

Characteristics of Mathematics Education in China

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Preface

- **A article in the U.S. *TIME* (12 Nov 2009) mentioned the following:**

As William McCahill, a former deputy chief of mission in the U.S. embassy in Beijing, says:

“Fundamentally, they are getting the basics right, particularly in mathematics and science. We need to do the same. Their kids are often ahead of ours.”

- **The self-depreciation once dominated the attitude toward Chinese mathematics education.**

Some scholars, on one hand, exaggerate the backwardness of China; on the other hand, advocates the advance of the western countries.

Though these scholars are the minority, the influence of their sayings is huge.

The mathematics education in China was once led astray.

- **The majority of the mathematics teachers in China have always persist in the good traditions of education.**

They carry forward the traditions and creatively contribute to the development.

In recent years, the upstanding reputation of Chinese mathematics education in the international arena is a full recognition of them.

Chinese scholars attempt to analyze the mathematics education in China and summarize its pros and cons.

**The Guiding Principles of
Mathematics Education in China**

1. Strengthen the “two basics” in teaching

- The **two basics** in mathematics refer to **basic knowledge and basic skills**.
- The “**two basics**” teaching principle aims to lay a solid foundation for the construction of knowledge since “a good foundation is essential for the construction of a building.”
- The “**two basics**” teaching principle has its historical roots.
- It was written into the Chinese mathematics syllabus in 1963.
- Our teachers constantly adhere to this principle in thinking and behavior.

2. Develop mathematical thinking skills

- It is well-accepted among Chinese teachers that mathematics is **a science of thinking;**
- Developing students' mathematical thinking is an important objective of mathematics teaching;
- A significant indicator is the development of students' **mathematical thinking skills;**
- The 1963 syllabus has put forward the idea of “**three basic mathematical abilities**”;
- Developing thinking and cultivating ability become the common awareness of mathematics teachers.

3. Preserve Heuristic Mathematics Teaching

- The heuristic teaching which was proposed by Confucius 2,500 years ago, has profound influence on Chinese education;
- Its essence is “**Do not intervene before students have made an effort to understand, before students have made an effort to express themselves**”.
- After thousands of years, this idea has gained much development;
- This idea is deeply rooted in the mind of Chinese teachers;
- A teacher may be considered as incompetent if he/she does not know **how to apply heuristic**.

4. Respect Mathematical Activity Approach

- Dewey's theory of “**learning by doing**” and Polya's theory about “**problem solving**” have huge influence on mathematics education in China;
- Dewey's pragmatism is very close to Chinese traditional emphasis on practicality;
- Polya's “**problem solving**” are accordant with Chinese consistent emphasis on problem solving;
- These two ideas are easily accepted by Chinese mathematics teachers and well-merged with mathematics teaching in China;
- From the modern education perspective, these two ideas are basic to the “mathematical activity teaching.”

**Several Characteristics
of Mathematics Education
in China**

1. Explicit Objectives & Refined Knowledge

- **Syllabus, examinations, and curriculum set different objectives for knowledge mastery;**
- **The teaching objectives are stated explicitly into four operable levels: knowing, understanding, mastering, flexible application.**
- **The objectives are implemented through the corresponding “actions” and exercises;**
- **Each chapter, each unit, and even each lesson has its respective specific objectives (of knowledge, skill, and method);**
- **Teachers strictly follow the hierarchy of the objectives set for each level;**
- **For each lesson, teachers design their lesson plans according to the teaching objectives so as to implement the objectives in real earnest;**

- **Teachers prepare well for each lesson by carefully analyzing the key points, difficulties, and attention points;**
- **The school mathematics Teaching Research Group or mathematics teachers of the same grade would prepare the lessons together and unify ideas for teaching.**
- **They collectively handle the objectives for understanding the mathematical objects and the depth of explanation in teaching, as well as the selection of the corresponding examples and exercises;**
- **The Teaching Research Group of the province level, the municipality level, and the district level will provide guide for teaching. The guide is implemented as a governmental behavior.**
- **The corresponding teaching reference books provide authoritative analysis on the contents in the textbooks.**

2. Review Prior Knowledge & Build New Knowledge

- **Building “new knowledge” from “prior knowledge” is a major method of teaching of mathematics in Chinese classrooms.**
- **In Chinese classroom teaching of mathematics, most new knowledge is built from existing knowledge.**
This is consistent with the development of human knowledge, cognitive theories, as well as ideas from constructivism.
- **Two possible tendencies could happen when adopting this method**
 - (1) **Students get perplexed with existing knowledge and new scenes may be constructed.**
 - ***Students are inspired and encouraged to know, discover, and then form new knowledge .**
 - ***Students can experience the process of knowledge origination and development.**

(2) However, the method may be easily distorted the process of knowledge development is ignored;

Teachers may directly “pump” new knowledge into students, only procedure knowledge is required students passively accept knowledge.

- **There are diverse ways to introduce “new knowledge” today:**
- **Introduce from “real life problems”, “authentic situations”, “mathematical problems” or “comments on exercises”,**
- **Introduce from “designed scenario”, or “suspense”.**

3. “Two Basics” Teaching & Insights come out of Familiarity

- **“Two basics” teaching** is an invention of Chinese mathematics education.
“Two basics” teaching receives the highest level of attention in China.

There are exercises for each unit, and each chapter; and in-class and after-class.

- **“Insight comes out of familiarity”** and **“two basics teaching”** is undivided.

Chinese proverb: insight comes out of familiarity.

(which is normally translated as *“practice makes perfect”*);

- **Chinese mathematician Hua Luogeng said:**

Working hard is number one.

Only when you know it well, you are able to innovate.

Hard working helps make up for your handicap,

You will get only what you put in.

- Repeatedly apply the **basic knowledge** in problem solving, do extensive exercise, so as to **remember and understand** the knowledge;
- Repeatedly practice the **basic skill** so as to achieve **flexible application**. For **example**:
 - Use “ 9×9 multiplication table” to do oral calculation and mental arithmetic.
- Memorization contributes to understanding, gain time by speed.
- However, this is not simply doing practice;
 - It requires **understanding by analogy** and **comprehend through connections**.
- Easily **be mislead** to the opposite side:
 - It is difficult to control the “extent” of practice, thus, **easily be distorted** as rote learning.

4. Practice with Variation & Understand with Depth

- The deep understanding of new knowledge is paid great attention by Chinese mathematics teaching.
- Thoughtful analysis of **key phrases** in new concepts or new statements;
 - Summarize the **key elements** and **attention points** of new knowledge,
 - Clarify the **connections** between new and prior knowledge.
- Use **variations to understand** the essence of new knowledge.
- **Variation** ——
 - represent mathematical objects from different backgrounds and perspectives,
 - change the **nonessential attributes** but maintain **essential attributes**.

▪ **Two types of variations:**

Conceptual variation——understanding concepts from multiple perspectives;

Procedural variation——scaffolding for a type of problems.

▪ **Practice with variation is a feature of math education in China.**

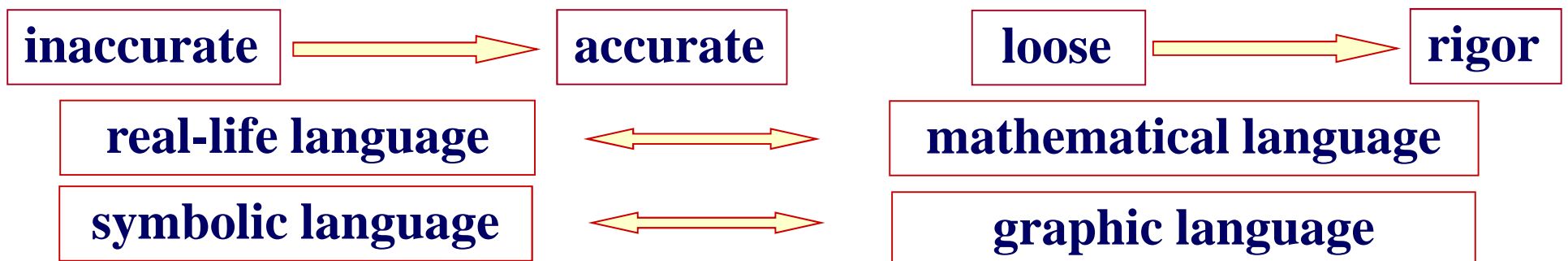
Variations are helpful for students to gain a comprehensive understanding of new knowledge;

Variations embedded the idea of innovation;

thus they are not only useful for building a solid foundation but also conducive for ability development.

5. Mathematical Communication & Student-Teacher Interaction

- A significant feature of Chinese schools is— large class (60 students);
- Thus, it is difficult to carry out “small-group discussion and representative report”.
- How to reduce the possibility of teachers’ “**cramming**” and interact well with students in class?
- The mathematical communication in Chinese classrooms has its distinguishing characteristics: **Question-answer**, **speak-write**, **blackboard-textbook**, **mental arithmetic-written calculation**
Speak-repeat, **repeat again**, **mutual complement**, **correct each other**;
Inquire reasons, **retort counter-examples**, **harmony conforming**, **achieve consensus**.
- Students’ verbal ability continues to be developed and improved.



6. Penetrate ideas & Master methods

- Infiltration of math thinking is an invention of mathematics teaching in China.
- It originates from the guide and influence of Chinese mathematicians;
Mr Hua Luogeng first proposed in the 1950s the idea of “**combination of number and graph**”;
Mr Xu Lizhi introduced in the 1980s theory about “**mathematical thinking-methods**;
- The main mathematical ideas in middle schools are:
equivalent transform, **combination of number and graph**,
function and equation, solving by exhaustion,
geometrical transformation;
conversion between finite and infinite,
conversion between certainty and uncertainty;

- **The main mathematical methods in middle schools are:**
 - change in variables,**
 - elimination method (in solving simultaneous equations)**
 - reduction of dimensions,** **to make perfect square,**
 - cross-multiplication,** **indeterminate coefficients,**
 - proof by contradiction,** **proof by transposition.**
- **Mathematics teaching should strengthen the infiltration of mathematical ideas and mathematical methods in all areas.**

Use mathematical thinking to reflect and summarize classroom teaching;

Help students to grasp the essence of mathematical thinking,

Guide them to use mathematical thinking for problem solving.

7. Develop thinking & Cultivate ability

(1) Developing students' mathematics thinking is an important tradition of mathematics teaching in China.

- **Believed —— “mathematics is the gym of thinking” and “mathematics can make learners smart”.**

The mathematics is one of the best subjects for developing people's thinking.

- **Teachers pay much attention to the development of students' mathematical thinking, especially its the flexibility, agility, fluency, reflexivity and creativity.**
- **In the teaching of problem solving ——**
Teachers advocate independent thinking, emphasize the exploration of idea, and encourage multiple solutions;
Emphasize reflection, advocate achieving understanding from reflection, advocate obtaining regularity, **and** facilitating knowledge transfer from reflection.

(2) The acquirement of “three mathematical abilities” is an objective of mathematical teaching in China: (1963s)

Abilities of basic operation,

Abilities of space imagination,

Abilities of logical thinking.

- **From 1980 to 1990, there was a nationwide large-scale discussion on mathematical thinking and mathematical ability;**
- **Experiments on teaching of mathematical thinking were actively conducted; the teaching of mathematical thinking was improved.**
- **The penetration and mastery of mathematical thinking also contribute significantly to the development of thinking and cultivation of ability.**

8. Cons and Pros of Exam-orientation

- **Exam is a great feature of Chinese Education.**

It is a typical Chinese traditional culture.

Exams are very frequent at different stage of semesters, e.g., monthly exams, unit tests, mid-semester exam, and final exams. (inter-school ones)

There are different types of tests, e.g., regional teaching quality tests and nationwide university entrance examination.

- **Though the examination system has many negative effects, it also has positive leading roles.**
- **Examining the “two-basics” is the focal point of all the tests; this would attract more attention to the “two-basics” teaching;**

- **Exams are useful in testing mathematical thinking and mathematical abilities; this would foster the teaching of mathematical thinking skills;**
- **Exams can reflect students' application of mathematical ideas; this would facilitate the penetration of mathematical ideas in teaching;**
- **Exams can test students' ability of math reading and language expression; this would help to enhance the mathematical communication in teaching;**
- **The University Entrance Examination is a fair and transparent selection test; until now, we haven't find a better selection method to replace it.**

Problems with Chinese Mathematics Education

- **Chinese mathematics education also face many problems:**

Due to too Heavy workload, students are sick of study.

This phenomenon still has the tendency toward worse.

The phenomenon of high-score but poor-ability is very common.

There is an increasing trend for the phenomenon of high-score but poor-moral.

- **Erroneous tendencies existing in mathematics education:**
 - Value concrete knowledge—despise methods,**
 - Value theory—despise application**

Value memorization – despise thinking,

Value dominant knowledge – despise recessive knowledge;

Value deduction – despise induction,

Value proof – despise discovery

Value review – despise teaching of new contents,

Value learning from teachers – despise students' creation

- **These erroneous tendencies are of different seriousness levels; however, they eroded Chinese mathematics education in varying degrees.**
- **Chinese Mathematics Education still has a long way to go.**

Thank You!