Research process, Changes and Implementation of Mathematics Curriculum Standard of China

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Abstract

This paper introduces briefly the research process, changes and implementation of mathematics curriculum standard of China. The paper consists of four parts. The first part outlines the research process and mechanism of curriculum standard of both compulsory education and senior high school education in the hope of shedding some light on mathematics education in China. The second part is focused on the major changes in Chinese mathematics curriculum standard such as curriculum sense、objectives、contents and teaching methods, etc. In the third part the author gives a detailed account of some implementation work including social dissemination, textbook editing, teacher training, and experience sharing, etc. The curriculum reform is an government action carried out from top to bottom, while curriculum implementation should be carried out in both ways, i.e. from top to bottom and from bottom to top. Here two projects are described. They are the project of teaching research mechanism on school base and the project of long-distance training on the Internet. In the last part some problems are discussed.

Kay wards: mathematics curriculum standard, change, implementation

1、Research process and mechanism of mathematics curriculum standard of China

1.1、Background of reform

To draw up the mathematics curriculum standard, we should first take into account the scientific, economical and social changes of our age. Since the 1950's science and technology have been developing at an increasingly fast speed, which turns many of our dreams into reality, to name a few, man's setting foot on the moon and the rapid development in information technology. Along with the development in science and technology, social economy has also achieved enormous progress. Such changes in both technology and economy result in great social changes. " People-orient" has become the fundamental principle in dealing with all kinds of social problems.

Knowing the development of mathematics is of essential importance for us. In the 20th century, mathematics has achieved unprecedented progress. Many famous "open problems" are have been solved, such as Fermat' great problem. Mathematics is beginning to play an important

role in more and more fields. Moreover, the role of mathematics is no longer restricted to science and technology. “High-tech is inherently the technology of mathematics.” It is widely accepted. In many aspects, “ mathematics is directly producing social assets.”

We should also be aware of the changes in China. In the last thirty years, China has shifted from planning economy to market economy. Besides, China has achieved dramatic progress in science, technology, economy, as well as education. The ratio of university recruitment has reached 20%, ten times more than that of the 1960’s. The development of the country require the cultivation of creative talents.

These changes make us reflect on our education in general and the education of mathematics in particular.

1.2 Research process and mechanism

Towards the end of the twentieth century the Education Ministry put forward literacy education for all-around development specially in elementary education and established a series of policies which was put into effect to promote the education for all-around development. One of the documents is “The Elementary Education Curriculum Reform Program”. The program raised an important task to draw up curriculum standard of all subjects in the elementary education and establishes the objectives of curriculum standard, as well as work mechanism.

- **Objective of establishing curriculum standard**

To establish a new curriculum which can meet the requirement of the 21st century and which reflects the nature of elementary education and the spirit of quality education in an attempt to promote the all-round development of every student and to enable them to become the master of their own learning.

- **Setting up the research group**

In March of 1999 the national research group of mathematics curriculum standard came into existence. The research group consists of 15 core members in which the proportion of members between university and elementary, middle school is about seven to three. The research group also invited some other researchers like classic researchers to take part in the research work, which brought about some good research results.

In January of 2000, the Ministry of education started to set up the research group of all the subjects in senior high school. Through bidding and evaluation, the research group was finally established in April of 2000. The 19 core members of the research group, coming from normal universities, middle schools, publishing houses, examination centers, are mathematicians, researchers in mathematics education, teachers, teacher trainers, researchers in testing, etc. Including the peripheral personnel, more than a thousand people got involve in the drawing up of the curriculum standard.

- **The research group develops some fundamental study and some special study. The study topics are as follows.**

List of fundamental study topics:

1、New development of international mathematics curriculum reform

2、Evaluation of Implementation Status quo of Chinese Mathematics Curriculum

3、Relation Research between Mathematics curriculum and psychology development rule of student of elementary、middle school.

4、21st Century Social Development and Forecast Analysis of Requiring Mathematics

5、Modern Society, Economics, Science, Technology, Mathematics Development and Mathematics Curriculum of Elementary and Middle School

6、International Comparison Research of Mathematics Curriculum

List of some special study topics:

7、Mathematics Curriculum Harmony Research of Compulsory education Stage and Senior High school Stage

8、Mathematics Curriculum Content Research Of Compulsory education Stage and Senior High school Stage

9、Mathematics Curriculum Evaluation Research

10、Experiment Research Of New Content (for example: Algorithm, some content of statistics and probability, some content of calculus, some topics taking as an elective course, etc.)

- **Teaching Experiment**

We carried out experimental teaching of new contents (for example, Algorithm, some contents of statistics and probability, some contents of calculus, some topics taking as an elective course, etc.) in more than 40 schools from three provinces（Beijing、Guangdong、Xinjiang province） and invite some teachers to teach these new contents.

- **Draft and version of mathematics curriculum standard**

We have undergone more than ten times of modification to get mathematics curriculum standard (experiment version) done. In this process we arrange a series of symposiums to hear the opinion from teachers、educators、mathematicians、scientists、engineers、enterprisers, etc. We also discuss with foreign experts who come from countries like France, Germany, Japan, Korea, Netherland, Russia, Singapore, United States of America, etc , and some regions, for instance, Hongkong, Macao and Taiwan. The Educational Ministry of China organizes the highest level of experts and official to examine and checkup formally the mathematics curriculum standard of China.

2、Major changes of the mathematics curriculum standard

2.1 Major changes of mathematics curriculum rationale and objectives

While designing the mathematics curriculum, we mainly followed the following rationale:

1. Advocate the active role of the students and the leading role of the teacher. Emphasize the knowledge and skills, as well as the process of learning in which the students practise the ability to solve mathematical problems and accumulate the experience of mathematical activities. Meanwhile pay attention to the changes in students' values, affect and attitudes The realization of the three-dimension objectives will, in turn, enhance the all-round development of the students.

2. Focus on both the process of teaching and the process of learning, with more attention paid to the learning process in order to promote the students' learning ability. Advocate such learning

methods as active participation, inquiry, and cooperation. Emphasize the role of the integration of information technology and mathematics curriculum in enhancing both teaching and learning.

3. Stress the importance of fundamental knowledge, basic skills, living experience, and mathematical thinking. It is essential to develop students' application awareness and ability. The cultivation of students' creativity should be started from children. Emphasize students' ability to analyze and solve problems, but also their ability to discover and raise questions. Both the ability to deduce and ability to induce should be fostered in the students.

4. Provide a variety of coursed so as to cater for different personalities, interests and needs of individual student. In senior high school, an even larger range of choices should be provided.

5. Give prominence to the basic structure and the nature of mathematics while choosing the contents.

6. Establish a proper and scientific evaluation system which emphasizes both students' academic achievement but also their learning process.

In the following, we are going to introduce the rationale and objectives of mathematics curriculum standard (MCS) for compulsory education and senior high school education.

- Basic Rationale of compulsory education MCS

(1) The **mathematics curriculum** for the stage of obligatory education should exhibit fundamental, universal and developmental characters. It seeks to realize:

- ☺ Everybody learns valuable mathematics;
- ☺ Everybody can acquire mathematics essential to him or her;
- ☺ Different person can have different types and levels of development in mathematics.

(2) We cannot do without **mathematics** in our daily living, work and study. Mathematics helps us process data, engage in computation, draw inferences and prove hypotheses. Mathematical models can describe natural and social phenomena effectively. Mathematics casts the foundation upon which all major technological advances are anchored, and it furnishes languages, ideas and methods for the other sciences. Mathematics has special contribution in raising our inferential and abstraction capacities, imagination and creativity, etc. Mathematics is one of the human cultures, and its contents, thinking, methods and languages are important constituents of modern civilization.

(3) Contents of **mathematics learning** for school children ought to be realistic, meaningful and challenging. These contents should facilitate school children to engage actively in mathematical activities, such as observation, experimentation, guessing, hypothesis testing, inference making, and communication. Contents should be presented in different ways so as to satisfy the diverse learning needs of the students. Effective mathematics learning activities cannot simply rely on imitation and memorization. Instead, hands-on practical work, autonomous investigation and cooperative exchanges are important modes of mathematics learning. Because of the differences in cultural environment, family background, and ways of thinking, our children's mathematics learning activities should be animating, lively, active, self-initiative and filled with individual characters.

(4) **Mathematical instructional activities** should be based on children's cognitive developmental levels and built upon the knowledge foundation of their past experiences. Teachers should stimulate children's initiatives in learning, provide ample opportunities for children to participate and acquire widespread experiences in mathematical activities, help children genuinely understand basic concepts, mathematical thinking and methods, as well as master basic knowledge and skills in their autonomous explorations and cooperative exchanges. The children themselves are masters of their own mathematics learning, whereas teachers are organizers, facilitators and collaborators of mathematics learning.

(5) The primary aim of **evaluation** is to understand fully school children's processes of mathematics learning, stimulate children's learning and improve teacher's instruction. There is a need to establish an assessment system with multiple ways and objectives of evaluation. Not only learning outcomes, but also processes are emphasized in the evaluation of mathematics learning. Teachers should pay attention to both levels of children's mathematics learning and the emotions and attitudes exhibited during mathematical activities. Teachers need to help children understand their self-concepts and build up their confidence.

(6) Development of modern information technology has great impact on the values, objectives, contents and pedagogy of mathematics education. Design and implementation of mathematics curriculum should pay attention to the use of modern information technology. In particular, the effects of calculators and computers on contents and methods of mathematics learning should be sufficiently considered. There is a need to exploit and provide richer learning resources to the children, and to use modern information technology as a powerful tool for mathematics learning and problem solving. Teachers should endeavor to change school children's learning styles so that they are willing to invest more energy in realistic, investigative mathematical activities.

● Basic Rationale of senior high school MCS

1. Construct a common foundation, provide a platform for development.

Senior secondary education belongs to basic education. Senior secondary mathematics curriculum should exhibit fundamental characteristics, comprising two aspects of meanings: First, after the stage of obligatory education, there is a need to provide students a higher level of mathematical foundation to adapt to modern everyday living and future development, so as to allow them to acquire higher levels of mathematical literacy. Second, there is a need to prepare students to further their studies in mathematics. The senior mathematics curriculum consists of the compulsory series and the optional series. Compulsory series are meant to satisfy the common mathematical needs of all students, whereas the optional series are for the individual needs. It is noteworthy that the optional series are still fundamental to the needs of students' development.

2. Provide multifarious curricula, and adapt choices to the needs of individuals.

Senior mathematics curriculum should demonstrate multifarious and selective characteristics so that different students can have different developments in mathematics.

Senior mathematics curriculum should provide students room for selection and development. There should be a number of levels and type of choices so as to foster students' individual development and thinking pertaining to their future career planning. Under the guidance of

teachers, students can engage in autonomous selection of courses, and if necessary can undertake appropriate conversion and modification. At the same time, senior mathematics curriculum should reserve some room for the teachers and schools to devise curriculum development plans to enrich and perfect continuously the options provided to the students in accordance with the basic needs and individual conditions of the students.

3. Propose learning formats that are constructive, autonomous, and eager to explore.

Students' mathematical learning activities should not be constrained to reception, memorization, imitation and exercise. Instead, senior mathematics curriculum should promote ways of mathematics learning such as autonomous exploration, hands-on practical, cooperative exchange, reading and self-learning. These modes of learning can promote students' initiatives in learning so that under the guidance of the teachers the learning processes become one that are "re-create" in nature. At the same time, senior mathematics curriculum should set up learning activities involving mathematical explorations and mathematical modeling. This would not only create facilitative conditions for students to engage in constructive, self-initiated, and multifarious modes of learning, but also stimulate students' interests in mathematics learning, and encourage students during the learning processes to develop habits of independent thinking and constructive explorations. Through multiple formats of autonomous learning and exploratory activities, senior mathematics curriculum should strive to enable students to experience the processes of mathematical discoveries and creation, and to develop their innovation consciousness.

4. Pay attention to elevate students' abilities in mathematical thinking.

Senior mathematics curriculum should pay attention to elevate students' mathematical cognitive abilities, and this is a basic objective of mathematics learning. When we learn mathematics and use mathematics to solve problems, we are continuously involving in intuition and perception, observation and discovery, induction and analogy, spatial imagination, abstraction and generalization, symbol representation, computation and evaluation, data processing, deductive reasoning and proving, reflection and processes involving cognitive constructions. These processes are concrete demonstrations of one's mathematical cognitive abilities, and are instrumental to help students engage in thinking and making judgment of mathematical patterns implicit in objective objects and events. Mathematical cognitive abilities demonstrate unique functions in the formation of objective reasoning.

5. Develop students' mathematical application awareness.

Since the commencement of the second half of the 20^{th} century, immense development in mathematical applications is one prominent characteristic of development in mathematics. During the knowledge society era, mathematics moves from the backstage to the forefront. Integration of mathematics and information technology enables mathematics generating worth for the society in many aspects. At the same time, the prospect of mathematical development is widely extended. For a long period of time mathematics education in China has not been sufficiently emphasized, particularly in relating mathematics with practical reality and in connecting mathematics with other subject areas. Therefore, there is a need to enhance greatly mathematical applications and relate mathematics to reality in senior mathematics. Recently, practices of mathematical modeling at the secondary and university levels in China reveal that promotion of instructional activities of

mathematical applications fulfils the needs of the society, facilitates stimulation of learning interests in mathematics, enhances students' application awareness, and extends perspectives of the students.

Senior mathematics curriculum should provide practical backgrounds of basic contents to reflect the worth of mathematical applications, conduct learning activities of mathematical modeling, and set up some courses of special topics that exhibit some important mathematical applications. Senior mathematics curriculum should strive to enable students to experience the functions of mathematics in solving practical problems, and the connections of mathematics with everyday living and other subject areas, as well as to enhance students to form and develop application awareness progressively in mathematics, and practical abilities as well.

6. Keep in pace with society's progress to know the "Double Basics".

In China, there is a tradition of mathematics education paying particular attention to the teaching of fundamental knowledge, training of basic skills, and development of abilities. Senior mathematics curriculum in the new century should propagate this tradition. At the same time, due to advances of the era, in particular due to the widespread applications of mathematics and development of computer technology and modern information technology, there is a need to form new "Double Basics" that fulfils the needs of the era. For example, due to the needs to adapt to the development of the information era, senior mathematics curriculum should add contents of algorithms, so that the most basic information processing and statistical knowledge can be treated as new fundamental knowledge and basic skills in mathematics. At the same time, there is a need to cut and diminish complicated computations, artificial tactics-oriented difficult problems, and contents excessively emphasizing intricate details so as to conquer tendencies of phenomenon of "disorganization and disorientation of the double basics".

7. Emphasize nature of mathematics and pay appropriate attention to formalization.

Formalization is a basic characteristic of mathematics. During teaching of mathematics, learning how to express formalization is a basic requirement. However, expression of formalization should not be solely emphasized, and there is a need to pay attention to the nature of mathematics as well. Otherwise, animating and lively mathematical cognitive activities would be drowned in the sea of formalization. Modern development in mathematics makes clear that entire formalization is impossible. Therefore, senior mathematics curriculum should revert back to simplicity and truth, striving hard to reveal developmental processes and nature of concepts, rules, and conclusions in mathematics. Mathematics curriculum should include logical deduction, and emphasize reasoning as well. Through analyses of typical examples and students' autonomous exploratory activities, students are enabled to comprehend mathematical concepts and processes so that conclusions are drawn progressively, to realize the methods of thinking implicit in these concepts and processes, to quest for developmental trajectory of history of mathematics, as well as to transform mathematics from the academic to the more acceptable educational form.

8. Exhibit the cultural values of mathematics.

Mathematics is an important constituent of human culture. Mathematics curriculum should reflect appropriately the history, application and developmental tendency of mathematics. In

addition, it should reflect the function of mathematics in propelling social development and the social needs of mathematics. Apart from these, propelling function of social developments on mathematics developments, thinking system of the social sciences, the aesthetic value of mathematics, and the innovation spirits of the mathematicians are included as well. Mathematics curriculum should help students familiarize with the function of mathematics in the development of human civilization and the progressive formation of correct mathematical perspective. Because of these, senior mathematics curriculum should promote exhibition of cultural values of mathematics, propose appropriate contents like "mathematical culture" as learning requirements. There are needs to set up courses such as "selected topics in the history of mathematics".

9. Pay attention to the integration of information technology and mathematics curriculum.

Widespread applications of modern information technology are now exerting deep influences on contents of the mathematics curriculum, mathematics teaching, and mathematics learning. Senior mathematics curriculum should promote realization of organization of information technology and curriculum contents (e.g. algorithms are integrated with related parts in the mathematics curriculum). The basic rule of integration is to facilitate students to know the nature of mathematics. Senior mathematics curriculum should promote the use of information technology to display those contents that in the past may not be presented easily. After guaranteeing the prerequisite of training of hand calculations, students should strive to use scientific calculators, all sorts of mathematics education educational platforms, so as to enhance integration of mathematics teaching and information technology, encourage students to deploy computers and calculators to carry out explorations and discoveries.

10. Establish reasonable, scientific evaluation system.

Demand of human developments by the modern society has caused deep changes to the evaluation system. Senior mathematics curriculum should establish an appropriate and scientific evaluation system, including aspects such as concepts, contents, formats and systems of evaluation. Evaluation should not only pay attention to students' mathematics learning outcomes, but also to mathematics learning processes; not only pay attention to the levels of mathematics learning of the students, but also to the changes of affection and attitudes exhibited in mathematical activities. In mathematics education, evaluation should establish a variety of objectives, and pay attention to the development of students' personality and potentials. For example, process evaluation should pay attention to the evaluation of students' understanding of mathematics concepts and mathematics thinking processes. Teachers should pay attention to the evaluation of processes involving how students pose, analyze and solve problems mathematically, as well as to the processes exhibiting attitudes of cooperation with others, consciousness of expression and exchanges, and spirits of exploration. Regarding learning activities such as mathematical exploration and mathematical modeling, teachers should develop corresponding contents and methods of evaluation.

● Overall Objectives of compulsory education MCS

Through mathematics learning at the obligatory stage of schooling, students are able to:

☺ Acquire important mathematical knowledge (including mathematical facts,

mathematical activity experiences), basic mathematical thinking methods, and necessary application skills that are essential for adapting to future social life and further development;

☺ Begin to know how to deploy various ways of mathematical thinking to observe, analyze realistic world, solve problems encountered in daily living and studies in other disciplinary areas;

☺ Realize the intimate relationships between mathematics and nature, as well as between mathematics and human society, know the worth of mathematics, increase understanding of mathematics, and gain confidence in learning mathematics with good results;

☺ Possess some degree of creative spirits and practical abilities, and develop sufficiently in areas of general abilities, affection and attitudes.

The overall objectives are concisely stated below:

Knowledge and Skills

- Involve in processes of how authentic problem situations are abstracted as number and algebra problems; master fundamental knowledge and basic skills pertaining to numbers and algebra; able to solve simple problems.
- Involve in and explore the processes of how shapes, sizes and positions of objects and figures are related and transformed; master fundamental knowledge and basic skills pertaining to space and figures; able to solve simple problems.
- Involve in the processes of problem posing, data collection and processing, decision making and prediction; master fundamental knowledge and basic skills pertaining to statistics and probability; able to solve simple problems.

Mathematical Thinking

- Involve in the processes of applying mathematical symbols and figures to describe the phenomenal world; establish initial number sense and symbol sense; develop abstract mathematical thinking.
- Enrich knowledge of space and objects in the phenomenal world, establish initial space concepts; develop iconic mathematical thinking.
- Involve in how information is described by data processing and organization, as well as how inferences are made; develop statistical thinking.
- Involve in how observation, experimentation, guessing, and proving are done in mathematical activities; develop reasonable analogical and induction abilities and initial mathematical deduction ability; able to present one’s ideas systematically and clearly.

Problem Solving

- Begin to learn how problems can be posed and comprehended from the mathematical perspectives; able to apply knowledge and skills acquired for problem solving in an integrated manner; develop application awareness.
- Formulate some strategies for problem solving; experience that problems can be solved in a variety of ways; develop practical abilities and creative spirits.

- Learn how to cooperate with others; able to communicate with others about one's processes and products of thinking.
- Begin to form an awareness of evaluation and reflection.

Affection and Attitudes

- Able to participate positively in mathematical learning activities; demonstrate curiosity and eagerness in mathematics learning.
- Experience success in mathematical activities; develop strong will in overcoming difficulties; develop confidence in mathematics learning.
- Begin to know the intimate relationships between mathematics and human lives, as well as the values and influences of mathematics on human civilization; experience that mathematical activities are full of explorations and creative productions; sense the rigor of mathematical knowledge and appreciate the certainty of mathematics conclusions.
- Form an attitude that is pragmatic and realistic; develop habit of doubts and engage independent thinking.

The above-mentioned four objective areas should be regarded as an intimately interrelated organic whole. They are very important for human development, and should be realized in rich and wonderful mathematical activities. In particular, development of mathematical thinking, problem solving, affection and attitudes cannot be separated from knowledge and skills acquisition. Likewise, knowledge and skills acquisition needs to satisfy one prerequisite, i.e. to facilitate the realization of the other three objective areas.

- **Curriculum Objectives of senior high school MCS**

Overall objectives of senior mathematics curriculum are: Based on the foundation of the nine-year obligatory education mathematics curriculum, students move a step further to elevate their mathematics literacy necessary for future citizenship, so as to satisfy individual development and societal progress. Concrete objectives are listed as follow:

1. Acquire necessary fundamental knowledge and basic skills in mathematics; understand basic mathematical concepts and nature of mathematical conclusions; familiarize with the background of genesis and application of concepts and conclusions; realize mathematical thinking and methods inherent in mathematics, and the function they play in the ensuing studies. Through different forms of autonomous learning, exploratory activities, experience the processes of mathematical discoveries and creation.
2. Elevate abilities of spatial imagination; abstract generalization, deductive reasoning, computation and evaluation, and data processing.
3. Elevate abilities in posing, analyzing and solving problems (including simple and practical problems), abilities in mathematical expression and exchanges, as well as abilities in acquiring mathematical knowledge independently.
4. Develop mathematics application and innovation awareness; strive to engage in thinking and making judgments for some mathematical models implicit in the realistic world.
5. Elevate interests in mathematics learning; establish confidence in learning mathematics well;

form spirits of perseverance and dedication, as well as scientific attitudes.

6. Possess a certain degree of mathematical perspective; progressively recognize the scientific value, application value and cultural values of mathematics; form habits of critical thinking; pay high regard to the rational spirits of mathematics; realize the aesthetic meaning of mathematics, so as to move a step further to establish dialectical and historical world view of objectivism.

2.2 Major changes of mathematics curriculum contents

What we teach is more important than how to teach, so we spend a lot of time and energy to think what knowledge and skill should be in curriculum.

1) The changes of curriculum structure and selectivity

- **The change of curriculum structure of compulsory education**

The curriculum content in compulsory education consists of four parts: number and operation; graph and geometry; statistics and probability; integration and practice. The integration and practice become important content in mathematics curriculum and have concrete and special requirements in different learning stage. These are more different from before.

- **The change of curriculum structure of senior high school**

The curriculum content in senior high school consists of obligatory curriculum and elective curriculum. The obligatory curriculum contains five modules and the elective curriculum includes elective curriculum 1、2、3、4.

The compulsory curriculum comprises of 5 modules:

Mathematics 1: Set, concept of function, and basic elementary function I (exponential function, logarithmic function, power function).

Mathematics 2: Preliminary solid geometry, preliminary plane analytic geometry.

Mathematics 3: Preliminary algorithms, statistics, probability.

Mathematics 4: Basic elementary function II (trigonometric function), vectors on a plane, trigonometric identity transformation.

Mathematics 5: Solution of a triangle, sequence, inequality.

The elective curriculum 1 is for student of liking humanities and social studies and contains two modules. The elective curriculum 2 is for student of liking science and technology and contains three modules.

The elective curriculum 1 Consists of 2 modules.

Optional Study 1-1: Common logic terminology, conic section and equation, derivative and its application.

Optional module 1-2: Case studies of statistics, inference and proof, extension of number system and introduction of complex number, block diagram.

The elective curriculum 2 Consists of 3 modules.

Optional module 2-1: Common logic terminology, conic section and equation, vectors in space and solid geometry.

Optional module 2-2: Derivative and its application, inference and proof, extension of number system and introduction of complex number.

Optional module 2-3: Principle of enumeration, case studies of statistics, probability.

The elective curriculum 3 includes 6 topics:

3-1: Selected topics of history of mathematics

3-2: Information security and cryptogram

3-3: The geometry of the sphere

3-4: Symmetry and group

3-5: Euler's formula and classification of closed surfaces

3-6: Trisection of an angle and extension of a number field.

Student can select any topic in the elective curriculum 3 to study.

The elective curriculum 3 includes 10 topics:

4-1: Selected topics of geometrical proofs.

4-2: Matrix and transformation.

4-3: Sequence and difference.

4-4: Coordinates system and parametric equations.

4-5: Selected topics of inequalities.

4-6: Elementary number theory.

4-7: Optimum seeking method and preliminary experimental design.

4-8: Overall planning (critical path method) and preliminary graph theory.

4-9: Risk and decision making.

4-10: Switching circuits and Boolean algebra.

Student can select any topic in the elective curriculum 4 to study and these contents in the elective curriculum 4 can become a part content of promotion examination which student could selects.

2) To intensify mathematics major venation

We intensify mathematics major venations in mathematics curriculum, such as:

Operation----operation of numbers, operation of polynomials, operation of vectors, etc----application of operation—discussing equation、inequality、function.

Quantity、 Function(variety) 、Model----measure of quantity, conversion of difference measures of quantity--equality relationship of quantity(equation), inequality relationship of quantity(inequality), equality relationship of variety quantity(function)—model of distance、velocity and time, model of gross、price and quantity, a series of functions, etc.

Graph（geometry）----basic graphes and their basic properties and some angle of view to cognize and know properties of graph(transformation geometry、analytic geometry and vector geometry, etc)

Etc.

We arrange mathematics contents around these major venations.

3) To reduce some content in traditional mathematics curriculum and to add some content

For example, we reduce some contents of Euclidean geometry and add some contents of geometry transformation (reflection、translation and revolution) and vector geometry in different

stage.

We add some contents of algorithm and put idea of algorithm program to cognize process of problem solving.

Etc.

If someone will know the contents of Chinese mathematics curriculum standard in detail, please read English version of them.

2.3 Changes of teaching rationale

In curriculum standard we emphasize diversification teaching mode and manner. For instance, teaching with enlightening and illumining; teaching with collaborating and work together; teaching with exploring and probing into something; teaching with using a question for discussion and using a task to work together; etc. We can use different mode and manner to teach different content and we alternate using different mode and manner to teach in a class. We advocate grasping the all and the one of curriculum and learning cell (chapter) design to increase teaching efficiency. Etc .

2.4 Reform of assessment

Reform of assessment and evaluation is very hard and difficult work but we do not shy away and blench. We do our best to find a good way to assessment integration literacy and we also explore assessment of school work of student and explore assessment of school development. We will use other paper to introduce these.

3、Implementation of Mathematics curriculum standard

Up to now all student has already entered into implementation of compulsory education mathematics new curriculum and the student of senior high school in 15 provinces has already entered into implementation of senior school mathematics new curriculum. It is very important and difficult how to implement new curriculum when the curriculum standard has designed. As we know, the curriculum reform is the government action carried out from top to bottom. But curriculum implementation should be carried out in both ways, i.e. from top to bottom and from bottom to top. We like to introduce a detailed account of some implementation work including social dissemination, textbook editing, teacher training, and experience sharing, etc. Particularly we present tow projects, teaching research mechanism on school base and the project of long-distance training on the Internet, which are to be put forward according to Chinese practicality.

3.1 Social Dissemination

Curriculum reform is not only educational problem, but is also social problem. We need society understanding include、teachers、parents of student、educationist、mathematicians，etc. The Educational Ministry establishes a project of social dissemination and requires local government to emphasize social dissemination. This work exerts very important function in implementation of curriculum reform.

3.2Textbook Editing

In this curriculum reform The Educational Ministry establishes policy of diversification of textbook editing. This is big change. There have been 8 system of textbook in elementary school、6 system of textbook in junior middle school and 6 system of textbook in senior middle school. These textbooks have different characteristics and student of different place can select different textbooks.

3.3Manager and Teacher training of school in diversification mode and manner

As we know China is large country and there are more than twenty million managers and teachers of school. The problem of managers and teachers training is most important when the curriculum standard has designed. The training work is huge and includes a lot of problems which contain experts team, expenses, time, etc.

We must mobilize all levels of government and social potence including publishing company and specialty academy, etc.

The Educational Ministry establishes policy in three levels training, national level、province level and district level including many county. The Educational Ministry organizes core teachers training in national level and local government organizes other level training. Every teacher can get one time training at least.

3.4Professional direct and Experiment communication

The Educational Ministry organizes many different symposiums and proseminars to direct work of experiment districts and communicate some good teaching experience. The Educational Ministry ask local government to do same jobs. The most of members of research group of curriculum standard are major strength of specialty to support implementation of curriculum reform.

3.5“Grass Root Project”

The curriculum implementation should be carried out in both ways, i.e. from top to bottom and from bottom to top. “Grass Root Project” is work from bottom to up. There are two projects, the project of teaching research mechanism on school base and the project of long-distance training on the Internet, which are very important and powerful to put forward curriculum reform.

4、Problems and Reflecting

We are very honour to take part the work of research and implementation of mathematics curriculum standard. Through almost eight years work, we like to give some suggestions to leader of Education.

- To establish long cooperation and communication mechanism of mathematics and science education
- To establish an internet flat roof of resource sharing of mathematics and science education
- To establish the mechanism of cycle improving on curriculum standard of mathematics and science

- To develop foundational research of mathematics and science education including curriculum content(for example geometry, etc), teaching, evaluation, etc

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