Open Access Library Journal
2025, Volume 12, e14082
ISSN Online: 2333-9721
ISSN Print: 2333-9705

Study on Coupling Mechanism and Educational Value of Scientific Spirit and Science and Technology Ethics Education

Renhai Liang

Department of Library, Guilin University of Technology, Guilin, China
Email: 11072145@qq.com

How to cite this paper: Liang, R.H. (2025) Study on Coupling Mechanism and Educational Value of Scientific Spirit and Science and Technology Ethics Education. *Open Access Library Journal*, **12**: e14082.
https://doi.org/10.4236/oalib.1114082

Received: August 5, 2025
Accepted: October 21, 2025
Published: October 24, 2025

Abstract

In the grand context of building a scientific and technological powerhouse in the new era, this research aims to deeply analyze the coupling mechanism between the spirit of scientists and scientific and technological ethics education, explore the effective practical paths of their collaborative education, and explore the educational value contained therein. The research uses the literature research method to systematically sort out the relevant research results of the spirit of scientists and scientific and technological ethics education; uses the case analysis method to deeply analyze the educational practice cases of Hunan Agricultural University and other institutions; and at the same time, combined with the theoretical analysis method, explains the coupling relationship between the two from the two dimensions of value core and practical logic. The study finds that the spirit of scientists and scientific and technological ethics education are symbiotic in terms of value core and complementary in terms of practical logic. Through practical paths such as deep integration of the education system and collaborative innovation of the evaluation mechanism, it is possible to significantly enhance the educational value of scientific and technological talents, shape their responsibility ethics, promote the construction of an innovative cultural ecology, and serve the country's scientific and technological self-reliance and self-improvement. This research provides important theoretical reference and practical guidance for improving the cultivation system of scientific and technological talents and promoting the construction of a scientific and technological powerhouse.

Subject Areas

Culture

Keywords

Scientific Spirit, Science and Technology Ethics Education, Coupling Mechanism, Educational Values, Science and Technology Power

1. Introduction

The development of Science and Technology Power in the new era has become a vital component of China's national strategy, with its core mission being to drive high-quality economic and social development through technological innovation. The report of the 20th National Congress of the Communist Party of China explicitly proposed the "Three Integrations" national strategy—integrating vocational education with general education, merging industry and education, and harmonizing scientific research with education—aimed at optimizing the positioning of vocational education and promoting deep integration between the education system and technological innovation [1]. In this context, cultivating scientific and technological talents serves not only as a key driver for achieving the goal of building an education powerhouse but also as a crucial safeguard for national self-reliance in science and technology. The spirit of scientists, as a precious spiritual legacy accumulated through long-term scientific practice, provides spiritual guidance and practical motivation for technological talents with its core values of "patriotism, innovation, pragmatism, dedication, collaboration, and nurturing talent" [2] [3]. Meanwhile, science and technology ethics education emphasizes the value concepts of "seeking truth, pursuing goodness, and striving for beauty," guiding professionals to consider both the social impacts and ethical boundaries of technological applications while pursuing truth, thereby ensuring that technological development serves human welfare [4]. These two aspects play irreplaceable roles in building Science and Technology Power, collectively forming the essential components of cultivating scientific and technological talents.

China is currently at a critical juncture in accelerating the development of a nation strong in education, science and technology, and talent. Basic education serves as the cornerstone for building an educational powerhouse, with its reform and development directly impacting the realization of this goal [5]. However, in the face of increasingly fierce global competition in science and technology, China still encounters multiple challenges in cultivating scientific talent. On one hand, the tendency toward utilitarianism in scientific research leads some researchers to prioritize short-term gains over the long-term value of scientific inquiry. On the other hand, weak ethical awareness among students results in insufficient sensitivity to ethical issues during research practices, even leading to academic misconduct [5]. Therefore, under the context of building Science and Technology Power in the new era, in-depth research on the coupling mechanism between the spirit of scientists and scientific ethics education, as well as their educational value, holds significant theoretical and practical importance.

While the scientific spirit inquiry and ethical education in technology play crucial roles in cultivating tech talent, their integration currently faces significant challenges. First, utilitarianism dominates academic circles, with metrics like "publish or perish" driving researchers to prioritize quantity over quality. This not only undermines the scientific spirit inquiry but also makes ethical education ineffective [6]. Second, students misconceptions about technology's "neutrality" often lead them to disregard ethical constraints in research, potentially creating social risks [7]. Third, the integration of these concepts remains fragmented across curricula. Existing educational resources are underutilized, and monotonous teaching methods fail to spark students' interest or intrinsic motivation [8].

The emergence of these issues demonstrates that the coupling mechanism between scientific rigor and ethical education in science and technology has yet to be fully established, with their educational value remaining underutilized. This study systematically analyzes the intrinsic connections between these two domains, exploring effective coupling mechanisms and practical implementation pathways. The research aims to provide robust talent support for building a nation strong in science and technology. Not only does this study help fill theoretical gaps in existing literature, but it also offers actionable guidance for educational practices [2].

This study aims to thoroughly analyze the coupling mechanism between the spirit of scientists and science and technology ethics education, explore practical approaches for cultivating tech talents, and uncover its multidimensional educational value. Specifically, the research will be conducted from the following aspects: First, by examining the connotations and developmental history of both the spirit of scientists and science and technology ethics education, this study reveals their symbiotic nature in core values and complementary practical logic, providing theoretical foundations for building a coupling mechanism [2] [9]. Second, drawing on domestic and international practical experiences, this study proposes specific strategies for deep integration of educational systems, including curriculum design, innovative teaching methods, and resource development, to promote organic integration between the two [9]. Third, through case analysis and policy research, this study emphasizes the importance of collaborative innovation in evaluation mechanisms, highlighting the critical role of process-oriented assessment and error-tolerant safeguard mechanisms in guiding students to practice the spirit of scientists and science and technology ethics [7].

Ultimately, this study aims to provide theoretical support and practical guidance for building China into a global science and technology powerhouse by systematically analyzing the coupling mechanism and educational value of scientific spirit and technological ethics education. The research findings not only offer references for universities and research institutions to optimize talent cultivation models in science and technology, but also provide scientific basis for policy formulation, thereby contributing to the overarching goal of Chinese-style modernization [10].

2. Literature Review

As an essential component of the discourse and academic systems within the Chinese context, the spirit of scientists has been extensively discussed in academic circles regarding its connotation and developmental trajectory. From a historical perspective, the spirit of scientists has undergone over a century of spatiotemporal evolution and conceptual interpretation, gradually evolving from scientific spirit into an independent spiritual system with Chinese characteristics [11]. This process not only reflects the theoretical debates on scientific spirit from "monism/dualism" to "seven-part/eight-part methodology," but also encompasses the transformation of the spirit's connotation from "four categories and five elements" to "six-in-one integration." Particularly within the spiritual lineage of Chinese Communists, the spirit of scientists has been imbued with collective expression of contemporary characteristics, becoming a vital force driving technological innovation and social progress [12]. Additionally, the core elements of the spirit of scientists—patriotism, innovation, pragmatism, dedication, collaboration, and education—serve not only as invaluable spiritual wealth accumulated by scientific practitioners through long-term practice, but also as crucial vehicles for achieving harmonious integration between scientific culture and humanistic culture [2]. The significance of the spirit of scientists lies in its ability to enhance the transformation of scientific achievements through a combination of public opinion guidance and collective cultivation, while providing enduring temporal value and substantial practical significance for building an innovative nation [13].

The objective of science and technology ethics education is to cultivate the ethical awareness and sense of responsibility essential for professionals when applying modern technological tools. With the widespread adoption of technology in fields like medicine and engineering, the importance of ethics education has become increasingly prominent. For instance, in medical schools, the ethics education community focuses on guiding ethical values through technology, aiming to advance new medical education and nurture innovative talents committed to ethical technology development [8]. This educational model emphasizes building diversified, systematic, and standardized educational entities, while establishing a comprehensive ethics education framework through multi-dimensional approaches: institutional ethics education that balances red lines and bottom lines, and life ethics education that equally values respect for and reverence for life. Internationally, ethics education has expanded to cover the entire process, lifecycle, and all domains, requiring collaborative participation from governments, medical institutions, pharmaceutical companies, and social organizations [14]. Meanwhile, STEM education—an interdisciplinary model—incorporates ethics education by integrating project-based learning and cross-disciplinary approaches to help adolescents internalize ethical values [10]. However, current challenges in ethics education remain, including excessive reliance on technology and the need to address issues like oversimplified value orientations [15].

While existing research on both the spirit of scientists and science and technol-

ogy ethics education has achieved certain results, studies on their coupling mechanisms and educational value remain notably insufficient. On one hand, current research predominantly focuses on either the spirit of scientists or science and technology ethics education, lacking in-depth analysis of their intrinsic connections [5]. For instance, the promotion and research of the spirit of scientists mainly rely on media-driven approaches, with insufficient academic motivation, making it difficult to fully demonstrate its social functions and contemporary value in spiritual production [12]. On the other hand, although science and technology ethics education emphasizes value revelation, its exploration of implementation pathways remains underdeveloped, failing to effectively integrate the practical demonstration role of the spirit of scientists [8]. Additionally, existing studies pay little attention to integration pathways between the spirit of scientists and science and technology ethics education in specific scenarios like ideological and political education courses and STEM education, resulting in underutilized synergistic effects in educational practice [2] [13]. Therefore, this study aims to fill these research gaps by analyzing the coupling mechanisms between the spirit of scientists and science and technology ethics education, exploring their deep integration pathways within educational systems, and uncovering their multidimensional educational value for cultivating tech talents. This will provide theoretical support and practical guidance for building a strong science and technology nation.

3. The Coupling Mechanism between Scientific Spirit and Science and Technology Ethics Education

The spirit of scientists and science ethics education share profound symbiotic values at their core. The spirit of scientists, centered on patriotism, innovation, pragmatism, dedication, collaboration, and nurturing talent, emphasizes the fundamental purpose of science serving humanity. Science ethics education focuses on responsibility, fairness, and humanistic care in research activities. Together, they form the value foundation for technological development. While science ethics serves as the essential guidelines for scientific endeavors, the spirit of scientists provides intrinsic value guidance and spiritual motivation for researchers. These two elements mutually reinforce each other and complement each other's strengths.

As an essential component of the discourse and academic systems in the Chinese context, the spirit of scientists can be summarized as "patriotism, innovation, pragmatism, dedication, collaboration, and education." These elements not only reflect the historical continuity of scientific spirit but also demonstrate the moral and professional requirements for science and technology workers in the new era. Taking Qian Xuesen as an example, he closely integrated his personal destiny with national needs, leading his team to break through technological blockades after returning to China and successfully developing China's first artificial satellite "Dongfanghong-1," which profoundly illustrates the central role of patriotic spirit in scientific practice [1]. Furthermore, innovation, as a crucial dimension of the spirit of scientists, emphasizes that researchers must courageously explore un-

known fields. For instance, Tu Youyou pioneered a new approach to malaria treatment through her discovery of artemisinin, making significant contributions to global public health [5]. Pragmatism requires researchers to maintain rigorous attitudes in scientific studies, respect objective laws, and avoid short-sighted behaviors. The spirit of dedication is exemplified by Deng Jiaxian's 28-year anonymity in nuclear weapons research, showcasing the noble character of scientists sacrificing personal interests for national goals [5]. Collaboration and education further highlight the importance of teamwork and knowledge inheritance, which aligns closely with the demands of interdisciplinary cooperation and talent cultivation in contemporary technological innovation.

Science and technology ethics education, guided by the core values of "seeking truth, promoting goodness, and pursuing beauty," aims to empower tech professionals to uphold ethical boundaries and social impact while pursuing scientific truth. The principle of "seeking truth" emphasizes that research must adhere to objective laws, ensuring data authenticity and transparency—a fundamental aspect of the scientific spirit. For instance, gene-editing technology applications require strict ethical frameworks to prevent irreversible impacts on human genetic resources [2]. "Promoting goodness" demands that technological achievements serve life dignity and social equity, such as ensuring algorithmic fairness in AI development to prevent social division caused by misuse [4]. "Pursuing beauty" focuses on enhancing quality of life through technology, advocating for welfare improvements over mere economic gains. Practical cases demonstrate that these ethical principles not only resonate with the scientific ethos but also provide tech professionals with comprehensive behavioral guidance.

The spirit of scientists and science ethics education share profound alignment in their dual objectives of "pursuing truth" and "serving humanity," forming the value foundation for cultivating tech talents. On one hand, patriotism and innovation within the scientist spirit provide spiritual impetus for ethics education, motivating researchers to integrate personal aspirations into national development strategies while advancing technological progress through bold exploration of unknown frontiers. On the other hand, truth-seeking and benevolence in ethics education impose ethical constraints on the implementation of scientific spirit, ensuring research activities align with societal interests [3]. For instance, when addressing global challenges like climate change or public health crises, the collaborative spirit fosters interdisciplinary cooperation, whereas ethics education's commitment to goodness ensures equitable and sustainable technology applications [10]. This value symbiosis not only strengthens the shaping of tech professionals' values but also lays a solid foundation for building an educational system that harmonizes scientific rationality with humanistic care.

The spirit of scientists has provided abundant practical models for science and technology ethics education through historical cases, demonstrating the art of balancing scientific research with social responsibility. Take Nan Rendong as an example: he spent 22 years leading the construction of the world's largest single-

aperture radio telescope, "Sky Eye," which not only showcased his exceptional innovative capabilities but also highlighted his unwavering dedication to scientific endeavors [5]. Similarly, Deng Jiaxian remained anonymous for 28 years during nuclear weapons development, exemplifying the significant sacrifices made by scientists between national security and personal interests. This spirit of dedication infused profound moral significance into science and technology ethics education [6]. These cases demonstrate that the spirit of scientists not only epitomizes the personal qualities of technical professionals but also serves as vital resources for ethics education. It inspires students to integrate scientific ideals with social responsibilities, thereby better practicing ethical standards in scientific endeavors.

Science and technology ethics education establishes clear regulatory pathways for practicing scientific integrity through institutional frameworks and cultural guidance. Institutionally, the development of academic misconduct investigation mechanisms sets baseline standards for research activities, ensuring scientists uphold academic integrity while pursuing innovation. For instance, recent exposes of academic fraud cases have not only exposed ethical issues in research but also driven the refinement of relevant systems [7]. Culturally, extensive promotion of research integrity awareness campaigns fosters a positive academic environment and strengthens researchers' ethical consciousness. Furthermore, through curriculum design and practical activities, ethics education helps students comprehend the social significance and ethical responsibilities of scientific research, thereby reducing utilitarian tendencies in technology development at their source [8]. This regulatory mechanism not only safeguards the spirit of science but also creates favorable conditions for the holistic growth of tech professionals.

Hunan Agricultural University has integrated Yuan Longping's spirit into its curriculum, setting a prime example for synergistic education that combines scientific ethos with technological ethics. As the "Father of Hybrid Rice," Yuan's legacy epitomizes the patriotic, selfless, and innovative essence of scientific endeavor, while embodying profound ethical awareness. For instance, his commitment to "writing papers on the land" in addressing global food security exemplifies how researchers harmonize personal aspirations with national needs [5]. Through ideological courses centered on Yuan's spirit, the university not only promotes scientific values but also incorporates technological ethics education, guiding students to examine ethical issues in agricultural innovation—such as the boundaries of gene-editing technology applications in crop improvement [8]. This educational model strengthens students' research ethics consciousness while deepening their understanding and appreciation of scientific ethos, vividly demonstrating their complementary nature and synergistic effects in practice.

4. The Practical Path of Coupling Mechanism

The deep integration of educational systems serves as a crucial practical pathway for coupling the spirit of scientists with technological ethics education. Its core lies in building a comprehensive, multi-level educational framework through cur-

riculum design optimization, teaching method refinement, and resource integration. Regarding curriculum design, science and engineering courses should incorporate ethical modules to address social risks and ethical challenges arising from modern technological development. For instance, AI-related courses could include dedicated chapters exploring issues like privacy violations and algorithmic discrimination caused by technology abuse, supported by concrete case analyses [10]. Meanwhile, humanities courses should introduce philosophy of science topics to guide students in examining the relationship between science and society from a philosophical perspective, cultivating critical thinking and value judgment capabilities [13]. This interdisciplinary curriculum design not only strengthens students' ethical awareness but also deepens the "pragmatism" and "innovation" concepts inherent in the spirit of scientists within an ethical framework.

Innovations in teaching methodologies are equally vital. The "problem-oriented + project-driven" model provides an effective pathway for integrating scientific ethos with technological ethics education. By designing interdisciplinary projects such as carbon neutrality solutions or gene editing technology applications, students can experience the entire research process while solving real-world problems, thereby internalizing a pragmatic spirit and collaborative skills [2]. For instance, in carbon neutrality projects, students must integrate knowledge from engineering, ecology, and sociology. This not only enhances their innovative capabilities but also prompts them to consider ethical boundaries in technology application [7]. Furthermore, project-based learning emphasizes teamwork and reflective summarization, helping students understand the value of "dedication" and "educational commitment" inherent in scientific ethos.

Resource development serves as the foundational support for deep integration within educational systems. The integration of scientists' spirit education bases with a scientific ethics case library, forming a tripartite resource chain of "history-practice-reflection," holds significant importance. Institutions like Qian Xuesen's Former Residence and Nan Rendong Memorial Museum, which preserve rich historical memories and spiritual values, provide vivid practical materials for teaching [9]. Simultaneously, establishing a scientific ethics case library covering academic misconduct investigations and research integrity promotion helps students understand ethical norms from both positive and negative perspectives [10]. By combining historical resources with practical cases, students can deepen their understanding of scientists' spirit and scientific ethics through reflection, thereby achieving the unity of knowledge internalization and value recognition.

The collaborative innovation of evaluation mechanisms is crucial for implementing the coupling mechanism between scientific ethos and technological ethics education. Its core lies in guiding students to practice scientific ethos and ethical standards through enhanced process-oriented evaluations, establishing error-tolerant safeguards, and achieving synergistic effects within the evaluation framework. Firstly, strengthening process-oriented evaluations effectively focuses on students' research attitudes and behavioral performance rather than relying solely

on outcome-based approaches. For instance, during experimental data analysis, evaluations should emphasize data authenticity and completeness while encouraging students to adopt rigorous scientific practices [7]. This evaluation method not only cultivates students' pragmatic spirit but also helps them establish proper research ethics [14].

Secondly, establishing a fault-tolerant safeguard mechanism holds significant importance for motivating exploratory research. In scientific practice, failure is inevitable, yet traditional evaluation systems often overemphasize outcomes, leading students to adopt conservative research approaches to avoid setbacks. By implementing error-tolerant mechanisms—such as conducting in-depth analysis of failed experiments and providing constructive feedback—we can guide students to confront failures courageously and embrace experimentation, thereby preventing short-sighted behaviors [7]. Moreover, such mechanisms foster a tolerant academic environment that promotes the "innovation" and "dedication" principles inherent in scientific ethos, while balancing the ethical requirements of "truth-seeking" and "goodness-oriented" practices in scientific research [11].

The Fujian Academy of Agricultural Sciences' case study vividly demonstrates how collaborative innovation in evaluation mechanisms drives talent development. By cultivating a culture that balances rigorous academic standards with failure tolerance, the institute has implemented strict research integrity protocols while encouraging bold exploration of uncharted territories. A prime example emerged in a crop breeding project: despite initial experimental setbacks, the team's thorough analysis of failure causes ultimately led to optimized breeding strategies [7]. This innovative evaluation model not only enhances researchers' creativity but also strengthens their commitment to ethical standards, offering valuable lessons for other educational institutions.

5. The Multidimensional Embodiment of Educational Value

The educational value of the scientific spirit manifests in three key dimensions: value orientation, personality cultivation, and skill refinement. In terms of value orientation, the scientific spirit embodies the pursuit of "devotion to the nation and service to the people," guiding young people to integrate personal aspirations into national endeavors and cultivate a sense of patriotism through "subordinating individual interests to collective goals." Regarding personality development, as a contemporary expression of Marxist scientific ethics, the scientific spirit provides ideological guidance for nurturing research ethics and academic integrity, fostering in youth the perseverance to "endure ten years of solitude on a bench" and the resolve to "achieve success through personal dedication." In skill refinement, the scientific spirit cultivates multidimensional growth through innovative, pragmatic, and collaborative qualities. It inspires "pioneering innovation and bold exploration," nurtures a scientific attitude of "truth-seeking and rigorous scholarship," and shapes team spirit of "collective intelligence and teamwork," comprehensively forging responsible ethics and professional competence in scientific tal-

ent development.

The integration of patriotic dedication in the spirit of scientists and life care in scientific ethics provides an important value orientation for cultivating "selfless" scientific workers. As the founder of China's geological mechanics, Li Siguang's return to China fully embodies the noble pursuit of scientists integrating personal ideals into national needs. He resolutely abandoned comfortable conditions abroad to devote himself to the construction of New China, making outstanding contributions to resolving the nation's energy crisis [5]. This spirit of patriotic dedication is not only a core element of the scientific spirit but also injects profound patriotism into scientific ethics education. Meanwhile, ethical discussions in cutting-edge fields like gene editing technology highlight the high concern of scientific workers for life dignity and social equity. For instance, how to balance scientific research freedom with ethical boundaries has become a critical issue in the application of gene editing technology. This requires scientific workers to not only possess rigorous scientific attitudes but also harbor deep concern for life [11]. By organically combining patriotic dedication with life care, we can effectively guide scientific talents to pursue scientific truth while always taking serving human welfare as their mission, thereby shaping a responsibility ethics view characterized by "selfless dedication".

The successful practices of the Chang' e-5 mission team collaborative soil sampling and the Beidou Navigation Youth Task Force further demonstrate the significance of the unified spirit of collaboration and ethical responsibility in shaping the ethical responsibilities of scientific talents. As China's first extraterrestrial celestial body sampling and return mission, the complexity and challenges of the Chang' e-5 mission are self-evident. Throughout the years-long R&D process, team members maintained high levels of collaboration and selfless dedication, ultimately achieving the mission objectives. This collaborative spirit not only embodies the "collaboration" element in the spirit of scientists but also reflects the collective responsibility and shared mission emphasized in scientific ethics [5]. Similarly, during the construction of the Beidou Navigation System, the youth task force overcame multiple core technological challenges through innovative courage and perseverance despite facing technical blockades and limited resources. While breaking through "chokepoint" technologies, they consistently balanced ethical risks such as algorithmic fairness and data security, demonstrating a practical path that equally emphasizes technological self-reliance and ethical responsibility [12]. These cases indicate that through the trials of major scientific projects, scientific talents can deepen their understanding and practice of ethical responsibilities in real-world applications, laying a solid moral foundation for the future development of science and technology.

The innovative courage in scientists' spirit and the truth-seeking ethos in scientific ethics work synergistically to foster an ecosystem of innovation culture. Tu Youyou's discovery of artemisinin stands as a prime example of such courage. She broke through traditional research methods by drawing inspiration from ancient

texts and integrating modern technology, ultimately extracting artemisinin—a monumental contribution to global malaria prevention [1]. This achievement not only demonstrated scientists' boldness in exploring uncharted territories but also embodied the core principles of truth-seeking pragmatism in scientific ethics. However, academic misconduct like data fabrication currently prevalent in academia severely violates this spirit of truth-seeking, hindering the healthy development of innovation culture [7]. Therefore, organically combining innovative courage with truth-seeking ethos helps combat academic dishonesty and cultivate a clean research environment. Only under the guidance of truth-seeking can innovative courage be properly exercised, thereby driving continuous progress in technological innovation.

The establishment of the "Scientist Spirit Course" at Huazhong University of Science and Technology's National Research Center for Optoelectronics provides valuable insights into integrating innovative culture with ethical standards. Centered on the scientific spirit inquiry, this course ignites students' passion for innovation and sense of responsibility through real-life stories of pioneers like Tu Youyou and Qian Xuesen. It emphasizes embedding ethical principles into research practices, guiding students to address issues such as academic integrity and intellectual property rights [10]. This educational model not only helps students internalize the scientific ethos but also strengthens their understanding and commitment to technological ethics. Practical evidence shows that systematic curriculum design effectively fosters the deep integration of innovation culture and ethical norms, laying the foundation for building a healthy innovation ecosystem. Furthermore, the center enhances the synergy between practical innovation and ethical standards by organizing interdisciplinary collaborations, encouraging students to apply theoretical knowledge to solve real-world problems.

In the process of breaking through "chokepoint" technologies in key fields such as chip R&D, balancing ethical risks like AI algorithm fairness is a crucial guarantee for achieving both "technology for good" and "self-reliance and self-strengthening". Currently, global technological competition is intensifying, and China faces severe challenges in key technology fields such as chips and artificial intelligence. Young scientists not only need to possess the determination and capability to overcome difficulties but also must fully recognize the ethical risks that technological development may bring. For instance, in AI algorithm design, how to ensure the fairness and transparency of algorithms and avoid social discrimination caused by data bias has become an urgent ethical issue [3]. The pursuit of truth and innovation in the scientific spirit research provides momentum for breaking through technological bottlenecks, while technological ethics education offers normative guidance to mitigate potential risks. The synergy between these two aspects can guide young scientists to prioritize ethical responsibilities while pursuing technological breakthroughs, thereby achieving the win-win goal of technological development and human welfare [13].

The Ministry of Education's 2023 "Scientist Spirit in Campus Initiative" en-

hanced the immersion and effectiveness of science ethics education through innovative approaches like virtual simulation and metaverse technology. Centered on the spirit of scientists, this initiative leverages virtual reality to create an educational platform integrating historical reenactments, interactive experiences, and deep reflection. For instance, students can use virtual simulations to witness Qian Xuesen's development of China's "Two Bombs, One Satellite" program, gaining a vivid understanding of scientists' patriotic dedication [9]. Meanwhile, metaverse applications bring complex ethical issues into sharp focus—such as the ethical debates surrounding gene editing technology and potential risks of artificial intelligence—helping students grasp the essence and significance of scientific ethics. Practice has shown that this policy-backed educational innovation not only boosts students' identification with the scientist spirit but also significantly strengthens their ethical awareness and sense of responsibility, providing solid talent support for China's self-reliance in scientific and technological development.

6. Challenges and Responses

The integration of scientific literacy into technology ethics education faces challenges including an incomplete curriculum framework, weak practical components, and a singular evaluation mechanism. Currently, technology ethics education has not been fully incorporated into core course systems, with teaching content lacking systematicness and contemporary relevance, resulting in insufficient student understanding of ethical issues. Meanwhile, traditional teaching methods emphasize theoretical indoctrination while lacking real-world research scenario experiences, making it difficult for students to internalize ethical norms as voluntary behaviors. Furthermore, evaluation mechanisms overly focus on academic achievements while neglecting assessments of research ethics literacy, failing to effectively guide students in establishing proper technological values. To address these challenges, we must establish a "trinity" integrated mechanism: First, integrate scientific ethics education throughout the entire talent development process by creating curriculum resources tailored to different academic stages, emphasizing case-based teaching and scenario simulations. Second, strengthen practical components by organizing students to participate in real research projects and enhancing experiential learning through platforms like "Scientists' Story Co-Creation Space". Third, develop a multidimensional evaluation system that incorporates research integrity and ethical judgment into comprehensive student assessments, guiding tech professionals to "scale new heights" while "upholding ethical standards", thereby truly achieving the educational goal of making technology serve society for good.

In the cultivation of contemporary scientific talent, utilitarian phenomena such as "paper quantity obsession" have significantly undermined the education of scientific spirit and technological ethics. This evaluation system overemphasizes short-term achievements and quantitative metrics, leading some researchers to prioritize personal interests over national needs and social responsibilities, thereby

eroding the core values of "patriotism and dedication" in scientific ethos [5]. For instance, excessive pursuit of publication numbers may trigger academic misconduct like data fabrication or plagiarism, which not only violates the truth-seeking principles of scientific research but also contradicts the "goodness-oriented" philosophy advocated by ethical education [11]. Moreover, utilitarian tendencies may cause students to neglect long-term accumulation and innovative practices in research, ultimately hindering their comprehensive development of research capabilities. Therefore, addressing how to counteract the erosion of utilitarianism on scientific ethos and ethical education has become a critical issue requiring urgent resolution.

The root of the problem with technological utilitarianism lies in the oversimplified evaluation systems and society's one-sided understanding of technological development. Universities and research institutions often use overt indicators like publication counts and project funding as primary benchmarks for measuring research performance, while neglecting the cultivation of scientific spirit and ethical literacy among researchers [5]. Meanwhile, society's excessive worship of technology has exacerbated this phenomenon, leading some students to embrace a "technology-first" mindset that overlooks ethical risks and social responsibilities in technological applications [11]. This value distortion not only hinders the inheritance of scientific spirit but also poses serious challenges to technological ethics education. Therefore, it is imperative to establish a more scientific and rational evaluation system through institutional and cultural reforms, guiding researchers to develop proper value systems.

The lack of ethical awareness among some students, such as the notion that "technology has no inherent good or evil," along with its underlying causes, warrants serious attention. In the context of rapid technological advancement, many students tend to view technology as a neutral tool, overlooking its potential profound impacts on human society in practical applications [8]. For instance, in cutting-edge fields like artificial intelligence and gene editing, some students lack sensitivity to ethical issues that may arise from technological misuse, even considering technology itself as morally neutral. This mindset not only contradicts the objectives of technological ethics education but may also lead future tech professionals to disregard ethical constraints during research and application processes, potentially triggering social controversies and trust crises [13].

The primary causes of weak ethical awareness stem from insufficient emphasis on science and technology ethics education within the academic system, coupled with students' limited engagement with ethical issues. On one hand, current university curricula often marginalize science and technology ethics content, failing to deeply integrate it with specialized courses. This disconnect prevents students from internalizing ethical consciousness during research practices [8]. On the other hand, some students' understanding of ethical issues remains superficial, lacking critical thinking and analytical skills. Consequently, they struggle to make sound judgments when confronted with complex ethical dilemmas [13]. There-

fore, strengthening ethics education and enhancing students' ethical awareness have become crucial components that cannot be overlooked in modern science and technology talent development.

To address these challenges, establishing institutional safeguards such as research integrity records and strengthened joint disciplinary mechanisms for academic misconduct has become crucial. Serving as a vital tool for documenting researchers' scholarly conduct, integrity records effectively regulate research practices while promoting the practical implementation of scientific ethics education [7]. A comprehensive integrity record system not only documents academic achievements but also enables tracking and punishment of misconduct, thereby creating an effective deterrent mechanism. Furthermore, enhancing collaborative disciplinary measures remains essential for maintaining healthy research environments. For instance, interdepartmental coordination in implementing cross-disciplinary sanctions against academic misconduct can both reduce violations and strengthen researchers' commitment to scientific ethics [15].

The refinement of institutional safeguards requires practical implementation and detailed adjustments. For instance, universities and research institutions should implement a scientific integrity commitment system, requiring researchers to sign ethical pledges during project applications and paper publications, clearly defining their responsibilities in adhering to research ethics [7]. Concurrently, dedicated integrity review bodies should be established to monitor and evaluate academic conduct, ensuring effective enforcement of regulations. These measures not only standardize research practices but also provide a robust institutional foundation for the deep integration of scientific ethos and technological ethics education.

Beyond institutional safeguards, enhancing cultural immersion through innovative approaches like music-based ideological education courses and historical science-themed short dramas (such as Hunan Agricultural University's "Dreams Under the Rice Plants") serves as a vital pathway to strengthen students' recognition and practical application of scientific ethos and ethical standards [8]. As an innovative educational format, music-based courses effectively convey the profound essence of scientific dedication through artistic expression, allowing students to absorb ideological enlightenment through emotional resonance. For instance, performances like "The Motherland Will Never Forget" enable students to vividly appreciate the selfless contributions scientists made for national development [9]. Similarly, these historical dramas captivate audiences with their engaging narratives and authentic historical contexts, sparking students' interest and reverence for scientific spirit. The university's production "Dreams Under the Rice Plants", which centers on Academician Yuan Longping's legacy, vividly portrays the scientist's patriotic devotion and pioneering spirit, earning widespread acclaim from faculty and students [8].

The essence of cultural immersion lies in integrating the spirit of scientists and ethical considerations of science and technology into students' daily lives and ac-

ademic environments. Universities can foster a strong cultural atmosphere through themed exhibitions, lectures, and other activities, allowing students to absorb these values through subtle influence [9]. Additionally, leveraging new media platforms to create and share short videos, animations, and other content centered on the spirit of scientists can expand educational reach and impact. Through these diversified cultural engagement methods, students can develop stronger identification with scientific ethics while consciously applying these principles in their practice.

7. Conclusions

Research on the coupling mechanism between scientific spirit and technological ethics education reveals their deep integration in value core and practical logic, providing crucial theoretical support for talent cultivation under the context of building Science and Technology Power in the new era. Studies show that the scientific spirit is centered on "patriotism, innovation, pragmatism, dedication, collaboration, and education," emphasizing researchers integrating personal aspirations into national needs. Examples include Qian Xuesen's patriotic dedication embodied in the "Two Bombs, One Satellite" spirit, and Yuan Longping's relentless pursuit of food security [1] [5]. Technological ethics education advocates the values of "seeking truth, pursuing goodness, and achieving beauty," demonstrating how technology serves life dignity and social equity through case studies like ethical boundary discussions on gene editing technology and inclusive applications of artificial intelligence [2] [4]. Both share a high degree of alignment in their goals of "pursuing truth" and "serving humanity," forming a symbiotic relationship that collectively shapes the values and ethical responsibilities of scientific talents.

In terms of practical approaches, this study proposes specific strategies for deep integration of educational systems and collaborative innovation in evaluation mechanisms. For curriculum design, science and engineering courses incorporate ethics modules (such as the "Social Risks of Artificial Intelligence" course) while humanities courses add philosophy of technology topics, providing students with interdisciplinary perspectives. The teaching methodology adopts a "problem-oriented + project-driven" approach, guiding students to internalize a pragmatic spirit through projects like carbon neutrality plan design [10] [13]. Meanwhile, resource development integrates scientist spirit education bases and scientific ethics case libraries, forming a tripartite resource chain of "history-practice-reflection" [9] [10]. Regarding evaluation mechanisms, process-oriented assessments focus on students' research attitudes, while establishing error-tolerant support mechanisms to encourage exploratory research. Case studies from the Fujian Academy of Agricultural Sciences demonstrate how collaborative innovation in evaluation mechanisms promotes talent cultivation [7].

Furthermore, the integration of scientific ethos and ethical education in technology demonstrates multidimensional educational value. On one hand, through

case studies like Li Siguang's return to China and genetic technology ethics, we cultivate scientists with a "broad-minded vision". On the other hand, innovations such as Tu Youyou's artemisinin research exemplify how bold creativity and truth-seeking spirit foster an innovative ecosystem [1] [7]. More importantly, addressing ethical risks while overcoming "chokepoint" technologies achieves dual progress in "technology for good" and "self-reliance", providing moral momentum for national technological self-sufficiency [3] [13].

Although this study has achieved certain results in the coupling mechanism and educational value of the spirit of scientists and science and technology ethics education, there are still many directions worthy of further exploration in the future. First, theoretical research needs to be further deepened, especially under the context of globalization, how to combine the spirit of scientists with Chinese characteristics and internationally recognized science and technology ethics norms to form a more universal theoretical framework [5] [13]. Second, practical applications should expand to more disciplines and industries. In particular, in emerging technological fields (such as quantum computing and the metaverse), how to enhance the immersion of ethics education through virtual simulation technology has become an urgent issue to address [9].

Furthermore, to address the current issues of technological utilitarianism and weak ethical awareness, future research could focus on the synergistic effects of institutional safeguards and cultural immersion. For instance, how to establish a more comprehensive system through scientific integrity records and joint disciplinary mechanisms for academic misconduct; meanwhile, enhancing the appeal and influence of cultural education via formats like music-based ideological courses and short plays about scientists' stories [8] [9]. Finally, with the rapid advancement of technology, the coupling mechanism between scientific spirit and ethics education requires continuous dynamic adjustments to adapt to ethical challenges and practical demands posed by emerging technologies, thereby better serving the overarching goal of Chinese modernization [15].

Conflicts of Interest

The author declares no conflicts of interest.

References

[1] Wang, C. (2024) The Historical, Theoretical and Practical Logic of the Scientific Spirit. *Hubei Social Sciences*, No. 2, 5-19.

[2] Kong, X. and Liu, S. (2023) Threefold Logic of Integrating Scientific Spirit into Curriculum Ideological Education. *Higher Education Exploration*, No. 6, 86-90.

[3] Zhu, D. and Bai, H. (2024) New Momentum of Educational Evaluation Reform in the New Era Empowering the "Three Integrations" National Strategy. *Modern Distance Education Research*, **36**, 55-63.

[4] Liang, W. and Xiao, L. (2023) Chinese-Style Educational Modernization: Developmental Trajectory, Key Characteristics, and Emerging Issues—An Analysis of Educational Content in Party Congress Reports Since the Reform and Opening-Up. *Jour-*

nal of Southwest University (*Social Sciences Edition*), **49**, 162-175.

[5] Liu, S. (2024) Practical Approaches to Integrating the Spirit of Scientists into Ideological and Political Education in Universities. *Party Building and Ideological Education in Schools*, No. 8, 42-44.

[6] Wang, Z. and Li, Y. (2024) Transformation and Restructuring of China's Higher Education Evaluation System in the Digital Intelligence Era. *University Education Science*, No. 2, 106-117.

[7] Chen, H., Li, M. and Kong, X. (2022) Excellence in Engineering Education under the New Engineering Initiative: A Framework Based on TRIZ-TAN Coupling Model. *Modern Educational Management*, No.8, 85-92.

[8] Liu, Y. and Yu, Q. (2024) Logical Framework for the Medical Education Community on Scientific Ethics. *Medicine and Philosophy*, **45**, 61-64.

[9] Tan, T. (2023) Building a University Governance Community: Practical Pathways for Modernizing University Governance through Party Leadership in the New Era. *Ideological Front*, **49**, 19-28.

[10] Ning, J. (2023) The Value Implications and Pathways for Integrating Scientific Spirit into Youth STEM Education. *Journal of Secondary School Political Education*, No. 39, 20-22.

[11] Liu, L., Feng, B. and Gao, X. (2024) The Chinese Experience and Problem Domain Turn in Labor Education Research—A Review of China's 70 Years of Labor Education Research Approaches and Achievements. *Journal of Chinese Education*, No. 4, 28-33.

[12] Liu, X. and Ren, J. (2024) Exploring the Integration of Educator's Spirit into Ideological and Political Education for Teacher Trainees. *China Journal of Secondary School Political Education*, No. 11, 26-30.

[13] Zhang, M. (2021) A Preliminary Study on Integrating the Spirit of Scientists into College Students' Ideological and Political Education. *Party Building and Ideological Education in Universities*, No. 12, 88-90.

[14] Jin, Y., Li, Z., Shi, O., Xu, J. and Liu, Z. (2022) Core Issues in the Construction and Development of High-Quality Basic Education System. *China Electro-Education*, No. 1, 24-35.

[15] Jin, Y., Wang, J., Lü, L., Luo, S., Zhang, M., He, X. and Guo, Y. (2023) Building a Strong Education Nation: The Mission and Practice of Basic Education (Pen Meeting). *Journal of Suzhou University* (*Educational Science Edition*), **11**, 11-32.