# Research on the Reform of Mathematics Curriculum Standards for Chinese High School

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*Date of publication (dd/mm/yyyy): 26/12/2018*

*Abstract* – **With the development of globalization of knowledge and the mutual influence and promotion of education in various countries, in recent years, the new edition of the Curriculum Standard of High School Mathematics has been implemented in China. In this paper, we make a comparative study of the curriculum reform of mathematics in China from various perspectives, so that let the world understand each other about the reform and innovation of mathematics education all over the world.**

*Keywords* – **Core Literacy of Mathematics, Criterion for Curriculum and High School Mathematics.**

## I. INTRODUCTION

Mathematics is a science that studies the relationship between spatial form and quantity, and it is also a scientific language and an effective tool to depict natural and social laws. Mathematics is the basis of natural science, technological science and other sciences, and plays an increasingly important role in the development of economic science, social science and humanities.

With the progress of our economy, the problem of education that does not match is highlighted. Curriculum reform is the only way for quality education. In order to improve the mathematics quality of senior high school students and the breadth and depth of mathematics learning of senior high school students, to adapt the continuous development of society, we must rebuild the traditional classroom and carry out curriculum reform of senior high school mathematics.

The curriculum standard is the basic programmatic document of schooling, and the basic norm and quality requirement of the basic education curriculum. It is the chief gauge of textbook compilation, teaching, evaluation and examination proposition, as well as the basis of evaluation management and evaluation of curriculum.

In 2001, National Development Group of Mathematics Courses for Ordinary High Schools was set up in China. In April 2003, the "Full-time Mathematics Course Standards for Ordinary High Schools (Experiments)" was promulgated, which guided the practice of curriculum reform for more than ten years in Ordinary High Schools, and adhered to the correct direction of reform and advanced educational concepts. The curriculum system of ordinary senior high school has promoted the renewal of mathematics education concept, the reform of talent cultivation mode, the overall level of mathematics teachers, the reform of talent cultivation mode, the overall level of teachers, the reform of mathematics examination and evaluation system. It has made positive contributions to improving the quality of Chinese basic education. However, in the face of the rapid development of economy, science and technology, profound changes in social life, the new requirements of the new era for improving the quality of all the people, the mathematics standard experimental draft still has some incompatibiliti--es. Facing the new requirements for improving the quality of personnel training, and the new situation of the basic popularization of high school education in China, the general high school mathematics curriculum program needs to be improved. In 2013, the Ministry of Education launched the revision of the curriculum of ordinary high schools. This revision summarizes in depth the valuable experience of the reform of mathematics curriculum in senior high schools since the 21st century, draws on the excellent achievements of the reform of International Mathematics curriculum[1]-[4]. It strives to revise the program and standard of mathematics curriculum in senior high schools into a programmatic teaching document that not only conforms to the actual situation of our country, but also has an international perspective. The curriculum system of ordinary senior high school with Chinese characteristics has been officially issued and implemented in 2017.

Based on the education reform in the new era, this paper mainly studies the following contents. Firstly, we analyze the differences between the experimental version of senior high school mathematics curriculum standards and the new curriculum standards implemented in 2017 from multiple perspectives. Secondly, we compare the curricu--lum settings and teaching objectives of senior high school mathematics before and after the curriculum reform, and at last illustrate the effect of the curriculum reform through specific case analysis.

## II. COMPARATIVE ANALYSIS OF THE STRUCTURE AND CONCEPT OF THE TWO CURRICULUM STANDARDS

High school mathematics curriculum plays a fundamen--tal role in understanding the relationship between mathematics and nature, mathematics and human society, understanding the scientific and cultural value of mathematics, improving the ability to raise, analyze and solve problems, forming rational thinking, developing intelligence and innovation consciousness. In addition, high school mathematics curriculum is the foundation of learning physics, chemistry, technology and other courses and further learning in senior high school. At the same time, it also lays the foundation for students' lifelong development, forming a scientific world outlook and values, and is of great significance for improving the quality of the whole nation. [5]

A. *Comparative analysis of Structure and properties*

From the perspective of the structure of curriculum standards, the 2017 edition of mathematics curriculum standards for general senior high schools has added three important parts: core literacy of Mathematics (it includes Mathematical abstraction, logical reasoning, mathematical modeling, intuitive imagination, mathematical operations, data analysis), curriculum structure and academic quality. At the same time, curriculum standards have also given relevant cases around core competence and teaching evaluation to help senior high school mathematics teachers better implement in the process of teaching practice. This is in line with the world's advanced mathematical education concepts. [6,7]

From the perspective of curriculum nature, in the nature of the 2017 curriculum, the social and educational functions of mathematics curriculum are clearly defined. It is emphasized that mathematics curriculum in senior high schools is the main curriculum in general senior high schools after the compulsory education stage, which is basic, selective and development. Compulsory courses are designed for all students to build a common foundation, select compulsory courses, elective courses, fully consider the different growth needs of students, and provide a variety of courses for students to choose independently. High school mathematics courses create conditions for students' sustainable development and lifelong learning.

B. *Comparative analysis for the Curriculum Ideas of two Edition Curriculum Standard.*

The core guiding principles of both two curriculum standards are: student development oriented. The new curriculum standard emphasizes teachers focusing on cultivating students' core competence rather than the development of students' ability, advocating independent thinking and learning, and collaborative learning mode. Moreover, in the process of education, new curriculum standard pay attention to process evaluation to promote mathematics core literacy level at different learning stages.

## III. CONTRASTIVE ANALYSIS OF MATHEMATICS CURRICULUM AND TEACHING OBJECTIVES

A. *Contrastive analysis of New and Old Curriculum Objectives.*

First of all, Curriculum objectives have changed from "double base"(basic knowledge and basic skills of Mathematics) to "four base" (basic knowledge, basic skills, basic ideas and basic activity experience of mathematics) and "four energy" (ability to analyze and solve problems and ability to discover problems ability to ask questions). It is proposed that students should learn the basic knowledge, basic skills, basic ideas and basic activity experience necessary for their further study and future development through high school mathematics curriculum, and that they should be able to discover and raise problems, analyze and solve problems from a mathematical point of view.

Secondly, curriculum objectives have changed from im-

-proving mathematical ability to developing mathematical literacy. In the process of learning mathematics and applied mathematics, students can develop core qualities of mathematics such as mathematical abstraction, logical reasoning, mathematical modeling, intuitive imagination, mathematical operation, data analysis and so on. (Briefly arranged as Table 1).

Table 1. Comparison of Course Objectives.

| | New curriculum objectives | Old curriculum objectives |
|---|---|---|
| Main difference 1 | "Four bases" | "Double base" |
| Main difference 2 | To develop mathematics core Literacy | To improving mathematical ability |

B. *Contrastive analysis of Senior High School Mathematics Curriculum Structure*

The curriculum structure has changed a lot. The curriculum in the past has been optimized, some teaching contents have been deleted, and the opportunities for students to choose independently have been increased. It is no longer confined to arts and sciences. [8, 9] Giving students the right to choose courses they are interested in, students can get a better all-round development.

Compared with the old version, the following courses were deleted in the curriculum standard of the 2017 edition: Preliminary Algorithms in Compulsory 3, Most of the contents of solving triangles and inequalities in Compulsory 5 were deleted, Reasoning and Proof in Elective 2-2, Elective Geometric Proof in Elective 4-1, Coordinate System and Parameter Equation in Elective 4-4, and Elective Amendment 4-5, "Selection of Inequaliti--es".

The new addition of full-scale quantifier and existential quantifier, binary inequality and linear programming, the nature of the function into the triangular function to understand the periodicity of the function, increased the function model, "triangular representation of complex numbers", knowledge point statistical chart added "combi--ng the statistical chart learned in compulsory education stage", mathematics. Inquiry, mathematical modeling and mathematical culture are important contents throughout the high school mathematics curriculum. [10]These contents are not set separately, but permeate each module or topic. Addition of "mathematical induction method", sequence limit, function limit of a small amount of content.

## IV. TEACHING CASE

CLASS 'Viewing Quadratic Equation with One Variable from Functional Perspective'

[*Teaching Objectives*] In the old version of the curriculum standard, it is required to sum up the relationship between the number of intersections of quadratic functions and x-axis and the number of roots for a quadratic equation with one variable, meanwhile to know when the equation has two different real roots, two

equal real roots and no real roots. Also it is required to use the graph to find the approximate solution of a quadratic function with one variable. Procedures and methods: We need to go through the process of exploring the relationship between quadratic function and quadratic equation of one variable, and understand the relationship between equation and function. In the aspect of emotional attitude and values, we can experience the idea of combination of numbers and figures by observing and discussing the roots of the unitary quadratic equation.

The teaching objectives in the new edition emphasize that (1) we can understand equations and inequalities from the point of view of functions, understand the importance of functions and the relevance between mathematical knowledge, and grasp the nature of equality and inequality. (2) In this section, the core qualities of mathematical abstraction, logical reasoning, mathematical operation and mathematical modeling are gradually improved. Learn to observe the world with mathematical eyes, analyze the world with mathematical thinking, and express the world with mathematical language. (3) Enhance students' interest in learning mathematics, enhance their self-confidence in learning mathematics well, develop good habits of learning mathematics, establish a scientific spirit of daring to question, good at thinking, rigorous and realistic, and recognize the scientific value, application value and cultural value of mathematics.

[*Key and Difficulty*] In the old version of the curriculum standard, (1) Emphasis: grasp the relationship between the equation and the function, and use the graph of quadratic function to find the approximate solution of quadratic equation of one variable. (2) Difficulties: the relationship between the number of intersections and the number of roots of quadratic equation with one variable.

In the new edition of the curriculum standard (1) the key point is to find out the relationship between zeros of functions and roots of equations by judging the roots of one-variable quadratic equations with images. (2) Difficulties: the transformation of the quadratic equation of one variable and the quadratic inequality of one variable.

[*Instructional Design*] In the past, this lesson followed the pattern of "problem situation-building model". By discussing "rectangular area problem", the students realized that some problems in daily life can be solved by equation, some problems in life can be solved by equation, and the equation comes from practical problems. Guiding students to analyze the meaning of the problem, find out the equal relationship and equation, enrich students' feelings from the problem to the unitary quadratic equation, and experience the model idea of the equation. The concepts of quadratic equation of one variable are summarized.

After the new edition of the curriculum standard, this lesson combines the image of the quadratic function of one variable to judge the existence and number of the roots of the quadratic equation of one variable, and to understand the relationship between the zeros of the function and the roots of the equation. From discussing the specific change of quadratic function of one variable (coefficient determination) as a situation, the students are guided to

discover the relationship between quadratic function of one variable and quadratic equation of one variable, and the concept of quadratic inequality of one variable is introduced. Then the students are further guided to explore quadratic function of one variable (coefficient unknown) and quadratic equation of one variable and quadratic equation of one variable. The relationship between inequa- -lities is summarized, and the procedure of solving inequalities by quadratic functions of one variable is summarized. The teaching of this concept course breaks away the cumbersome training mode, enables students to experience the process of problem situation and mathema- -tical model, strengthens the thought of equation model, obtains more methods and experience of solving problems, and enables students to better understand the value of mathematics.

[*Analysis*] In the example of the unitary quadratic equation, we can see that although the old curriculum standards in the teaching objectives, the three-dimensional objectives of students are very clear and comprehensive, but there are also levels of knowledge inculcation, and the content of learning is also limited. In the new version of the curriculum standard, the unitary quadratic equation and the unitary quadratic inequality are linked and compared. In teaching, students are encouraged to explore independently and cooperate in research. According to the orientation and educational value of the content, we should pay attention to the cultivation of the core quality of mathematics. Students should gradually develop the learning habits of logical reasoning, independent thinking and cooperative communication by means of intuition, so as to guide students to understand the characteristics of mathematics curriculum in senior high school and adapt to the learning in senior high school. This section helps students to understand one-dimensional first-order equation and one-dimensional first-order inequality with one-dimensional first-order function, and one-dimensional quadratic equation and one-dimensional quadratic inequa- -lity with one-dimensional quadratic function. By sorting out the relevant contents of junior high school mathematics, understanding the relationship between functions, equations and inequalities, understanding the integrity of mathematics, improve mathematical operation literacy. Through the study of mathematics curriculum in senior high school, students can improve their interest in learning mathematics, enhance their self-confidence in learning mathematics well, form good habit of learning mathematics, develop their ability of self-learning, establish the scientific spirit of daring to question, being good at thinking and being rigorous and realistic, constantly improve their practical ability and enhance their awareness of innovation, understand the scientific value, application value, cultural value and aesthetic value of science. Guiding students to discover and understand that mathematics is an integrated whole, and the content of learning is intrinsically linked. Through training students' overall outlook and comprehensive thinking, mathematics literacy has been greatly improved.

## V. Conclusion and discussion

With the emergence and development of more and more interdisciplinary disciplines, the application of mathemati--cs is more and more extensive. With the globalization of knowledge, schools are required to develop the core literacy of students. For these reason, the Ministry of Education has revised the curriculum of ordinary high schools. This paper mainly studies the comparison of the new and old mathematics curriculum standards in high schools in China. In the process of continuous develop--ment in China, China's education is also progressing. Through the change of the curriculum standard of high school mathematics, we can see that China's demand for talents in the new era.

## Acknowledgment

## References

[1] Morris Kline. Mathematics: A Cultural Approach. Addison-Wesley, 1962.
[2] Ole Skovsmose, Mathematical literacy and Globlisation. Chapter one from book 'Internationalisation and Globalisation in Mathematics and Science Education'. Springer, 2007, pp. 3-18.
[3] V.J. Lyle, C.D. Ernest, B. Aloha, etc., "Mathematics and Science Test Scores as Relater to Courses Taken in High School and Other Factors". Journal of Educational Measurement, 2010, Volume 23, Issue 3.
[4] Fish, Michael Charles, "Promoting Critical Mathematics Literacy in Secondary Mathematics Teacher Education." Proquest Llc, 2012.
[5] O. Publishing, PISA 2012 assessment and analytical framework: mathematics, reading, science, problem solving and financial literacy. Oecd Publishing, 2012, pp. 264.
[6] Furuto, H. L Linda, a Study of the Privatization of Mathematics Education in Japan and Lessons for the U.S. International Journal for Mathematics Teaching & Learning, 2014.
[7] Granucci, Nicole, Gorjian, V, Paulsen, etc., "NITARP Alignment with Common Core Literacy and Mathematics Standards." American Astronomical Society, 2014.
[8] Sunisa, Sumirattana, Aumporn Makanong, Siriporn Thipkong "Using realistic mathematics education and the DAPIC problem -solving process to enhance secondary school students' mathematical literacy." Kasetsart Journal of Social Scienc--es, Volume 38, Issue 3, September–December 2017, Pages 307-315.
[9] Ministry of Education of the People's Republic of China. Mathematics Curriculum Standards for General Senior High Schools. Beijing: People's Education Press, 2017.
[10] Temple, C (Temple, Codruta) [1] ; Doerr, HM (Doerr, Helen M.) [ 2 ], How Do Teachers Develop and Enact a Disciplinary View of Literacy in Mathematics JOURNAL OF ADOLES CENT & ADULT LITERACY. Volume 61: 5 pages: 483-488 2018.

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