

# Comparison and Enlightenment of Fundamental Education System between China and America

## --Take Mathematics Education as an Example

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### Abstract

Mathematics education is an important part of fundamental education and the basis of science and engineering education. Mathematics fundamental education in China and the United States has gradually become one of the hot issues in the study of mathematics education. Mathematics fundamental education in China and the United States has their own characteristics in educational objectives, teaching contents, teaching materials and teaching effects. Comparing the mathematics fundamental education in China and the United States has great significance for China's mathematics fundamental education, in which, we should pay attention to the educational objectives; multidimensionality, giving full play to students' personality characteristics, emphasizing the flexibility of problem solving, improving students' mathematical literacy, advocating the diversity of teaching methods, and cultivating students' innovative thinking.

### Keywords

Fundamental education, mathematics, China and the United States.

### 1. Introduction

Since the 21<sup>st</sup> Century, with the progress of technology, education has become extremely important and as a fundamental curriculum, mathematics plays a tremendous role in education. Since 2000, for cultivating students' mathematical literacy and capacity, countries in the world have started the educational reform to strengthen mathematical fundamental education. In 2005, China promoted "Mathematics Curriculum Standards for Full-time Compulsory Education (test version)", called as "the standards (test version)" in following article. [1] By several years' exploring and modifying, the test version finished its mending in 2010, then it called for advices from the public, which the first version of "Mathematics Curriculum Standards for Full-time Compulsory Education (the revised version) came to the world; then it got approved in 2011 and was officially released to people: "Mathematics Curriculum Standards for Full-time Compulsory Education (Version 2011) [2]

In America, on 10 March, 2010, National Governors Association (NGA) and the Council of Chief State School Officers (CCSSO) jointly launched the "Common Core State Standards (Draft)" and collected opinions from the public. The standards on two basically course-standard systems (English Language Arts and Literacy in History/Social Studies & Science) covered K-12 grades. And the "Common Core State Standards for Mathematics (CCSSM)" were officially finalized and announced to the public in June, 2010, [3] which proved that the deep reform has always been proceeded on Mathematics. Based on China's condition, this article analyzes Chinese mathematics fundamental education from angles of educational purpose, contents and results by comparative study so as to better learn from other countries, improve the fundamental mathematics courses' settings and standards to improve children's core competitiveness on mathematics.

## 2. Comparison of Mathematics Education between China and America

Many domestic scholars compared courses on different subjects and grades between China and America. Yayun Qian (2018) made comparison and analysis on course objectives, teaching arrangement, course contents and course assessment in Chinese and American research universities [4]. Yao Zhao (2018) comprehensively analyzed reform purpose and its effects from the angle of Sino-US educational course reform [5]. Nana Luo (2015) compared the differences and similarity of Chinese and American basic course reform from six aspects including course objectives, course structure, course contents, course assessment, course management, course organizing and implementing etc. The scholars above made comparative analysis from different perspectives of courses, while they did not make detailed comparison on some particular course of one discipline. Lianghuo Fan (2005) put forward that mathematics is the foundation of many disciplines. This article focuses on mathematics education as a research object. Since 1980s, Chinese mathematics education has drawn international education circles and mathematics education world's wide attention, for one reason is that Chinese students have prevailed over western students in most international mathematic tests and Mathematical Olympiads and for another reason is that the learning elements such as the large-size classes teaching, teachers' controlling status on giving lessons and the machinery training to students are considered as strangling students' activeness and innovation for study. Since most references are concentrated on high-school and advanced mathematic courses and there are few comparative researches on mathematics fundamental courses between China and America, this paper analyzes elementary stages of mathematics education before middle school (middle school included) in China and in America means grades K-8 correspondingly from five aspects (teaching objectives, course contents, teaching methods, teaching effects and course assessment) of comprehensive comparison by comparative analysis. The comparative analysis is a kind of logical reasoning way combining the qualitative research and quantitative research. It means analyzing associated objects or phenomenon comparatively so as to find out the different and similar relations, the same laws and the specific essences. [8]

### 2.1 Educational Goals

The goal of mathematics education is a standard to be achieved by exponential mathematics education, reflecting a country's direction and expectation of mathematics education. Different scholars have different views on the similarities and differences of educational goals between China and the United States.

In China, Xinzhuang Wu (2018) put forward that target of mathematics course is to enable student to master necessary fundamental knowledge and skills, cultivate their own abstracting and inferential ability, develop their sense of innovation and practical ability, and promote students' emotion and value development. While its core objective is to cultivate students' key competence for mathematics as following: (1) the equity of mathematical educational opportunities enables everyone to accept good mathematical study and achieve an accomplishment [9] (2) mathematical education helps students learn fundamental knowledge improving their logic ability, thinking training, emotional and attitude cultivation. (3) Students are oriented to build an interest in studying mathematics in a good atmosphere created by advanced technology. According to the study on Chinese mathematics education objectives, it could be seen that China attached much importance to education fairness; its education objective combined educational universality and personalization, who not only highlighted universality education but also pay much attention to elite education. China's educational target setting emphasized on full-scale and application-oriented education. Purpose of Chinese mathematical education not only pay close attention to students' scientific thinking and ability, but also cared about students' development on values and study attitude. In this way, mathematics could lead students finding out questions, exploring questions and seeking out solutions; besides, it could also promote students cooperating with others. As thus, mathematics could be blended into students' daily life and improve their mathematics ability in daily life.

In America, in Yiming Cao, Lidong Wang, Paul Cobb (2010)'s opinion, it was a breakthrough that America took the mathematical thinking ability as the core of the mathematics education [10]. Qin Zhou and Dengmiao Yang (2010) thought that the objectives of mathematics education should highlight its applications for further education and careers [11]. Hence, the target of American mathematics education concentrates on cultivating students' mathematical ability, their understanding and the application for mathematics concepts, and besides the mathematical consistency and practicability.

By comparison, there are similarity in China and America's mathematical target settings: attach importance to students, highlight mathematics skills and ability; but American mathematics education lay more emphasis on mathematics application for solving practical problems, which has more practical significance.

## 2.2 Teaching Contents

In international mathematics competition, Chinese students excel than other countries', hence, many scholars make comparison on mathematics contents and course settings between China and America. Xinzhuang Wu (2018) has categorized Sino-US mathematics education as the following three parts: "number and algebra", "graphics and geometry", and "statistics and probability"; then he made the comparison analysis of the course contents from four aspects: breadth, depth, cognitive level and core knowledge [4]. Breadth of the course means the extent of scope and domain of the course which could be quantized as "knowledge points" [13].

As statistical results referring to the knowledge points in Sino-US middle school mathematical courses shows in table 1, from the breath of courses, Chinese knowledge points are two times as American's; in "number and algebra" and "graphics and geometry", the knowledge points are much more than American's, especially in Function. While, American courses lay much emphasis on "statistics and probability", and "equation and inequation"; from the comparison, it could be seen that Chinese middle-school mathematics courses concentrate on cultivating students' core competence, while American courses emphasize on mathematics practical application. The depth of the course means requirements for the course and intellectual depth when studying the course. [14], for instance, abstract degree of concept, and reasoning procedures of operation. American course settings are classified as 4 levels: understanding, comprehending, mastering, and applying flexibly. [15] According to the comparison, Chinese courses in "number and algebra", "graphics and geometry", and "statistics and probability" are inferior to American's; it could be seen that degree of Chinese course settings are far-ranging and easy, while American's are narrow and deep. On the basis of analysis of cognitive level and core knowledge, it could be found that Chinese courses highlight "graphics and geometry" and in the meanwhile, the learning depth for "graphics and geometry" is kept in comprehending level. American CCSSM emphasized on "number and algebra" and "statistics and probability" and the learning level is kept in applying flexibly.

Table 1 The statistical results referring to the knowledge points in Sino-US middle school mathematical courses (Xinzhuang Wu 2018)

Comparison contents	Chinese	Special instruction	American	Special instruction
Number and algebra	52	Number and form: 19 Equation and inequation: 13 Function: 20	45	Number and form: 19 Equation and inequation: 21 Function: 5
Graphics and geometry	89	Property of Graph: 55 Variation of Graph: 25 Graph and coordinate: 9	25	Property of Graph: 13 Variation of Graph: 3 Graph and coordinate: 3
Statistics and probability	11	Statistics: 9 Probability: 2	17	Statistics: 13 Probability: 2
In total	152		87	

### 2.3 Teaching Method

Mathematics education in China focuses on static acceptance of knowledge, while mathematics education in the United States focuses on dynamic mastery of knowledge; China is a model education, while the United States is an elite education. Most of Chinese middle school students passively accept the mathematics by teachers, while American students have better independent learning ability in mathematics. In Li Ren (2016)'s point of view, in China-US middle school mathematics teaching, both countries' teacher paid much attention to inducing and expository teaching. They would assign the coursework when students need. Meanwhile, they encourage students to voice their opinions about the course. The difference is that American classroom ambience is more easy-going; teachers tend to impel students to ask questions actively and the teaching process is carried out interactively between teachers and students when comparing with China's teaching [16]. Lili Zhang (2016) analyzed the influence of teaching methods by application of information technology in China-US middle school mathematics teaching. She found out that both countries have strongly supported the use of technology in mathematics except for electronic equipment such as calculators [17]. The application of information technology enriches the class and makes the teaching more vivid which stimulates students to absorb information; however it could be a barrier of interaction between students and teachers.

### 2.4 Teaching Effect

According to the mathematics learning between Chinese and American students, China's teaching is more focused on students' fundamental learning. Therefore, Chinese students laid a solid fundamental mathematics foundation while they normally have a rigid understanding towards math; they pay more attention to math problems and mathematical induction in books. As a result, Chinese students is hard to apply mathematics for problems faced in daily life.

American students are not as good as Chinese students in international mathematics competitions, while Chinese students need to be strengthened in mathematical thinking ability, mathematical literacy and innovation ability, and the ability to solve practical problems. Mathematics education in the United States responds to the call of "mathematics teaching services higher education and career". Hence, they emphasize mathematics teaching on application to practical problems; the students possess ability of solving math problems in life flexibly rather than stuck themselves in books.

## 3. Enlightenment

The purpose for the research on differences of Sino-US middle school mathematics courses is to make best use of mathematics education's advantages and bypass the disadvantages so that it could improve China's middle school mathematics education, cultivate more talents and integrate general education and elite education effectively.

### 3.1 Pay attention to the multidimensional education objectives and give full play to students' personality characteristics

In China, limited by national policies and the enrolment pressure, mathematics education is a test-orientated and rigid educational pattern; however, each student is an independent individual, who has different cognition, thinking and personal hobby; therefore, mathematics education should give consideration to fairness, universality and individual variation. Teaching objective settings should be multi-dimensional by interest learning groups to develop each one's mathematics potential, lead students experiencing the beauty of math, which not only could solve mathematics problems effectively, cultivate students' mathematics core competence, but also enable students experience the charm of mathematics in daily life.

### 3.2 Emphasize the flexibility of problem solving and improve students 'mathematical literacy

In America, mathematics education is much more flexible. They cultivate students to solve practical problems on the basis of each student's condition; besides, they encourage students to use math in daily life. China's mathematics education also need learn from American's to cultivate students'

ability of using math rather than keep math in books. Mathematics application could improve students' critical thinking, logical reasoning and judgment. In the future, it could better promote students' core competence instead of laying mathematics aside. China's middle school mathematics education need integrate mathematics and students' physical and psychological health.

### 3.3 Advocate the diversity of teaching methods and cultivate students 'innovative thinking

Multi-teaching method could better improve interactivity and interestingness of middle school mathematics education; moreover, the technology such as multimedia could also enrich class teaching and learning. In the meanwhile, textbooks' amendment could make teaching more vivid and interesting. Improvement on coursework could promote students' cooperation and their divergent and innovative thinking. To sum up, teaching methods' improvement could enhance students' mathematical literacy and their comprehensive abilities.

## 4. Conclusion

Mathematics basic education in the United States and in China have their own advantages. Comparing the two countries' mathematics basic education and exploring their respective strengths and weaknesses, we can get a lot of Enlightenment from them, whether for today's reform of basic mathematics education or for the education and teaching of front-line teachers.

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