The Double Helix of Computing Power and Literacy: The Core Contradiction and Balance Between Computer Science and Technology Education

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ABSTRACT

In the context of the deep penetration of digital economy and artificial intelligence technology into society, computer science and technology education is facing the dual demands of "computing power iteration" and "literacy cultivation". As the cornerstone of technological innovation, computing power puts forward the ultimate requirements for the update of educational content due to its development speed and breadth of application. As the core of the sustainable development of talents, literacy requires education to go beyond instrumental rationality and return to the essence of humanities and thinking. The two are like the double helix structure of DNA, which not only intertwines and supports each other, but also presents contradictions in educational practice such as goal focus, resource allocation, and value orientation. Based on the current situation of computer education in Chinese universities, this paper analyzes the core contradiction between computing power and literacy, explores the balanced path of coordinated development between the two, and provides ideas for cultivating computer talents with both technical competitiveness and social responsibility.

Keywords: *Computing power, Attainment, Computer science and technology education, Double helix, Educational balance.*

1. INTRODUCTION

With the transition of computing power from "general computing" to "intelligent computing", and from "stand-alone computing power" to "distributed computing power", the technical attributes of computer science and technology education have been continuously strengthened. The School of Computer Science and Technology of Qingdao University has built a research and integration curriculum system covering 4 national first-class courses and 25 provincial first-class courses to achieve synchronous iteration with chip architecture, programming language, and algorithm framework. The Shuguang Tianchao computer cluster equipped with the National Laboratory of Computational Fluid Mechanics of Beihang University accurately matches the hardware requirements for distributed computing power in the aerospace field with nearly 3,000 CPU cores and a peak computing power of 30 trillion times per second [1]. This technical orientation is reflected in the talent evaluation as the Department of Computer Science of Tsinghua University directly links the course results of "Introduction to Artificial Intelligence" with algorithm development ability, forming an implicit evaluation standard that "technical ability determines employment competitiveness" [2].

However, the rapid advancement of technology also brings deep problems. Amazon's AI recruitment tool in 2020 caused a lawsuit for filtering women's resumes, revealing the algorithm's implicit coding bias in gender characteristics; In 2012, Target predicted teenage pregnancy through shopping patterns, exposing the penetrating infringement of personal privacy by data mining. While Qingdao University students have won 1,505 national awards in competitions such as ACM-CIKM, it also reflects the shortcomings of traditional computer education in the cultivation of humanistic literacy - the initial introduction to philosophy course opened by the college was disconnected from professional practice, and the student feedback was not ideal [3].

In this context, the relationship between "computing power" and "literacy" has become an unavoidable proposition in computer education. The metaphor of the "double helix" aptly reveals the dialectical relationship between the two: the "Intelligent Science and Technology" major of Beijing University of Posts and Telecommunications has set "artificial intelligence ethics" as a compulsory course, requiring students to submit social impact analysis reports simultaneously when developing algorithms, confirming that "computing power is the carrier of literacy, and literacy without computing power support will become empty talk"; The Department of Computer Science of Tsinghua University emphasizes the "adherence to the essence of technology" in the reform of the curriculum system, and guides students to reflect on the ethical issues behind technology from code writing by introducing computational thinking training modules, reflecting that "literacy is the soul of computing power, and the computing power guided by literacy may lead to alienation".

The ultimate goal of computer science and technology education is to build a dynamic balance between the two that empowers each other. The "virtual and real chimerism" teaching scenario proposed by Tianjin University is quite enlightening: optimizing environmental parameters through affective computing cameras in the physical space, and using Scratch programming to restore the market scene of "Qingming River Map" in the digital space. The campus security data governance platform built by Central South University is more of practical value, realizing real-time data analysis of 58,000 public security video surveillance probes in the university through the deployment of edge computing nodes, and reducing the congestion rate by 32% in combination with the AI traffic management system [5].

This balance is not a simple proportional distribution, but the creation of a fusion scenario where technology empowers humanities and humanistic guidance technology. When students can use brain-computer interfaces to feel the state of mind of Dunhuang mural creation, or realize cross-school data collaborative modeling through federated learning frameworks, the boundaries between science and technology and humanities will naturally melt at the cognitive level. As pointed out in the 2025 Zhihu hot discussion: "The core contradiction of future education is not the choice of technology or humanities, but how to build an ecosystem that allows the two to have a natural dialogue [6]." This cognitive shift is reshaping the implementation paradigm of computer science and technology education.

2. THE CORE CONTRADICTION BETWEEN COMPUTING POWER AND LITERACY IN COMPUTER EDUCATION

2.1 The Imbalance Between the Speed of Technology Iteration and the Literacy Training Cycle

The computing power iteration follows the acceleration logic of "Moore's Law", and the technical cycle of quantum computing to 6G has been shortened to 1-2 years. In order to avoid "falling behind after graduation", colleges and universities need to continuously update their courses (such as Tsinghua University's revision of the syllabus of the introduction to AI every semester) and upgrade the experimental platform (the computing power platform of Nanjing University's Suzhou campus supports hundreds of trillions of calculations). This "fast technology" requires a quick response to educational content [7].

On the other hand, literacy cultivation is a "slow variable" project: critical thinking takes 3-4 years of humanistic immersion (the case of the 2011 experimental class of Beijing Post), and it takes 3.5 years for ethical judgment ability to reach the industry benchmark (2025 data from Sohu Research Institute). The time difference between "fast technology" and "slow literacy" leads to the utilitarianization of education - 72% of colleges and universities give priority to ensuring technical class hours (Qingdao University 2023 survey), and the preparation time for algorithm positions for 985 graduates is only 1.2 years, which is far lower than the 3.5 years required to meet the humanistic literacy standard.

Solving contradictions requires a dynamic balance: Tianjin University realizes the synchronization of technical practice and humanistic reflection through the "virtual and real chimerism" scenario (affective computing + ancient painting programming), and Beihang's "three-dimensional evaluation model" includes the technology/humanities/integration dimensions into the assessment [8]. This balance is not the allocation of class hours, but the creation of an integrated ecology of technology empowering humanities and humanities guiding technology.

2.2 The Conflict Between Instrumental Rationality and Value Rationality

Computing power education is essentially the embodiment of "instrumental rationality", and its goal is to teach students "how to do" - how to optimize algorithm efficiency, how to deploy computing power clusters, and how to develop intelligent systems. This educational orientation emphasizes the practicability and efficiency of technology, and is often manifested in the curriculum as a focus on quantifiable indicators such as programming language proficiency, computing power resource scheduling ability, and system development cycle. For example, in big data courses, students are required to complete terabytes of data in parallel within a limited time, and the assessment criteria focus on task completion speed and resource usage rate. In the intelligent system development training, the core evaluation indicators are system response time and error rate. This overemphasis on the instrumentality of technology can easily lead students to form a "technological omnipotence" mindset, reducing complex social problems to technical problems, such as simply blaming the uneven educational resources on the lack of computing power of online platforms, while ignoring deep factors such as the economic gap between urban and rural areas and the tilt of education policies [9].

Literacy education points to "value rationality", focusing on "why to do" and "whether to do it" - where is the ethical boundary of artificial intelligence? How can technological innovation take into account fairness and inclusiveness? How to balance data privacy protection with technological development? These problems cannot be solved through code or computing power, and students need to have philosophical speculation, social insight and ethical judgment skills. For example, when developing intelligent services for vulnerable groups, it is necessary to consider not only technical feasibility, but also how to avoid the secondary harm of algorithmic bias to special groups, and how to ensure that the threshold for the use of technology products does not exacerbate the digital divide. However, driven by employment pressure and industry demand, colleges and universities often pay more attention to the cultivation of instrumental rationality, and the curriculum is full of technical courses such as programming languages and data structures, while courses involving value rationality such as science and technology ethics and philosophy of technology mostly exist in the form of elective courses, accounting for less than 5% of the class time, resulting in the serious marginalization of value rationality education [10].

2.3 The Tension Between Standardized Training and Personalized Development

The degree of standardization of computing power education is high - the syntax of programming languages, the logic of algorithms, and the operation specifications of hardware have clear standards, which are suitable for batch training through unified courses and unified assessments. For example, there is a global consensus on the pointer operation rules of C language and the indentation syntax of Python, and colleges and universities can adopt a unified textbook system and experimental manuals to allow students in different classes and campuses to receive homogeneous training; In the algorithm course, there are standard answers for the time complexity calculation of the sorting algorithm and the derivation of state transfer equations for dynamic programming, which is convenient for automatic scoring through the machine test system. This model can quickly improve students' technical proficiency, cultivate a large number of graduates who have mastered basic computing power skills in a short period of time, and accurately meet the large-scale needs of basic computing talents such as programmers and operation and maintenance engineers in Internet, cloud computing and other industries [11].

The cultivation of literacy has personalized characteristics - different students have different understandings of technical ethics, concerns about social issues, and choices of innovation directions, and need to be guided by diverse educational scenarios (such as interdisciplinary discussions, social practice, and project-based learning). Some students may be more concerned about the ethical risks of artificial intelligence in the medical field, some are enthusiastic about how technological innovation can help rural revitalization, and some will focus on cutting-edge issues such as data property rights protection. This requires colleges and universities to set up scenario simulation classrooms for students to play different roles in virtual cases such as "algorithmic decision-making leads to employment discrimination" to debate; organize visits to science and technology enterprises to observe social contradictions in the implementation of technology; Support students to participate in community digital transformation projects and form unique value judgments in solving practical problems. The tension between standardized training and personalized development makes it difficult for some colleges and universities to balance limited educational resources, either compressing social practice class hours, canceling interdisciplinary salons, and sacrificing the richness of literacy education to ensure the efficiency of computing power training; or due to excessive emphasis on personalized topic discussions, students' programming language training is insufficient, core algorithms are not solid, and finally the technical foundation is weak [12].

3. A BALANCED PATH FOR THE COORDINATED DEVELOPMENT OF COMPUTING POWER AND LITERACY

3.1 Establishing the Educational Concept of "Technology Foundation - Literacy Casts the Soul"

The premise of balancing computing power and literacy is to clarify the positioning of the two in talent training: computing power is the "foundation", which determines the technical depth of talents and the ability to solve practical problems; Literacy is the "soul", which determines the breadth of vision of talents and the value of social contribution. Computing power is like the foundation of a building, only by firmly mastering core technologies such as programming languages, algorithm optimization, and computing power scheduling can we have the ability to tackle complex technical problems, such as whether we can improve efficiency through distributed computing architecture when processing massive data, and whether we can optimize user experience through algorithm iterations when developing intelligent systems, all of which rely on a solid computing power foundation. Literacy is like the design concept and humanistic connotation of architecture, which allows technical talents to jump out of a pure technical perspective and think about the impact of technological innovation on social structure, ethical norms, and individual rights and interests, which determines whether technological achievements can truly serve human well-being and avoid technological development falling into the misunderstanding of "efficiency theory". Therefore, colleges and universities should abandon the binary thinking of "either/or" and incorporate the two into a unified educational goal system, neither allowing students to become "technical tools" who only understand code, nor cultivating "castle-style" talents who lack hard-core abilities [13].

For example, the Department of Computer Science of Tsinghua University clearly puts forward the training concept of "paying equal attention to technological innovation and ethical responsibility" in the construction of the "Intelligent Science and Technology" major, and makes "artificial intelligence ethics" a compulsory course, requiring students to submit an analysis report on the social impact of technology while completing the algorithm design course [14]. In the curriculum system of this major, there are core courses such as "deep learning framework" and "high-performance computing" to strengthen computing power, and through a large number of programming practices and computing power cluster operation training, students are ensured to master cutting-edge technology; It also offers literacy courses such as "Technology and Society" and "Data Ethics and Law", and guides students to analyze practical issues such as the boundary between facial recognition technology in public safety and privacy protection, and the ethical priority in autonomous driving decision-making through case studies and mock hearings. This concept not only ensures that students master cutting-edge computing power technology and have the technical strength to participate in major national scientific and technological projects, but also guides them to think about the humanistic value behind the technology and grow into compound talents with both technical depth and social responsibility [15].

3.2 Building a Curriculum System That Is "Spiraling"

The curriculum system is the core carrier of balancing computing power and literacy, and it is necessary to break the status quo of "technical courses and literacy courses" and build a structure in which the two penetrate each other and spiral:

- Basic layer: Through systematic curriculum to build a technical foundation, core courses such as programming language and computer composition principles form a computing power knowledge network, and cooperate with computational thinking training modules to cultivate students' ability to understand the essence of technology from the underlying logic. This infrastructure construction not only involves code writing capabilities, but also emphasizes the overall understanding of computing paradigms, laying a cognitive framework for subsequent technology deepening [16].

- Advanced level: Focusing on the integration of technical practice and ethical reflection, special modules are set up in cutting-edge courses such as artificial intelligence to guide students to analyze the potential biases and social impacts of algorithmic decision-making. Through a structured discussion framework, students are required to evaluate key issues such as data collection boundaries and model transparency, and form a mindset that aligns technical solutions with societal norms. This design avoids simplifying complex problems to technical optimization, but establishes a multi-dimensional evaluation system [17].
- Innovation layer: Courses such as breaking through disciplinary barriers and building cross-domain cognitive networks and philosophy of technology require students to critically examine technological innovation and explore the social value of technological solutions in combination with real-world scenarios. The practical link emphasizes human-machine collaborative innovation, cultivates a sense of responsibility through simulated decision-making scenarios, and ensures that technology application is in the public interest. This hierarchical and progressive education model not only ensures the in-depth development of technical capabilities, but also builds a broad vision of humanistic care, and finally forms an educational ecology in which technical rationality and value rationality nourish each other [18].

This curriculum system not only ensures the systematization of computing power training, but also enables literacy education throughout, forming a closed loop of "technical learning, literacy reflection, and technical optimization".

3.3 Innovating the Teaching Model of "Practice-driven - Reflection Empowerment"

The improvement of computing power needs to be achieved through a large number of practices (such as code writing, system development, and computing power optimization), while the cultivation of literacy relies on in-depth reflection on practice. Universities can organically combine the two through the "project-based learning + scenario simulation" model:

- The design of technical projects should build a closed-loop path of "real problems-technical practice-value reflection". By creating typical scenarios such as community smart elderly care, technical operations such as data collection and algorithm training are deeply bound to ethical and social issues such as privacy protection for the elderly and technology accessibility for vulnerable groups, so that students can naturally form a boundary awareness of technology application in the process of solving specific problems. This design breaks through the single skill training model, puts computing power deployment and humanistic thinking in the same practical framework, which not only strengthens technical execution capabilities, but also cultivates a sense of systematic social responsibility.
- Interactive seminars need to build a multi-subject dialogue platform. By simulating different roles such as developers, users, and policymakers, students are organized to carry out technical ethics debates and future technology hearings, guiding them to go beyond the single perspective of technology executors and examine technical solutions from the dimensions of policy norms, user rights, and social equity. This role substitution mechanism can activate critical thinking, enable students to understand the complexity of technical decision-making in the collision of opinions, and then form a concept of technology application that takes into account efficiency and fairness. The two forms of activities complement each other and jointly build a complete educational chain from concrete practice to abstract reflection, from technical operation to value judgment.

For example, in the "Artificial Intelligence Practice" course, the School of Computer Science of Zhejiang University requires student teams to submit not only technical reports but also a "algorithm fairness evaluation report" when developing recommendation algorithms, analyzing the differentiated impacts that algorithms may have on different groups and proposing optimization plans. This model enables students to naturally form literacy awareness in the process of improving computing power[19].

3.4 Improving the Guarantee Mechanism of "Multiple Evaluations and Long-term Feedback"

Balancing computing power and literacy requires breaking a single technical ability evaluation system and establishing a multiple evaluation mechanism:

- In terms of assessment content, it not only pays attention to students' code quality and system performance (computing power indicators), but also pays attention to the ethical considerations and social value of their technical solutions (literacy indicators). For example, in the design of artificial intelligence courses, it is not only necessary to evaluate the hard-core indicators such as algorithm efficiency and model accuracy, but also to examine whether students have considered the privacy boundaries of data collection, the risk of bias that may be brought about by algorithm decision-making, and whether technological achievements can truly solve practical problems such as educational equity and medical resource allocation, so that technical ability and humanistic care can form an evaluation dimension with equal weight in the assessment [20].
- In terms of evaluation subjects, industry experts and sociologists are introduced to participate in the evaluation, such as corporate mentors evaluate the practicability of technology and ethicists evaluate the social responsibility of the program. Universities can set up a cross-disciplinary review panel, where engineers from technology companies evaluate the rationality of the system architecture from the perspective of industrial implementation, invite professors from the Department of Philosophy to analyze the value orientation behind the technical solution, and combine the academic evaluation of teachers in the school to form a three-dimensional evaluation matrix of "technical feasibility + social impact + academic innovation" to avoid one-sided evaluation perspectives.
- In terms of feedback mechanism, through the follow-up survey of graduates, the technical ethics dilemmas encountered in their career development and the ability to cope with social problems are analyzed, and the education program is reversely optimized. Establish a tracking database covering 5-10 years after graduation, record how programmers handle user data leaks, and product managers weigh the trade-offs between technical inclusion and business interests, and transform literacy performance in these real-world scenarios into course adjustment bases, such as adding technical ethics case seminars or social problem solution design modules [21].

In addition, colleges and universities need to strengthen the construction of teaching staff, encourage computer teachers to cooperate with philosophy and sociology teachers in teaching and research, and improve teachers' ability to integrate literacy education into technical teaching [22]. Through the joint development of cross-curricular courses such as "algorithm ethics" and "data society", interdisciplinary teaching workshops can be carried out, so that technical teachers can master the method of analyzing programming cases from the perspective of social impact, and simultaneously discuss the avoidance path of algorithm discrimination when teaching machine learning, so that computing power training and literacy improvement can form a synergistic effect.

4. CONCLUSION

The "double helix" relationship between computing power and literacy is essentially the dialectical unity of "art" and "Tao" in computer education, and the two are intertwined and evolve together like a double chain of DNA. "Technique" is the mastery of technical tools, which is reflected in the ability to control specific skills such as algorithm optimization and computing power deployment; "Tao" is the wisdom of technology application, encompassing the ability to judge deep values such as ethical boundaries and social impact. This relationship is not a simple superposition, but a dynamically balanced symbiosis - computing power improvement provides practical soil for literacy cultivation, and literacy development points out the value direction for computing power application.

In the context of the acceleration of technological iteration, simply cultivating "computing power operators" can no longer meet the needs of social development. Although such talents can efficiently complete technical execution, they are prone to fall into the misunderstanding of "technology omnipotence", reducing complex social problems to technical problems such as algorithm optimization or computing power deployment. The "technology helmsman" needs to have dual abilities: not only to be proficient in the operation logic of computing power tools, but also to understand the social context of technology application, and to find a balance between the pursuit of efficiency and value adherence.

To achieve this balance, colleges and universities are required to break through the limitations of instrumental rationality in educational philosophy and establish the core value of "technology for people". In practice, it is necessary to build an integrated and symbiotic education system: in the design of the curriculum system, it is necessary to consolidate the technical foundation such as programming language and computer composition principles, and also to offer humanistic courses such as technical philosophy and scientific and technological ethics; In terms of teaching methods, it is necessary to improve computing power skills through project practice and cultivate ethical awareness through case studies. In the evaluation system, it is necessary to evaluate not only technical indicators such as code quality and system performance, but also the social value, ethical adaptability and other literacy dimensions of technical solutions.

This kind of educational transformation is not only a strategic choice to cope with technological change, but also an inevitable requirement for computer education to return to the "essence of educating people". Only by cultivating talents in the new era who understand technical logic, social insight, master computing power tools, and adhere to the bottom line of value can technological innovation truly serve the all-round development of people and the sustainable progress of society, and realize the resonance of technological progress and human civilization at the same frequency.

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