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Mathematics Development in China

Ade Nandang Mustafa
Beijing Normal University
adenmustafa@hotmail.com

Abstract

China has a very long history of contributing to human civilisation, including its contribution to mathematics development. The Chinese had discovered many essential theories and concepts in mathematics long before the more famous Western mathematicians. Many of China's theories and concepts thousands of years ago have become references to many Western mathematicians. This paper traces the development of mathematics in China from all the dynasties in its history, including the development of mathematical theory, mathematical texts, and the famous mathematical figures of his time.
Keywords: Ancient China, Mathematics Development

Abstrak

Cina memiliki sejarah yang sangat panjang dalam berkontribusi pada peradaban manusia, termasuk kontribusinya terhadap pengembangan matematika. Cina telah menemukan banyak teori dan konsep penting dalam matematika jauh sebelum matematikawan Barat yang lebih terkenal. Banyak teori dan konsep yang dikembangkan oleh Cina ribuan tahun yang lalu menjadi referensi bagi banyak ahli matematika Barat. Makalah ini melacak perkembangan matematika di Cina dari semua dinasti dalam sejarahnya. Termasuk teori matematika yang berkembang, catatan yang dibukukan, dan tokoh matematika yang terkenal di zamannya.
Kata kunci: Cina, Perkembangan matematika

Introduction

In China, mathematics was seen as a necessity and a utility. The mathematics education practice in China has attracted much attention not only from educational communities but also from society. The long history of Chinese civilisation has had an impact on how Chinese people think. The high achievement of Chinese students' abilities in math competitions in the world (such as IMO and TIMMS) is undoubtedly related to the developments in mathematics that have occurred throughout Chinese civilisation. One prominent example is the construction of the Great Wall around 220 BC; it is considered a triumph of engineering and mathematical calculation. Another example is sundials' construction. Abacus's use is also an example of mathematical

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advances in this region. The Chinese were one of the first civilisations to understand that calculations performed in a decimal system are more straightforward and effective.

The oldest suspected mathematical text is the Zhou Bi Suan Jing (The Mathematical Classic of the Zhou Gnomon and the Circular Paths of Heaven). It was probably compiled between 500–200 BCE (States et al., 2016). Some of China's oldest texts are preserved from that time, such as the Suan Shu Shu (a compendium), written on bamboo rods, about problems of basic arithmetic; and the Jiǔzhāng Suànshù or treatise on the nine chapters of mathematical art containing chapters dedicated to geometry, proportions, systems of linear equations. One of the most exciting aspects about this book is approximating the number pi and the "Gaogu theorem" in the Chinese version of the Pythagorean Theorem. There are still many examples of other texts that provide an overview of mathematics development in China – these books can be said to have fundamentally developed mathematical concepts.

The culture of carving and writing in Chinese society from ancient times allows historians to trace historical characteristics of each era. Likewise, in tracing the development of mathematics in China, through excavations carried out in modern times and collecting historical artefacts from each dynasty, historians have succeeded in tracking the developments. At least it can be known since a particular time the development of specific mathematics concepts such as the number system has occurred in China. Through historical artefacts, historians can predict what significant events occurred and how they influenced mathematics development in China and vice versa.

The Xia Dynasty Period (c. 2070-1600 BCE)

Xia Dynasty was considered as mythology prior the excavations at the end of the 20th century, which revealed the sites corresponding to the Xia Dynasty. In this dynasty, China began to have a form of government that regulated every aspect of Chinese society, such as economy, law, security, and education.

Although not much can be traced to the development of mathematics in the Xia Dynasty period, the study of mathematics was essential in the education of students even before the imperial system was adapated by China. Therefore, it is normal to assume that these developments continued during this period.

The Shang Dynasty (c. 1600 - c. 1050 bc)

The Shang Dynasty has heralded the Bronze Age in China. They became renowned for their innovations in mathematics, physics, artwork, and military technologies. People of the Shang Dynasty are thought to have used calendars and gained knowledge of astronomy and mathematics due to the inscriptions on archaeologists' tortoiseshell.

During this period, the Chinese already had a fully developed decimal system. There is proof of two numerological schemes, one based on numbers from 1 to 10 and the other on numbers from 1 to 12. Since the early times, the Chinese have understood basic arithmetic, algebra, and equations. Advanced arithmetic and algebra are used for astronomy and mysticism. Chinese were also one of the first to develop negative numbers using counting rods.

The early inscriptions of the numerals can be traced to the bone oracle of the Shang Dynasty. The oldest known form of enumeration dates from the Shang Dynasty was commensurate with the earliest known oracle bone script for Chinese characters. Most of the details on the Shang Dynasty comes from the comments of later scholars. However, many of the original oracle bones have been excavated, particularly from the capital of Anyang. Furthermore, around the year 1400 BC, there was evidence of using the abacus and the decimal system.

The Zhou Dynasty (c. 1050-256 bc)

Mathematics was one of the Liù Yì or Six Sciences; students were supposed to learn from the Zhou Dynasty. Learning all of them was necessary to be a true

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gentleman or, in Chinese, a "Renaissance Man" (Martzloff, 2006); the six arts are rooted in Confucianism.

By 770 BC, Zhou's official court had reduced its authoritative control over the growing number of dukedoms. This action was the primary year of what would later be called the Eastern Zhou Line (770-256 BC). This period would prove to be a significant five-century era for Chinese civilisation. This time of war was able to create a few rudimentary kingdoms that competed with rapid technological growth for unprecedented consistency. A few schools of thought, such as Daoism, Confucianism and Mohism, have started to question current social structures and ethical standards on the premise that human life is more widely understood and that society is moving forward. As for mathematics, a few advances made science more apparent to the commoner. During the 4th century B.C., the most accomplished decimal multiplication table discovered from archaeological discoveries was assembled.

The control board and control poles would be the most crucial numerical development of the Eastern Zhou system. One of a kind in the Far East, the Control Board, was the Largest Operating Machine from the Warring States period (476-221 BC) to the 15th century. Numbers are typically built with digits that correspond to the distinctive values of the group. This development was attributed to one significant development: the decimal positioning system. In the decimal positioning system, the number 9999 would, as it were, entail four items (but 20 poles to be checked). Not as it was, the check-board eased the expression of numbers, but the built-in collection of values resurrected the time of measurement. Besides, the rules on borrowing in subtraction can now be conveniently visualised. The control board designed different number-crunching algorithms as prescribed on the cutting edge day.

The Mozi (墨子) or Mohist canon (*Chinese overview - MacTutor History of Mathematics*, n.d.; Chung, 2010) is an ancient Chinese text from the Warring States

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period (476 – 221 BC). Mozi discusses different facets of several areas relating to physics, and also provides some information on mathematics. This discussion gives an 'atomic' definition of a geometric point, specifying that the line is split into parts. The part that has no remaining parts (i.e., can not be divided into smaller sections) and therefore forms the line's end is a point (Needham & Joseph, 1959). Like Euclid's first and third meanings and Plato's 'beginning of a line,' Mozi notes that 'a dot may stand at the end (of a line) "(Needham & Joseph, 1959) Similar to the atomists of Democritus, Mozi argued that the point is the smallest element which cannot be halved, since 'none' cannot be halved (Needham & Joseph, 1959). It is claimed that two lines of the same length would always terminate at the same place (Needham & Joseph, 1959), thus defining the comparison of lengths and parallels (Needham & Joseph, 1959), along with the theory of space and finite space (Needham & Joseph, 1959). It further highlights that planes of no standard of thickness can not intersect so they can not strike each other (Needham & Joseph, 1959). The book includes the description of the term for length, diameter, and distance, along with the concept of volume (Needham & Joseph, 1959).

The Warring States have seen the rise of sophisticated rational thought, in particular the portrayal of rationality and boundlessness. Several intellectual schools of the Warring Nations during those period were engaged in the craftsmanship of argumentation and semantics. The Mohist (墨家) and the Dialecticians (名辯家) have been most involved in writing their views on classes and communities, in particular on the concepts of universals and particulars. The rationalist Gongsun Long (c. 325-250 BC) mixed these type concepts with a refutation to establish generalised articulations, such as a white horse is not a horse (白馬非馬). In any case, more dominant schools of thought, especially Confucianism, subsequently expelled such articulations as verbal corruption. What is better than the "white horse case" is the confusion of the argument. The theory of uncertainty can be found in Han Feizi's law profession in the record. The story shows the arms merchant offering shields and

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lances. The merchant's arms glow so that his lances are so sharp that nothing can penetrate, while at the same time his shields are so strong that nothing can penetrate. This story, not as it is, is indicative of the meaning of inconsistencies but is the origin of the Chinese term for misunderstanding, Mao-dun (矛盾), which deciphers a spear and a shield.

The most recent archaeological discovery of Tsinghua Bamboo Slips dated c. 305 BC revealed certain pre-Qin mathematics features, such as the main established decimal multiplication table (Qiu, 2014). Ruler Wen of Zhou cites the most commonly used numerological details in China, and this content is called the Yijing or Book of Changes. Over the next three decades, the methods proposed by Yijing has received a great deal of mental focus. The book has made an intricate use of hexagrams for mathematics. The appearance of the Yijing to Europe in the middle of the 18th century was fascinated by European academics, particularly Gottfried Leibniz. Leibniz was shocked by the resemblance of the eight trigrams and the sixty-four hexagrams of the Yijing to his newly invented parallel number system. While trigrams and hexagrams were indeed embodiments of a dual structure, they were not logically used for computing.

Some paradoxes have been identified by the Daoist philosopher Zhuang Zhou (4th century B.C.). These catch 22s are due to his long-time friend and dialectician Hui Shi (c. 370-310 BC). In the last chapter of Zhang Zhou's book, Zhuangzi, what remains of Hui Shi's dumbfounding argument explicitly discusses the theories of the infinite and the microscopic. Hui Shi called what is so vast that there is no one beyond, the one of infinity, and what is so small there is no below, the one of littleness. In contrast, Hui Shi made a puzzle close to the paradox of the Greek logician Zeno Elea. One state: 一尺之棰，日截其半，萬世不竭 (A pole of one chi break every day does not cease to be cut after ten thousand eras).

This paradox is a reflection of the boundary of infinitesimal length. All these mathematical ideas appear to have been littered with random quotations and

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observations instead of scientific treatises. There is, however, one exception: the Mojing or the Mohist canon. The Mojing can be viewed as a treasure chest of scientific knowledge native to China. What distinguishes Mohists from other schools of thought is their commitment to natural science. Many schools of thought already recognise the value of empiric knowledge; thus, they ignore the need for theory. The Mohist philosophers have researched the mechanics of nature out of a need to learn the fundamental principles.

The Qin Dynasty (221-206 BC)

A standard weight system has been developed in the Qin tradition. Gracious Qin Tradition ventures have been crucial landmarks in human engineering. Emperor Qin Shihuang (秦始皇) directed many men to erect giant, life-size statues for the royal tomb in conjunction with other sanctuaries and the layout of the tomb was designed with geometric modelling expertise. It is one of the most remarkable accomplishments of human history, the Great Wall in China, included several numerical procedures. All Qin dynasty buildings and big projects used advanced mathematical equations for height, area and proportion.

Five hundred years of civil war led to the rise of Qin Shihuang, China's first emperor. In 27 years, Qin Shihuang has benefited from the best military capabilities and an unwaveringly powerful foreign stance to control all of China. With many socio-economic reforms, the legalism of Shang Yang, Han Fei and Li Si, and their strict meritocracy, transformed Qin's kingdom from the backwaters of China into an agricultural and technical powerhouse. Qin Shihuang was a famous figure in China's culture. He was the one who coined the Chinese name, but at the same time, he found himself a cruel tyrant. However, there is no evidence of any development in mathematics during the Qin Dynasty. There were undoubtedly two reasons for this: first, the short timeframe; second, the tremendous amount of transition. The Qin dynasty only lasted for 15 years, and Qin Shihuang only survived for four years. Most of the 15 years centred on standardising printing, weights and scales, roads and

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various mega-projects. There was no need for the development of a culture or the imagination of the mind. Besides, Qin Shihuang decided to eradicate many of the "antiquated" schools of thought. Later, mathematicians like Liu Hui accused Qin Court of burning mathematical texts within Confucian classics. While this claim may have been confirmed, it was not based on objective evidence.

The Han Dynasty Period

The abacus was first mentioned at the end of the Eastern Han Dynasty (25-220 A.D.) by the mathematician Xu Yueh (徐岳) (possibly improved but not invented). Numbers have been developed into a position value decimal method in the Han Dynasty and used on a counting board with a series of counting rods called chousuan, consisting of only nine space symbols on the counting board representing zero (Chung, 2010).

Negative numbers and fractions have also been introduced into the solutions of the great mathematical texts of the period (Needham & Joseph, 1959). The mathematical texts of the time, Suàn shù shū and Jiuzhang suanshu have addressed fundamental arithmetic problems such as addition, subtraction, multiplication and division (Needham & Joseph, 1959). Besides, square and cube root extraction processes were given, which were gradually applied to the solution of quadratic equations up to the third order (L Wang et al., 1955). Both texts have made considerable advances in Linear Algebra, i.e. solving equation structures of multiple unknowns (Branner, 2011). In both sources, the value of pi is assumed to be equal to three (Berggren et al., 2004). However, the mathematicians Liu Xin (d. 23) and Zhang Heng (78–139) provided more reliable approximations for pi than the Chinese used in the intervening centuries.

The Nine Chapters on Mathematical Art is a book of Chinese mathematics, the oldest archaeological date being 179 AD (traditionally dated 1000 BC), although probably as early as 300–200 BC (J. W. Dauben, 2013). Some Chinese mathematicians (for example, Liu Hui) claim that the foundation of the Nine Chapters was written

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around 1000 BC, and later some mathematicians contributed to it (Finashin, 2013). While the author(s) are anonymous, they have made a significant contribution to the Eastern world. Problems are presented with questions that are directly answered by responses and procedures (L. L. Yong, 1994). The text does not contain any formal mathematical evidence, only a step-by-step procedure (Straffin, 1998). Liu Hui's commentary offered geometric and algebraic proof of the problems in the text (Chung, 2010).

The Nine Chapters on Mathematical Art was one of the most famous mathematical books in China and consisted of 246 subjects (J. W. Dauben, 2013). For decades, this work has been used in schools, as its nine chapters are rich in substance, ranging from realistic regular adjustments to abstract mathematical statements (Yuan, 2012). It was then incorporated into the Ten Computational Canons, which later became the cornerstone of mathematical education (L. L. Yong, 1994). This book covers 246 topics relating to surveying, agriculture, treaties, infrastructure, taxation, estimation, equation solution and the properties of right triangles (L. L. Yong, 1994).

Suàn shù shū (The Book of Computations) is an ancient Chinese text of about 7,000 characters long mathematics, written on 190 bamboo strips (J. Dauben, 2008). It was discovered in 1984 when archaeologists discovered a tomb in Zhangjiashan, Hubei province. From historical records, this tomb is believed to have been closed in 186 BC, early in the Western Han dynasty (Needham & Joseph, 1959). Although its association with the Nine Chapters is still under debate, some of its contents are paralleled there. However, the text of the Suan Shu Shu is much less organised than the Nine Chapters and appears to consist of a series of brief, more or less independent pieces of text taken from several sources (J. Dauben, 2008). The Book of Computations provides a variety of observations into problems that can be expanded to the nine chapters of mathematical art (J. Dauben, 2008).

The Six Dynasties (220-589 A.D.)

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The Three Kingdoms (220-280 AD) were the first time in disunity. The era between the years 221 and 581 is known as the three kingdoms and six dynasties. During this time, China suffered internal divisions and attacks by several nomadic peoples (Tibetans, Turks and Mongols). This troubled time, however, did not put an end to mathematical practice. The mathematician Liu Hui (c. 260) lived during this period. Liu Hui (3rd century A.D.) was probably the most innovative mathematician in ancient China. Not long after the Han Dynasty collapsed, he was born into the family descendants of the Zixiang branch. Apart from the year he finished his commentary on the Jiuzhang Suanshu (263 AD), little is known about his personal life. However, Liu's mathematical ideas and works are well preserved and later disseminated to mathematicians. Without a doubt, Liu Hui left an irreplaceable mark on ancient Chinese mathematics culture. He explained and interpreted not only the methods, formulas, and theorems of the original book in a general way, but also systematically laid out the theoretical framework of traditional Chinese mathematics and mathematical concepts, and there are several developments in his discourse (Schwartz, 2008).

His commentary on the Jiuzhang Suanshu was Liu's most significant work. Liu Hui gave better explanations to the old Han algorithms and tried to create some geometric formulas. Using dissection arguments, he suggested using value 3.14 for pi and derived formulas to calculate pyramids and cones. Liu Hui expanded the Jiuzhang Suanshu by adding an appendix to the document, using the chongcha approach to construct more advanced surveying problems. The method of chongcha was a nascent form of trigonometry originating from the Han dynasty, according to Liu.

Another famous mathematician, Zu Chongzhi, invented the Da Ming Li in the fourth century. Precisely, this calendar was planned to forecast several cosmological cycles that will occur over some time. Liu Hui proved that the volume ratio of a right-angled square cone and a right-angled tetrahedron is always 2:1 by infinite segmentation, which solves the critical problem of regular solids volume. It is speculated that based on Liu Hui's cut circle technique, Zu Chongzhi calculated the area of the circle enclosing the regular 6144 and regular 12288 polygons, and obtained this result (Martzloff, 2006). He used the pi-algorithm of Liu Hui applied to the 12288-gon and obtained a pi value of 7 proper decimal places (between 3.1415926 and 3.1415927), which would remain the most accurate approximation for the next 900 years. Zu Chongzhi's work has enabled China to be about one thousand years ahead of the West in terms of pi calculation. His dissertation, Zhui Shu, was discarded during the Song Dynasty and lost to the mathematics syllabus. Many believed that Zhui Shu included formulas and methods for linear, algebra matrix, the algorithm for calculating the value of π, formula for sphere volume.

Sunzi Suanjing (Master Sun's Mathematical Scripture) is a mathematical text written between the 3rd and 5th centuries A.D. by the unknown mathematician Sun Zi (not to be confused with the 5th century B.C. general and military theorist). This book is divided into three sections, the last of which includes a set of arithmetic problems; this section contains 92 problems divided into three parts. The text refers to the Buddhist sutras, and the tax scheme levied in AD 280, suggesting that it was written during the Jin dynasty (AD 265-420).

Like Sun Zi, apart from his work, Zhang Qiujian Suanjing (lit. Zhang Qiujian Mathematical Scripture) is not known about Zhang Qiujian. It is unclear when this book was written, but some scholars settled down sometime around 468 AD. Many of the techniques used by Suanjing Zhang Qiujian can be traced back to the Han Dynasty.

Zhao Shuang, a Wu from the Three Kingdoms, was one of the first mathematicians to prove mathematical theorems and formulas in ancient China. His Pythagorean Theorem was proven, and his method embodied the theory of the principle of cutting and filling. Zhao Shuang has also suggested a new approach for solving quadratic equations using geometric methods. The "Pythagorean diagrams

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and notes" and "Hidaka graphs and notes" supplemented by him in the "Book of Zhou Ji Shu Jing" are significant mathematical literature. In "Pythagorean Circle Plots and Notes," he proposed five formulas to prove the Pythagorean theorem and the solution of Pythagoras with chord diagrams; in "Hidaka Plots and Notes," he used graphic areas to prove the weight difference commonly used in the Han Dynasty. Zhao Shuang's work is groundbreaking and occupies an important position in the development of ancient Chinese mathematics (Martzloff, 2006).

The Sui dynasty (581 to 618) reunited the country in 581. The Tang Dynasty (618-906) was followed. During that time, China underwent outstanding artistic (poetry and painting) and scientific advances and came into contact with other civilisations, such as Japanese, Korean, Indian and Arab. It was from this period that the text Jigu Suanjing-Continuation of Ancient Mathematics (around 625) appeared. It was written by Wang Xiatong and contained 22 problems with irrigation, granary construction, and right triangle solution. Also from this time appeared the Encyclopedia of Classical Mathematics from the Past-Suan Ching Shih Shu-The Ten Manuals of Mathematics.

Tang Dynasty Period

The Sui Dynasty and the Tang Dynasty ran the "Computation School" (L. Yong, 1970). The Ten Computational Canons was a collection of ten Chinese mathematical works compiled as official mathematical texts for imperial mathematics examinations by early Tang dynasty mathematician Li Chunfeng (李淳风, 602–670).

Wang Xiaotong was a great mathematician at the beginning of the Tang Dynasty, and he wrote a book, Jigu Suanjing (Continuation of Ancient Mathematics), in which numerical solutions appear for the first time in general cubic equations (Swetz & Liu, 1992). At the beginning of the Tang Dynasty, Wang Xiaotong wrote "The Ancient Classic of Suspension" which mainly discussed how to create a cubic polynomial equation geometrically through practical problems in the measurement

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of earthworks, engineering and civil engineering, and warehouse and cellar calculations (Li et al., 2019; Wang et al., 2017).

Though Chinese excelled in other mathematical fields such as solid geometry, binomial theorem, and complex algebraic formulas, early trigonometry was not as generally accepted as in contemporary Indian and Islamic mathematics (Mikami, 1913). Yi Xing, a mathematician and Buddhist monk, was credited with the calculation of the tangent table. Instead, the early Chinese used an empiric alternative known as Chong cha, while the practical use of plane trigonometry in the use of sine, tangent and secant was known (Karp & Schubring, 2014). Yi Xing was famous for his creativity and was believed to have calculated the number of possible positions in a go-board game (though he had difficulty expressing a number without a zero symbol).

In the Tang and Song Dynasties, the size of the mathematics school was further increased, reaching 200 students at peak time (Zhang, 2016). In 656, the Guozijian built a mathematics hall with a doctorate in mathematics and a teaching assistant. Tai Shiling Li Chunfeng and others compiled and commented the "Book of Ten Books", including "Book of Zhouyue", "Nine Chapters of Arithmetic", "Island Arithmetic", " Sun Zi Suan Jing, Zhang Qiu Jian Suan Jing, Xia Houyang Suan Jing, Qi Gu Suan Jing, Wu Cao Suan Jing, Wu Jing Arithmetic, and Suffix Shu, for students of the math school textbook. It has played a major role in the preservation of ancient mathematical classics.

When some of the significant astronomical observations of the Northern and Southern Dynasties started to be included in the calendar calculation at the turn of the Sui and Tang Dynasties, some essential mathematical achievements appeared in the Tang Dynasty calendar. In 600 AD, when Liu Ye of the Sui Dynasty invented the "Emperor's Calendar," he first suggested a formula for equal-interval quadratic interpolation in the world (Martzloff, 2006). This invention was a groundbreaking development in the history of mathematics. It has been developed into an unequal

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quadratic interpolation formula. Computer technology was further developed and popularised in the later Tang Dynasty, and some practical arithmetic books appeared.

The Song (960-1279) and Yuan (1279-1368) Dynasties Period

In 960, the establishment of the Northern Song Dynasty ended the secession of the Five Dynasties and Ten Kingdoms. Agriculture, handicrafts, and commerce of the Northern Song Dynasty had resulted in unprecedented prosperity, science, and technology advanced by leaps and bounds, and the three significant inventions of gunpowder, the compass, and printing were widely used in this economic boom. In 1084, the Provincial Secretary printed and published the Ten Books of the Abacus for the first time, and in 1213 Bao Gangzhi re-engraved it. These created the right conditions for the development of mathematics (Martzloff, 2006).

During the Song Dynasty and the Yuan Dynasty, four outstanding mathematicians emerged, particularly in the 12th and 13th centuries: Yang Hui, Qin Jiushao, Li Zhi (Li Ye) and Zhu Shijie. Six hundred years earlier, Yang Hui, Qin Jiushao, Zhu Shijie all used the Horner-Ruffini method to solve these types of simultaneous equations, roots, quadratic, cubic, and quartic equations. Yang Hui was also the first person in history to discover and prove the "Pascal Triangle" along with his binomial proof (although the first mention of the Pascal triangle was made in China before the 11th century A.D.). Yang Hui in "Details of the Nine Chapters Algorithm," he contained the diagram of Jia Xian's "origin of the open method, the example of the "multiplication method to find cheap grass" and the fourth method using the multiplication method (Martzloff, 2006).

Li Zhi, by contrast, investigated the form of algebraic geometry based on the tiān yuán shù. During this time, Guo Shoujing also worked on spherical trigonometry for accurate astronomical calculations. Chinese mathematicians have already discovered most modern western mathematics at this point in mathematical history. Things remained quiet for awhile until the Revival of Chinese math in the

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thirteenth century. The highlight of this period was Zhu Shijie's two books Suanxue qimeng and Siyuan Yujian.

In 1247, Qin Jiushao in the Southern Song Dynasty expanded the multiplication method in the Book of Numbers Nine chapters and defined the numerical solution of higher-order equations. He reports more than twenty solutions from higher-order equations in use, up to ten times. That was not until the 16th century that the Italian Scipio del Ferro suggested a solution to the cubic equation. Qin Jiushao was the first to use the zero sign in Chinese mathematics (Needham & Joseph, 1959). Before this discovery, empty spaces were used instead of zeros in the counting rod system (Needham & Joseph, 1959). Referring to Qin's solution of the fourth-order equation, Yoshio Mikami said, "Who can deny that Horner's exalted method was used in China at least six long centuries earlier than in Europe?"(Mikami, 1913). He collected 21 questions in the "Nine Chapters of Numbers" to solve the higher-order equations by using the multiplication and opening method (the highest order is 10) (Martzloff, 2006; Needham & Joseph, 1959). Qin has also systematically researched the principle of congruence and developed a method of solving simultaneous linear congruences (Clark et al., 2016; Martzloff, 2006).

The triangle of Pascal was first illustrated in China by Yang Hui in his book Xiangjie Jiuzhang Suanfa, although it was defined earlier by Jia Xian around 1100 (Needham & Joseph, 1959). Mathematician Jia Xian of the Northern Song Dynasty has developed an additive multiplicative method for the extraction of square root and cubic root, which has implemented the Horner rule (Martzloff, 2006). Although the Introduction to Computational Studies written by Zhu Shijie (13th century) in 1299 contained nothing new in Chinese algebra, it had a significant effect on the growth of Japanese mathematics (Needham & Joseph, 1959). Jia Xian also mentioned a table of binomial theorem coefficients, and a similar "Pascal triangle" appeared only in Europe in the 17th century.

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Ceyuan haijing is a compilation of 692 formulas and 170 problems related to the inscribed circle in the triangle, written by Li Zhi (1192–1272 AD) or Sea-Mirror Circle Measurements. He used Tian yuan shu to transform complex geometry problems into pure algebra problems. He then used Fan Fa, or Horner's system, to solve grade equations as high as six, although he did not explain his method of solving equations (Boyer & Merzbach, 1991).

Jade Mirror of the Four Unknowns was published in AD 1303 by Zhu Shijie of Yuan Dynasty (the date of birth and death is unknown), marking a peak in the growth of Chinese algebra. Four elements, called heaven, earth, man, and matter, represented four unknown of algebraic equations. It deals with simultaneous equations and equations with degrees as high as 14. It was not until 1775 that the Frenchman Etienne Bezout proposed the same solution. Zhu Shijie also studied the summation of the series of finite terms and based on this, the interpolation formula of high order difference was obtained. Zhu Shijie's representation of the quaternary high-order simultaneous equations is undoubtedly developed based on Tian Yuanshu, and he puts the constant in the centre. The powers of the quaternion are placed in four directions (above, below, left, and right), and the other items are placed in the four quadrants (Martzloff, 2006). Zhu Shijie's method is 400 years earlier than similar methods in the West.

In 1261 AD, Yang Hui of the Southern Song Dynasty (the date of birth and death is unknown) used the "stacking method" in the "Detailed Nine Chapters Algorithm" to find the sum of many forms of higher-order difference series. In 1274 AD, he also defined the "nine returning shortcuts" in "Multiplication and Division" and introduced various algorithms for multiplication and division calculation. In 1280, when Wang Yuan and Guo Shoujing of the Yuan Dynasty invented the "Time Grant Calendar," three interpolation formulas were established (Martzloff, 2006). Guo Shoujing has used the geometric approach to find two formulas that are identical to the existing spherical triangle.

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The Ming Dynasty (1368-1644)

Following the collapse of the Yuan Dynasty, China became wary of Mongolian-favored information. In favour of botany and pharmacology, the court turned away from mathematics and physics. Imperial tests included little mathematics, and recent developments have missed little. Martzloff (2006) writes: at the end of the 16th century, Chinese autochthonous mathematics, known by the Chinese themselves, was almost little, little more than an abacus calculation, while in the 17th and 18th centuries nothing could be paralleled with the groundbreaking developments in the theatre of European science.

Moreover, at the same time, no one could tell what had happened in the distant past, because the Chinese themselves had only a fragmentary knowledge of it. It should not be forgotten that autochthonous mathematics had not been rediscovered on a wide scale in China itself until the last quarter of the 18th century (Martzloff, 1997). As a result, scholars paid little attention to mathematics; prominent mathematicians such as Gu Yingxiang and Tang Shunzhi seem to have been ignorant of the Tian yuan shu (Increase Multiply) method. Without the auditors to explain to them, the documents quickly became incomprehensible; worse still, many of the problems may be answered by more straightforward approaches. Tianyuan tended to be numerology to the ordinary student. As Wu Jing put together all the mathematical works of the preceding dynasties in The Annotations of Formulas in the Nine Chapters of Mathematical History, he omitted Tian yuan shu and the Multiply Method (Needham & Joseph, 1959).

Scientific development has always been focused on computational techniques. In the 15th century, abacus came into pan type. Easy to use, yet practical and reliable, the rod calculation was soon overtaken as the preferred form of computing. Zhusuan, an abacus-based mathematical approximation, Inspired by several new works. Suanfa Tongzong (General Source of Computational Methods), a 17-volume work written by Cheng Dawei in 1592, has remained in use for more than 300 years

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(Needham & Joseph, 1959). Zhu Zaiyu, Prince of Zheng, used the 81-position abacus to calculate the square root and the cubic root of 2 to 25 digits of precision. While this shift from counting rods to abacus required reduced computation times, it may also have led to stagnation and decline in Chinese mathematics.

The rich pattern of counting rod numbers on counting boards has inspired many Chinese advances in mathematics, such as the principle of cross-multiplying fractions and methods for solving linear equations. Similarly, in explaining the concept of a matrix, Japanese mathematicians were influenced by the number rod shape. Abacus algorithms have not led to equivalent technology advances.

The Qing Dynasty (1644-1912)

Under the Western-educated Kangxi Emperor, Chinese mathematics got a fleeting period of official support (Martzloff, 2006). In Kangxi's guidance, Mei Goucheng and three other outstanding mathematicians compiled a 53-volume Shuli Jingyun (The Essence of Mathematical Study) (printed 1723) which provided a comprehensive introduction to western mathematical knowledge (Martzloff, 2006).

Mei Goucheng also created Meishi Congshu Jiyang (Mei's Compiled Works) at the same time. Meishi Congshu Jiyang was at the time an encyclopedic description of nearly all Chinese mathematics schools. Still, it also included the cross-cultural contributions of Mei Wending (1633-1721), the grandfather of Goucheng (Brucker, 1912)(Martzloff, 2006). The encyclopedias, however, were written no sooner than the Emperor of Yongzheng had taken the throne. Yongzheng brought a decisive anti-Western turn to Chinese affairs and removed most of the missionaries from the courthouse. With neither Western texts nor intelligible Chinese texts, Chinese mathematics has become stagnant.

In 1773, the Emperor of Qianlong decided to compile Siku Quanshu (Full Library of the Four Treasures). Dai Zhen (1724-1777) selected and re-read the nine chapters on mathematical art from the Yongle Encyclopedia and some other mathematical works from the Han and Tang Dynasties (Jami & Qi, 2003). Long-

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standing mathematical works by the Song and Yuan dynasties, such as Si-yüan yü-jian and Ceyuan haijing, were also discovered and published, which immediately led to the emergence of new research (Jami, 2011). Jiuzhang suanshu xicaotushuo (Examples of the Computation System of the Nine Chapters of Mathematical Art) contributed by Li Huang and Siyuan yujian xicao (The Detailed Description of Si-yuan yu-jian) by Luo Shilin (Mullaney, 2007).

After that, the succession of dynasties dominated China until 1912, when the monarchy was abolished. While this simple explanation may indicate a long period of peace in which Chinese culture and technology continued to grow peacefully, the empire has endured its fair share of rebellions, schisms, and reprisals.

Further Development

Although nearly sixty years since the establishment of the People's Republic of China, mathematics education has long experienced ups and downs due because of interruption from foreign educational thoughts and the internal political revolution; considerable progress has been made in mathematical research (Xie, 2009). Chinese mathematicians have exerted a significant influence on the world and Asia (primarily) Japan since the 6th century onwards (Kangsheng, 1988). In the early 1950s, Hua Luogeng's "Theory of Stacked Prime Numbers" [1953], Su Buqing's "Introduction to Projective Curves" [1954], Chen Jiangong's "Sum of Right-Angle Function Series" [1954], and Li Zhi's "Theory of Chinese Mathematical History" "Cong" 5 episodes [1954-1955] and other monographs were published. By 1966, published a total of about 20,000 mathematical papers had been published. In addition to continuing to make new achievements in disciplines such as number theory, algebra, geometry, topology, function theory, probability theory and mathematical statistics, and history of mathematics, breakthroughs have also been made in branches such as differential equations, computing technology, operations research, mathematical logic, and mathematical foundations. Many books have

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reached an advanced level in the world, and at the same time, a large number of outstanding mathematicians have been trained and teach in modern universities.

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