Language, Culture, and Science-technology Development

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Abstract

By an analysis of Chinese character and Western alphabet and a review of the cultural conditions of China and Europe in the Middle Ages, it is argued that the reason China fell behind the West in the development of contemporary science and technology since the seventeenth century is probably because of cultural differences and not necessarily because of the differences in language scripts.

I. Alphabet and logography

The benefits of writing to civilization are incalculable. Writing enables humans to record natural phenomena and commercial transactions and to transmit culture and knowledge across space and time. It is one of the most important ways people acquire the information that allows them to function as useful members in an industrial society People should be able to reap these benefits of writing no matter what kind of writing system – alphabet or logography – they use.

An alphabet is a set of symbols used to represent the sounds of a language. Each letter or symbol in an alphabet usually represents a simple vowel, a diphthong, or a consonant, rather than a syllable or a group of consonants and vowels. So in an alphabet, one letter represents in principle one phoneme. Logography is pictorial symbol intended to represent a whole word. In logography, one graph in principle represents one morpheme. But no known writing system is totally logographic; all such systems have both logogram and symbols representing particular sounds or syllables. The most representative languages nowadays in alphabet and logography are English and Chinese respectively.

A Chinese ideograph is a monosyllabic, pictorial and well-proportional structure. With its graphemes semantically loaded, a Chinese ideograph has a unique power of combining sound, shape and meaning. Chinese characters are not simply a collection of unrelated arbitrary symbols. Just as English has some major word formation processes like derivation, compounding and conversion, Chinese also has its ways of forming new characters, including pictographs, meaning composites and semantic-phonetic composites. Pictographs are drawings of objects, such as 山, the ideograph pronounced LU, originally representing three peaks of a mountain. Because of stylistic changes over the years the pictographic origins have been all but lost in modern Chinese characters. However, they still act as the main components of other characters. They are the basic elements in other two-part formations. Two or more pictographs may join to form a meaning composite. For example, the two pictographs, one for sun, 日, and the other for moon, 月, join the character for bright,

明. In a semantic-phonetic composite, a sound-cueing phonetic component and a meaning-conveyed semantic component are joined. For example, in the composite character 妈, the left character 'woman' supplies its semantic component, while the right character supplies its phonetic sound "Ma". For Chinese characters nowadays, the most dramatic change is the decreasing proportion of pictographs and the increasing proportion of semantic-phonetic composites. Joining semantic and phonetic components is a favored way of creating new characters in China. 80-90% of the characters have been semantic-phonetic composites.

By the analysis of two languages, some similarities are found between English and Chinese. Both languages involve sound, form and meaning in structure. Nowadays, whether alphabetic symbols or pictorial symbols are used, they remain abstract for their users. And both languages are meaning-motivated in some cases.

II. Alphabet for science and technology

Some scholars claim that logical thinking and abstract science is possible only for users of an alphabet but not for users of logographs. One such scholar, McLuhan (1962, p.65) observed, "By the meaningless sign linked to the meaningless sound we have built the shape and meaning of Western man". Another scholar, Havelock (1976), attributes the ascendancy of Greek analytic thought to the introduction of vowels in the alphabet. "The Greeks did not just invent an alphabet; they invented literacy and the literate basis of modern thought". "It is no accident that the pre-alphabetic cultures of the world were also in a large sense the pre-scientific cultures, pre-philosophical and pre-literary". (p. 50)

McLuhan's and Havelock's extravagant claims on the power of the alphabet are taken up and expanded by Logan (1986). "The alphabet has contributed to the development of codified law, monotheism, abstract science, deductive logic, and individualism, each a unique contribution of Western thought" (p. 18). As an analogy, the use of logographic Chinese characters is said to have contributed to the non-development of abstract thought and science in China.

Logan then makes some sweeping generalizations shown as follows: Differences between East and West

Differences between East and West

East	West
right-brain oriented	left-brain oriented
nonlinear	linear
decentralized	centralized
craft	technology
relativity	absolutism

These dichotomies are simplistic, inaccurate, and dangerous. Take, for example, the right-left brain and nonlinear-linear dichotomies for East-West. Whether one speaks Chinese or English or whether one reads in logographic characters or in a phonetic script, one has to arrange sounds and written signs linearly in a sequence. Also in comprehending a sentence and eventually a text, the meanings recognized in individual words or characters must be related to each other in order to obtain the sense of that sentence or text. And even in Chinese text this relating appears to be done in a phonetic coding in short-term memory. So language is mostly, though not exclusively, processed in the left hemisphere, which specializes in sequential, temporal, and phonetic processing.

The claims made by the scholars mentioned above were probably made on the assumption that western alphabet and contemporary science have similar features. Contemporary science was born in the second half of fifteenth century and has two most distinguished features, one of which is analytical study. Different from the method adopted in ancient science that nature was studied as a whole, contemporary science tried to divide the study of nature into different fields, like animal, plant and mineral or into different facets, like mechanical movement, physical movement, chemical movement and biological movement. Contemporary scientists no longer considered the origin and nature of world as the focus of study like ancient natural philosophy, but paid much attention to the specific aspects of nature and probed the special rules of various movements instead.

Another distinguished feature of contemporary science is experimentation, a method never adopted by any ancient philosopher, scholar or scientist. Contemporary science, especially natural science, provided theoretical explanations of the studied natural phenomena based on observations and results of experiments. Unlike the ancient scholars who relied on philosophical reasoning to give various conjectures of nature and the ancient craftsmen who only pursued practical results like the manufacture of products and the improvement of technologies, contemporary scientists tried to understand nature from a theoretical point of view. In order to reveal the rule underlying natural phenomena, it is necessary to take them out of the actual manufacturing process and technological practices so as to study them under artificial manipulation. This experimental method that was originated by contemporary science as an independent practical activity differentiated from the former production activity, becomes the necessary condition for the development of contemporary science.

In light of the features of contemporary science, there is some doubt about the determining role of alphabet in forming contemporary science. Both Chinese and English are analytical languages and the product of abstraction. The claim that the introduction of vowels in the alphabet attributes to the ascendancy of Greek analytic thought seems to be confusing for Chinese speakers, since in the same way the words represented by Chinese characters contain a series of vowels and consonants while being spoken. Against another claim that the meaningless sign linked to the meaningless sound in alphabet built the shape and meaning of Western man, it can be argued that semantic-phonetic composites that make up 80-90% of Chinese characters also represent an arbitrary relationship between meaningless signs and meaningless sounds and they may have the same function in shaping Chinese thought as the alphabet. Thus we cannot jump to such a conclusion without more exploration of the idea that literacy determines cognition.

III. Chinese characters and science-technology development in China

Anyone who claims that science is possible only with an alphabet but not with logographs should at least have an adequate knowledge of Chinese characters. Scripts and literacy may influence reading and cognition, but this influence is probably restricted to lower-level, specific tasks. The logographic Chinese characters differ from phonetic scripts in several characteristics: the linguistic units they represent; how they represent meanings and sounds; in the number of written symbols or graphs; and in the complexity of the shapes of these graphs. Such differences are bound to affect how graphs of different writing systems and scripts are learned and used. They affect word recognition. Reading aloud is faster in a phonetic than logographic system, but meaning extraction is faster in a logographic than phonetic system. Such differences are revealed in laboratory experiments, but are too minute for readers to be aware of. In teaching word recognition using an alphabet, phonics can be – though need not be – used, whereas Chinese characters and their semantic or phonetic components are commonly taught by their whole shape. Taught by a phonics method, children can sound out and thereby recognize new words on their own; taught by a whole-word method, children are not equipped to recognize new words. (Taylor, 1994, p. 38)

Beyond word recognition, in reading text, differences among different types of writing systems and scripts disappear. Text readers, in whatever script they may read, relate recognized words to each other in comprehending a sentence in order to sort out who does what to whom, and they relate sentences to each other in order to sort out which is central and which is supporting. During the comprehension processes, the readers tend to hold words phonetically in short-term memory.

Some scholars claim that a particular type of script, i.e., an alphabet, promotes abstract concepts, analytic reasoning, new ways of categorizing, a logical approach to language, and so on. They blame the use of logographic Chinese characters for the non-development of abstract science in China. If their claim is true, one has to conclude that logical analysis, reasoning and abstraction can be done only through writing and that Chinese characters cannot shape a mind to think in an abstract or analytic way. These claims should be taken skeptically because Chinese characters can do the same job as Western alphabets in conducting science. They are used to record what have been observed in the experiments and used to analyze data and the results of mathematical calculations. Chinese characters can represent all concepts, concrete or abstract. For example, the Five Virtues of Confucianism, benevolence, righteousness, reverence, wisdom, and sincerity are so abstract that it is very hard to understand them in some cases. So Chinese characters, as a tool for doing science, are no better or worse than an alphabet.

In practice, contrary to the claims made by some Western, the Chinese had made numerous scientific and technological advances long before the Westerners in the Middle Ages of Europe, such as the four best-known Chinese inventions – paper, gunpowder, compass, and printing. There were also many less well-known inventions and discoveries: irrigation systems, seismographs, acupuncture, herbal medicine, etc. We admit that science in China lagged behind the West in modern times, but it is not denied that China had the leading position in developing science and technology in the Middle Ages. Thus it is argued that the Chinese and Westerners may have different ways of thinking, probably because of the cultural differences and not necessarily because of the differences in language.

IV. The Middle Ages and science and technology

China took the lead in science and technology in the Middle Ages. It is an unarguable fact that Chinese science and technology fell behind the West. Many scholars think that the obvious lag happened during the Ming and the Qing Dynasties, specifically, the period between Wanli of the Ming Dynasty (1573 - 1620) and Qianlong of the Qing Dynasty (1736 - 1795), a transitional period which lasted about two hundred years. But before this period, the great scientific and technological progress that Chinese people achieved were extremely admired by the Westerners. In terms of European history, the achievements the Chinese produced were notable for being made before the Middle Ages. Especially in the Song Dynasty, development of science and technology reached its peak, among which the three inventions – compass, power and printing – became the most advanced technologies in the world when the Song and the Yuan Dynasties dominated China from the eleventh to the fourteenth century, at the time that Europe was immersed in the so-called "the dark Middle Ages".

The Middle Ages are a very important historical period for Europe. In AD 476, the Western Roman Empire disintegrated and Europe entered feudalism. Historians usually take the one thousand years between the disintegration of Western Roman Empire and the British Bourgeois Revolution in 1640 as the Middle Ages. The Middle Ages in the history of science and technology differ slightly by referring to the one thousand years between the end of ancient Greek and Roman civilization and the Renaissance in Europe, that is, from the fifth to the fifteenth century At that time, medieval Europe was far from unified; it was a large geographical region divided into smaller and culturally diverse political units that were never totally dominated by any one authority. With the collapse of the Roman Empire, the church gained secular authority. During this period the science and technology in Europe had to defer to theology because of the suppression and persecution by the church. Any idea on natural science would be denounced as heresy and squashed until it could be shown to be in accord with the doctrines of Christianity. Especially when the church became the universal and unifying institution, it monopolized the education, the culture and the whole spiritual world of Westerners. The special status of the church meant the development of science was subject to restrictions and close scrutiny that often severely limited its study .

One typical example can be used to illustrate this point. The Academy founded by the Greek philosopher Plato near Athens, along with other pagan schools, was closed by Emperor Justinian in AD 529 after Plato's followers met there for nine centuries. This indicates the end of classical European science and culture and the real beginning of the Dark Middle Ages in the history of European civilization. The darkness remained until the eleventh century when Crusades discovered the lost classical Hellenistic civilization. In a social environment like this, it was hard for science to flourish, so scientific research and technological inventions in the Middle Ages in Europe suffered great resistance.

It was all but impossible for science and technology to develop in the social conditions of Europe in the Middle Ages. Compared with the Middle Ages in Europe, China had a comparatively stable social system for two thousand years since China had been unified by the Qin Dynasty and had developed centralized feudalism. During those two thousand years, there was no great transition and change in the mainstream of ideology and there was a relaxed environment for the development of science and technology. The ruling class and science and technology were not absolutely irreconcilable as in Europe in the Middle Ages. If there was an intelligent emperor and proper policy in a dynasty, science and technology had a vigorous growth, as did , for example, the scientific and technological development in the Tang and Song Dynasties. The fact that China took lead in science and technology for nearly one thousand years after the Han Dynasty was greatly due to the stable and peaceful political and social environment of that time. That is to say, Chinese feudalism could adapt itself to the development of science and technology and hence there appeared the advance of science and technology in the Tang and Song Dynasties. During the same time, Europe was suffering under the restrictions of the church and could not recover its vitality. Because Europe ceased to develop science in the Middle Ages, China assumed the leading position in science and technology in the world.

The Chinese people did not, however, realize that opportunity and timeliness facilitated their significant accomplishments, instead of competition and dialogue with thinkers in other parts of the world. Perhaps because of the absence of competitive thinkers and an attitude of superiority, they did not consider the disadvantage of having no serious competition and the potential restrictions this vacuum created for the pace of developments in Chinese science and technology. Had they thought through the consequences of no apparent opposition, they would not have been so blindly optimistic and considered themselves as a great nation without peer. This extremely arrogant and egocentric attitude of the Chinese then led to their satisfaction with the status quo and contributed to the later diminished development of science and technology in China. For example, the Chinese had developed mathematics early in their history, but more as a tool of science that for its own sake. Between the mid-thirteenth and the sixteenth century, they did not produce any mathematical innovations. If they could have made a comparison between the science and technology in China and that of the West, they could have found out the underlying strengths and weaknesses of the West as well as their own. With stimulating opposition and dialogue, the history of science and technology in China would probably have been quite different.

V. Factors for the non-development of contemporary science in China

1. Philosophical basis

The earliest Greek philosophers focused their attention upon the origin and nature of the physical world like ancient Chinese philosophers. But they made a dramatic change later. For example, Empedocles of Acragas, a philosopher of the mid-fifth century, declared there are four material elements which he called roots of everything. Anaxagoras of Clazomenae, in fifth century, believed that everything is in the form of infinitely small parts, or particles. And Democritus built a whole system, aiming at a complete explanation of the varied phenomena of the visible world by means of an analysis of its atomic structure. All these claims, whether elements, particles or atoms, are concerned with the physical structure of matter. That is, they all shifted their attention from the origin and nature of the world to the understanding of the physical structure of matter. Especially the theory of atom initiated by Democritus is much more similar with the basic idea of atomic theory in contemporary chemistry. Dalton who originated the atomic theory for contemporary chemistry admitted that his theory was greatly owed to the claim of atom by Democritus. Even Newton thought the ancient theory of atom produced great influence on his scientific study The shift to individual unit from the world as a whole not only means the shift of study objects, but research method as well. The study of world as a whole usually makes use of synthetic approach, while the study of individual units takes analytical approach, an approach adopted by contemporary science. For example, contemporary and modern scientists, by using analytical approach, have reached such particles as molecule, atom, nucleus, proton, neutron, electron, and even quark. The analytical approach, originated from the ancient Greek theory of atom, is one of the most distinguished features of contemporary and modern science, as mentioned in Section II. It can be said that there would not have been today's various branches of science but for ancient Greek philosophy of nature.

Different from the ancient Greek philosophy, dialectical logic is the main characteristic of classical Chinese philosophy. Yin-Yang and Five Phases (Wu Xing) are two characteristically Chinese beliefs. Many ancient Chinese philosophers considered that Yin-yang, the two complementary forces, or principles, make up all aspects and phenomena of life. The two are both said to proceed from the Supreme Ultimate (Tai Chi), and their interplay on one another (as one increases the other decreases) is a description of the actual process of the universe and all that is in it. In harmony, the two are depicted as the light and dark halves of a circle. The significance of Yin-Yang through the centuries has permeated every aspect of Chinese thought, influencing astrology, divination, medicine, art, and government. The Five Phases are, in ancient Chinese cosmogony, the five basic components of the physical universe: earth, wood, metal, fire, and water. These elements were believed to destroy and succeed one another in an immutable cycle and were correlated with the cardinal directions, seasons, colors, musical tones, and bodily organs. The Five Phases cycle served as a broad explanatory principle in Chinese history, philosophy, and medicine. Besides these two beliefs, the conflict belief also held that anything has two sides and would not exist without the unity of two sides. The dialectical thinking of motion and motionless maintained that motion and motionless could not be separated absolutely; one was involved in the other. In general, classical Chinese philosophy was more concerned with the dialectical explanation of the origin, nature and movement of the world. Most of those beliefs, based on the philosopher's own hypothesis, were considered integrally and dialectically. Due to the popularity of dialectical thinking in classical Chinese philosophy, it was impossible for Chinese to establish the theory of the atom. They would not have done sufficiently accurate and deep work on any question. What is more, the dialectical thinking had almost no relation with the ancient science in China and did not contribute much to the development of natural science except for traditional Chinese medicine.

From the comparison of ancient Greek philosophy and classical Chinese philosophy, it is known that the thought and method of ancient Greek philosophy are very close to those of contemporary science. Greek philosophy contributed much to human civilization in that it emphasizes abstract thought and analytical thought, both of which are necessary conditions for scientific study. The emphasis on analyzing rational knowledge predicts the great potential of western science and the arrival of contemporary science in Europe. The science in China, from the very beginning, was congenitally deficient in rational thinking. The achievements the Chinese produced were notable for their practical rather than theoretical importance. That's why the development of science in China lacked its own impetus and began to fall behind the West in Song and Yuan Dynasty.

Different philosophical beliefs of the Chinese and the Greek give rise to their different understandings of science and technology. In Europe since classical times the various sciences were part of a single structure that included all systematic rational knowledge. The natural sciences were subsumed under the overarching structure of natural philosophy. By contrast, in China the sciences tended to develop independently of each other, rarely responding directly to contemporary philosophic innovations. Chinese scientists were aware of their increasing ability to predict, but lacked the conviction that eventually all phenomena would yield their ultimate secrets. Typically, they believed that natural processes wove a pattern of constant relations too subtle and too multi-variant to be understood completely by empirical investigation or mathematical analysis. Scientific explanation merely expressed, for finite and practical human purposes, partial and indirect views of that fabric.

2. Ideology

During the two thousand years of feudalism in China, the doctrines of Yin-Yang and the Five Phases had deeply and chronically influenced Chinese people's ideology. The origins of the Yin-Yang idea are obscure but ancient. In the third century BC in China, it formed the basis of an entire school of cosmology and was summarized in the classic *Book of Documents*, one of the Five Confucian Classics. The Yin-Yang doctrine has touched every aspect of Chinese civilization, whether it be cosmology, metaphysics, medicine, government, history, art, or even cooking. According to the doctrine, all things and events are products of two opposite yet complementary forces: Yin, which is negative, passive, weak, and destructive; and Yang, which is positive, active, strong, and constructive. Yin-Yang is usually represented in a picture of a circle divided into two halves by a curved line. The two forces complement each other, as a male does a female, or grows out of the other, as day does out of night and vice versa. The Yin and Yang components never become completely separated, but at each stage, in any given fragment, only one is manifested.

The doctrine of a stable society stresses harmonious, if hierarchical, human relations. People attain of the Five Phases (wood, fire, earth, metal, water) elaborates the Yin-Yang doctrine and at the same time adds the important concept of rotation, i.e., that things succeed one another as the Five Phases take their turns: wood produces fire, fire earth, earth metal, metal water, and water wood.

The Five Phases were believed to lie behind every substance and every process. Things behaved in particular ways not necessarily because of the prior actions of other things, but primarily because their position in the ever-changing cyclical universe organized by the fivefold correlations. The doctrines of Yin-Yang and the Five Phases, which have been absorbed by Confucians and Daoists, became the repository of pseudo-explanations of natural phenomena and human affairs.

Confucianism was mainly concerned with the cultivation of moral virtues in individuals and with the maintenance this ideal state by studying the Confucian classics and observing Confucian rites. Confucianism favors past over present, orthodoxy and conformity over original and heterodox thinking, and the study of human relations and classic texts over the probing of nature. These Confucian attitudes do not foster science.

Another influential Chinese philosophy, Daoism, originated in antiquity. Dao means literally a way or path, and philosophically the truth or reality. As a way of life, Dao preaches simplicity, spontaneity, tranquility, weakness, and above all, non-action (Wu Wei). Non-action means taking no action that is contrary to Nature. It operates mysteriously and secretly without fixed shape; it follows no definite rules; it is so great that you can never come to the end of it; it is so deep that you can never fathom it. (*Huainanzi*, a Daoist text of 139 BC.)

The Daoist philosophy is embodied in a small classic called the *Laozi* or *Daodejing* (*Classic of the Way and its Virtue*), which is believed to have been written by Laozi in the sixth century BC. Examples of the teachings on the *Daodejing* are:

> There is no calamity greater than lavish desires.
> There is no greater guilt than discontentment.
> And there is no greater disaster than greed.
> He who is contented with contentment is always contented.
> The pursuit of Tao is to decrease day after day.
> It is to decrease and further decrease until one reaches the point of taking no action.
> No action is undertaken, and yet nothing is left undone.

These Daoism teachings contain gems of wisdom. But they seem to advocate people to be in tune with nature rather than actively probing it. They teach, "Do not seek to probe the workings of nature, and all things will then flourish of themselves." They do not advocate that people use their powers of reason and logic.

The Chinese were influenced also by Buddhism, which came to China from India during the Han dynasty (206 BC – AD 22). One of its sects, Chan, developed in China around the sixth and seventh centuries AD as an indigenous sect under the influence of Daoism. Chan Buddhism considers meditation, not the study of texts or chanting, as the best means of attaining a spontaneous intuition of one's own Buddha nature. The meditation is intense and prolonged and enlightenment may come either gradually or suddenly. Chan Buddhism views the visible world and existence as an illusion. It has had a salutary effect on painting and poetry but has not fostered science.

In early history, such Chinese world views may have been neutral to the development of science and technology, but when they were held for too long and too deeply, almost to the exclusion of new ideas from outside, they may have come to inhibit it. The correlative thought based on the Five Phases gained unusual currency and dominated thinking for an unusually long time in China because of the centripetally organized Chinese state and society. To conclude, it was Chinese worldviews and not Chinese characters that influenced how Chinese did, or did not do, science in the past. (Taylor, 1994, p.37) While Chinese ideology was contaminated with those beliefs embedded in traditional thinking, the Europeans underwent a great reformation of thought and culture towards the end of the Middle Ages. From the disintegration of the West Roman Empire in the fourth and the fifth century, the Middle Ages lasted until the fifteenth century, i.e., the period of Renaissance. The Dark Ages, formerly a designation for the entire period of the Middle Ages, now refers usually to the Early Middle Ages, when people's thought was severely controlled by the church. In the second half of the Middle Ages, especially when the Europeans rediscovered the civilization of their ancestors, science and technology in the West began to resuscitate. This period was not so dark as the early half, which was usually called the wakening period.

In spite of the fall of Roman Empire and the control by the church in the Middle Ages, the thought of ancient Greek science was partially preserved. Benedictine monasteries contributed much to the keeping of traditional culture and civilization. Those early monasteries later become the European universities. One of the most important channels by which Greek philosophy was transmitted to the Middle Ages was Boethius. He translated the logical writings of Porphury, a third century Neoplatonist, and Aristotle. His translations and commentaries on those writings brought about the rudiments of Aristotelian logic in Europe. In addition, from the Crusades and other sources, the Europeans had the opportunity of contacting Arab culture, and found the works of some Greek philosophers which had not survived in Europe but had been preserved in Arabic culture. Facing the splendid civilization of their ancestors, they tried to learn from the Arabic anything new and advanced. Until the thirteenth century, they had mastered all the advanced technologies, then including dynamical mechanism, iron casting, shipbuilding, and powder-making, etc. These technologies greatly promoted the development of productivity in Europe and accelerated the progress of thought emancipation of Europeans. So the classical Greek thought and philosophy of science were finally assimilated into the tenets of the Christian faith and gave an impetus to the development of science and technology in Europe.

The liberating developments of Europeans triggered a chain of social innovations that were beneficial for the later development of science and technology in Europe. Some independence from feudal rule was gained by the rising towns, and their system of guilds perpetuated the Christian and medieval spirit of economic life. A money economy weakened serfdom, and an inquiring spirit stimulated the age of exploration. Banking, the bourgeois class, and secular ideal flourished in the growing towns and lent support to the expanding monarchies. Security and prosperity stimulated intellectual life, newly centered in burgeoning universities. The church was weakened by internal conflicts as well as by quarrels between church and state. As feudal strength was sapped, there emerged in France and England the modern nation state. The transition from the medieval to the modern world was foreshadowed by economic expansion, political centralization and secularization. So it can be concluded that the Middle Ages were not the holocaust of science, but the gestation of a scientific revolution in Europe.

3. Educational system

Education also plays an important role in the development of scientific knowledge. At the end of the eleventh century, Europe began to establish universities. Of these, the most important were Paris and Oxford, formed during 1150-70 and in 1268, respectively. Scholasticism is the name given to the theological and philosophical teachings of the schoolmen in the universities. There was no one Scholastic doctrine; each of the Scholastics developed his own, which was often in disagreement with that of his fellow teachers. They had in common a respect for the great writers of old, such as the Fathers of the Church, Aristotle, Plato and Boethius. These they called "authorities." Their interpretation and evaluation of the authorities, however, frequently differed. They also shared a common style and method that developed out of the teaching practices in the universities. Teaching was done by lecture and disputation (a formal debate). A lecture consisted of the reading of a prescribed text followed by the teacher's commentary on it. Masters also held disputations in which the affirmative and negative sides of a question were thoroughly argued by students and teacher, before the latter resolved the problem. The seminar form remains as the main teaching and research method in most universities in Europe nowadays.

Greek and Arabic treatises had an immediate effect on the teaching of university teachers. Among them, Robert Grosseteste, the first chancellor University of Oxford, and his pupil, Roger Bacon, lay the foundation of contemporary scientific methodology. Grosseteste was deeply interested in the scientific method, which he described as both inductive and deductive. By the observation of individual events in nature, man advances to a general law, called a "universal experimental principle" that accounts for these events. Experimentation either verifies or falsifies a theory by testing its empirical consequences. For Grosseteste the study of nature is impossible without mathematics. Roger Bacon made the mathematical and experimental methods the key to natural science. The term experimental science was popularized in the West through his writings. For him, man acquires knowledge through reasoning and experiment, but without the latter he can have no certitude.

The education system in China is quite another picture. The members of Chinese civil service, the administrative system of the traditional Chinese government, were selected by a competitive examination – the civil-service examination. The Chinese civil system gave the Chinese empire stability for more than 2000 years and provided one of the major outlets for social mobility in Chinese society. The civil-service examination had almost the same life span until it was finally abolished in 1905 by the Qing dynasty in the midst modernization attempts.

The Qin dynasty (221-206 BC) established the first centralized Chinese bureaucratic empire and thus created the need for an administrative system based on talent to staff it. From then on, those desiring to enter the upper levels of the bureaucracy competed in the civil-service examination, which tested a candidate's knowledge of the Confucian Classics. The testing matter was limited to the Nine Classics of Confucianism. Furthermore, the examination became so stylized that the set form for an examination paper came to be the famous "eight-legged essay", which had eight main headings, used not more than 700 characters, and dealt with topics according to a certain set manner. It had no relation to the candidate's ability to govern and was often criticized for setting style above thought. For nearly 2000 years the best minds in China were devoting their brains, time, and energy to learn and memorize the ancient and archaic Confucian classics. Had all these talented people devoted their energies to the pursuit of science the situation in China would be much different from what it is today.

In general, in Chinese education from the Qin to the Qing Dynasty, learning cultural heritage, such as the Confucian classics and classic literature, was valued more than original thinking. This tradition was entrenched in the civil-service examination that tested mainly memorized knowledge of the classics. Teaching in schools in China tended to emphasize memorization of information rather than original thinking. The sciences in ancient China only reflected the concerns of the tiny literate elite and their theories. But, in Europe, teaching began to spur experimentation, inductive reasoning, and the mathematical approach to all natural phenomena since the late Middle Ages. Common people were encouraged to involve in scientific study and experiment.

Besides the factors mentioned above, some other political, social and economic factors should be blamed for the diminished development of science and technology in China. As Sivin (1990, p.166) pointed out "Some of the reasons for the reversal in technological preeminence are internal to China: centuries of disastrous fiscal and other administrative policies, the remorseless pressure of increasing population, and a large measure of social stability and cultural homogeneity that left traditional values and forms practically unchallenged as the creativity behind them was sapped by intellectual orthodoxies. Other reasons for the reversal arose in Europe, above all a universal quantitative and logical approach to empirical knowledge and practice that gradually redefined nature, reshaped society, and remade human consciousness".

Conclusion

The ups and downs of science and technology in China should be attributed primarily to the domination of feudalism in China for too long time, to the notorious civil service examination system, which catered to the interests of ruling classes, and especially to the ideology of the Chinese embedded in traditional thinking. Chinese characters, which have been in use for over four thousand years to record the greatness and trials of Chinese civilization, should not be blamed. The Chinese people are now striving to catch up with the West in science and technology. They see science and technology as the main route to economic advancement, for an individual as well as for a nation. They value education in science and engineering more than in social sciences and humanities and they do so more than do the Westerners. Especially in the noted College Entrance Examination, increasing focus is paid to examining students' creativity instead of memorized information. Perhaps because of all these efforts, at international competitions in science and mathematics students from China outperform those from the West. Chinese people are making these advances while using Chinese characters.

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