
Implementation of Scientific Spirit Education based on the History of Natural Science

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Abstract:

Relying on the history of natural science, this paper explores the scientific spirit, scientist spirit, and philosophical and dialectical materialist thoughts contained in the major scientific discoveries and achievements made in the modern history of global science development, in order to explore how to integrate the matter-of-fact scientific attitude, the spirit of rationality, the spirit of exploration and innovation, into classroom activity. In the process of knowledge imparting, typical cases recorded in the history of science can be used to implement scientific spirit education in order to fulfill the goal of fostering virtues through education and helping students establish a correct outlook on life, worldview, and values, with a goal of cultivating both people and talent.

Keywords: *History of natural science, classroom activity, scientific spirit, scientist spirit.*

I. INTRODUCTION

Mach said, "There is only one way of achieving scientific inspiration: learning history."

The scientific spirit was slowly formed as people understood and transformed nature with the gradual increase in productivity^[1]. Historically, the scientific spirit achieved gradual development on the basis of inheriting the ideological heritage of all ages with the birth of modern natural science. The history of natural science^[2] is a history of analyzing the development course of natural science and summarizing the historical experience of science development to reveal the laws of evolution. The discovery of various facts, recordings of phenomena, implementation of various experiments, and the advancement of various theories all abound in ideological and educational resources, and are full of human wisdom. Therefore, if these resources are excavated and integrated into classroom teaching according to the history of science, students will be enabled to comprehend the implied scientific spirit, scientist spirit, and philosophical and dialectical materialist thoughts while learning scientific knowledge so as to establish a correct outlook on life, worldview, and values. In this way, it is quite possible and necessary for them to strengthen their ideals, conviction, and patriotism and improve their overall character through subtle learning^[3].

Scientific innovation makes it imperative to inherit and carry the scientific spirit forward. However, the inheritance particularly relies on young people. It is on colleges and universities to cultivate young people with the scientific spirit^[4]. Therefore, during college, the humanistic scientific

spirit should be imperceptibly integrated into classroom teaching to help foster virtues through education.

II. RELYING ON THE HISTORY OF NATURAL SCIENCE TO EXPLORE THE SCIENTIFIC SPIRIT AND INTEGRATE IT INTO CLASSROOM TEACHING

The scientific spirit is a spiritual weapon for promoting the sound development of the whole society^[5]. If the scientific spirit is reflected in classroom teaching, it will be possible for colleges and universities to better impart knowledge and educate students so that students will be able to develop a good habit of loving, learning, and applying science. By understanding and carrying forward the scientific spirit, students can establish a scientific world outlook and methodology, act and speak under the guidance of a correct scientific outlook, strive to learn scientific knowledge, develop a scientific and humanistic spirit, and deal with various problems encountered in their study and life using a scientific method^[6].

As a lofty spirit of human civilization, the scientific spirit is the attitude of the scientist revealed in the process of investigation, scientific spirit does not have a specific concept or definition, and it represents the courage to hold scientific thinking as well as the awareness of constantly seeking truth. But it has rich connotations and many characteristics. Specifically, it refers to a matter-of-fact attitude and positive spirit, a spirit of rationality and suspicion, an exploring and innovative spirit, a spirit of independent thinking, etc. At its core is exploration and innovation that must be made in a realistic and rational manner^[7]. The scientific spirit can also be viewed as the determination and action to work tenaciously and even give life to scientific truth.

2.1 Keep seeking truth from facts to integrate the matter-of-fact attitude into classroom teaching

The scientific matter-of-fact attitude advocates that science should correctly reflect objective reality, seek truth from facts, and overcome subjectivity. Perseverance in practice is the only criterion for testing the tenability of scientific theories. The matter-of-fact attitude emphasizes that the practice is above everything else, because it is through practice that human beings explore the world, and all scientific conclusions are based on scientific practice. Scientific practice is the pillar and fundamental driving force for the formation and development of the scientific spirit. Many natural laws were discovered by humankind through repeated observation and experimentation. Without practice, science would lose its significance and authenticity.

Roger Bacon, a pioneer of natural science, said, “Experimentation outperforms all kinds of speculation. Experimental science is the king of all science”. “What is heard is unreliable. What is summarized and imagined is also unreliable. Experiments should be conducted for natural sciences”. Inspired by his thoughts, modern scientists attach great importance to experimenting^[7-8]. Faraday, a great electromagnetic experimenter from the nineteenth century, did a lot of electromagnetic and chemical experiments throughout his life. The British physicist Joule was the first person to verify the conservation of energy by experiment. He obtained a formula for calculating the quantity of heat generated by current passing through a conductor, i.e., Joule’s law. Edison, the “king of invention,”

invented more than 2,000 new things in tens of thousands of experiments. Through amazing hard work and courage, he made outstanding contributions to human civilization and social progress. Nobel also did numerous experiments and experienced failure many times before developing permissible explosives. After 20 years of painstaking research and repeated animal/human experimentation, Jenner invented and popularized the vaccine inoculation method, thoroughly doing away with “variola” on a global scale^[8].

The French philosopher Comte said, “The empirical spirit is important because observation is performed for prediction, and reality is studied in accordance with the unchanged universal natural law to judge the future”^[9]. After any theory is put out, it must not only be able to explain the known facts proverbially but also make a rational prediction about the unknown facts. That’s the main character of real science.

This spirit, one of respecting objective facts and using a large amount of objective data to eliminate subjectivity and explore scientific laws by experience and experiments, is a perfect embodiment of the matter-of-fact attitude or empirical spirit exclusive to science, an embodiment of the basic requirements of dialectical and historical materialism, and an embodiment of the scientists’ determination to seek the truth and their rigorous academic attitude. This spirit is of important guiding significance in real life. In classroom teaching, teachers should strengthen scientific practice so that students can feel the ingeniousness of experimental design. Teachers should also focus on developing students’ experimental capacity and hands-on ability so that they can recognize the significance and value of experiments and practice through trials and errors. In this way, students will develop scientific consciousness, then have an empirical spirit, and finally establish a dialectical materialist outlook and methodology^[10]. On the other hand, by understanding the process of scientists’ scientific exploration, students can develop the idea of seeking the truth from facts in order for them to be able to seek reality in everything and rely on facts rather than resort to deceit while working meticulously in good faith to constantly strive for perfection and learn from others. They will also behave honestly in exams and refuse to tell lies or cheat.

2.2 Advocating rationality and the spirit of daring to question

Rationality refers to the human ability to use the mind rationally. It usually refers to a way of thinking in which people make a summary by reasoning after careful thinking. It’s antonym perceptuality. The spirit of the rationality of science advocates critical and independent thinking, bold doubting the authorities, and adhering to the truth. The spirit of rationality advocates judging between right and wrong through rational and logical thinking. It proposes that people should uphold rationality and reject blind obedience and worship so as to avoid blind and rigid thought and superstitious behavior. In practice, people are required to rationally restrain irrational factors such as emotions and proceed from reality rather than act at will and follow their instincts^[11]. Theoretically, everybody is rational, but in real life, whether a man can behave rationally depends on whether he can use the spirit of rationality to scientifically analyze and judge social phenomena rather than

follow the crowd blindly with his own feelings. “Doubt is the predecessor of rationality.” It is also a necessary requirement for exploring the truth and the starting point of scientific creation. The sense of doubt means reasoning all problems encountered in work and life according to the acquired knowledge.

Descartes was a modern philosopher, physicist, and astronomer, the founder of modern mathematics and modern Western philosophy, a pioneer of modern materialism, and the founder of Western rationalism. The spirit of skepticism is the starting point of Descartes’ scientific methodology. He said, “To seek the truth, we must doubt everything in our lives.” He was even skeptical as to whether he had hands and a mind. According to him, doubt will not make you fall into indecision, but to build confidence, eliminate quicksand and find a solid foundation. He argues that sensibility can only provide something vague, while only rationality is able to offer a “clear, easy-to-understand concept.” Mathematics, especially geometry, is the best example of starting from clear, easy-to-understand concepts in order to acquire scientific knowledge. The founding of the Descartes’ analytic geometry was a turning point in the history of science. However, Descartes’ main contribution was also his methodology of science. His achievements in mathematics and natural science are actually just an embodiment of his philosophical thoughts on science, and the analytic geometry is, as it were, the product of his scientific methodology and the reflection of his spirit of skepticism^[12-13].

As can be seen from Descartes’ story, upholding the spirit of rationality means upholding independent thinking, daring to question authorities, and refusing to blindly follow others, adhering to scientific objectivity in scientific practice in order to avoid subjective prejudice, and constantly making progress in the scientific spirit of rationality. Carrying forward the spirit of rationality is of great practical significance for contemporary students. Most of them tend to think irrationally. For example, some students keep using their mobile phones during and after class, have little passion for participating in class and studying, and seldom think independently or do their homework on their own. Their spiritual lives are filled with the pursuit of “entertainment,” especially the online stars; games, and lethargy have become the norm. In the information era, young people’s lifestyles are becoming increasingly irrational and even anti-rational. For example, they get impatient with learning and are anxious to achieve success quickly, value grades and look down on knowledge, compare each other based on the material, and do everything for their own interests^[14]. Because they lack the spirit of rationality and skepticism, young students may have difficulty avoiding being blindly gullible or even believing in superstition and start gambling.

Therefore, teachers should firmly seize the classroom as the main medium and give full play to the classroom educational function in order to carry out ideological education in due time, and vigorously advocate the spirit of rationality during classes, in order to develop students’ rationality and a quality way of thinking. In this way, students will be able to distinguish the true from the false, do away with all fetishes and superstitions, give up utilitarianism, set long-term life and spiritual goals, and make plans for their studies and careers using the dialectical materialist viewpoints and

philosophical methodology^[15].

2.3 Seek the truth and advocate the spirit of exploration

The spirit of scientific exploration is a quality that, based on the revelation or prediction of existing knowledge and experience, enables scientists to always have direction, confidence, and perseverance in their activities while trying to reveal the laws of the unknown world. Problems are the forerunners of science, and one cannot make a scientific exploration without a problem. Therefore, the spirit of exploration is first manifested in being good at identifying problems and looking at things critically. Kepler was a typical representative of scientists with the spirit of exploration.

Kepler made a detailed study of the observations left by the astronomer Tycho. After many failures, he finally questioned the traditional concept that planets move at a uniform speed along a circle or an orbit composed of circles, thus discovering the three laws of planetary motion. Kepler was poor and susceptible to diseases all his life. He also had poor eyesight, but he struggled alone for most of his lifetime^[8]. How did he achieve success?

His spirit is reflected in his courage to explore, adeptness in innovation, and the bravery to break off from traditional ideas and explore again after identifying something incorrectly. He had his own firm beliefs and confidence. He respected science and practice. No matter how many setbacks he had experienced, he would never lose confidence. Daring to innovate did not mean giving up faith. Instead, the faith must be scientific and able to withstand the test of practice. He was good at exploiting his strengths and circumventing his weaknesses, thus utilizing his full potential. With poor eyesight, he couldn't observe clearly, but he achieved success with rich imagination, strong theoretical generalization ability, and mathematical calculation capabilities. He was good at making breakthroughs in the right places, refused to follow the paved paths, and dared to break into the forbidden areas. He was also adept at solving tricky problems using clever methods; he could endure hardship and worked hard rather than being afraid of hardship, and he always kept exploring with perseverance in spite of failures and setbacks because he was ready to give up everything for science. All this is an embodiment of the spirit of exploration and is something essential for scientific exploration^[16]. It is an excellent quality that contemporary students should learn and is also the most important ideological and political educational element in our course teaching.

2.4 Breaking the routine and advocating the innovative spirit of daring to breakthrough

The spirit of innovation is a spiritual quality expressed by people in innovation activities. It means that, while dealing with the outside world, people should be unreconciled with stereotypical routines and repetition, fearless of risks and failure, above empty words and conventions, brave in opening up new worlds and taking new roads, diligent in invention and creation, good at turning new ideas into new things, and never complacent, restrained or overcautious in exploration^[17-18]. Those who lack the spirit of innovation tend to muddle along, be satisfied with the status quo and never

make progress. Even if their living environment changes, they will be indifferent and adopt a negative attitude towards life.

Newton was a great scientist. Standing on the shoulders of giants such as Galileo, Kepler, Descartes, etc., he brought the predecessors' scientific theories together and also made use of his own extensive research knowledge, eventually making remarkable achievements in astronomy, physics, and mathematics through thorough thinking and precise calculation. He proposed the three laws of physics and the law of universal gravitation, and succeeded in describing a complete, universal classical mechanics theory system using mathematical methods, thus achieving the first comprehensive synthesis in the history of science^[8]. Later, Halley' Comet, Uranus, and Neptune were discovered, showing that Newton's theory is a universal law followed by macroscopic low-velocity mechanical motion^[19]. In the 1660s, Newton and Leibnitz simultaneously advanced the theory of calculus, laying a solid theoretical foundation for the rapid development of modern science. The emergence of calculus is a major event in the history of human science because of its profound influence on the development of natural science and production technology starting from the 18th century.

The scientists' achievements fully reflect and prove that true science can withstand the test of practice. Thus, students can understand the viewpoint of dialectical materialism that says theory comes from practice and in turn guides practice, and that practice is the sole criterion of truth. Teachers should integrate the innovative spirit of scientists, who are not afraid of difficulties and daring to be a pioneer, into classroom teaching to make students aware that scientific achievements are hard-won so that they will cherish the disciplinary knowledge they have learned. Students should be guided in accepting the scientific heritage, inheriting the previous wealth of mankind, doubting or criticizing their predecessors' achievements, and facing up to new problems and facts; they should also be encouraged to develop a rigorous and precise analytical spirit, to think out new ways for solving various problems and come up with new ideas and dare to be unconventional^[6]. At present, most college students lack satisfactory innovation ability, e.g., open-book examinations follow the same pattern, and very few graduation theses are original, etc. Although they are quick-witted, have inspiration for innovation, and are keen on innovating, they usually lack innovative skills, hands-on ability, as well as the courage, determination, and willpower to overcome difficulties. Although this is related to the teaching model, including teaching methods and textbooks, the main reason is that the students are content with things as they are rather than being willing to work hard and improve. For the reasons above, teachers should pay attention to the role of humanistic education in the cultivation of creativity and focus on developing students' awareness for asking questions and their innovation consciousness. Teachers should also arouse students' curiosity and imagination, actively encourage them to participate in scientific research, innovation and entrepreneurship projects, competitions in various disciplines and extracurricular practical activities so that they can enhance their creative thinking.

2.5 The scientist spirit is a good material for classroom teaching

Judging from the development of natural science, all scientists are devoted to seeking the truth and brave in exploring and innovating. They advocate materialism, adhere to the truth, seek truth from facts, and respect objective laws. That is because they have the scientist spirit. The scientific exploration is endless.

Einstein founded the special theory of relativity and the general theory of relativity before the age of 40, making a name for himself. He was called the “Newton of the 20th century”. After the year of 1923, he began to study the unified field theory. He was deeply aware that he would not be able to complete the work in his lifetime, but he knew the significance of the research, so he worked hard, often lonely, and never regretted it. He was still reviewing his manuscripts while lying in bed days before his death^[20]. Despite his failure due to adverse conditions, his pioneering spirit is indeed admirable. He often said, “A person’s value depends on what contribution he has made, not what he has achieved” and “Only by devoting himself to the society can a man find the meaning of what is actually a short and risky life.” He did not run after fame and gain, refused to be president of Israel, but was happy to discuss math problems with a little girl. He said, “Everybody has their ideals. I never regarded comfort and pleasure the purpose of my life—This ethical basis is what I call the ideal of the pigsty”^[8].

He fought for the development of science all his life, reflecting the great scientific spirit. His outstanding wisdom, tenacious perseverance, tireless industrious spirit, and noble scientific morality all embody his matter-of-fact attitude, the spirit of perseverance in exploration, the spirit of continuous innovation, and the spirit of strict, precise analysis. He was a great scholar and a kindhearted person. The scientists, who are indifferent to fame and fortune and work with perseverance, have the spirit of dedication and hold a rigorous scientific attitude. Moreover, their independent thinking ability and creativity truly reflect the scientific spirit of practicality, exploration, innovation, rationality, and dedication. Not only scientists but everyone should carry the scientific spirit because it is the embodiment of dialectics and epistemological thinking in the history of science development, and a good material for ideological education^[10].

III. CONCLUSION

Scientific achievements can only be made with the support of the scientific spirit. The scientific spirit urges people to consciously seek the truth from facts through scientific activities, respect objective laws, start from reality, strive for practical results, and unify subjective initiative with realistic possibility. Advocating the scientific spirit is, in the final analysis, a practice of sticking to correct philosophical propositions and cultivating correct thinking habits. The scientific spirit is rich in ideological and educational elements, such as philosophical thoughts and moral values. These elements can be incorporated into classroom teaching to form good habits among students of respecting, loving, and applying science. This will also help to improve students’ scientific literacy, human qualities, and morality, stop the decline of spiritual pursuit and ideal morality, and help them

set up a correct outlook on life and moral values so that the scientific spirit can become a part of everybody's self-consciousness.

The scientific spirit cannot be formed overnight. It must be cultivated imperceptibly under guidance. Therefore, teachers should thoughtfully design a way of integration, the point of integration and the connection to the knowledge into the curriculum, in order to "influence students silently." The anecdotes of scientists can be told to students to arouse their interest and enthusiasm for classroom participation; scientists' achievements can be used to enhance their scientific spirit and advocate the unity of the true, the good, and the beautiful. Bernoulli said, "If we could observe all events for eternity, we will eventually find that all things in the universe are governed by the law of causality, and we will also recognize a certain kind of inevitability in various complicated and chaotic phenomena." This type of inevitability is exactly reflected in the process of combining classroom teaching with cultivating people, according to the patriotism and scientific spirit found in the history of science. The integration and mutual support of the two helps achieve the goal of implementing synergic education. Values are incorporated into knowledge imparting and ability training in order to cultivate qualified builders and successors of the country.

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