and utilization system, encouraging new paradigm changes, reserving high-level talent teams, improving scientific education and popular science capabilities, *etc*., and increasing joint construction and sharing for common reform.

Second, comprehensively sort out and reshape the orientation of universities. At present, the orientation of China University is not clear, and the concept implementation is not thorough, which leads to the unsatisfactory reform effect, resulting in a focus on form rather than content. The real reform should be carried out in different categories, and their respective positions should be clearly defined, and then the reform plan should be formulated, so as to avoid the occurrence of

phenomena such as "large and comprehensive" and "nominal but not real" in disciplinary construction, as well as "one change, all changes" and "one withdrawal, all withdrawals" in reform. It is suggested that classified reform should be carried out according to research universities, applied universities and vocational universities: research universities should focus on cultivating high-level scientific talents (including social sciences) and do a good job in postgraduate education, especially doctoral education; Application-oriented universities aim at cultivating application-oriented scientific research talents, focusing on undergraduate education; Vocational universities aim at cultivating technical talents with craftsman spirit, focusing on the education of junior college students. At the same time, it is necessary to set up channels for further studies between different types of universities, such as building cross-disciplinary university alliances, so as to facilitate talents who are interested in scientific research to continue their studies.

Third, focus on reforming high-level research-oriented education. As the theme of this paper says, high-level research-oriented education is the most important way to promote the construction of China as a world leader in science and technology, and it is also the most urgent reform direction. We must speed up and give priority to such reforms, make overall plans, make real moves and do practical work. Specific suggestions include: (1) Improving the status and autonomy of graduate schools. Give the graduate school the responsibility and power to be in charge of graduate education, strengthen the connection with undergraduate education, reserve academic talents in advance, formulate scientific procedures, and screen those with academic aspirations and potential to give priority to training. (2) Implement refined management of graduate students. The academic master and professional master will be trained separately, and the full-time doctor and on-job doctorate will be trained separately. Clearly distinguish their positioning, develop different training programs, and assess them separately. (3) Strengthening the training of academic norms for undergraduates. Improve the quality of classroom education, implement the discussion class and lecture system teaching, and realize the free discussion, mutual criticism and mutual inspiration between teachers and students. (4) Boost the spiritual temperament of the tutor. By vigorously improving the treatment of professors (researchers), based on salary and supplemented by reputation, we will reshape the fine atmosphere of "respecting teachers, valuing teaching and being proud of teaching" in society and promote mentors to strengthen their beliefs and focus on academic work. (5) Remould the function of academic journals. Vigorously rectify the chaos of periodicals and explore the system of "one publication and two editions" (Student Edition and Teacher Edition) on a pilot basis, expand the proportion of non-periodical academic achievements assessment, and alleviate the situation that periodical pages are in short supply. (6) Establish new types of universities in due course. Empower social forces to establish high-starting research universities, explore new scientific research systems with high standards, and force and drive the reform of universities within the system. (7) Strengthen policy and academic exchanges. Strengthen the cooperation between universities and national high-end think tanks, set up two-way intercommunication research posts, bridge the communication between national policy research and academic professional research, and improve the timeliness and accuracy of information communication between demanders and supporters.

Fourth, accelerate the reform of primary and secondary education. The primary and secondary school stage determines the real level of scientific and technological innovation in China, because once the innovative thinking is restricted from childhood, it is difficult to open it again in the higher education stage. The high-level research-oriented education reform must be supplemented by the primary and secondary education reform at the same time, so as to achieve the expected results. First of all, we should adjust the scope of compulsory education. Make overall plans to reduce primary and secondary education, and bring high school into compulsory education, and keep the nine-year period unchanged; Compulsory education implements continuous study, substantially cancelling junior high school entrance examination and senior high school entrance examination, cancelling the practice of linking primary and secondary admission qualifications with various evaluations, awards, and honors, and weakening the pressure of exam oriented education. Secondly, we should reform the examination system. Unify teaching and examination, give front-line teachers the right to put forward propositions, only test basic knowledge points in assessment, and do not judge thinking ability and creativity by scores, thoroughly weaken score competition and fundamentally reduce the demand for extracurricular training. Thirdly, we should strengthen quality and cultivation education (including moral education, physical education and practical ability). Pay attention to the cultivation of children's independent personality and free mind, first re-educate educators, and reform the teacher assessment system to enable teachers to establish an innovative educational concept of "putting morality first". Finally, it is necessary to strictly regulate the off-campus training classes and parents' homework groups, effectively reduce the burden on students and parents, put an end to the "starting line" involution, and ensure that children can devote more energy to cultivating innovative thinking and establishing

a correct outlook on life.

DECLARATION

Author contributions

Qin Z and Ding ML developed the concept for the manuscript, reviewed the literature, formulated research questions, collected the data, conducted analyses and interpreted the data. The author read and approved the final manuscript.

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Conflict of interest

The authors declare no competing interest.

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