

# Mathematics Education Reform in Mainland China in the Past Sixty Years: Reviews and Forecasts

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*In order to adapt to the development of society, the Chinese elementary and middle school mathematics education has experienced many significant reforms since the Peoples' Republic of China was established sixty years ago. These reforms have been both successful experiences and frustrating lessons. In order to further the healthy development of current mathematics education, it is necessary to make profound reconsideration of the past reforms. On the one hand, we should explain and reflect on Chinese mathematics education from our national conditions. On the other hand, we need to examine some superiority and limitation of Chinese mathematics education from the tendency of international mathematics education.*

**Key words:** mathematics education, reform, reconsideration, forecasts.

## **The Past Significant Mathematics Education Reforms in Mainland China**

The development of mathematics education reforms in mainland China is going along with the development of the nation, politics, economics and culture. According to this historical clue, mathematics education can be divided into the following stages:

### **Learning from the Soviet Union's Experiences Roundly**

In order to transfer the old-fashioned education to the socialistic educational track, the whole field of education has tended to learn from the Soviet Union since the early 1950s. Consulting the mathematics syllabus of ten-year elementary and middle schools of Russia, New China's first mathematics syllabus was made. Pedagogy (written by N.A.Kaiipob) and Mathematical Pedagogy for Middle Schools (written by Helena P. Blavatsky) were used by advanced teachers' schools and teaching training programs at that time. Elementary and middle schools' education was in conformity with the Soviet textbooks and teaching methods, featuring paying great attention to

the teaching of basic knowledge and basic skills as well as the scientific and precise arrangement of the textbooks (Ma, Wang, Sun, & Wang, 1991 ).

The references of the Soviet education model made China's mathematics education go down the right path with its significance affirmed in a relatively short time, but the limitation of "copying" appeared at the same time. For example, the Soviet Union had a ten-year basic education while in China it was twelve years. Thus, some compulsory contents such as Analytic Geometry couldn't be learned in middle school simply because it wasn't included in the Soviet Union's textbooks. It resulted in wasting a great deal of time for students majoring in science and technology to have to learn it after entering the university. Additionally, overemphasizing the oneness of the textbooks also impedes the initiative and creativity of the teachers and students.

### **The period of Educational Revolution**

This refers to the time from 1958 to 1961 when the government of The Peoples' Republic of China put forward the General Line of "going ahead with all efforts and building socialism with more outcomes, higher speed, better quality and less cost." The mathematics education adapted itself to this political slogan. For example, it seriously criticized the old-fashioned mathematics education in accordance with the policy "without destruction there can be no construction." On criticizing the barren, old-fashioned, nonpolitical, unpractical, isolated, complex and repetitive mathematics education, Beijing Normal University brought forward the project of The Modernization of Mathematics in Elementary and Middle School which greatly affected the mathematics education domain in China of the time by the standpoint of "Guided by the functions, Integrate geometry with algebra, Unite the concepts with Computation." Breaking the boundaries of each subject, forming a united mathematical system, emphasizing the combination of theory and practice, adding new contents of modern mathematics, all these aspects were presented in the project. This reform program at that time was very purposeful and the suggestions were helpful in altering the poor condition of mathematics education in China.

A lesson must be learned in this period that the unilateral consideration of the modern mathematical contents is not enough, and the lack of understanding of the students' ability may result in a blind development of mathematics curriculum. Textbooks compiled hastily in just a few months

were not suitable for students. It was pointed out and criticized that the elementary and middle school's mathematics education was "small quantity, low speed, bad quality and wasteful input," and the reform of mathematics education went directly to the other extreme of dismissing the necessary repetitive training and exercises, resulting in the decline of students' calculating ability (Wang, 1996).

### **The period of Educational Adjustment**

This period ranged from 1961 to 1966. The scientific and systematic of knowledge was weakened as a result of the haste in educational reform while the quality of mathematics education was affected in particular (Yan, 1998). So there came an educational adjustment phase: Under the guideline "adjusting, consolidating, enriching and improving," the Ministry of Education of People's Republic of China summed up experiences from provinces nationwide as they came up with the new syllabus and also rewrote the mathematics textbooks in 1962. Meanwhile, the teaching materials for elementary and middle school were renewed. Mathematics education then, on the one hand, was characterized with more emphasis on imparting basic knowledge to students and improving their calculating and problem-solving ability; on the other, it was based itself on the reconsideration of what it had done in the past, so, its general development was healthy (Wang, 1996).

### **The Period of Cultural Revolution**

The traditional teaching methods along with the mathematics syllabuses were entirely denied in the decade of 1966 to 1976. It was the guideline "cutting learning period, simplifying curriculum, reforming textbooks" that abided by abolishing school entrance examinations and making mathematics education objectless, ruleless and self-guided. Schools were run "openly" and associated with practical work, therefore only the application of measurement, cartography, accountancy and architecture were given great importance, whereas its reasoning was simply replaced by simple measuring, drawing, and counting.

Important lessons should be drawn from this period. Without systematic training and a good mastering of basic knowledge and basic skills, students were unable to solve the various coming problems in practice. We stress the importance of application of mathematics, but actually practical work is not the only factor. We should not only consider the practical work,

but also handle the relationship between the mastering of “two basics” (basic knowledge and basic skills) and practical work. We should make an effort to improve students’ basic ability, especially the problem-analyzing and problem-solving abilities.

### **Mathematics Education in the New Era**

With the end of the Cultural Revolution, entrance examinations at different levels were renewed in the late 1970s and the Ten-years School syllabus (1978) was revised according to the guideline “enriching elementary and middle schools’ educational contents with modern science and absorbing advanced foreign teaching materials.” Later, the mathematics syllabus for compulsory education was established on the Compulsory Education Law legislated in 1986. The mathematics educational reform experiment in Qingpu county, Shanghai at that time was full of Chinese characteristics, for it tried to improve the quality of education with a good start, a sound foundation and a well-handled crux in order to enable all students to learn efficiently (Gu, Zheng, & Li, 1999). In 1987, the mathematics syllabus for elementary and middle schools went through examination and experiment and in 1992 it was promulgated and put into effect by The Ministry of Education of People's Republic of China. Nevertheless, main shortcomings of mathematics education in this period were several, such as its contents were more difficult and demanding than it should be, and the knowledge acquired from the textbooks had not much to do with real life for it failed to combine theory with practice well. Furthermore, in pursuit of the development of cognitive capability, the cultivation of students’ sensibility and attitude was neglected. The above-mentioned aspects became the basics of new mathematics curriculum reform in mainland China in the new millennium (Zhang, 2000).

### **Problems to Face and Bones of Contention for Mathematics Curriculum Reform in mainland China in the new millennium**

The promulgation of national mathematics curriculum standards in compulsory education in 2001 was the beginning of the unprecedented potent mathematics curriculum reform with new concepts involved. The brand-new concept about mathematics education makes the current curriculum reform different from the former ones. The Mathematics Curriculum Standards of Compulsory Education which was established by Ministry of Education of the People’s Republic of China clearly illustrates the following basic concepts in the preface:

- (1) Gear mathematics education to the needs of all the students.
- (2) Mathematics is a tool in people's daily life, work and study, and a part of human culture.
- (3) Learning materials of mathematics should be practical, significant and challenging, and mathematics teaching methods should be pragmatic, innovative, self-exploring
- (4) A teacher is an organizer, guider and cooperater in mathematics study while the students should take the lead.
- (5) Pay considerable attention to both the process and outcome in mathematics learning and set up the evaluation of a multi-cultural approach.
- (6) Make modern information technology a powerful tool in students' mathematics study and problem-solving.

Conceptions in Mathematics Curriculum Standards of Compulsory Education represent the Educational development requirements of time. While certain achievement has been made in the past several years, the related problems are also appearing such as teachers and students in some schools feel a heavier burden instead of a lighter one for the declining in the performance of school's mathematics proficiency. So the mathematician holds diverse views on this curriculum, some even put forward intense criticism on it.

Critical focus: the way New Standards deal with Euclidean geometry, namely plane geometry, actually weakens the knowledge of plane geometry which attaches importance to ratiocination because of the replaced contents of "space and figures." However, in the traditional Chinese culture, logical thinking ability has been a scarcity, making mathematics-related training, especially about Euclidean geometry, a great need.

Critical focus: it tends to adopt more advice from psychology and pedagogy and the radical mathematics curriculum reform has made both society and teachers unacceptable. Some hold that too many applications introduced in the state of compulsory education make it impossible for the students to grasp the essence of mathematics. Students should be guided and inspired by its concise and intense regularity instead of purely infusing multifarious examples.

Critical focus: teachers are not well trained before implementing the mathematics curriculum reform. The key to the reform is to perform training of teachers by equipping them with a set of excellent teaching and experimental materials and then following the uniform standards and textbooks. However, the reform went in the opposite direction.

The advice proposed by the mathematician has proved to be rather pertinent and pragmatic for they give people enlightenment and urge people to reconsider the current mathematics curriculum. While highly affirming their rationality, we should also prevent them from going to extremes and pay special attention to the main issues existing in the new curriculum to avoid unnecessary confusion. There are two remaining aspects to be discussed concerning the question of whether the new curriculum standard has lowered the mathematical level? One is that whether the standard of "mathematical level" simply takes some students' scores of the tests as the sole decisive factor while the other is that whether the "mathematical level" is barely set by the difficulty in learning mathematics as the only index. The decline in the performance of mathematics proficiency for the students of some new-curriculum experimental districts can be considered a phenomenon that needs careful analysis. For instance, have we taken the improvement of students' ability and their emotional and attitudinal changes and the enlargement of knowledge into account? It is also obvious that these factors cannot be fully reflected by a mere test paper. As it is known to all, Chinese traditional mathematics teaching does have its own existing shortcomings, and especially, it is commonly considered that mathematics curriculum tends to be more difficult and the contents seem relatively narrow and meanwhile the students' ability to apply mathematics to real life still needs further enhancement. In this case it is quite necessary to put forward some notions in compliance with the international trend so as to widen the knowledge and simplify the complicated contents and skills while in the course of dealing with the existing shortcomings. Thus the general orientation of new mathematics curriculum reform in mainland China in the new millennium is worth the affirmative.

Besides, the above statement "the difficulties that current curriculum reform faces are mainly attributed to the adoption of more advices from both the pedagogy and psychology" pointed out by the mathematician also deserved further elaboration. It is undeniable that the mathematical contents and systems play an important role in the mathematics curriculum reform. However, simply taking the perspective from mathematical subject is unadvisable and also unworkable in practice, when the mathematical contents are set, it is important for a mathematics teacher to process those contents in order to make the selected materials better fit for the students. But this process must take the psychology and pedagogy as the guidance. Therefore, when implementing the mathematics curriculum reform, what really important is how to correctly take advice from pedagogy and psychology rather than

whether to take advice and how much should be taken from them. There exist many phenomena as to the misapplication of pedagogy and psychology. Followings are the most typical:

- (1) It is misunderstood that the transition from behaviorism to cognitive means that mathematics as an overall knowledge cannot be decomposed to its components for teaching need. Actually, it is essential for cognitive psychology to decompose an overall mathematics into certain cognitive components and attach more attention to the interaction of those components in a broader task. Thus; it is possible and imperative to separately select some important and difficult mathematical contents for intensive training. By doing this, it is propitious to alleviate the cognitive burden and advantageous to mathematics knowledge grasping (Zheng & Xie, 2005).
- (2) It is misunderstood that the situated cognitive theory means any mathematics knowledge is related of context. Mathematics abstraction teaching is minimally effective. Actually, as the most distinctive trait of mathematical subject, it is the abstraction that makes mathematics possible for extensive application. Therefore, the abstract concept of mathematics is still the main contents for students; we should not unlimitedly exaggerate the importance of contextual aspects of mathematical knowledge. Furthermore, the modern information-processing theory point that it is a rather effective learning method when the abstract training are properly combined with some concrete examples (Xie, 2005).
- (3) It is misunderstood that all mathematical knowledge must be actively constructed by the learner and should not be impacted by any other people. Virtually, due to its own complexity, declarative mathematics knowledge can be instructed by the teacher while procedural mathematics knowledge is fit for students' initiative learning. Furthermore, students who differ in their academic ability can be linked to those who are capable of constructing knowledge, and those who are not. To those students who are unable to construct mathematic knowledge for themselves, they need some instruction. The construction of knowledge is taken into consideration from a psychological or cognitive perspective, however, from the pedagogical point; mathematical teaching also possesses its knowledge-inherited essence (Zheng, 2005).

- (4) It is misunderstood that cooperative learning is a kind of panacea. The new curriculum has suggested transforming passive learning to active learning. But active learning is not equal to cooperative learning which also has its limitation compared with many other learning methods. For instance, it may easily be confined to the surface so that few are actively learning while the majority is passive to receive knowledge. Though it may superficially seem activating, cooperative learning is not sure to bear good learning results. In that case, the curriculum reform should call for the diversification of learning methods and set different learning activities for students according to their different abilities rather than solely learning method.
- (5) It is misunderstood that if only modern technology is used, learning effects can be firmly guaranteed. In a classroom equipped with modern information technology, the mathematical contents are seemingly vivid and abundant, however, what people are concerned most about is how to effectively process those given contents and what knowledge and methods students can eventually acquire, alone mention those poorly-equipped schools (mainly distributed in China's remote rural areas). Even if some schools are provided with advanced equipment, they are still facing many underlying questions that need further studying, such as the combination between the computers and the students and the integration between modern technology and some traditional teaching tools like paper and pens. Hence, when applying modern technology, we should stick to the reality and avoid seeking innovation in a blind way.

### **Forecasts of the Reform of Mathematics Education in Mainland China**

Nearly sixty years since the establishment of the People's Republic of China, mathematics education has long experienced ups and downs due to the interruption from both the foreign educational thoughts and the internal political revolution. At the very beginning of the new millennium, the new-rounded curriculum reform has put China's mathematics education at a historical turning point. So there is still a lot of work to do to ensure the healthy and successful development of curriculum reform and help us reach the advanced international level without delay.

Firstly, we should get well-prepared to see the reform of mathematics education as a long and complicated mission and any thoughts concerning only quick success and instant benefit should be firmly weeded out. While



avoiding some hastiness at the beginning of the reform, currently we should prevent people from rashly quitting their mission when facing the emerging difficulties and then return to the obsolete methods. Instead, we should face every possible situation with an active attitude and try our utmost to solve the constant emerging problems lying in the reform.

Secondly, we should establish an open decision-making mechanism. The reform of mathematics education cannot rely on the governmental support and intervention or the individual behaviors. By contrast, we should attract more mathematicians, mathematical educators, teachers and researchers into the revision of curriculum standards and then together shoulder the responsibility of the textbooks' compilations and the experimentations.

Thirdly, we should seek for the foothold of the reform of mathematics education. Since the promulgation of Curriculum and Evaluation Standards for School Mathematics (1989) in the United States, many countries have superlatively undergone new trends of the reform of mathematics curriculum. In this case we should take a deeper consideration of whether wholly copying the foreign teaching methods, especially the Anglo-American ones or base them on our own conditions. Besides, there are still many questions which should be theoretically declared: Are the western mathematics education definitely correct and available? Though the Western mathematics education may show its advancement and superiority in some aspects, are we capable of obtaining those within a short period? Is there only one model of mathematics education? If we admit the diversification of Mathematics Education, then the next task is how we should build a mathematics education model that can reflect China's current conditions.

Lastly, since we cannot indiscriminately imitate the West, we should instead try to be more realistic and independent to build the model according to our own history and tradition. Thus, it is important to define China's mathematical education and make a general summary from the traditional mathematics education. For instance, our mathematics education emphasizes the comprehension of concepts, basic skills' training, flexible study and the cultivation of Arithmetic operation and Deductive reasoning; these are the strong points of Chinese mathematics education. However, we also have many existing weaknesses. For example, some students simply imitate mechanically and lack the ability to think independently, or to raise questions actively, or more often they study inefficiently though much time is taken.

Additionally, we can also analyze Chinese mathematics education from various perspectives: What is the basis of its philosophy (or epistemology)?

Can we make a psychological analysis on it? Especially for the latter, we can make use of cognitive psychology to illustrate some traits of mathematics education. For instance, from the view of Ausubel's theory of meaningful learning, acquiring knowledge provided by the teacher or by books as a method of meaningful learning. In addition, the Chinese mathematics education is positive and reasonable in the Information-processing theory, which accounts for the great success achieved by Chinese students in the international contests. If we can do all of the above, we can not only make Chinese mathematics education known by experts at home and abroad, but also better grasp the rationality and limitation of Chinese mathematics education and make full use of our own advantages so as to promote the sound development of Chinese mathematics education.

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