MATHEMATICAL THINKING IN PRIMARY SCHOOL AND JUNIOR HIGH SCHOOL

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In this paper we introduce simply mathematical thinking in 《Full-time Obligatory Education Mathematics Curriculum Standards (Experimental Version)》 and in teaching practice.

1. HOW MATHEMATICAL THINKING IS DEFINED IN CURRICULUM DOCUMENTS AND LESSON

In 2001, Ministry of Education of People's Republic of China promulgated 《Full-time Obligatory Education Mathematics Curriculum Standards (Experimental Version)》（hereinafter referred *Standards*）.As a national unity document, *Standards* provides mathematics curriculum objectives, content and implementation of recommendations at the stage of full-time Obligatory education .In this paper, and place more emphasis on the students in mathematical thinking. The concrete manifestations are as follows:

1.1 First put forward " mathematical thinking " in the target and give a detailed description of it

AS Standards pointed，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.
- *Standards* clarifies the overall objectives applicable to the stage of obligatory education. Furthermore, it elucidates the objectives in greater details along four dimensions: Knowledge and Skill, **Mathematical Thinking,** Problem Solving, Affection and Attitudes.
- Further, about"Mathematical Thinking", *Standards* also include a detailed explanation of several aspects of it:
- 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**.

1.2 In the contents of learning, mathematical thinking is integrated with knowledge.

Three prominent manifestations :

- In the process of studying Numbers and Algebra、Space and Figures、Statistics and Probability，pay attention not only to acquire knowledge, it also stressed that the process of acquiring knowledge. Such as : "Involve in processes of how authentic problem situations are abstracted as number and algebra problems "，"Involve in and explore the processes of how shapes, sizes and positions of objects and figures are related and transformed"，"Involve in the processes of problem posing, data collection and processing, decision making and prediction".
- In contents of learning, *Standards* emphasize "number sense", "symbol sense", "space concepts", " statistical concepts", "application awareness" and " inferential abilities".
- Specially set up for a few aspects of the *standards*, Practical and Integrated Applications will help students deploy acquired knowledge and experiences in an integrated manner。 Meanwhile, students will develop mathematical thinking and problem solving, cooperating and exchanging abilities.

2. HOW TO DEVELOP MATHEMATICAL THINKING IN TEACHING PRACTICE

2.1 Encourage students abstract mathematical knowledge from the specific context, and use several graphic, symbolic expression to describe，develop student's abstract mathematical thinking.

The process of abstract mathematical knowledge from the specific context is very important. It profoundly revealed the existence of a category of problems in common and universal. This will enhance students knowledge and thinking to a higher level. Students will realize that graphics, symbols play a important the role in the law, feel the value of abstract ,develop their own number sense, "symbol sense and abstract mathematical thinking.

For example, in order to help the student study the concept of "fraction" in third grade, teachers created the following activities : first, cutting a rectangular piece of paper; using it to measure the length of the different items.

In the process of measuring, the students will find, sometime the measurement results is not the times of the entire length of the paper . In order to acquire the exact measure result , he(or she)will fold the paper, use "half" as the measurement units. Further, teachers joined the students found many other "half" : one apple average to two children, each child have "half"; a square divided into two parts, each part is the "half" ,etc. On this basis, the teacher introduce the fraction "1/2".

2.2 Encourage students to use graphics for visual thinking, develop student's iconic mathematical thinking

In many ways students can feel graphic visual effect. For example, when they study the relationship between variables, student often need to make images to "see" the changes in the trend; When they face the data, student often want to make a visual map to describe these data; When they learn some important concepts (such as real number , ratio), student often hope to build the geometric model to a deeper understanding; When they use knowledge to solve problems or create, graphic often provide ideas and inspiration.

2.3 Encourage students to develop awareness of the data to thinking, develop statistical thinking

At the stage of full-time Obligatory education, student's first target of studying statistical is to develop awareness of the data to thinking. This is the other universal way of thinking. Students should learn through a curriculum that in the event of some, they should collect and analyze data.

For example, teachers can engage the students to be a "little shoe store management", students need to consider the purchase of each month. They can recognize that they can not rely solely on their own preferences, they need to do research, collect certain data,

such as the person's common size and preferences, the trend in fashion this year, etc. They can put forward reasonable ideas based on these data.

2.4 Encourage students to guess and prove, develop reasonable analogical and induction abilities and initial mathematical deduction ability

Student's mathematical reasoning ability is an important aspect of the mathematics thinking. Mathematical reasoning include reasonable analogical and induction abilities and initial mathematical deduction ability, people often use reasonable analogical to put forward assumption and use deductive reasoning to prove it . This constitutes a complete combination of the reasoning process. Mathematics Teaching should enable students to experience the entire process, to encourage students to put forward assumption through the observation, experimentation, induction , analogy, and seek further evidence to prove or give counter-examples.

For example, the following is the Chinese traditional problem: there are a number of chickens and rabbits in one cages ,the total heads of chickens and rabbits are 20, the total legs of chickens and rabbits are 64. The question is to find numbers of chickens and rabbits.

The primary students can resolve the problem through the list (below):

heads	chickens	Rabbits	Legs
20	1	19	78
20	2	18	76
20	3	17	74
20	……	……	……

Students can try each case, or find the law, to find the ultimate answer: eight chickens, and twelve rabbits. To the junior high school, students can use the binary linear equation to solve the problem.

Mathematics teaching entails teaching of mathematical activities and mathematical thinking. It is an interacting exchange and joint developmental process between teachers and students, as well as amongst students.

Mathematics teaching should start from students' practical experiences, and create problem contexts and situations conducive to students' autonomous learning. Through practical work, thinking, exploration and communication, students master basic mathematical knowledge, form skills, develop thinking, and learn how to learn. Under the guidance of the teacher, students are able to learn actively, autonomously and with individuality.

During teaching, teachers should promote democracy in teaching, so as to become organizers, guides, and collaborators of student mathematical activities. Teachers should be good at inspiring students' learning potentials, encourage students to innovate and practice boldly. They should deploy teaching materials creatively, exploit actively, and use all sorts of teaching materials, so as to provide students rich and multifarious learning materials. They should pay attention to students' individual

differences and practice individualized teaching effectively, so that students receive sufficient developments. Application of modern educational technologies to teaching should be emphasized. For those areas where conditions permit, teachers should try hard to use computers and related software reasonably and effectively to raise teaching efficiency.