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The Review of Science Education in China

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Abstract. Science education is paid more attention nowadays. This article describes the current situation of Science education in China. As a concept paper, it is divided into some aspects, such as the history and development, the Necessity of Science history, incorporate the history of science into today's science education, the future trend of science education, the goal and significance of science education, also, it states the problems and solutions in science education as well. More importantly, science education in the 21st Century is introduced in the end which combines the advanced technology in science teaching and learning process. Conclusion comes lastly with the enlightenment for future development of science education.

Keywords. Science education, situation, development, significance, technology

1.1 The history and development of Science education in China

For China’s modernization, the low level of science and technology is still a serious problem faced by the Chinese people. Many advanced science and technology are still in the stage of introduction and digestion, especially in basic disciplines, high-tech and technological industrialization, and the gap with advanced countries. What China lacks today is the “scientific technology that has both the superficial level of science and the scientific rationality of the essence of science” (Huang, 2003). This is a kind of “gap” faced by the modernized countries of the “late and exogenous” type. However, correspondingly, with people's reflection and criticism of modernization, science education has also become the object of reflection and criticism. This is particularly prominent in Western countries where modernization has occurred early and science education is extremely developed. So, how to develop science education not only in conformity with the trend of the world but also in consideration of China's own characteristics?

1.11 The roots of science education

Regarding the positioning of science education, one view holds that science education is essentially education aimed at "cultivating scientific taste" and it should attach importance to "science of ordinary things." Its primary goal is to "arouse people's love for nature", and the goal in intellectual development is to train for observation. However, others regard science education as a means of intellectual development, by analyzing and explaining data, and using evidence to debate the corresponding scientific theories, so that students can engage in reasoning exercises. In addition, it also allows people to verify speculations. The content of science education is not particularly important. It is crucial for its unique function-science which can train thinking, that is, the process of scientific inquiry is more important than the content itself. Unlike elementary schools, the centrality of science in secondary education has been opposed by those who support the classics and Christians. They believe that humanities education is more valuable than science and technology education for cultivating people's comprehensiveness (Wang, 2005). From the Victorian era to the century, this view was relatively strong. Although science and technology played a key role in the success of the two world wars and the industrial revolution, in the school science curriculum formulation process, its dominant values still believe that, as a form of education, scientific training only produced a "useful expert", not a truly educated person. During this period, science education and its courses are essentially regarded as a kind of pre-employment training, and the training targets are those who want to engage in science or technology occupations; for the cultural education of cultivating all-round development of individuals, science education and the course itself is of little value. Contrary to education, "scientific training" is essentially preaching and authoritarian, requiring novices to learn and digest established knowledge. Although this knowledge is essential for people to understand the discourse and the problems facing scientists today, it ignores the inquiry into the nature of the discipline itself and its history. The former (disciplinary nature) is ignored, because people think that this knowledge can be obtained by the way in learning. The latter (disciplinary history) is neglected. It is believed that this retrospective study of the history of science and its methods cannot help people understand the problems, even if these problems are faced by newcomers who are about to enter the scientific community. In short, this "scientific training" emphasizes scientific facts and scientific content rather than scientific processes. Evidence shows that the vast majority of students cultivated by this kind of science education have very naive views on the nature of science. They regard science as a process of conducting experiments to obtain data, then generalizing or formulating rules. Another social context factor that affects the form and nature of science education and also its quality, is that a system has been developed to evaluate school performance through examination results (Gao, 1998). Today's evaluation system attaches importance to paper-based examinations, and emphasizes the part that is easy to evaluate, namely the scientific content knowledge that students possess. However, when an indicator is selected because it can reflect the quality of service, and then used as a single quality indicator, its operability will destroy the relationship between the indicator and the referent. For those learning experiences provided to children, the high risk of assessment distorts the nature and quality of this experience. Teachers feel a lot of pressure on course teaching, which will inevitably lead teachers to value course content more than scientific process. It will also reduce or delete opportunities to discuss questions raised by students and explore unimportant but very interesting content in the course. A special problem faced by science courses is not only to carry out practical work, but also to evaluate students' abilities and skills in this field. Although the first edition of the national curriculum included models of scientific inquiry, in the eyes of today's scholars, this is very limited. This is the brief picture of science education at the turn of the century. Some of the dissatisfaction expressed in it comes with people's gradual understanding of science and its practice; it comes with the rapid development and growth of the team of scholars in the field of scientific research.

1.12 Benefits represented by science education

The scientific education concept with Chinese characteristics attaches importance to and highlights people. It is based on the modernization of people—that is, people’s pursuit of a full-scale possession of their own human nature to achieve healthier development of them, and consciously based on this. Elevating individual practice to the height of human practice represents the interests of the broadest masses of people.

1.13 The Philosophical Foundation of Science Education

The scientific education thought with Chinese characteristics is based on the philosophy of higher education with the core of shaping the perfect personality, and it is based on the Marxist philosophy. Marxist philosophy is both a great spiritual weapon for understanding the world and transforming the world. Solving the relationship between human beings and the world from practice is the essence. It is the key to the great philosophical transformation of Marxist philosophy. The philosophy of higher education based on Marxist philosophy also emphasizes understanding people and understanding education from a practical point of view (Barton, 2000). Human being is an open existence that is self-generated through practical activities, it has the characteristics of value pursuit, self-creation and self-transcendence, and also, it has the characteristics of taking the self as the subject. To understand "education" in terms of human characteristics, education is a self-constructed practice method of human beings, and its essence is the two-way construction of culture and human beings. The modernization of education is an endless process that starts with people and returns to people. The main body is "people", not "things."

1.14 The spiritual value of science

Science is not simply a natural knowledge system or a tool to meet the needs of human existence, but is closely related to human mental development. Therefore, it must go beyond the notion that science has only utilitarian values to fully grasp its composition and its core. The development of science education should not only focus on scientific knowledge and scientific skills, but also the inherent spirit and human value of science and culture: the instrumental value of people in the development of science and technology. The value of subjectivity in human beings means that it makes people feel the value of science and technology driven by human material desires, also it makes them realize that science and technology have the value of satisfying people’s unique deep spiritual needs (Feuer, 2002).

1.15 Combination of science and humanities

For a person to obtain comprehensive development, he must receive both science education and humanities education. Otherwise, he is a one-sided development person, that is, a "half person." That is because science and literature are two aspects of the same thing. The greatest danger that science must avoid is the one-sided development of those engaged in science. Therefore, a comprehensive education should be introduced into the school. "The question of whether science and technology education and humanities education can be integrated is essentially a question of whether science and technology rationality and value rationality can be integrated. In today's era, the integration of these two rational spirits is inevitable and necessary." First of all, Scientific and technological rationality and value rationality are complementary in essence, and they are unified in practical rationality (Linn, 2004); at the same time, scientific and technological rationality and value rationality are also unified in the real needs of people; moreover, the dilemma of modernization forces people to adopt a more conscious attitude, and the way to achieve the integration of the two kinds of rationality.

1.16 Implementation path of science education

Science education first started in Western countries. The process of higher education modernization can be a process of growth, development, and dominance of science and technology education. However, with the development and growth of science and technology, modern people have been completely "swallowed up" by instrumental rationality. "While man has achieved the most glorious victory over nature, man has also become a prisoner of his own creativity and has fallen into the worst of his own destruction dangerously" (Baez, 2009). Therefore, it is necessary to get out of the fog of "instrumental rationality" and materialism, realize a fundamental change in concepts, and take "human" as the subject and theme. Education is "human" education, not "materialistic" education. Only science education, that is, taking scientific knowledge, technical ability and other aspects outside the spiritual and moral world of human beings as a model of human knowledge, is the alienation of education. The integration of scientific and technological rationality and value rationality, the coordinated development of science education and humanities education, are inevitable and necessary. It has also become the trend and theme of educational reform and development in the 21st century.

1.2 The Necessity of Science History in Science Education

An undeniable fact is that not all scientists need to understand and master the history of science. Some scientific practical activities can be completed without knowledge of the history of science (Tao, 2013). For example, successful model construction or experimental operations can be achieved without understanding the history of science. This means that as long as you work hard and strive for perfection at the technical level, you can become a qualified or even excellent scientist without paying attention to the history of science. However, it is also undeniable that almost all the top scientists are familiar with the history of their research fields. The so-called "top class" refers to those scientists who have the ability to gain insight into the laws and potentials of the development of the research field, and are able to lead the theoretical and practical breakthroughs in the research field. These capabilities depend on the understanding of the development process of the research field. Newton can only develop a theory that unifies these two fields if he has insight into the previous development of mechanics and astronomy. Before the introduction to the book "Origin of Species", Darwin arranged a small chapter entitled "A Brief History of the Development of Insights on the Origin of Species". It is not difficult to see that he regards his theory of natural selection as a reaction to various previous evolutionary thoughts. Both Einstein and Bohr developed their revolutionary theory of relativity and quantum mechanics after having their own unique insights into the development of classical mechanics. If you apply Kuhn’s terminology, scientists who do not pay attention to the history of science can generally only be qualified for technical work in conventional science, because the basic task of conventional science is to apply theories in the same paradigm without doubting the paradigm and the theory itself. The top scientists can complete theoretical breakthroughs, and even trigger a paradigm shift, that is, a scientific revolution, and theoretical breakthroughs often require an understanding of the development history of previous theories. Perhaps Kuhn’s picture of scientific practice is too simplistic. Some scholars have pointed out that in real scientific practice, theoretical innovations and changes are not as drastic, sudden and large-scale as Kuhn's scientific revolution, but more flexible, continuous and small-scale. However, even in flexible, continuous and small-scale innovations and changes, it is still the top scientists who are in the leading position, because it is the top scientists who have achieved theoretical breakthroughs. This is why in science education, great scientists such as Newton, Darwin, Einstein, Bohr, rather than technically good scientists are regarded as role models for students to learn, although the achievements of great scientists are inseparable from technically good scientists work support.

The above observations urge us not to ignore the history of science education in the process of science education, especially when the focus of science education is on overall quality rather than just test-taking ability. There are profound reasons why science education cannot ignore the history of science. Two of them deserve our attention. Let's look at the first reason: Scientific concepts and theories can be understood in both historical and non-historical ways. In contrast, non-historical ways of understanding have practical advantages, while historical ways of understanding have epistemological advantages. It is this kind of epistemological advantage that makes top scientists, without exception, experts in historical understanding. We must clarify what is historical understanding and what is non-historical understanding. Generally speaking, we can understand a scientific concept non-historically. For example, for the concept of "force", generally middle school physics textbooks will tell us that its precise definition is mass multiplied by acceleration. Middle school physics textbooks will also tell us that this is the definition given by Newton's second law, which together with Newton's first law that defines the conditions for the generation of "force" and Newton's third law that defines reaction forces which gives Newton's mechanics. This is one of the most basic concepts that contemporary young people need to learn in the process of learning physics. Many other physics concepts must be derived from this concept. At the same time, this is an accurate concept, which can be derived from the three measurable properties of quality, time, and length, so it is completely different from the vague understanding in daily life. In daily life, we will intuitively realize the so-called "force" we feel in the process of pushing and pulling, but it is difficult to define this psychological feeling in a precise way. It is completely non-historical to understand "force" as the product of mass and acceleration. As long as students master the mathematical and logical relationship between this concept and other related concepts, it can be used to do middle school physics exercises (Gao, & Watkins, 2002). The concept of force can also be understood historically. Looking back, Einstein's special theory of relativity means that Newton's universal gravitation cannot travel faster than the speed of light. Looking forward, a series of metaphysical, epistemological and methodological questions will be raised. The concept of force has been vague and ambiguous before Newton, carrying various metaphysical understandings of causality in different theories. And Newton used the concept that can be measured or quantified to define "force", so that mechanics can get rid of the previous metaphysical burden, especially Aristotelian, and become a research field that can be processed by mathematics, thereby providing a mechanized understanding of the world. The picture provides the final theoretical support. Most top scientists have their own in-depth understanding of the historical significance of Newtonian mechanics carried by the concept of force. For example, Darwin tried to make the natural selection theory's explanation of the origin of species meet the requirements of Newton's real cause. Einstein's theory of relativity and the debate between Einstein and Bohr about whether God rolls the dice permeate their understanding of the ontological characteristics of Newtonian mechanics. The distinction between the non-historical and historical ways of understanding scientific knowledge has long been noticed by some big thinkers in the West. The French positivist philosopher Comte called the former a dogmatic method and the latter a historical method. The dogmatic method refers to the textbook method that has nothing to do with history. This method is essential for science education and teaching. However, a mere dogmatic approach does not help to understand the nature of science. He believes that "as long as a person does not understand the history of a science, then he does not fully understand that science." The Austrian physicist and philosopher E. Mach insisted that the historical method is more conducive to a thorough understanding of the method and purpose of science, because only through dialogue with past scientists can scientists critically reflect on their own research. Mach has a very enlightening observation on the importance of historical understanding, which is worth quoting below: "We should realize that not only the various ideas accepted and disseminated by teachers are necessary for the historical understanding of science. Thoughts that have been abandoned by researchers and existed for a short period of time, and even that obviously wrong happiness, may be very important and instructive. It is necessary to explore the development history of a science, which makes the principles hidden in it. Historical research has shown that the existence of science is largely ordinary and accidental, which not only helps us understand the current state of science, but also brings us new things that may happen. From the point of view that different ways of thinking can meet, we can look around with a relatively free perspective and discover routes that we have never known before." Both Comte and Mach admit that in most textbooks, it displayed non-historical understanding of science is necessary in science education, because the non-historical understanding not only gives a clear description of scientific concepts and theories, but also is more direct for training young scientists. However, these two thinkers also emphasized that only through historical understanding can scientists gain an in-depth understanding of science. Therefore, it is only natural that the top scientists have more historical understanding of science than ordinary scientists (Roth & Lee, 2004).

The second reason why science education should not ignore the history of science is that historically understanding scientific content is more in line with the constructive characteristics of the cognitive process in science education, and it is therefore particularly important for quality training. A simplistic view of science education believes that the process of science education is to transmit objective knowledge to students through teacher's teaching. The quality of teaching is determined by the following factors: Whether the teacher can fully display the objective knowledge in the classroom, whether students understand the objective knowledge displayed by the teacher during the learning process, and whether they remember the results of the understanding. The examination attempts to test the success of the above-mentioned objective knowledge transmission process. However, in the second half of the 20th century, more and more scholars realized that the cognitive process in science education is not a simple knowledge transfer, but a constructive process. To learn a new concept or a new theory, the cognitive subject needs to find the way in which this concept and theory relates to its previous knowledge structure, and finally construct a new knowledge structure. In Piaget terminology, learning is a process of absorption and adjustment. The so-called absorption refers to the incorporation of new information provided by the outside into the students' internal cognitive framework, and the so-called adjustment refers to the reorganization of the existing belief structure in the internal cognitive framework of the students, so that the newly incorporated information is related to the existing beliefs. Since each person's experience is different, the existing information of different students is various, so the way of inclusion and adaptation will be different as well. For example, a southern student who has never seen snow, so he understands the phenomenon of a snowstorm in a different way than a northern student who has experienced a snowstorm. In other words, different students learn the same knowledge through different construction processes. Effective science education requires awareness of the importance of constructive features in the learning process. Science education, which is based on constructivism rather than transmission, requires teachers to prepare teaching content and at the same time pay attention to different cognitive processes when different students receive the same knowledge point, so as to help students successfully complete the learning process. The examination is also a means to help students complete the construction (Chan, 2005). It is worth noting that constructiveness in the learning process is a cognitive feature shared by scientists and students. Most constructivist science education scholars believe that students and scientists in schools will be interested in the surrounding objects and things, and will try to understand why these objects and things behave and exist in their own way. In practice, scientists discover or accept new theories that can better explain the research phenomenon to replace the old theories. Similar to the process of students learning new concepts or new theories, it is also a construction process of absorption and adjustment. In other words, scientists try to incorporate new explanatory tools into their own research framework and adjust the old framework to construct new theories. Therefore, historically understanding scientific content means letting students understand the true cognitive construction process that the scientific content experienced when it was discovered and accepted (Aikenhead, 1999). This kind of understanding allows students to better understand the difficulties and confusions they encounter when learning the corresponding content. For example, our perception of force-related phenomena that occur in our body and surrounding things in our daily lives is not completely consistent with the connotation of force given in Newton's law. We generally think that muscular manpower is strong, and we rarely think of using the product of the mass and speed of an object to describe the concept of force. The idea that a moving object that is not interfered by external forces will maintain the same movement forever is also inconsistent with our intuition and observation. Learning the history of science will enable us to understand how Newton formed his mechanics laws. This understanding helps us know why our intuition does not conform to Newton's laws. Of course, the above analysis does not mean that the non-historical understanding cannot explain why ordinary people's intuition of force does not conform to Newton's law. Different from historical understanding, the explanation of non-historical understanding is more arbitrary, that is, to presume the correctness of Newton's law without doubt, and then explain the difference from our intuition based on Newton's law. This arbitrary method is not illegal, but it is difficult to show the constructive characteristics of both the scientific practice of scientists and the learning process of students. It is not difficult to see that from the perspective of the constructive characteristics of science education, historical understanding methods are more conducive to students' quality training than non-historical methods of understanding.

1.3 Incorporate the history of science into today's science education

Under the current educational situation in my country, there are at least two reasons that make the history of science not optimistic in the education before university. Firstly, under the current pressure of exam-taking, non-historical comprehension methods are more favored by teachers and students. From the above analysis, we can see that compared with historical understanding, non-historical understanding is faster and more direct for students. Students do not need to learn the historical process of forming a certain formula, only learn to apply the formula to deal with the exam. Therefore, schools, students, and parents who focus on coping with various exams will naturally favor non-historical comprehensions and actively compress historical comprehensions. Secondly, in order to reduce the burden on students, the current new curriculum for primary and secondary schools has adopted a method of reducing teaching content. The original intention of this reform is undoubtedly good, but its effect is not ideal. As most experts and scholars in the Second Science Education Forum realized, reducing teaching content did not encourage students to spend the time they saved on learning activities that increase interest and quality, but instead allowed students to spend more time (Ma, 2012). Come to think about the skills of coping with exam questions or repeat the problem-solving practice. Once students know which content is not within the scope of the exam or the elective part, they don't spend much time studying. The fact that the reform effect of the new curriculum standard failed to be as expected by the reformers deserves further consideration. Some scholars believe that if the baton of the college entrance examination remains unchanged, any reform aimed at improving quality will be difficult to succeed. There is some truth to this pessimistic observation, but we should realize that it is difficult to cancel or change the college entrance examination system. Therefore, it is difficult for us to pin our hopes for quality education on the cancellation or change of the college entrance examination system. The unified examination is a relatively objective way of selecting talents. It is not an easy task to find a way to replace it nationwide without losing roughly the same objectivity. Therefore, we should think about ways to improve quality education under the premise of the college entrance examination.

Under such circumstance, I would like to make two principled observations and a proposal related to the education of the history of science. The first principled observation is that due to the importance of the college entrance examination to candidates, future education reforms should not undergo large-scale changes. Instead, more consideration should be given to adopting partial measures to reduce negative factors under the existing structure. The college entrance examination is an important hurdle that determines the trend of life for most examinees. Therefore, for examinees and their parents, the reason for quality cultivation is always second compared with the results of the college entrance examination. This means that any changes for the purpose of improving quality training, no matter how the test subjects, test times, test content, and score calculation methods change, candidates and parents will ensure and improve college entrance examination scores as the ultimate goal to make exquisite tools for these changes. Philosophical calculation, large-scale reforms will allow candidates and parents to spend more energy on the corresponding changes in instrumental calculations, and the results are more likely to be detrimental to the improvement of quality training. The second principle observation is that the fundamental improvement of quality training before the college entrance examination depends more on the improvement of the external social environment. If society can allow students who have not passed the college entrance examination to live a dignified life in the future and still have the opportunity to improve their current living conditions, then the college entrance examination will become a lifestyle choice rather than the most important opportunity in life. In this kind of ideal social environment, the purpose-based quality training can fundamentally surpass the weight of examination-oriented education based on means in the education process of primary and secondary schools. Of course, this is the so-called ideal social environment, which is still difficult to achieve in our country where educational resources are still quite scarce, but it is undoubtedly the goal we should strive for. In other words, we have reason to believe that the baton of the college entrance examination decisively dominates the situation of primary and secondary education methods, and it should loosen or even undergo fundamental changes in the future as our country's power improves.

In view of the above two observations, I would like to make some suggestions for science education in middle schools on the issue of the history of science. Although under test pressure, middle school textbooks and teaching inevitably adopt non-historical comprehension methods, course standard makers, textbook editors, and teachers should all have a certain historical understanding of scientific content and try their best add historical understanding in some possible places. This will facilitate students' in-depth understanding of scientific content. For example, as mentioned above, the introduction of some historical backgrounds of Newtonian mechanics will help students understand the concept of force based on measurable properties in Newtonian mechanics and the concept of force based on causality in daily life. Also, know much about the difference and the relationship between each other. For another example, when classifying species in biology class, in addition to the standard classification based on the theory of evolution, students can also be introduced to the classification methods that have appeared in history based on form or function. This will allow students to experience the cognitive process of different conceptual processing of the same research object. Of course, the content layout of middle school textbooks is limited by the number of words, and it is difficult to systematically take care of the historical understanding. Therefore, sometimes we should rely more on the understanding and interpretation ability of specific teachers. Finally, the history of science courses in universities is undoubtedly a very crucial part of university education from the standpoint of reasons one and two. The history of science should become a compulsory course for science and engineering students. Undergraduate is a very important stage in the life of most college students, so their choice of major will decisively affect their future life path. To borrow the words of Lin (2013), at this stage, college students must find "their careers that they are willing to dedicate for life. We have mentioned that a good scientific researcher does not necessarily have to understand the history of science, but the top scientists must have their own unique views on the history of science. It is certainly good if university education can "create" scientists, who are competent for general work, but the training goal of university education should be higher, and it should aim at cultivating the most top scientists. Only by setting up this higher goal can we show the best state of their chosen career for college students who are looking for their life-long dedication.

1.4 Science education should be integrated and developed with humanities education

People are now increasingly aware that science and culture are two value systems and ways of thinking formed in the process of human understanding and transforming nature, society, and human beings. They should be complementary, not mutually exclusive. Similarly, in the field of education, science education and humanities education are not opposed to each other, but need to be integrated and mutually promoted.

1.41 Science education and humanities education should complement each other in content

Scientific knowledge focuses on the natural world and its objective laws, while humanistic knowledge is based on human inner spirit, human life as the body, and culture as the load of the world of meaning and value. Although these two have their own different research fields, they are not isolated knowledge systems, but different emphases of human civilization, and neither of them is indispensable. The education of students should pay attention to the cultivation of scientific research methods and ways of thinking, and develop their comprehensive ability to solve problems.

1.42 Science and humanities are complementary in research methods

Science education imparts scientific knowledge, pays attention to the reliability of knowledge, emphasizes standardization in teaching methods, emphasizes the use of empirical methods to reveal objective laws, and explores the natural world in a realistic spirit. Humanities emphasizes people-centeredness, advocates non-mandatory teaching methods, pays attention to the harmonious development of interpersonal relationships and informed intentions, and asks the world of life with feelings of kindness. These methods act as bridges and bonds in the process of internalizing knowledge into qualities and have independent value. The use of humanistic methods in science education will help to discover the humanistic spirit of scientific knowledge, point out the right direction for science, enhance students' critical thinking and intuitive thinking, and stimulate students' imagination. The scientific spirit helps promote the rigor and science of the humanities, can enhance students' objectivity and rationality in thinking and ability of solving problems. If the two methods can be organically integrated in teaching, they will learn from each other and complement each other, so that students have both scientific literacy training and humanistic care input. Therefore, in terms of cultivating students' overall thinking mode, science education and humanities education cannot ignore either. The integrated development of science education and humanities education is a key measure to implement quality education, cultivate innovative talents, and obtain original scientific research results; the combination of logical thinking and critical thinking is an important measure to cultivate students' innovative ability. Through the integration of science education and humanities education to change the school's subject atmosphere, broaden students' subject horizons, and change the original training mode will play an important role in cultivating students' innovative thinking and even innovative ability. The integration of science education and humanities education is a major educational ideology, educational concept, and a major educational theoretical issue. It needs to cause researchers and educational administrators to jointly research, discuss, and practice.

2.1 The current situation and future trend of science education in China

2.11 Looking forward to the future development trend from the reform of science education

Science education is the main channel to improve the scientific quality of the people. Therefore, the international community and various countries attach great importance to the reform of science education. Science education is by no means simply transferring knowledge, but fostering a scientific way of thinking and a scientific lifestyle. In the 1970s and 1980s, some developed countries began the reform of inquiry-based science education. In 1994, the World Science Union established the Scientific Capacity Building Committee (ICSU-CCBS), which focuses on scientists, to promote the reform of science education in developing countries. The committee has carried out fruitful work under the leadership of Lederman, the American Nobel Prize winner in physics and the American sponsor of "hands-on" science education, and Charpak, the French Nobel Prize winner in physics and the initiator of the French similar project "LAMAP". In 2001, the committee held an international meeting in Beijing and issued the Beijing Declaration. After the meeting, the Ministry of Education of China and the Chinese Association for Science and Technology jointly launched the "Learning by Doing" project of exploratory science education reform. It lasted for ten years from 2002 to 2011, and the pilot project covered 200,000 students in 22 provinces in China, accumulating experience for the reform of science education in primary and secondary schools in China. We also use the newly developed neuro-pedagogy research whose results promote the development of inquiry-based science education. For example, in the “learning by doing” project, we firstly included the cultivation of social emotional ability in the “learning by doing” science education standard, and implemented it in classroom teaching, and achieved obvious results. The "learning by doing" exploratory science education pilot project won the International Children's Science Education Award and the first prize of the Basic Education Reform Award of the Ministry of Education of China. Pilot projects have not stopped so far. For example, the "Learning by Doing" project in Jing'an District, Shanghai, which related to social emotion training, just won the first prize of the National Education Basic Education Curriculum Reform Teaching Research Achievement Award last month. We have also actively participated in many activities of ICSU-CCBS and have become a member of the Expert Committee on Inquiry Science Education (IAP-IBSE). In the expert committee, a writing group composed of 10 experts from 7 countries successively wrote two books of guiding significance for science education in 2009 and 2014, Principles and Big Ideas of Science Education and Working with Big Ideas of Science Education (applying the ideas of science education to work). The English version is currently available for download on the IAP website, and there are also translations in Chinese, French, Spanish (including South American and Spanish native versions), Serbian and Greek. We have actively participated in scientific education reform conferences and activities in Southeast Asia, Latin America, Europe and the United States, such as Argentina, Mexico, and other countries. As we all know, a famous conference with the theme "History and Science Education along the

'Belt and Road'" was held in Beijing, China. Social changes are intensifying, requiring continuous changes in science education. This change is far more than the upgrading of information technology or the application of big data, but a major change in education itself. We recognize that education is constructing students' brains. We recognize that without correct evaluation methods, the correctness and effectiveness of education reform cannot be guaranteed. The different people hold the different ideas, without them, there can be no individualized education. For this reason, since 2002, we have become one of the first countries to develop neuro-pedagogy, a new translational discipline, to implement educational reforms based on empirical research and develop various evaluation methods. In April 2007, on the basis of 15 years of research, the Neuro-Education Branch of the Chinese Cognitive Society was formally established. In July this year, the China Brain and Education Research Alliance was formally established. Chongqing Bashu Elementary School has gradually introduced new technical methods based on the long-term successful teaching reform practice. It also won one of the two special prizes of the Basic Education Curriculum Reform Teaching Research Achievement Award issued by the Ministry of Education of China in August 2018. Educational reform will not stop, and will closely integrate and advance with the forefront of scientific and technological development. Science education is always in the way of innovation driven by S&T. We will always work hard. We also look forward to continuing to expand cooperation with the international scientific and educational circles (Luke, 2011).

2.22 The modern picture of science

Unlike the picture usually presented in school science education, there is no single scientific method in reality. There are fundamental differences between rigorous sciences such as physics, chemistry, and even biology, and those that try to reconstruct the past historically (such as evolutionary biology, geographic science, and so on). The dominant advantage in rigorous science is the "hypothesis-deduction" method, whose purpose is to develop explanatory models of the physical and biological world. On the contrary, those sciences that attempt to construct historically aim to construct chronologically what happened naturally in the past, and their direct goal is to establish a credible record of what happened. More detailed, the methods used by archaeologists and nuclear physics experts are quite different, just like chalk and cheese are different, they have in common only to promise to use evidence as a means of resolving disputes. In the past years, the work of historians of science, philosophers of science, and especially experts in sociology of science has also caused changes in our understanding of science. Years ago, logical positivism—science is a set of logical inferences derived from observational entities—has a great influence in the scientific community. However, it shows that theories are believed, not because experiments have verified them, but simply because scientists cannot deny them. The real shift in our understanding of science stems from Kuhn's work. He believes that the work of a scientist is a cultural product, and all cultural activities are composed of social actors in a social network; the same is true for science, controlled by a series of explicit or implicit rules. Studies in history and sociology have shown that this is particularly important for "science in formation." Because most of the political and moral problems caused by contemporary science are generated around the uncertainty of new scientific knowledge, such as the transmission mechanism of mad cow disease, the environmental impact of genetically modified crops, and the long-term impact of mobile phones and so on. Sociologists Sadler (2009) point out that "in order to be able to make well-founded scientific public judgments, what non-scientists need to know most is the rubrics of scientific history, philosophy, and sociology, rather than the technical content of scientific topics." At present, science education in schools is almost ignored this dimension of science.

3.1 The problem of science education in China

Due to differences in national conditions and traditions, there are different options for the implementation of science education. For modernized countries like China, the following issues should be paid attention when implementing science education:

First, we must have a complete and comprehensive understanding of science and technology. Science includes not only spiritual and cultural dimensions, but also utilitarian and practical technical dimensions. From the perspective of spiritual culture, scientific culture is a unity that includes scientific knowledge, scientific methods, and scientific spirit. It covers the three fields of truth, goodness, and beauty in content. It is helpful to healthy people’s hearts and promotes the comprehensiveness of people. Development is as important as the humanities. The negative effects brought about by modern science and technology is actually the result of modern people's one-sided understanding of science. Therefore, in the process of higher education modernization in our country, we must learn from this aspect, and we must fully understand and grasp the essence and connotation of modern science and technology.

Second, abandon the "development first, then integration" model on the integration model of "science education" and "humanities education". In fact, our country’s modernization construction is not only facing the reality of serious shortages in science education, but also facing the lack of hidden connotations of science such as the spirit of science. It is faced with how to vigorously develop science education while effectively restraining and restricting it. Modern Western higher education takes a path of first developing science education and then seeking the integration of the two types of education. It is a model of "development first, integration later". For "late" modernized countries, it is possible to learn more consciously from the experience and lessons of Western education modernization. Therefore, while vigorously developing science education, it is necessary to consciously use value rationality and humanistic education to care for and restrain it, and seek the integration and balanced development of the two types of education.

Third, we must fully tap the spiritual resources of Chinese excellent traditional culture. In today's era of globalization, cultural exchanges and integration in the world have become increasingly prominent, but the internationality of culture is based on its nationality. Therefore, when conducting science education, on the one hand, we must absorb the beneficial elements of Western civilization to realize the humanistic culture of science education; on the other hand, we must tap the spiritual resources of traditional Chinese culture to realize the integration of science education and humanistic education. Only in this way can we embark on a path of science education with Chinese characteristics that conforms to the trend of modernization and is rooted in national cultural traditions.

In 1959, the British scholar Charles Pachy Snow pointed out in a lecture at Cambridge University that there are two opposing cultures in modern society, one is scientific culture and the other is humanistic culture. Correspondingly, in the field of education, humanities education and science education actually exist. The humanities education we are talking about now does not refer to the humanistic education in the European Renaissance, but the education that is generally believed to be based on the humanities. The separation of science education and humanities education is a drawback in Chinese educational thinking and educational practice.

Also, we need to focus on “Excessive independence of science education”. Due to the excessive emphasis on the independent social function of science education, there is a shortcoming in science education in our country that only emphasizes the instillation of scientific knowledge, while ignoring the cultivation of scientific methods and scientific literacy; Due to excessive emphasis on the objectivity and scientific nature of science education, science is ignored “humanity” and “spirituality” of education which have caused the lack of communication between the arts and sciences in our country's education, the scholars despise science, and the scholars despise the humanities.

What's more, we need to focus on "Excessive limitations of liberal arts branch schools". Our country has always implemented the measures of branching schools for liberal arts and sciences, which has led to one-sided education and excessively specific educational content. In addition, my country's scientific and technological development is relatively lagging, and the purpose of education is only limited to "seeking knowledge" and has not been improved to enhance the overall quality of people. Under this education method, the students have narrow knowledge. The long-term existence of the division of liberal arts and sciences in middle schools has caused students to bias their subjects. Not only are they biased in knowledge, but more importantly, they have accepted the idea of division of liberal arts and sciences since childhood, and have been marked by the division of humanities and science education. More scholars have analyzed that the relatively lagging development of science and technology in our country is also a major factor leading to the long-term separation of science and humanities. Due to various reasons, Chinese science and technology has been relatively backward for a long time. The trend of interdisciplinary integration lags behind the world trend for a period of time. The concept of emphasizing science and neglecting literature is relatively deep-rooted. With the deepening of reform and opening up, our country's social and economic development has gradually merged into the world trend, and the development of science and technology is changing over time. The trend of integration has become increasingly prominent in all fields of society, economy, technology, and education. The separation of humanities education and science education has caused education bias. Naturally, people pay more attention, and the call for solving this contradiction is bound to increase (Elman, 2009).

4.1 The goal of science education in China

4.11 Utilitarianism

This view believes that learners can benefit from scientific learning—for example, scientific knowledge helps them learn to connect plugs or repair cars; scientific training can cultivate people's scientific thinking attitude, rational thinking style, and the ability to solve practical problems; this is what we called "Science Unique", which can improve the individual's ability to deal with daily life problems. Science can cultivate people's ability to observe and have the ability to recognize patterns when faced with excess data. This argument may easily resonate with readers, but unfortunately, it has not yet stood up to the test. First, there is little evidence that scientists are more rational or irrational than other humanist scholars. As pointed out (Gaskell, 2003), "There is no evidence that physicists have fewer traffic accidents than others because they understand Newton's laws of motion, and they can better insulate their houses because they understand the laws of thermodynamics." Second, living in a technologically advanced society, we rely less and less on scientific knowledge. Because, now more and more complex artifacts make their functions can only be repaired and maintained by professionals. At the same time, their applications and operations are simplified, requiring only minimal skills. Electrical appliances are equipped with pre-wired plugs, and equipment such as washing machines, computers and cameras can be used almost intuitively. Even in social situations where people believe that scientific knowledge is needed, such as the control of personal diet, recent studies on student food choices show that students' food choices are not related to their knowledge of healthy eating. The conclusion that can be drawn from these studies is that the utilitarian view of knowledge faces many challenges, and it cannot justify the previous courses scientifically.

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4.12 Economic view

From this perspective, school science education provides students with a kind of pre-employment training. Its essence is like a sieve, screening out a small number of people who will enter the scientific academic field or engage in related occupations in the future. The justification for this "waste" phenomenon is that the vast majority of people can ultimately benefit from the material information provided by a small number of people selected. However, a previous study analyzed the occupations of scientists and science-related workers, questioned this view (Lee, 2007). Through the analysis of scientists and their work, the data obtained shows that the knowledge required by scientists is determined according to the work situation, and scientific knowledge is only a part of the many knowledge and skills required for work. In this research, scientists especially emphasized the importance of data analysis and interpretation skills, emphasizing basic skills such as team work ability, fluency in written expression and oral communication. However, current scientific education practices underestimate these aspects. The findings show that the skills developed by participating in practical investigation work—such as the ability to interpret, present and evaluate evidence, the ability to operate equipment, and the awareness of using scientific methods to solve problems—are equivalent to scientific "factual" knowledge value.

4.13 Cultural view

There is also a view that science is one of the great achievements of human culture. As a shared cultural heritage, it forms the background of language and conversation, permeating media, dialogue and daily life. This view holds that the distinctive feature of modern Western society is its scientific and technological knowledge base. In order to decode this culture and enrich the activities we participate in (including opposition and rejection), we need to appreciate and understand science. The enlightenment of this view is that science education should be more of a science appreciation course. It should not only make people understand the value of scientific research, but also make people understand that this kind of knowledge represents both an arduous war and a great achievement. However, to understand scientific culture, it requires some knowledge of the history of science, scientific ethics, scientific debates and scientific controversies (it emphasizes more on the human of science). Therefore, we should put more emphasis on the "explanatory topics" provided by science and enable people to have a better understanding of a series of "views on science".

4.14 Democratic view

Some political and moral problems in today's society have increasingly scientific characteristics. For example, do we allow human cloning? Do we allow nuclear power plants to generate electricity? Participating in this kind of debate requires people to have some knowledge of science and social practice. However, as subject knowledge becomes more and more specialized and fragmented, we can only rely more on expert opinions. This dependence will gradually weaken the basic principles of a democratic society, which is all citizens should be able to participate in the decision-making process. However, only when individuals have some basic understanding of science, and can participate in public debates critically and reflectively, as a result they can participate in the decision-making process. The vast majority of scholars today believe that if future citizens hold a more critical attitude towards science, then the public debate on the concept of social science will benefit the people. However, it is not easy for us to see how science education achieves this, because science education now does not provide people with opportunities to understand how scientists work; nor have they conducted exploration to determine which scientific research is "good."

5.1 Scientific culture in China

According to surveys, the scientific literacy of our citizens lags far behind developed countries. The current status of science education in our country is unsatisfactory: people either limit science education to systematic knowledge transfer, or pursue an idealized inquiry teaching model that is out of reality. It is difficult to improve people's scientific literacy. It is believed that in order to solve the problems in science education, it is far from enough to change the curriculum, compile several textbooks, and implement a certain teaching model. We are accustomed to regarding science as a scientific knowledge system, but not as a scientific culture. The problems in science education are not unrelated to this. To change the status, the key is to establish the scientific and cultural orientation of science education, carry out scientific and cultural quality education, build a scientific education system based on science and culture, make science classrooms to be the main channel for students to form scientific and cultural qualities, and make scientific and cultural concepts and spirits in students themselves (Wang, 2005).

5.11 Establish the value orientation of inheriting scientific culture

The essence of science education is to cultivate people who dare to question and criticize the predecessors. Science culture is the soul of science education, and the inheritance of science culture is the basic task of science education. The so-called culture refers to the way human beings engage in practical and spiritual activities in the process of their own development, as well as the material and spiritual results created by these activities, including the totality of formed systems, norms, and customs. Science, as a way for human beings to understand the world which explore something unknown, is a way of practice and spiritual activity, and also constitutes an important part of human culture. Scientific culture includes not only scientific knowledge and scientific methods, but also scientific spirit and scientific ethics. Scientific knowledge is the material result of people's understanding of the objective world, the fruit and product of scientific labor, is loaded with scientific methods and scientific spirit, and is the foundation of scientific culture. The scientific method can best reflect the process and quality of scientific thinking, and it is the most important realistic expression of scientific culture. Scientific spirit is the unique spiritual temperament formed by internalizing scientific knowledge and methods in the scientific activities of the community of scientists in pursuit of truth and approaching truth. It is the core and essence of scientific culture. We believe that the basic elements of scientific culture transmitted in science education are knowledge systems and conceptual forms. The knowledge system is mainly composed of scientific phenomena, scientific facts, scientific methods, scientific principles and their connections in various disciplines. Since ancient times, especially since the founding of Newtonian mechanics for more than 300 years, the scientific community has created a huge knowledge system and carried out organized knowledge dissemination, so that scientific knowledge is continuously accumulated and disseminated, and a knowledge system is established: such as physics Science, chemistry, biology and other disciplines, each discipline has its own complete system. Such systematic and standardized knowledge, academic and spiritual resources, when entering the classroom as a course, become an educational resource, passed on from generation to generation through the teaching of teachers and the learning of students. It can be said that science education is to allow students to acquire knowledge and absorb the most extensive spiritual resources through the teaching of a subject, arm themselves with all the spiritual wealth created by scientific culture and human civilization, not only to learn professional knowledge, but also to apply it into the reality. Life-long spiritual growth lays a solid foundation, while at the same time inheriting and carrying forward the basic experience and spiritual traditions of scientific culture and human civilization. The ideological form is the scientific spirit and scientific value standards created and formed by the scientific community in the process of understanding and disseminating scientific laws. These constitute the ideological form of scientific culture. As a brand-new concept, the exploratory, innovative, pragmatic, and critical temperament of scientific culture has distinct cultural characteristics. In specific science teaching, the ideological elements of scientific culture are embedded in scientific knowledge and displayed. Therefore, in science education, while transferring scientific knowledge, teachers should pay attention to combine scientific concepts and their cultural elements. To convey the cultural elements of scientific concepts in scientific knowledge, in addition to necessary explanations and demonstrations, when teaching scientific knowledge, the background, formation process, genre disputes surrounding it, knowledge reality performance and possible development routes should be introduced to be taught to students. Teaching knowledge in this way will not only enable students to understand science as a career for exploring the truth, but also create a unique humanistic personality, a very responsible humanistic spirit, that is, a sense of social responsibility, unremittingly exploring the truth, and having the courage to persist. More importantly, it includes the truth-seeking spirit of respecting facts, the critical spirit of suspicion and self-denial, also, the creative spirit of being innovative and transcending the status (Chan, 2005). As a result, the elements of science and culture contained in scientific knowledge are experienced over time. An important aspect of the cultivation and training of students in school education is to cultivate students' critical thinking ability, doubt and spirit, imagination, and independent creativity. The basic task of science education is to cultivate students' "forever critical and creative spirit" that is never satisfied with the status. It is contrary to the aforementioned "inheritance of scientific knowledge" and constitutes the "soul of science education."

5.12 Enrich the scientific and cultural connotation of science education

In addition to imparting scientific knowledge, science education must also spread the spirit, methods, and value of science and culture. This requires scientific and cultural quality education to enrich the scientific and cultural connotation of science education. In recent years, international science education reforms have advocated HPS education is the embodiment of this idea. The so-called scientific and cultural quality education is based on student development, and it focuses on the comprehensive and harmonious development of students. It not only focuses on the education of scientific knowledge, but also pays more attention to the education of scientific methods and the cultivation of scientific spirit. Its main characteristics are reflected in the following aspect.

Transmit scientific rationality and empirical spirit: Scientific culture is a rational and positive culture. One of the greatest characteristics of scientific culture is based on empirical evidence and guided by pure reason. Reason and empirical evidence have become distinctive signs of scientific culture. Scientific life is the epitome of rational life, and scientific practice is a school of empirical life. Scientific life and its practical process should become an indispensable content of science education, and its content should also include the scientific methods needed to participate in scientific life and practical process. The practice of scientific method should become an important part of science education, and students receiving science education should acquire scientific method and understand its diversity and limitations. For methodological issues, they should have a sense and ability. For example, how to evaluate the scientific method and how to distinguish the pros and cons of various theories is most important. We need to know the interaction between experiment, mathematics, religion, and philosophy in the development of science. When conducting experiments and illustrating problems, students need to understand how data depends on theory and how evidence supports or denies hypotheses, how does the actual situation in science relate to the ideal situation of science, and a lot of other content related to philosophy and methodology?

Highlight the humanistic value of science: Since the beginning of the 20th century, more and more scientists and educators have felt that science itself must be considered from the perspective of the fundamental significance of human existence. Einstein once said earnestly: "If you want to make your life's work beneficial to mankind, well, it's not enough for you to understand applied science itself. Caring about people themselves should always be the main goal of all technical struggles; caring about how to organize people's labor and product distribution, such major unresolved problems, to benefit mankind without from science". Science and culture do not exist in isolation. It is closely related to people and society. "Look at science as a historical activity of mankind, emphasize the connection between science and other cultures, especially the connection with humanities and culture, and emphasize the value of people." The humanistic understanding of science is not only the contemporary call and requirement of humanistic thoughts of caring about people, caring about life, caring about people's living conditions, caring about people's happiness, and caring about people's values, but also the need for the healthy development of science and culture. Therefore, the humanistic understanding of science should be emphasized in science education. The development of science needs the guidance of humanities, and the progress of humanities should be based on science. The integration of science and humanities is a concentrated expression of the nature of science "being human." The content of STS should be integrated into science education, so that students can realize the interactive relationship between technology and society, how technology sprouts and develops in the social field, and how it can fully and profoundly affect the progress of civilization and social changes. We need to recognize the root cause of the split between science and technology and humanities in modern times, and the inevitability of communication and integration between science and technology and humanities in contemporary times. Through the rational positioning of science and technology in the context of society, students will more accurately grasp the connotation of scientific norms and scientific spirit, and deeply understand the humanistic implication and ultimate value of science and technology, thereby enhancing their sense of social responsibility and historical mission. Applying technology to benefit mankind establishes good professional ethics.

Emphasize scientific skepticism and critical spirit: The essence of scientific culture is exploration, and the spirit of scientific culture is the spirit of exploration and innovation. Scientific research is an endless exploration of knowledge, and what runs through this exploration and seeking knowledge is the spirit of suspicion and criticism in science. The spirit of suspicion and criticism is the prerequisite and basis for scientific innovation. Dare to innovate is the life and soul of scientific research, which reflects the significance and value of scientific research. Only by daring to doubt and criticize can we promote the development and innovation of scientific theories. Without the spirit of suspicion and criticism, the scientific undertaking of mankind will stop, and we will still live in the theoretical system constructed by Aristotle. Therefore, science education must attach importance to the cultivation of students' critical and skeptical spirit. In science education, students should learn to boldly question the scientific method in the process of practice. To make students understand: "A scientific attitude is a critical attitude. This attitude does not seek confirmation, but a critical test." "The experimenter cannot wait for the natural world to cheer up and reveal his secrets. He must question the natural world. He must interrogate the natural world based on his suspicions, his conjectures, his theories, his ideas, and his inspiration." Therefore, science education must adhere to critical principles in the process of imparting scientific knowledge and train students to be questioning spirit of existing knowledge. Among the many elements of scientific culture, the spirit of criticism and skepticism is the most important. It is the ideological premise and spiritual motivation of the spirit of seeking truth and being pragmatic and innovative. If you lack the spirit of skepticism and criticism, you will make dogmatic mistakes, blindly follow authority, and believe in books, which will hinder the progress of scientific undertakings and affect the pace of scientific innovation. In the history of science, because you do not blindly follow or believe in authority, you will have doubts about the theories of the predecessors, and seek empirical tests to have new scientific theories come out. Copernicus's "heliocentric theory" system, Harvey's blood circulation theory, Galileo's law of falling bodies, and Planck's quantum theory are all the results of doubts and criticisms of existing theories. Therefore, science education must attach importance to the cultivation of students' critical and skeptical spirits. Only science education that includes critical and skeptical spirits can improve the ability and level of students' scientific innovation and help the cultivation of innovative talents. As Einstein said, "The independent thinking that enables young people to develop criticism is vital to valuable education."

All in all, science education should focus on different forms of science. Knowledge is the static form of science; exploration and creation are the movement forms of science; doubt and criticism are the spiritual forms of science. They exist in all the scientific activities of mankind. They are colorful, beautiful and charming. Science education should be a lively, lively, cordial and profound intellectual dissemination activity. To infiltrate science and culture education in science education, the criticality, innovation, and humanity of science should be transmitted to cultivate students' questioning and innovative spirit, promote students to understand the nature of science, and improve students' scientific literacy.

5.1 The significance of science education in China

5.11 The survival and development of a nation cannot do without science education

In modern times, science and technology as the primary productive forces are the foundation of the survival and development of a nation. The role of science education in cultivating outstanding scientific and technological talents and thus promoting the development of science and technology has also been increasingly strengthened. The 16th National Congress of the Party and the important thinking of the "Three Represents" pointed out the direction for scientific and technological education. The 16th National Congress of the Party put forward the grand goal of building a well-off society in an all-round way. Improving the scientific and cultural quality of the whole nation is an important content. Education is the foundation of the development of science and technology. In order for a nation to survive and develop, it must first inherit traditional knowledge. Science education inherits and disseminates scientific knowledge, and develops human civilization. Huang (2003) believes in the "Critical Outline of Political Economy" that the development of science is the same as the previous generation. The amount of knowledge left by people is proportional. Without the inheritance of knowledge, there would be no scientific development. The preservation, teaching, dissemination, application and innovation of scientific knowledge, and the inheritance and progress of civilization all depend on scientific education. Therefore, science education is the foundation for the survival, development, and self-reliance of a nation. In addition, science education is popularized by the whole people, the quality of the nation is improved, and the character of the nation is defended, so that the Chinese nation can stand in the world.

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5.12 The prosperity of the country cannot do without science education

Scientific discoveries and technological updates, as well as social civilization and rationality, are inseparable from education. Education is an important foundation for implementing the strategy of rejuvenating the country through science and education and the strategy of sustainable development. Science education is a prerequisite for the development of science and technology. The expansion of educational objects, the expansion of educational functions, the improvement of education standards, the popularization of education levels and the improvement of the education system provide a very important preparation for the development of science and technology and the update of scientific and technological achievements. Science education is an inevitable requirement of social and economic development. It is an important means to improve overall national strength, an important aspect of advanced cultural construction, and a sharp weapon to eliminate ignorance. The scientific spirit shaped by science education is to stimulate the national spirit and the reality needs.

5.13 Individual development is inseparable from science education

It is very different from the past is that one's future depends almost entirely on education. Science education can cultivate the innovative ability of scientific and technological personnel. The necessary condition for engaging in high-tech work is to have sufficient but rich knowledge, which does not mean scientific research ability and innovative ability. Education plays a leading role in the enlightenment and cultivation of these abilities. Science education focuses on natural science and technology knowledge. Namely, it also focuses on seeking truth. The purpose of science education is to educate individuals to explore the truth. Science education improves the individual's scientific quality, enables individuals to understand basic scientific knowledge, and has the ability to use scientific attitudes and methods to judge and handle various affairs, moreover, have a scientific world view that seeks truth from reality. Science education realizes the objective needs of the all-round development of people, and the urgent need of the public to establish a scientific, civilized and healthy lifestyle is the requirement to improve the quality of life of the public, serve the all-round development of people, and promote the public's understanding and support for scientific undertakings.

6.1 Science Education in the 21st Century

In the face of existing views, science education is caught in a dilemma. A basic point mentioned before: In the course planning process, the needs of most people: the needs of those who no longer receive formal science education after years of age, are the most important (Luke, 2011). For most young people, science courses for year olds are very important. It should not only lay a good foundation for lifelong learning, but also prepare for life in contemporary democratic society. This kind of course should essentially aim at cultivating people's scientific literacy. The content and structure of science education must be adjusted, not just to prepare for deeper learning. What kind of education can help future citizens make decisions? It is believed that "culturally educated" means having knowledge and familiarity with the discourse of the subject, that is, understanding "scientists' words, behaviors, values and beliefs", as well as their common goals and activities, and how they do things, how they discuss, and how they communicative. To become a scientific person requires people to master relevant knowledge, understand scientific themes, and have at least a reason to believe in part of the content, especially the reason for its application and abuse.

6.11 ICT's potential in supporting science education

Firstly, apply ICT to support scientific teaching and learning. One factor that has driven changes in the teaching methods of science education is the new inquiry model proposed by computer-based tools and resources, now collectively referred to as information and communication technology. In the transformation of science curriculum and teaching methods, this kind of educational technology and its wide application in schools have played a potential impact. It enables people to easily access Internet resources and other new tools and resources, and can promote and expand opportunities for experimentation in and out of class. Besides, it can eliminate the strict boundaries between school science education and today's science, because it can help people obtain large-scale data, such as real-time air pollution measurement, and direct connection with high-quality astronomical telescopes.

Secondly, the application and teaching of ICT has an inseparable relationship. Like the application of other tools, the social and cultural environment will greatly affect the application. These influencing factors include: the purpose and nature of the activity, the age and ability of the student, the degree of student participation, curriculum requirements, education and political agenda, and so on. In addition, teachers' existing teaching methods also need to be changed accordingly, by selecting and evaluating technical resources, and applying them to design, construct, sequence, support and monitor learning activities. Should I use it in teaching? The general view of educators is that in the teaching and learning of any subject, the use should be appropriate and should be oriented to the learning goals of the subject itself. Teachers oppose the suggestion that "must be used in the course", and they also oppose the application just because it is available, or encourages and expects to use it. They believe that selective application is very important, so as to "add value" to learning activities. One of the main obstacles to application is the teacher's existing teaching concepts. The report pointed out: generally speaking, there are only a few teachers who integrate into subject teaching in a way that stimulates students' motivation, enriches learning activities, and stimulates high-level thinking and reasoning (Ma, 2012). These teachers usually hold innovative teaching concepts. A study by Tao, Oliver and Venville, (2013) for elementary school teachers found that teachers will choose applications, activities and methods that conform to their teaching and learning concepts. It is found that teachers are unwilling to give up their existing teaching methods, which is greater than the impact of limited resources on teachers' application. Before teachers are willing to apply, they must first realize the potential benefits of computer-supported science teaching and learning, and its special role in satisfying classroom teaching. Successful integration depends on the development of appropriate teaching methods. In the science department, colleague collaboration has a great influence on the development of individual teachers. Evidence shows that only when activities can be provided to support and promote learning, can they begin to be adopted and integrated into the department's work plan and all teachers' classrooms. Students' autonomous learning will not weaken the importance of science teachers, but it will obviously challenge teachers' beliefs to some extent (Gao & Watkins, 2002). In the classroom culture of student inquiry, collaboration, debate, and interaction, technical support activities are coming step by step, and classroom practice is facing great obstacles because it conflicts with the current classroom culture. For example, (Lin, 2013) noticed that when science teachers used to conduct experiments and refine their opinions, they cited very few references (compared to English teachers and math teachers). Maybe it is because they tend to design investigations and research in advance and regard writing as a means of recording results, rather than a means of forming and evaluating ideas. In this culture, teaching methods emphasize the coverage of teaching content rather than the cultivation of reasoning ability. This also reflects the tendency of a preaching class teaching method, which may only include computers in this teaching method, and computers are mainly used for demonstration. The potential of applications to support inquiry activities and experiments has not been developed by most teachers.

7.1 Enlightenment for future development of science education

Implications for teachers:

Through the creation and dissemination of successful teaching practice cases, educational technology can be more extensively and deeply applied in science education. This means that as science teachers become more confident and experienced in the integration into the teaching process, exploratory applications will become more practical and popular. Improving the effectiveness of interactive links between software means that electronic worksheets or electronic tutors can be used to construct tasks and to guide students to learn along a certain path. In these resources, you can also add relevant guidance so that students can discuss a certain point of view with teachers and peers. In fact, one of the basic characteristics of successful use of teaching is to expect and cultivate students' active participation, especially in research and practical work, as well as in teacher-guided discussions and demonstrations. At present, the role of interactive teaching in class has not been fully developed. In terms of cultivating students' investigation and research skills, the application of network is also insufficient. However, people are paying more and more attention to these contents. It is necessary to clearly develop students’ new skills (like critical literacy) so that students can obtain, discuss, and evaluate information extracted from scientific resources. Providing a clear basic theory for each form of application (with clear learning results as the first priority) is the first step in advancing the contribution to science learning, especially science education aimed at cultivating "critical scientific literacy" , It is also the most important step. Applications are infiltrating more classrooms. However, further development depends on providing teachers with more time and chance to obtain reliable resources, encouragement, and provide specific guidance for appropriate and effective applications. In short, it depends on a sustainable professional development plan.

Implications for evaluation:

At present, almost all course evaluations are written tests of content knowledge, and this type of evaluation does not include application-related educational results. Therefore, the evaluation framework itself needs to be adjusted to reflect changes in teaching and learning with support. Science education emphasizes the critical evaluation, analysis and interpretation of data and evidence. At present, people are focusing on the results rather than the process itself, which will adversely affect the teaching methods of teachers and their applications. Evaluation can replace or detect the correct application of methods, which will involve a wider application of teacher evaluation. When evaluating comprehension, reasoning, or analysis skills, temporary records during the activity may be useful indicators. For example, the teacher can ask students' forecasting graphs, annotation graphs, written work drafts, or research results seen on the screen to ask questions in a loop, and they can also make judgments on well-defined performance standards. The benefit of this form of work is that we will adjust our evaluation model and style to suit the expected teaching method, rather than the opposite.

8.1 Conclusion

Although the correct application of is likely to have a transformative effect on science education and student learning, only a few innovative cases and a few passionate people will use it. From this point of view, it still needs to be integrated into the habits and culture of current regular classroom teachers. The current national curriculum with overloaded content and corresponding evaluation measures has further strengthened the cultural view of "scientific teaching through the process of knowledge transmission". These factors have severely restrained the application in the classroom, making it impossible to effectively exert its interactive characteristics, and also unable to support students' active participation, exploration and collaboration in scientific activities. On the contrary, the new science curriculum is open to all students. It focuses on developing students' critical and analytical skills. This kind of curriculum may be more capable of promoting and supporting applications. As school curriculum begin to establish closer links between science teaching and scientific practice, the major obstacles that affect the integration of the curriculum may be lifted. The acquisition and interpretation of information and data, as well as critical evaluation will become the core features of all new syllabuses. This transformation will promote the teaching methods and the interactive application to support and develop students' scientific reasoning skills and analytical skills. Application may become the core of science teaching and learning, rather than fade away at the edge.

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