The Origin of Educational Technology in China

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Abstract: Educational Technology is the means and methods employed in educational activities. Since the inception of education, there has been a parallel development of Educational Technology with a rich historical background. The entire evolutionary process of Educational Technology can be divided into three stages: Pre-Educational Technology, Current Educational Technology, and Post-Educational Technology, corresponding to the past, present, and future of Educational Technology. Throughout history, the Chinese nation has made irreplaceable contributions to the creation and inheritance of human civilization. The educational philosophy embedded in the discussions of education and technology among various schools of thought in ancient China and the educational ideas found in ancient Chinese scientific works laid the theoretical and practical foundations for optimizing the teaching and learning process. The creation of Chinese characters, the invention and dissemination of papermaking and printing techniques, and the development and application of intuitive teaching aids enriched the theory and practice of teaching and learning resources. The combination of the two not only promoted the development of Chinese education, but also influenced the process of global education development. Ancient China possessed the necessary and sufficient conditions for the birth of Educational Technology; therefore it can be considered that China is the birthplace of Educational Technology, and the Chinese nation is the indigenous people of Educational Technology.

Keywords: educational technology, historical periods, various schools of thought, Chinese characters, papermaking technology, printing technology, origin

In addition to its eternal, historical, and relatively independent characteristics, education has another important feature that is not often mentioned in educational literature: technicality. The technical nature of education is reflected in the means and methods of education, which are indispensable elements for the development of educational activities. With the progress of science and technology, more new technologies have entered the field of education, promoting changes in the educational environment, methods, and organizational forms, thereby leading to innovations in educational ideas and concepts. The several educational revolutions in history have all occurred due to technological advancements leading to changes in educational methods. Therefore, research on Educational Technology is one of the decisive factors in promoting the modernization of education.
1 Education and Educational Technology

1.1 Educational Revolutions in History

Educational revolution is a nuanced process involving a shift from quantitative adjustments to qualitative transformations, encompassing both sudden and gradual changes. Sudden changes manifest as distinct educational revolutions, while gradual changes involve conventional educational reforms and innovations. Importantly, the relationship between new and old education is not characterized by complete rupture, akin to social revolutions, but rather entails a gradual abandonment. Even in cases of revolutionary changes in education, the transformation is not instantaneous; it unfolds over a period of gradual development before producing observable results. The logical progression unfolds as follows: educational activities must adopt appropriate technologies (means and methods), and technological advancements instigate changes in educational methods, thereby catalyzing shifts in the organizational structure of education. These changes, in turn, necessitate new theories to guide them, fostering the development of education and learning theories. The emergence of new theories subsequently propels the application of technology in education, leading to further alterations in educational methods and organizational structures. Through a cyclical process of negation and subsequent negation, this cycle repeats and spirals upwards, fostering the continuous development of education. The evolutionary process of education is represented in Figure 1.

Figure 1

Evolutionary Process of Four Educational Revolutions


Approximately 300,000 years ago, ancient humans first developed rudimentary forms of language communication. It was not until 100,000 to 50,000 years ago that they mastered more sophisticated languages, transcending mere imitation of physical actions. This mastery allowed for life and production experiences to be conveyed through oral language, marking a significant leap in communication. Fast forward to around 1500 BC, during the Xia and Shang dynasties in China, the earliest human writing took form in the Oracle Bone Inscriptions. The invention of writing marked the true birth of education, as human experiences could now be recorded in writing and passed on to future generations, combining oral and written traditions.
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The emergence of specialized educational institutions and professional teachers can be attributed to the division of labor in human society, leading to a significant shift in the responsibility of educating the younger generation from families to full-time teachers. This transformative change is often recognized as the first educational revolution. The timeline for the appearance of specialized educational institutions and full-time teachers varied across different countries and regions. For example, during the Spring and Autumn period in China, Confucius initiated a lecture platform at the age of 30 (521 BC) to start teaching and accepting students. In contrast, similar educational practices among the Jewish people did not materialize until the 2nd century AD.

During the Western Han Dynasty in China (206 BC to 8 BC), the advent of hemp fiber paper marked a significant development. In 105 AD, Cai Lun further refined the papermaking process, presenting an economical and convenient medium for recording writing. By the 7th century AD, the invention of woodblock printing revolutionized the reproduction and preservation of documents, facilitating mass dissemination. The widespread use of textbooks and the introduction of class-based teaching during the 7th century AD set the stage for the second educational revolution. The adoption of class-based teaching systems, however, exhibited variations across different countries and regions. In Europe, class-based teaching originated in the 16th century and gained momentum in the 17th century. In contrast, China took its initial steps with the introduction of a class-based teaching system by the Tongwen Guan in the capital in 1862. This system, however, achieved widespread nationwide promotion with the implementation of the "Guimao Educational System" in 1903.

From the late 19th century to the early 20th century, the rapid advancement of science and technology ushered in a transformative era for education. Innovations such as photography, slides, movies, radio, television, and satellite television were gradually incorporated into educational practices. These audio-visual teaching methods played a pivotal role in making abstract teaching content more tangible, particularly in the dynamic presentation of static knowledge and skill training. This marked a significant shift in educational methods and gave rise to what is often referred to as the Third Education Revolution. The application of audio-visual teaching methods broke geographical restrictions, expanded the scale of education, and improved its efficiency and effectiveness.

During the 1990s, the advancement of computers and the internet instigated a transition from one-way to two-way communication in the transmission of information. This transformative shift not only facilitated modifications in teaching methods but also sparked a revolution in students’ learning approaches. It empowered personalized and remote learning experiences within a digital environment. The impact on educational methods, organizational structures, concepts, and systems transcended previous boundaries, signifying the ongoing Fourth Educational Revolution. This revolution holds the promise of realizing the lifelong learning aspirations of humans.

As we witness the rapid advancement of artificial intelligence, quantum communication technology, and brain neuroscience, the potential impact on education becomes increasingly complex to predict. However, one certainty is that education will undergo unprecedented transformations in terms of modes, forms, and mechanisms. This heralds the imminent arrival of the next educational revolution, ushering in a transformative era for lifelong learning that appears on the horizon.
1.2 Historical Period Division of Educational Technology

Educational Technology encompasses the means and methods employed in educational activities, evolving in tandem with the emergence of education and advancing in sync with the progress of science and technology. As a result, Educational Technology has been an integral part of education since its inception, boasting a history that is both ancient and extensive (Li, 2004).

From the perspective of communication media, Educational Technology has traversed various stages including oral communication, written language, tangible teaching aids (emerging in China before the era of print media), print media, audio-visual media, computer and internet media, and the ongoing emergence of new technological media that integrate artificial intelligence, quantum communication technology, and neuroscience. This progressive infusion of “technological content” has penetrated the realm of education, inducing changes in the educational environment, teaching (learning) methods, organizational forms, and even influencing the reform of educational ideologies and systems. It is essential to acknowledge, however, that these technologies consistently serve as tools and methods (including new educational environments) for education, not its dominators. While they alter the modes and mechanisms of education, they cannot change its fundamental essence.

The author has crafted a continuous spectrum of Educational Technology development, outlined in Figure 2 based on its historical evolution. The visual representation illustrates that what is commonly labeled as Educational Technology today constitutes merely a segment of this expansive historical continuum. It is more aptly termed as Current Educational Technology. Notably, it is a substantial period often referred to as ancient Educational Technology that remains overlooked and warrants more attention in our understanding of the broader context.

Figure 2
Continuous Spectrum of Educational Technology Development


Therefore, the author categorizes the entire developmental trajectory of Educational
Technology into three distinct stages: (1) the era predating the late 19th century, characterized by low “technological content,” is termed the Pre-Educational Technology stage; (2) the span from the late 19th century to the foreseeable 2030s is designated as the Current Educational Technology stage; (3) and the era beyond the 2030s (with a specific time determined by significant changes in Educational Technology) is denoted as the Post-Educational Technology stage. This delineation of the three stages aligns with the author’s exploration of the past, present, and future of Educational Technology.

2 Theoretical Contributions of Ancient China to the Inheritance of Human Civilization

Between 800 BC and 200 BC (particularly between 600 BC and 300 BC), a momentous breakthrough in human civilization unfolded within the latitude range of 25 degrees to 35 degrees north. The German philosopher Karl Jaspers coined the term “Axis Age” to denote this epoch (Jaspers, 2017). Throughout this period, four major civilizations sequentially emerged: the pre-Qin civilization of China, the ancient Indian civilization, the ancient Israelite civilization, and the ancient Greek civilization, as illustrated in Figure 3.

Figure 3

Global Distribution Map of Four Major Civilizations

Note. Adapted from “World History Atlas”.

Each of these civilizations gave rise to notable figures. In ancient China’s pre-Qin period, luminaries like Laozi, Confucius, and Mozi made significant contributions. Ancient India witnessed the presence of Shakyamuni, while ancient Israel boasted prophets of Judaism. In ancient Greece, intellectual giants such as Socrates, Plato, and Aristotle emerged. The philosophical tenets articulated by these influential figures shaped diverse cultural traditions, leaving an enduring impact on subsequent human societies. Among them, China’s influence on the world stands out as particularly profound.

In the pre-Qin period in China, the country stood at the heart of the world’s “Axial Age,” a remarkable epoch characterized by the flourishing diversity of the Hundred Schools of Thought. This era bore witness to the emergence of a myriad of profound thinkers, educators, philosophers, politicians, scientists, and military strategists. Their visionary insights, profound contemplations, and cultural knowledge left an indelible mark on the trajectory of Chinese history. Amidst the tumultuous backdrop of rising warlords and regional conflicts, these intellectuals, united by
a collective aspiration to reshape historical and societal landscapes, employed their wisdom to articulate various theories on governance and social development. This period gave birth to the most vibrant and far-reaching ideologies and cultures in Chinese history, bequeathing a treasure trove of invaluable scriptures and texts for future generations. The thoughts expressed by these luminaries transcended specific fields; they were a profound philosophical reflection on the world, nature, society, politics, and life. This philosophical expression wielded a profound influence on subsequent generations of scholars and became the wellspring of knowledge and the logical starting point for various disciplines in contemporary China, spanning philosophy, natural sciences, education, anthropology, ethics, and history. While many of these ideas initially germinated in realms such as politics, society, and the economy, their applicability extended even to technological activities. This attests to the breadth of their thinking and their concern for the multifaceted aspects of technology (Lin, 2015).

Historical records indicated that by the conclusion of the Han Dynasty (206 BC-220 AD), a remarkable 189 scholars have conveyed their academic perspectives through writings, collectively comprising an impressive 4,324 works. Subsequent compilations like the “Book of Sui - Catalog of Books” and the “Comprehensive Catalog of the Four Repositories” meticulously documented over a thousand schools of thought. However, amidst this abundance, only ten of these schools attained widespread transmission, influence, and evolved into distinct schools of thought: Confucianism, Mohism, Taoism, Legalism, Logicianism, School of Yin and Yang, School of Diplomacy, Syncretism, Agriculturalism, and School of Minor Talks (儒家、墨家、道家、法家、名家、阴阳家、纵横家、杂家、农家和小说家). Notably, during the Western Han period, Liu Xin excluded the School of Minor Talks, categorizing it as one of the “Nine Systems of Philosophy九流” in his seminal work, “Seven Summaries: A Brief Introduction to the Scholars《七略·诸子略》”.

The Hundred Schools of Thought, especially Confucianism, Mohism, Taoism, and Legalism, played a decisive role in the formation of traditional Chinese culture. Their doctrines not only had a significant impact on social and political changes, but also promoted the development of education and the economy, and even made predictions about the fate of humanity in the world.

2.1 Educational Perspectives of the Hundred Schools of Thought

The various schools of thought have extensively discussed educational concepts, educational ideas, educational principles, and educational methods, which have had a significant impact on education throughout history. Until today, these insightful ideas and viewpoints remain the cornerstone of modern educational theory (Mao et al, 1979; Wu, 2020).

2.1.1 Educational philosophy

Confucius championed the educational principle of “education without discrimination有教无类”, stem from the “Analects of Confucius–Wei Ling Gong《论语·卫灵公》”. He underscored “the significance of continuous learning学则不固”, as expressed in the “Analects of Confucius - Learning《论语·学而》”, emphasizing that learning serves as a vital avenue to transcend stagnant thinking and break through fixed ideas.
Mencius held the belief that the essential method for governing the world lay in winning the hearts of the people, with education being the most potent means to achieve this objective. He expressed this viewpoint in the statement, “Good governance is not as effective as good education in winning the hearts of people... Good governance gains wealth while good education gains the hearts of the people.” (from “Mencius - Li Lou Shang 《孟子· 离娄上》”).

Xunzi posited that individuals are born without inherent distinctions of nobility, intelligence, or wealth. According to him, the sole force creating such disparities is education. The profound impact of education, he argued, arises primarily from the persistent subjective efforts of individuals; an idea encapsulated in the concept of “accumulation.” In his words, “If you amass sufficient earth to construct a lofty mountain, it will be accompanied by rain and wind. With an accumulation of abundant water, scaly dragons will come into existence. Similarly, by accumulating virtuous deeds to nurture your moral character, a natural realization of divine clarity of intelligence will occur, bringing forth a sagelike mind.” (from “Xunzi - Exhortation to Learning 《荀子· 劝学》”).

Laozi introduced China’s earliest form of materialistic thought known as the “Way of Heaven 天道”. In “Tao Te Ching 《道德经》” Chapter 25, he articulated, “People follow the Earth, the Earth follows Heaven, Heaven follows the Tao, and the Tao follows nature.” Those who aligned themselves with the natural order discover innate contentment, illustrating the state and expressions of the Tao, rather than alluding to a physical nature beyond the Tao. Laozi asserted that the “Heavenly Way” was synonymous with nature and undergoes transformation through non-action. He believed that the “Way of Heaven” is nature and is transformed by inaction.

Zhuangzi, as conveyed in “Zhuangzi - Autumn Floods 《庄子· 秋水》”, advocated the principle of refraining from compromising the natural in favor of the artificial. He emphasized avoiding the extinguishing of life for worldly pursuits and resisting sacrificing oneself for the allure of greed and reputation. Upholding the Way of Heaven without deviation, according to Zhuangzi, signifies a return to simplicity and authenticity. (无以人灭天，无以故灭命，无以得殉名。谨守而勿失，是谓反其真)

2.1.2 Educational thoughts, principles, and methods

Confucius places a high value on both learning and thinking, emphasizing the fusion of these two processes. He eloquently stated, “To learn without thinking is futile; to think without learning is perilous.” (Analects - On Government 《论语· 为政》). Confucius highlights the importance of thoughtful reflection during the learning process as a lack of active engagement may lead to minimal understanding. Similarly, he cautioned against thinking without a foundation of learning, as it may devolve into mere speculation. In addition, Confucius articulated his approach to teaching and learning, stating, “I do not unveil the truth to those lacking a thirst for knowledge, nor extend assistance to anyone unwilling to articulate themselves. If, after indicating the direction of a subject, I observe that my student cannot perceive its implications in other directions, I refrain from reiterating my lesson.” (Analects - Describing 《论语·述而》).
This underscores the significance of a student’s active thinking on a solid foundation. Teachers, according to Confucius, should offer guidance to cultivate independent thinking abilities when students reach this level. The concept of “teaching according to one’s aptitude 因材施教,” originating from “Analects - Advanced 《论语·先进篇》” and “Analects - Yong Ye 《论语·雍也》,” involves tailoring education based on an individual’s interests and abilities. Furthermore, the idea of “reviewing the old to understand the new 温故而知新” (“Analects - On Government” 《论语·为政》) encourages exploring new knowledge while reviewing and building upon old knowledge. Confucius also advocated the learning attitude of “knowing what one knows, and knowing what one does not know 知之为知之，不知为不知，是知也” (“Analects - On Government” 《论语·为政》).

Mencius, as articulated in “Mencius - Li Lou (II) 《孟子·离娄下》,” advocated that a noble person should wholeheartedly engage in profound learning, aspiring towards self-attainment. The attainment of self leads to a tranquil abode, and within this tranquility, one can deepen their intellectual resources. With profound resources at their disposal, individuals can adeptly navigate diverse situations. Hence, a noble person endeavors to achieve self-attainment (君子深造之以道，欲其自得之也。自得之，则居之安；居之安，则资之深；资之深，则取之左右逢其原。故君子欲其自得之也). This concept emphasizes the necessity for individuals to exert subjective efforts in their learning, demonstrating a persistent will for continuous improvement. Simultaneously, it underscores the importance of active self-awareness in the pursuit of genuine understanding, consolidation, and the gradual accumulation of knowledge, transforming it into a personal intellectual asset.

Xunzi placed significant importance on the spirit of earnestness, as conveyed in “Xunzi - Ruxiao,” asserting 《荀子·儒效》, “to know it is to know it, and to not know it is to not know it 知之曰知之，不知曰不知，内不以自诬，外不以欺.” He emphasized the internal integrity of refraining from falsely accusing oneself and externally cautioned against deceiving others. According to Xunzi, engaging in the act of pretending to know when ignorant constitutes a form of self-deception and deception of others.

Laozi advocated the avoidance of preconceived notions and discouraged self-assumed cleverness. In Chapter 22 of the Tao Te Ching （《道德经》）, he espoused that “By avoiding personal biases, clarity emerges; refraining from presumptions fosters clear distinctions between right and wrong 不自见，故明；不自是，故彰.” Laozi’s philosophy aligns everything with nature, drawing an ideal resemblance to water, which “assists all things without contending and is content to be” （以辅万物之自然而不敢为） (Chapter 64 of the Tao Te Ching 《道德经》).

2.2 Perspectives of the Hundred Schools on Technology

Technology embodies a dual nature, comprising instrumental rationality and value rationality. The essence of instrumental rationality is the pursuit of “efficiency,” “benefits,” and “efficacy (effect),” that is, regularity. On the other hand, value rationality scrutinizes behavior rationality through specific value concepts, focusing on the purposefulness of actions.

While the philosophies of the Hundred Schools primarily originate from political, social, and economic spheres, their seemingly disparate statements also unveil a thoughtful consideration of
technology. These statements exhibit clear logical patterns at the philosophical level, possessing coherent and comprehensive theoretical features. Serving as historical soil, intellectual sources, and cultural roots, these notions contribute to the growth and development of modern technology. They lay the groundwork for the evolution and refinement of the philosophy of Educational Technology. A succinct overview is presented below, laying the foundation for more in-depth exploration (Lin, 2020).

2.2.1 Confucius on technology

Confucius’ aphorism “To do a good job, one must first sharpen one’s tools 工 欲 善 其 事 ,必先利其器” (Analects: Wei Ling Gong 《论语·卫灵公》) underscores the acknowledgment of the rationality of technological tools. The notion that “By fully understanding the nature of things, one can praise the nurturing of heaven and earth 能尽物之性,则可以赞天地之化育” (Analects: Zhong Yong 《论语·中庸》, Chapter 22) articulates an expectation for the value rationality of technology. In further elaboration, Confucius introduces “The Doctrine of the Mean 中庸” with the passage: “While there are no stirrings of pleasure, anger, sorrow, or joy, the mind may be said to be in the state of Equilibrium. When those feelings have been stirred, and they act in their due degree, there ensues what may be called the state of Harmony. This Equilibrium is the great root from which grow all the human actings in the world, and this Harmony is the universal path which they all should pursue. Let the states of equilibrium and harmony exist in perfection, and a happy order will prevail throughout heaven and earth, and all things will be nourished and flourish 喜怒哀乐之未发,谓之中;发而皆中节,谓之和。中也者,天下之大本也;和也者,天下之达道也。致中和,天地位焉,万物育焉” (Analects: Zhong Yong 《论语·中庸》, Chapter 1). This passage introduces specific methods and principles, encapsulated in “The Doctrine of the Mean,” providing a framework for balancing the relationship between regularity and purposefulness in technology. The concept of “achieving Equilibrium to attain harmony” emphasizes the simultaneous attention to both the regularity and purposefulness of technology. It aims to reconcile the contradictions inherent in the dual nature of technology, fostering a state of harmony and unity (Zhang, 2011).

2.2.2 Mencius on technology

Mencius posited a profound perspective on technology, stating, “Is the arrow-maker less benevolent than the armor-maker? The arrow-maker is concerned that his arrows cannot hurt people, whereas the armor-maker is concerned that his armors cannot protect people. The same goes for wizards and craftsmen. Therefore, one should not be careless in their techniques 矢人岂不仁于函人哉?矢人惟恐不伤人,函人惟恐伤人。巫匠亦然。故术不可不慎也” (“Mencius - Gongsun Chou Part I” 《孟子·公孙丑章句上》). This passage argues that the control and application of technology should be rooted in “benevolence 仁,” aiming to prevent misuse and chaos while emphasizing the ethical essence of technology. In another instance, in “Mencius - Liang Hui Wang Part I 《孟子·梁惠王章句上》,” Mencius underscored the significance of adhering to standards in technical activities: “Even with Lilou’s brightness and Gong Sunzi’s skill, without the use of a square, one cannot achieve squareness and roundness; Even with Shi Kuang’s intelligence, without the use of the six musical pitches, one cannot correct the five notes; Even with Yao and Shun’s governance, without the use of benevolent policies, one cannot bring peace and order to the world 离娄之明、公输子之巧,不以规矩,不能成方圆; 师旷之聪,
不以六律，不能正五音；尧舜之道，不以仁政，不能平治天下”。The passage emphasizes the necessity of standards and ethical considerations in the application of technology. Mencius further illustrated the importance of measurement and evaluation: “To weigh, and then you know what is heavy and what is light; to measure, and then you know what is long and what is short. Everything is like this, and it is especially so in the mind.” Then, Mencius added: “To weigh, and then you know what is heavy and what is light; to measure, and then you know what is long and what is short. Everything is like this, and it is especially so in the mind.” This emphasizes the role of careful evaluation and discernment in the ethical application of technology.

Mencius believed that, “If wise individuals were to emulate Yu’s approach to managing water, there would be no fault in their wisdom. Yu managed water by engaging in actions aligned with the natural course. Just as wise individuals act in harmony with the natural course of events, their wisdom would be truly profound” (Mencius Li Lou Chapter1《孟子·离娄章句上》). Mencius adeptly encapsulates the principles of water governance through the illustration of Yu’s successful water management using the ‘conveying water’ method. In contrast, Yu’s father’s failure in water management using the ‘blocking water’ method stemmed from a disregard for the natural principles, emphasizing the importance of respecting the inherent order of things and going with the flow (Yang, 1960).

2.2.3 Xunzi’s Discussion on Technology

In “Xunzi - Encouraging Learning《荀子·劝学》”, Xunzi asserted, “The essence and attributes of a noble person were indistinguishable from those of common individuals. The distinction lies in their adeptness at utilizing external elements君子生非异也,善假于物也.” This highlights the simple characteristics of materialistic and rational thinking, representing a scientific cognitive approach. It underscores human subjectivity and agency in understanding and transforming nature. Simultaneously, it serves as a reminder that in the interaction between humans and nature, one should “employ tools役物” rather than being “enslaved by them役于物”.

Xunzi said “When the carpenter’s line is drawn true, deceit with crookedness or straightness becomes impossible. Similarly, when the scale is hung true, deceit with lightness and heaviness is impossible. When the compass and square are set true, deceit with squareness and roundness is impossible. A gentleman, with a clear understanding of rituals, cannot be deceived by cunning. Hence, the carpenter’s line signifies the pinnacle of straightness, the scale signifies the pinnacle of levelness, and the compass and square signify the pinnacle of squareness and roundness绳墨诚陈矣,则不可欺以曲直;衡诚县矣,则不可欺以轻重;规矩设矣,则不可欺以方圆;君子审于礼,则不可欺以诈伪。故绳者,直之至;衡者,平之至;规矩者,方圆之至”(Xunzi · Ritual Discourse《荀子·礼论》). “When the mold is level, and the quality of copper and tin is good, the metallurgical workers are skilled, and the firing process and ingredients are appropriate, then opening the mold results in the casting of the Moxie sword. However, if its surface’s hard skin is not removed, and it is not sharpened, it cannot be used to cut a rope; once its hard skin is removed and it is sharpened, it becomes suitable for cutting copper objects, slaughtering cattle and horses, making the process effortless刑范正,金锡美,工冶巧,火齐得,剖刑而莫邪已。然而不剥脱,不砥厉,则不可以断绳;剥脱之,砥厉之,则剺盘盂,刎牛马,忽然耳”(Xunzi · Strengthening the Country《荀子·强国》). These discussions present some fundamental standards for various skills, which are also professional norms that all
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craftsmen should collectively adhere to. The emphasis on “Draw the line straight, lay the scale flat, use a ruler and compass to draw squares and circles 纵直衡平，规矩方圆” highlights the normativity of technology (Jiang et al., 1995).

2.2.4 Laozi on technology

The core philosophy of Laozi revolved around the concept of “Dao 道”. “The Dao acts without acting, and there is nothing it does not do 道常无为则无不为” (Tao Te Ching 《道德经》, Chapter 37). “Acting without acting 无为” does not imply passivity but aligning with the natural properties and laws of all things, allowing them to unfold naturally. “Constantly embracing the good, one can assist all things, and thus, there is no abandonment 常善救物, 故无弃物” (Tao Te Ching 《道德经》, Chapter 27). This suggests aiding all things in aligning with their inherent nature, ensuring that everything serves its purpose, even seemingly discarded items can hold value, highlighting the methodological function and significance of the Dao.

In Chapter 11 of the Tao Te Ching 《道德经》, Laozi uses examples to illustrate the interdependence and complementary nature of existence. For instance, “the utility of a chariot depends on the unity of its thirty spokes converging at the empty hub; the usefulness of a vessel lies in its hollowness; and a dwelling’s functionality relies on the spaces it contains 三十辐共一毂, 当其无, 有车之用。埏埴以为器, 当其无, 有器之用。凿户牖以为室, 当其无, 有室之用。故有之以为利, 无之以为用” (Tao Te Ching 《道德经》, Chapter 27). This illustrates that the presence of something “having 有” provides convenience, but its true utility is derived from the absence or emptiness “not having 无”. The relationships between “having 有” and “not having 无”, “benefit 利” and “utility 用” are vividly portrayed, showcasing their interdependence, mutual expression, and dialectical unity.

The phrase “Misfortune is what fortune depends on, fortune is what misfortune hides in祸兮福之所倚, 福兮祸之所伏” expresses the cyclical and transformative nature of the Dao, indicating the dynamic law of opposition and interconversion (Ren, 1956).

2.2.5 Zhuangzi on technology

“Having expertise across diverse domains, we term it as ‘skill’ or ‘technique.’ Skills interweave with practical affairs, affairs interconnect with righteousness, righteousness intertwines with virtue, virtue merges with Dao, and Dao encompasses heaven 能有所艺者, 技也。技兼于事, 事兼于义, 义兼于德, 德兼于道, 道兼于天 (Zhuangzi, Outer Chapters, Chapter Twelve: Heaven and Earth 《庄子·天地第十二》). This sentence not only amplifies the definition of “technology”, but also elucidates the two paths of “Dao-technique correspondence and unity.” One is from technique to Dao, and the other is from Dao to technique. According to the logic of “technique — affairs — righteousness — virtue — Dao — heaven 技—事—义—德—道—天”, as long as “technique 技” follows the principles of heaven, it naturally leads to “Dao 道”; On the contrary, it is also possible to advance from the “Dao” to the “technique 技,” which is the ideal realm of technology. Zhuangzi illustrated the unity of Dao and technique through a plethora of vivid and metaphorical fables. For instance, in the fable “Butcher Ding’s Cutting Up an Ox 庖丁解牛” (from “Zhuangzi: Health Master “《庄子·养生主》”), the idea of progressing from Dao to technique and the unity of Dao and technique are exemplified. Similarly, in the fable “The Hunchback Carrying the Cicada 佝偻承蜩,” (from “Zhuangzi: Outer Chapters,”

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the concept of advancing from technique to Dao and the unity of Dao and technique are highlighted. Zhuangzi went beyond embracing the Dao and natural principles; he aspired to transcend nature, advocating for the unity of all things, a carefree existence, and the harmony of heaven and humanity. Zhuangzi was not merely content with following the natural way; he sought to transcend nature, unite all things, live freely without constraints, and achieve the harmonious unity of heaven and humanity.

People often seek the “unknown” and what is negated is the so-called “bad” things, but there is a lack of exploration of the “known” things and the negation of “already good” things. Modern technology brings benefits to humanity but also challenges, forcing us to critically examine and reflect on what is “known” and deemed “already good.” It encourages us to “explore what we already know and question what we have already accepted求其所已知者,非其所已善者.” The concept of “using things without being used by them 物物而不物于物” (from “Zhuangzi :Mountain Trees”《庄子·山木》) suggests utilizing all things without becoming subservient to them, maintaining independent subjectivity. In technical activities, emphasis should be placed not only on the effectiveness of technology but also on seeking technological subjectivity, maintaining independence, and avoiding being driven or alienated by technology (Chen, 2009).

2.3 Educational Ideas Contained in Ancient Chinese Scientific and Technological Works

Over the course of China’s illustrious five-thousand-year civilization, it has witnessed the creation of remarkable technological marvels, leaving an enduring legacy to the present day. The pivotal role of ancient scientific and technological works in preserving these achievements cannot be overstated, serving as a vital link across the ages. Encompassing a diverse array of fields, these ancient scientific and technological works encapsulate profound educational insights that continue to resonate today (Xie, 2020a).

2.3.1 “Mo Jing”《墨经》

The “Mo Jing” is an important part of the collection of works from the Mohist school in the book “Mozi” during the Warring States period. It records early scientific research achievements of the Mohist school, covering various disciplines. In the field of physics, there are about twenty entries, mainly including topics in mechanics and geometric optics. The mechanical content includes the definition of force, levers, pulleys, axles, inclined surfaces, and discussions on buoyancy, balance, and the center of gravity. The optical section elaborates on shadows, imaging through small apertures, flat mirrors, concave mirrors, convex mirrors, and the relationship between focal length and object imaging. In addition, the book also includes content on ethics, psychology, political law, economics, architecture, and more.

The Mohist school, a prominent pre-Qin academic institution, articulates its educational philosophy primarily through the “Mo Jing.” Guided by the “Three Standards Method,” their epistemological foundation emphasizes the integration of theory and practice, highlighting the essential link between knowledge and action. In the “Mo Jing,” the Mohists employ teaching methods such as observation and experimental techniques, underscoring the importance of meticulous observation for a comprehensive understanding of the world. Experimental methods are not only seen as tools for acquiring knowledge but also as integral to effective teaching. Mozi, a central figure, advocates a fundamental teaching principle of adapting to individual capacities,
emphasizing the need to tailor educational goals, content, and methods to accommodate the diverse levels of learners (Qian, 2006).

2.3.2 “Kao Gong Ji”《考工记》

“Kao Gong Ji” stands as an ancient Chinese treatise on handicrafts from the pre-Qin period, encompassing over 7,100 words and detailing 30 distinct types of work across six major craftsmanship categories: woodworking, metalworking, leatherworking, dyeing, scraping and grinding, and ceramics. This comprehensive monograph provides insights into the technological and craft achievements of ancient China during that era, covering various fields like mathematics, geography, mechanics, acoustics, and architecture.

The influence of “Kao Gong Ji” on education can be dissected from two significant perspectives. First, the book meticulously documents the technical standards of the official handicraft industry during the pre-Qin period, establishing transparent learning objectives for those pursuing craftsmanship. Second, its elaborate depiction of 30 distinct types of craftsmanship across six major categories underscores a thoroughly structured division of labor and collaboration within pre-Qin handicrafts. The monograph delineates precise production processes and standards, thereby consolidating the apprenticeship training model in craftsmanship. The content enshrined in the book serves as a benchmark, offering a reference standard for the assessment of learning outcomes in the realm of craftsmanship education (Xiao, 2005).

2.3.3 “Huangdi Neijing”《黄帝内经》

The “Huangdi Neijing,” an integral component among the four classic works of traditional Chinese medicine, has been a foundational textbook for novices in this field throughout ancient times. This seminal work establishes the theoretical framework of traditional Chinese medicine encompassing human physiology, pathology, diagnosis, and treatment. Comprising two parts, “Su Wen素问” and “Ling Shu 灵枢” and each with 81 articles, the book unfolds through dialogues and discussions between Huangdi and Qibo, presenting content in a methodical and progressive manner. Emphasizing respect for nature and life, the Huangdi Neijing imposes clear standards for medical ethics education, underscoring the importance of inheriting medical knowledge. It addresses diverse aspects of medical education, including learning content, methods, principles, and individual development, offering profound insights into these areas.

The teaching principles of the Huangdi Neijing involve tailoring instruction to individual needs and connecting theory with practice. The teaching methods include the Five-Step Recitation Method, Situation Teaching Method, and Socratic Teaching Method. These approaches have demonstrated significant effectiveness in promoting learner reflection, enhancing problem awareness, and stimulating active learning (Zhao & Chen, 2008).

2.3.4 “Nine Chapters on the Art of Mathematics”《九章算术》

The “Nine Chapters on the Art of Mathematics” is a comprehensive mathematical encyclopedia. Since the Sui and Tang dynasties, it gradually formed the ancient Chinese mathematics curriculum system centered around this book, marking the basic formation of China’s ancient mathematical system. The book is structured as a collection of problems divided into nine chapters, containing 246 applied problems related to production and daily life. These
problems cover various aspects such as area and fraction, proportions, allocation, square roots, volume, distribution, profit and loss, equations, and the Pythagorean theorem. They involve calculations related to area, proportion, volume, systems of equations, and many practical mathematical problems. The book is notable for its pioneering work on fraction operations, negative number addition and subtraction, representing unique Chinese mathematical thinking. Each problem in the book consists of questions, answers, and methods, with the structure centered around algorithms, forming a theoretical system based on these algorithms (Du, 2016).

During the Tang and Song dynasties, the “Nine Chapters on the Art of Mathematics” was designated as an official textbook, and its influence on mathematical development extended not only domestically but also to countries within the Sinosphere, including Japan and Korea, as well as some European nations. Its educational principles emphasized practical application, the cultivation of thinking methods, and the incorporation of interest into teaching.

2.3.5 “Comprehensive Treatise on Agricultural Administration” 《农政全书》

The “Comprehensive Treatise on Agricultural Administration” was written by Xu Guangqi, a scientist in the late Ming Dynasty. The book consists of 60 volumes and over 500,000 words. It can be broadly divided into two parts based on its content: (1) agricultural policies and agricultural technology, covering 12 topics such as agricultural principles, land systems, farming practices, irrigation, agricultural tools, arboriculture, sericulture, fiber plants, planting, animal husbandry, manufacturing; and (2) land reclamation. The book extensively cites and compiles agricultural literature from earlier dynasties while also presenting the author’s own research findings and interpretations in agriculture and water management. It serves as a comprehensive compilation of ancient agricultural literature, showcasing Xu Guangqi’s political and agricultural governance philosophy.

- The central theme of the “Comprehensive Treatise on Agricultural Administration” revolves around agricultural education, with a specific emphasis on three pivotal issues: land reclamation, water conservancy, and famine relief. This underscores Xu Guangqi’s perspective that agriculture serves as the “source of livelihood and population growth” and the “foundation of national prosperity and strength,” asserting that “a prosperous country must rely on its own agriculture.”

- The “Comprehensive Treatise on Agricultural Administration” is primarily directed at emperors and officials. Consequently, the initial section of the book, titled “Taking agriculture as the foundation,” extensively employs historical references and classical allusions to underscore the importance of rulers’ attention to agricultural affairs.

- Xu Guangqi diligently studied existing agricultural classics, actively participated in practical experiences, and drew extensively from Western agricultural knowledge through interactions with Italian missionary Matteo Ricci. He urged learners to adopt a method that combines theory with practical application (Xu & Shen, 2016).

2.3.6 “Tiangong Kaiwu” 《天工开物》

“Tiangong Kaiwu”, authored by the late Ming dynasty scientist Song Yingxing, is the
The origin of educational technology in China

world’s first comprehensive work on agriculture and handicraft production. It consists of three volumes with eighteen sections. The book covers various production technologies and crafts such as machinery, bricks and tiles, ceramics, sulfur, candles, paper, weapons, gunpowder, textiles, dyeing, salt production, coal mining, and oil extraction. It systematically summarizes various technologies before the Ming Dynasty, forming a complete scientific and technological system, and is referred to by foreign scholars as the “Encyclopedia of Technology in 17th-century China.”

Song Yingxing proposed the educational idea of promoting national prosperity through industry. He advocated a down-to-earth learning attitude and an illustrated teaching method, presenting important content in the form of images to facilitate better understanding for readers.

"Tiangong 天工” is derived from the phrase “the responsibility of heaven is replaced by people 天工人其代之” in “the Book of Documents 《书经》,” while “Kaiwu 开物” is derived from “the Book of Changes 《周易》,” specifically from “revealing the truth of things and accomplishing tasks 开物成务”. “Tiangong Kaiwu 《天工开物》” not only reflects the production technologies and craftsmanship created by our ancient ancestors, but more importantly, it enlightens us with the philosophical thinking behind these technologies. The title itself embodies the profoundness of traditional Chinese culture (Sun, 2017).

In summary, ancient scientific and technological works in China not only introduced the achievements of science and technology, but also included numerous scientific and technological philosophies, laying the ideological foundation for the formation of scientific and technological philosophy. These ideas not only promoted the development of science and technology in China but also played a promoting role in the global advancement of science and technology, education, and the establishment of science and technology philosophy.

3 The Practical Contribution of Ancient China to the Inheritance of Human Civilization

In the long process of human history, the Chinese nation has created the only ancient script in the world that has not been lost: Chinese characters, invented papermaking and printing, and the first to use intuitive teaching aids. These have spread to various parts of the world, making outstanding and irreplaceable contributions to the creation and inheritance of human civilization.

3.1 Chinese Characters

Chinese characters stand alone as the only ancient script that has withstood the test of time. Unlike pinyin (phonetic) scripts, they are ideographic symbols rooted in pictographs, encapsulating both sound and meaning. Functioning as a symbol for language recording, these characters hold profound cultural significance, acting as dynamic artifacts of history. As the Chinese nation undergoes a renaissance, Chinese characters are poised to serve as a vital conduit for cultural exchange among nations across the globe (Fei, 2020).

3.1.1 Origin and development of Chinese characters

As primitive societies evolved, methods like knot-tying and incised marks on objects gradually became insufficient for meeting the growing need to communicate more information.
In response, ancient people began to explore new ways of recording information, giving rise to primitive forms of Chinese characters, including pictograms and symbolic characters. The legend of “Cangjie Creating Characters” is a widely circulated myth about the origin of Chinese characters (Yin, 2006).

The proliferation of pictographic symbols saw a gradual transition toward greater abstraction, symbolism, systematic organization, and standardized usage. This evolution led to the formation of oracle bone inscriptions during the Shang and Zhou periods, representing a numerous and stable system of characters. Engraved on turtle shells or animal bones, these inscriptions were utilized for recording and divination purposes. They already incorporated various character creation methods such as pictography, indicatives, ideography, phono-semantic compounds, loan characters, and transference, indicating the mature development of a written language system.

In addition to oracle bone inscriptions, another crucial form of writing emerged during the Yin and Shang dynasties, the “Jinwen 金文” (Bronze Inscriptions), which reached its peak during the Zhou Dynasty. Jinwen denotes characters engraved on bronze artifacts, particularly on bells and cauldrons found in bronze ritual vessels. Its prevalence on bronze vessels earned it the alternative name “Zhongdingwen 钟鼎文,” meaning “bell and cauldron script.”

By the late Western Zhou Dynasty, Chinese characters had evolved into a relatively mature and complete form. The characters became uniform, orderly, and suitable for writing. Subsequently, Chinese calligraphy went through various stages including Seal Script, Clerical Script, Regular Script, Cursive Script, and Running Script. “Seal Script is like a circle, Clerical Script is like a silkworm, Regular Script is like a standing, Running Script is like walking, and Cursive Script is like running.” The fonts in each stage have their unique characteristics (Liu & Liu 1989).

Figure 4
The Evolution of Chinese Characters

3.1.2 Characteristics and influence of Chinese characters

Chinese characters, as the world’s only existing and still in use pictographic script, exhibit remarkable vitality. Their endurance for thousands of years and continued use today can be attributed to the unique characteristics and unparalleled advantages that Chinese characters inherently possess, distinguishing them from other writing systems.

(1) Chinese characters are unique morpheme characters

Chinese characters, as the fundamental unit of morpheme writing, are known for carrying concrete meanings. Referred to as ideographic characters, they are based on pictograms, utilizing shapes to represent ideas. Moreover, morphemes in Chinese characters combine both sound and meaning, creating a unified entity encompassing form, sound, and meaning. Each Chinese character represents a single sound unit, forming an independent block character with an intuitive, concrete, and visually representative nature.

(2) Chinese characters are intricately linked to culture

As symbols for recording language, Chinese characters inherently carry rich cultural connotations and are a living fossil of history. With a history spanning thousands of years, Chinese characters preserve ancient cultural information within their forms. Over the millennia, historical events and cultural achievements have been documented through Chinese characters, creating countless ancient texts. Classics in philosophy, literature, history, political science, economics, military strategy, medicine, and technology have been recorded and passed down through these symbols, showcasing how Chinese characters play a direct role in the transmission of culture.

(3) Chinese characters have the characteristics of transcending dialects and regions

China, with its vast expanse and diverse ethnicities, has various regional languages with distinct phonetic features. However, the intercultural communication across different regions is unimpeded, thanks to the ideographic nature of Chinese characters. Chinese characters are not confined to domestic use but also extend their influence to neighboring countries. Over the long course of history, Chinese characters have spread with the brilliance of Chinese culture to surrounding nations, gradually forming the Chinese character cultural sphere. The dissemination and use of Chinese characters have played a crucial role in preserving and transmitting the cultures of these countries. With the rejuvenation of the Chinese nation, China’s political, economic, and cultural impact on the world is increasing, making Chinese characters an important medium for cultural exchange worldwide.

3.2 Invention of Papermaking

The invention of papermaking, by replacing other media, elevated paper to the primary material for writing, greatly enhancing the speed and scale of cultural dissemination (Bao, 2020a).
3.2.1 Evolution of text carriers

Before the true invention of “paper,” various materials such as oracle bones, bronze bells and cauldrons, bamboo slips, wooden tablets, silk, and even materials like sheepskin and palm leaves were used as recording media. These materials are either bulky and scarce or inconvenient for long-time preservation. The invention of “paper” marked a comprehensive solution to these challenges, representing a significant contribution by the Chinese people to the recording and transmission of human culture.

Figure 5

Carriers for Recording Text


3.2.2 Invention and development of papermaking technology

(1) Birth of Papermaking Technology

Due to the limited quantity and cumbersome nature of oracle bones and bronze vessels, they were unsuitable for recording large amounts of text. Bamboo slips, while convenient for writing, occupied a considerable amount of space and were not easy to use and preserve. Silk and silk fabrics, though lightweight, were expensive, inconvenient for writing, and prone to damage and decay, making them unsuitable for long-term preservation. With the development of social, economic, and cultural activities, the need for recording information increased. Therefore, there was a demand for a lightweight, inexpensive, readily available medium that was easy to write on and preserve.

The ancient Chinese ancestors already knew how to raise silkworms and reeling silk. In their long-term production practices, they discovered that the waste cocoons and diseased cocoons, when repeatedly pounded and crushed through the process of beating for silk extraction, resulted in residual fibers on the mats after the fluffing process. After multiple rounds of beating, a layer of fibrous sheets would accumulate on the mats. Once air-dried, these accumulated fibers could be peeled off and used for writing. This byproduct of the fluffing process, though not abundant, was referred to as “Heti 赫蹏” (thin paper) or “Fangxu 方絮” (silk paper) in ancient texts.

Inspired by this, during the Western Han Dynasty (206 BC to 8 AD), a technique emerged
that involved using lime water to degum plant fibers such as silk and hemp. These fibers were then pounded, washed, and processed to create paper made from hemp fibers.

(2) Improvement of Papermaking Technology

In the first year of Yuanxing in the Eastern Han Dynasty (105 AD), Cai Lun presented a batch of high-quality paper he had produced to Emperor Han He. The emperor praised his talent and immediately ordered the China to adopt it. In this way, Cai Lun’s papermaking method spread throughout all places and quickly became popular nationwide.

The invention of papermaking sparked a revolution in writing materials. Although Cai Lun was not the original inventor of papermaking, he significantly improved the process, and earned him a lasting place in history. Therefore, he is considered a pioneer in the technological innovation of papermaking (Hua & Feng, 2017).

(3) Development of Papermaking Technology

In the 2nd century AD, after the widespread adoption of papermaking throughout various regions in China, paper emerged as a powerful competitor to silk and bamboo slips. The Sui, Tang, and Five Dynasties period marked a crucial stage in the development of papermaking technology in China. During this time, further progress was made in raw materials, papermaking equipment, varieties of paper, and its usage expanded further.

During the Song and Yuan dynasties, China’s papermaking technology reached a level of maturity, with continued developments in the regional production of paper, diverse varieties, and improved technologies. The use of paper extended to various industries. During the Ming and Qing dynasties, China’s traditional papermaking techniques reached their peak, accompanied by the emergence of illustrated treatises specifically dedicated to the art of papermaking.

Figure 6

Process Flowchart of Bamboo Papermaking in “Tiangong Kaiwu”

Note. From “Tiangong Kaiwu”, by Song Yingxing (Ming Dynasty).

3.2.3 Dissemination and exchange of papermaking technology
Due to its unique geographical location, China’s paper and papermaking technology first spread to various Asian countries, extending southward to Vietnam, Myanmar, Nepal, Thailand, India, Pakistan, and Oceania. It also spread eastward, first to Korea and then to Japan. With the extension of the Silk Road, papermaking technology also reached Central Asia, West Asia, North Africa, and subsequently Europe and the Americas, becoming widespread globally.

From the 2nd century BC to the early 18th century AD, over a span of two thousand years, China’s papermaking technology consistently maintained a leading position globally. The techniques, equipment, and processing involved in papermaking provided a comprehensive system for countries worldwide. The initial forms of various key technological aspects in modern machine papermaking industry can be traced back to ancient Chinese papermaking. The traditional Chinese papermaking methods have been utilized worldwide for over a thousand years.

The invention of papermaking, by replacing other mediums, elevated paper to the primary material for writing, significantly enhancing the speed and scale of cultural dissemination. This advancement played a pivotal role in fostering the development of various aspects of societal, economic, religious, educational, and technological culture globally. It stands as a significant contribution of the Chinese civilization to world culture.

3.3 Printing Technology

Printing is one of the Four Great Inventions of the Chinese nation, including woodblock printing and movable type printing. Woodblock printing was invented during the Tang Dynasty and widely used in the later period of the dynasty (Deng, 2005). Movable type printing was invented by Bi Sheng during the Song Dynasty, more than 400 years earlier than its Western counterpart. The invention of printing allowed for the mass reproduction and dissemination of human cultural achievements, leading to changes in educational practices and fostering societal development (Bao, 2020b).

3.3.1 Woodblock printing

Before the invention of printing, the dissemination of culture mainly relied on hand-copied books. Hand copying was time-consuming, labor-intensive, prone to errors, and omissions, negatively impacting cultural development and causing unwarranted losses in cultural dissemination.

The unique seals and inscriptions in China provided direct empirical inspiration for printing. Seal engraving, rubbings, and dyeing provided clear directions for woodblock printing. The mutual inspiration and integration of seals, rubbings, and dyeing, combined with the experiences and wisdom of ancient Chinese people, gave rise to woodblock printing.

3.3.2 Movable type printing

During the Northern Song Dynasty, spurred by economic, commercial, and cultural growth,
there arose a demand for rapid and extensive information dissemination. While woodblock printing had numerous advantages, the lengthy process from carving to printing hindered its ability to meet urgent requirements. In response to this societal need, Bi Sheng innovated movable type printing between the first and eighth years of the Qingli era (1041-1048 AD) during the reign of Emperor Renzong of Northern Song.

The invention of movable type printing overcame the drawbacks of woodblock printing. With a sufficient supply of individual movable types prepared in advance, typesetting could be done at any time, significantly reducing the time required for plate-making. Following the printing process, the movable types could be disassembled, reused, and occupied less space compared to woodblocks, facilitating storage and preservation. This demonstrated the superior efficiency of movable type printing.

Bi Sheng’s initial use of wood for movable type encountered challenges due to uneven wood grain, susceptibility to swelling and deformation when exposed to water, and difficulty in separation after sticking to the adhesive. To address these issues, he transitioned to clay as a material for movable type, crafting durable clay types that were fired. Following this innovation, further experimentation involved the creation of metal movable type using materials such as tin and copper.

**Figure 7**

*Printing Techniques*

![Engraving, Movable type, Typesetting]

*Note.* Typesetting is Rotating typesetting rack, from “Agricultural Books, The Method of Naking Movable Type to Print Books” by Wang Zhen (Yuan Dynasty).

### 3.3.3 The dissemination and exchange of printing technology

The invention of printing, enabling the mass reproduction and dissemination of human cultural achievements, has facilitated societal development. This represents another significant contribution of the Chinese nation to the inheritance of human history and culture.

During the Tang Dynasty, China witnessed economic prosperity and cultural flourishing. From the 8th century AD onwards, Japan adopted woodblock printing to extensively reproduce Chinese books. In the Goryeo period of the Korean Peninsula under King Munjong (998-1009 AD), woodblock printing of scriptures began. The wooden movable type technology from China was introduced to Korea and Japan around the 14th century. Korea innovated by creating metal...
movable type based on wood type. Chinese printing technology eventually reached Europe via Persia and Egypt, playing a crucial role in accelerating European societal development and contributing to the groundwork for the Renaissance.

German inventor Johannes Gutenberg made significant improvements to ancient Chinese movable type printing. Between 1440 and 1448 AD, Gutenberg developed the technique of using lead-alloy movable type. Although this innovation occurred about 400 years after Bi Sheng’s invention of clay movable type printing, Gutenberg achieved substantial success in improving the materials for movable type, applying oil-based ink, and manufacturing printing presses. These achievements laid the foundation for modern printing technology.

3.4 Intuitive Teaching Aids

While writing is a highly efficient means of recording information due to its high information density, simplicity, and quick dissemination, its significant drawback lies in abstraction. In the transmission of Chinese civilization, various auxiliary methods have emerged to compensate for the abstract nature of writing. These include tangible objects, charts, specimens, models, and other tools collectively referred to as intuitive teaching aids (Xie, 2020b).

3.4.1 Pictorial-based intuitive teaching aids

(1) Mingtang Diagrams and Illustrations

In the transmission of skills and knowledge in ancient China, a rich array of pictorial resources was utilized. For instance, in acupuncture teaching, external views, internal views, Mingtang diagrams, and massage diagrams were employed. Li Shizhen’s “Compendium of Materia Medica” was adorned with vivid illustrations for each medicinal herb. Besides detailing the characteristics and functions of each herb, corresponding illustrations were included, facilitating learners in grasping the content more efficiently.

(2) Shadow Puppetry and Farming and Weaving Map

One of the most vivid and illustrative visual aids in Chinese history is shadow puppetry. Shadow puppetry is an artistic form of storytelling performed silhouette figures. The performances are accompanied by vocal narration and musical instruments, making it a significant avenue for the general public to acquire knowledge.

In the field of agriculture, the “Farming and Weaving Map 耕织图” stands out as a prominent achievement in the popularization of agricultural knowledge. “Farming and Weaving Map” originated in the third year of Shaoxing in the Southern Song Dynasty (1133). Subsequently, it received great admiration from successive dynasties, with many emulating and reproducing it. For example, the “Yongzheng Statue Farming and Weaving Map 雍正像耕织图” in Figure 8 depicts the labor scene of farmers transplanting rice seedlings, demonstrating the emperor’s concern and advocacy for agricultural production.
Figure 8

Pictorial-based Intuitive Teaching Aids

Note. Mingtang Three-person Picture of Sun Simiao, imitated by Sun, Zhongnian & Shao, Futang, 1992. Illustration of Compendium of Material Medica (Qing Dynasty engraved edition), by Li Shizhen (Ming Dynasty). Yongzheng Statue Farming and Weaving Map, by Chen Mei (Qing Dynasty).

3.4.2 Model-based intuitive teaching aids

Models are artificially designed and crafted objects that retain the key features of the original items while removing less essential components. This facilitates teaching by emphasizing key points and overcoming difficulties.

(1) Architectural Models and Sand Tables

In ancient architecture, the “hot sample” technique was a famous design technique in the history of architecture, serving as a primary teaching tool for the transmission of architectural skills and a crucial approach to learning architectural design techniques.

The earliest documented example of the application of sand tables is found in “the Book of the Later Han: Biography of Ma Yuan 《后汉书.马援列传》”. It was used as a teaching aid for learning military command strategies and regional economic development planning.

(2) Acupuncture Models and Bronze Figures

In the Han Dynasty tomb discovered in the northern suburbs of Chengdu, Tiangui Town, Jinniu District, a remarkable 14-centimeter-high acupuncture model was unearthed. The intricately carved figure boasts well-proportioned limbs and organs, adorned with white and red lines depicting meridians across the body. Additionally, small characters like “heart,” “lungs,” “kidneys,” and “pelvis” are meticulously carved in different areas. This significant find was accompanied by the discovery of 920 bamboo slips, with nine identified as medical texts. Archaeologists speculate that these bamboo slips may be the long-lost classical works of the ancient Chinese medical school associated with Bian Que (Chengdu Institute of Cultural Relics and Archaeology, 2013).

In the fourth year of the Tian Sheng era during the Song Dynasty (1026 AD), Wang Weiyi, a renowned imperial physician and acupuncture expert, based on the classics “Neijing” 《内经》
and “Nanjing” 難經  compiled the “Copper Man Acupuncture and Moxibustion Diagram Classic 銅人腧穴針灸圖經.” Integrating perspectives from previous medical scholars and incorporating his own clinical experiences, Wang Weiyi’s work helped reconcile various disagreements on meridians and acupuncture points at the time, playing a significant role in the development of meridian theory. At the behest of Emperor Renzong of Song, Wang Weiyi casted the first two bronze acupuncture figures in the fifth year of Tian Sheng (1027 AD). These figures, known as the “Tiansheng Bronze Figures 天聖銅人,” marked a milestone in the field of acupuncture and contributed greatly to the understanding of meridian theory.

The “Tiansheng Bronze Figures” resembling middle-aged men with well-proportioned bodies were crafted in bronze during the Song Dynasty. These life-sized nude sculptures were meticulously crafted with a thick outer shell that could be disassembled. The movable chest and back could be opened to reveal internally carved wooden organs. The body’s surface featured inscriptions of acupuncture points, with a total of 657 points marked with black paint. To assess acupuncture proficiency, instructors sealed the surface holes with yellow wax, filling the figures with water or mercury from the top. If the acupoints were accurately located, the needles would penetrate, allowing the fluid to flow out. However, inaccurate needle placement would result in the inability to insert the needles. The Tiansheng Bronze Figures represented an exceptionally sophisticated teaching model in ancient technology. In subsequent periods, including the Ming and Qing Dynasties, both Chinese and Mongolian medicine practitioners replicated these acupuncture bronze figures for instructional purposes (Beijing University of Chinese Medicine, 2012).

**Figure 9**

*Model-based Intuitive Teaching Aids*


**3.4.3 Instrument-type intuitive teaching aids**

Instrument-type of visual aids such as tools, learning aids, and instruments can enhance
learners’ skills and knowledge through hands-on operation.

1) Calculating tools and learning aids

In the field of mathematics, “Counting rods 算筹” were among the earliest computational aids, and by the Yuan and Ming dynasties the abacus emerged. The ingenuity of these tools has played an undeniable role in promoting and popularizing mathematical knowledge. During the promotion process, they naturally served as mathematical teaching aids.

Traditional educational toys from ancient times, such as the tangram, and nine linked rings, Luban lock, were common learning tools in early education. These tools not only developed children’s observation skills, creativity, spatial thinking, and manual dexterity but also aligned with certain goals in subjects like mathematics. For example, the tangram involves the Pythagorean theorem and the principle of complementarity in arithmetic. The nine linked rings involve binary and recursive equation principles. The Luban lock covers solid geometry and was a commonly used educational tool for ancient carpentry, mainly focusing on learning the characteristics of mortise and tenon structures and practicing basic operational skills.

2) Instruments

Taking astronomy as an example, the Beijing Ancient Observatory was first built during the Zhengtong period of the Ming Dynasty. Subsequently, instruments such as sundials, gnomons, clepsydras, quadrant instruments, armillary spheres, and azimuth instruments were created. In the Qing Dynasty, eight major astronomical instruments were also produced, including the Altitude-Azimuth Instrument, Celestial Globe, Equatorial Instrument, Ecliptic Instrument, Theodolite, Quadrant, Meridian Instrument, and Gnomon for Solar Transit Instrument. During the Ming and Qing dynasties, observatories were under the jurisdiction of the Qintianjian (Imperial Academy of Astronomy). The abundant astronomical instruments served as crucial tools not only for observing celestial phenomena but also for educating astronomers at the Qintianjian.

Figure 10
Instrument-type Intuitive Teaching Aids

Note. Western Han Dynasty Counting Rods, stored in Shaanxi History Museum.

3.4.4 The dissemination and impact of intuitive teaching aids

In the case of the acupuncture bronze figure, the application of models in the transmission of medical knowledge has advantages unparalleled by two-dimensional graphical representations. These advantages manifest in their more specific and clear functionality, providing a more vivid
representation of medical knowledge and addressing some of the challenges in information dissemination in the real world (Zhou, 1983).

The societal impact and widespread dissemination of acupuncture bronze figures are challenging to precisely quantify. After the Song Dynasty, there were many replicated bronze figures produced by officials, civilians, and countries such as Japan. Apart from documented instances of domestically produced bronze figures, some have been lost or replicated abroad, with records in countries such as South Korea and Japan.

4 Conclusion

In the early stages of Educational Technology, besides China, other countries and regions have also made positive contributions to the development of Educational Technology. For instance, around 3000 BC, ancient Egyptians began using a material called “papyrus” made from the stems of the papyrus plant to record information. Due to the limitations of papyrus in terms of preservation, they also used parchment made from animal skins as a medium for writing. It was not until the 8th century AD that paper making technology from China reached Africa and Europe, leading to the more widespread use of affordable paper. In the 5th century BC, the ancient Greek philosopher Socrates proposed the heuristic teaching method known as “maieutics,” contributing to the development of education.

In the 17th century, classroom teaching, organized with textbooks, chalk, blackboards, pictures, models, and oral communication, gradually emerged in Europe. In 1658, Czech educator Comenius published the textbook “Orbis Pictus” with 150 illustrations. Swiss educator Pestalozzi (1746-1827) designed spelling boards for phonetic exercises in language teaching and used teaching aids such as fraction tables and arithmetic boxes in arithmetic education. In 1836, German educator Froebel invented “Froebel Gifts” based on Rousseau’s educational philosophy, which helped children understand nature and its inherent principles.

However, China’s contribution to the development of ancient Educational Technology in the world is still far greater than that of other countries and regions. The insightful discourse of various schools of thought in China on education and technology, along with the educational ideas contained in ancient Chinese scientific and technological works, laid the theoretical and practical foundation for optimizing the teaching (learning) process. The creation of Chinese characters, the invention and dissemination of paper making and printing, as well as the emergence and application of Intuitive teaching aids, enriched the theory and practice of teaching (learning) resources. The combination of these elements not only promoted the development of education in China, but also had a profound impact on the global progress of development.

According to the widely accepted definition from the Association for Educational Communications and Technology (AECT) in 1994, “Instructional technology is the theory and practice of design, development, utilization, management and evaluation of processes and resources for learning” (Seels & Richey, 1994). This implies that Educational Technology is a field involving both “theory and practice,” focusing on the “learning (teaching) processes and learning (teaching) resources.” It aims to optimize the learning (teaching) process, enhance
learning (teaching) resources through “design, development, utilization, management, and evaluation,” ultimately facilitating the occurrence of learning. In other words, any theory and practice that can optimize the teaching (learning) process, enrich teaching (learning) resources, and enhance teaching (learning) performance should fall within the scope of Educational Technology.

Figure 11

Ancient China’s Contribution to World Education

Figure 11 illustrates the contributions of ancient China to global education in comparison with the definition and connotations of the AECT (Association for Educational Communications and Technology) from 1994. From the content depicted in the figure, it can be seen that the Chinese nation has made irreplaceable contributions to the creation and inheritance of human civilization, promoting the dissemination of knowledge and technology worldwide, and fostering the development of education. Ancient China already had the necessary and sufficient conditions for the birth of Educational Technology. Therefore, it can be considered that China is the birthplace of Educational Technology, and the Chinese nation is the indigenous people of Educational Technology.

Acknowledgement

This research is supported by Key Project of the 14th Five-Year Plan of the China Association for Educational Technology: “Compilation and Research of Historical Literature on Educational Technology in China”, Project Approval Number: XHZDKT2022001.

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