

Educational Tactics of Mathematics for Gifted Children

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Gifted children are a country's potential resources of qualified personnels. Their education has been receiving more and more attention from families, schools, educational administration departments, educational research departments as well as from the whole society. In China, it has become an established practise to arrange the gifted children in special classes so as to provide them with a complete and systematic basic education. This trial has been carried for ten years.

As it is known that the mathematics course is crucial in middle schools and elementary schools, it plays a unique function in the development of children's perceptual, intellectual, and personality development. Since the gifted children process special ability and needs, the usual classroom teaching, the traditional curriculum, and the unified teaching progress dose not suit them; instead, it can hinder them from developing their potential talent. In order to assist these children to develop further, it is necessary to formulate a set of scientific and effective educational tactics. This paper intends to discuss the educational

tactics for the gifted children based on a seven-year teaching and research of the Gifted Class in Beijing No. Eight Middle School.

Principal Practice

During the seven-year teaching and research of the Gifted Class, we have selected and tried out these seven educational tactics of mathematics:

A. High Starting Point

The starting point is an essential factor: it concerns the starting point in acquiring knowledge (what and from where to teach) and the starting point for perceptual development (how and on what abstract level to teach). As the gifted children are far more developed than children of their age in abstract thinking, the traditional mathematics lessons can not meet their needs. To give full play to their advantage in abstract thinking, and to stimulate their strong interest and motivation in learning mathematics, it is necessary to heighten the starting point. Generally speaking,

there are three ways to achieve the purpose:

1. Select the teaching material

The textbook An Experimental course of the middle school mathematics (for both junior and senior high schools), published by the People's Education Publishing House, has a solid theoretical base, explaining the profound in simple terms; it can thus help students understand development of mathematical thinking and method. This textbook aims at deepening and broadening the necessary basic knowledge in mathematics.

2. Early exposure to mathematical thinking and instrumental theory

For example, during the first year of the Gifted Class, students are exposed to the principles of transforming and simplifying, and in the second term of the first year (around the age of 11), aggregate and simple. The purpose is to improve the students mathematical concept, comprehension of the theorem, and understanding of the basic mathematical thinking which will guide them in solving mathematical problems.

3. Lay stress on the relationship,

interlinkage, and inter-penetration between mathematics and other related subjects, deepen theoretical studies

For example, we frequently refer to physics, explain in advance mathematical instruments needed for physics lessons, distinguish the deformation of mathematical formula from the deformation of physical formula. In this way, we hope to ensure the gifted children a complete, harmonious development in their acquisition of knowledge.

B. Speed-up teaching progress step by step

In the past few years, our experience in teaching the gifted shows that the principle of speeding-up teaching progress step by step, a widely-adopted educational principle, is also suitable to the gifted education. This is because that the essence of the intellectual development is to form the knowledge structure step by step. Our practise reveals that the gifted children can not actually skip certain perceptual stages in their mathematics learning; they can, however, speed up or shorten the process: perception, comprehension, retaining and practise. So, it is essential to straighten the relationship between progressing step by step and speeding

up the teaching progress, that is to find an appropriate way, considering both the general educational principle and the gifted educational principle. This issue has drawn attention from not only teachers, but also parents and society. Our conclusion is to speed up teaching step by step. In practise, we have come to understand the following:

1. Select the level of difficulty

This consideration concerns the level in abstractness, in theory, and in the relationship and comprehension of former knowledge. The comparatively smaller knowledge units should be chosen for speeding up the teaching progress.

2. Partially adjust the logic structure of the teaching material, and combine knowledge that has the same principles.

3. Pay attention to feedback from teaching and learning. It is important to observe the students reactions in class, and their facial expressions when they are listening to the teachers. Students' homework, in-class exercises, and tests should be analysed. Teaching should be controlled with a flexible pace.

C. Lay stress on the fundamental

principles, enhance skill training

Which is the most effective way to input knowledge information so that students can comprehend and master it well? In our history, explaining the profound in simple terms has always been recommended. However, this traditional, figurative and objective teaching is now challenged by gifted children and the more and more abstract mathematical studies. As it is known, the relationship between abstractness and concreteness is relative. Once it is produced, the abstract object (concept and model), the result of mathematical thinking or target, becomes concrete; it turns into a "concrete shape" (or concrete knowledge background) of the next abstract concept. So, along a "concept chain" that consists of a successive abstract processes, the abstract object at the lower level is more concrete and objective compared with that at the higher level. Therefore, in mathematical education, the abstract level in "simple terms" is gradually rising. The accumulation and comprehension of knowledge relies more and more on abstract thinking, so teaching the gifted through fundamental principles will promote transforming and memory of the learned principles, and it will also

provide a foundation for discoveries of new principles. Facts show that laying stress on fundamental principles is not only necessary but also effective. For this purpose, we have been doing as follows:

1. Teaching with fundamental principles

The teaching of algebra focuses on the use of the general principles in calculation. In geometry classes, the principle of the shortest passage between two space points is emphasized to explain point-line distance, parallel-line distance, point-plane distance, and parallel-plane distance.

2. Lay stress on comprehension of the mathematical structure and form.

3. Lay stress on utilization of principles in solving mathematical problems. While we emphasize on learning of basic principles, we pay attention to the training of basic skills; this is necessary because most of the children prefer to think than to do written exercises. In order to stimulate their interests in skill training, we have adopted the following measures:

a. Increase the quantity of in-class exercises, and leave adequate

after-class exercises.

b. Explain the purpose of the assigned exercises, improve the quality, and ensure a scientific combination of different kinds of exercises.

c. Vary the types of exercises

d. Adopt flexible teaching methods

There are always distinct differences among the gifted children. Although comprehension of knowledge and learning of the forms is along a stable process, the gifted children progress at a strikingly different speed. A part of the group are not satisfied with what they can learn from the class, so they study by themselves, learning ahead of other students. Therefore, the mathematical education of the gifted should be flexible so as to meet their individual needs. A flexible teaching method is necessary, and we have tried the following two tactics to ensure it.

1. Combine receptive learning with discovery learning, and turn the teaching-learning activity into a process of thinking and problem solving involved by both teachers and students.

2. Group learning

Divide the class into A and B groups according to students performance in mathematical studies, motivation and emotional strength. In Group A, students spend most of their time doing self-studies, discussion and exercises under the guidance of teachers. Group B students mainly learn from teachers' lectures. After a knowledge unit and a test, students can switch between the two groups. With this tactic, we hope to create a competitive environment so as to promote learning. Group A are always seen to progress faster than Group B.

E. Encourage discovery and creativity

This is an important ability that the mankind relies on to realize a desirable future. Studies show that high intelligence or high academic achievement has little to do with the score in creativity tests. Creativity needs to be fostered. The gifted is believed to be far more creative than children of the same age. So, in mathematical education we should let the gifted to give full play to their advantage in creativity. The following measures have been tried to encourage discovery and creativity:

1. Select material of high intellectual value and prepare challenging questions

so as to increase opportunities for creative reactions.

2. In solving problems that need creativity, we provide students with time and space for thinking, and encourage solutions from different angles and methods so that students will think in depth and bring about creativity based on smoothness and adjustment, which will improve the quality of creative reaction.

3. Set up an educational ecological environment, that is a positive, friendly, respectful and equal class atmosphere. Such an environment encourages students who have experienced setbacks to get an active involvement in creativity and to express his opinions. The gifted should be taught to be moderate in learning.

F. Those of high intelligence play a unique role

With the progress of education, a group of students will show their brilliant ability in mathematics. Having a strong interest in mathematics, in thinking and studying, they are efficient in self-studies: they often discuss about mathematical problems in and after the class and

exchange their opinions with others. These students gradually form a group of high intelligence. This group frequently raise new questions and opinions, pushing mathematical education into depth. Meanwhile, they are teachers of other students, explaining questions in their own way. These students play an important function, which can not be replaced by adult teacher. In short, to let the high intelligence play a unique role is one tactic in the mathematical education of the gifted children. In doing so, we have taken the following measures:

1. In class, offer them more opportunities to raise questions and different opinions
2. Organize after-class study groups, in which they discuss what they have learned in class. The teacher sometimes joins discussions or organizes mathematics competitions.
3. Organize volunteer helping-each-other group and encourage learning from each other.
4. The teacher offers guidance to students who learn ahead of others.

G. Promote a harmonious emotional and intellectual development

The gifted, in the process of development, shows disequilibrium in three aspects:

a. Their cognitive development in linguistics and mathematics are not parallel. To be compared with the mathematical cognitive development, the development in linguistics is far behind their intellectual age.

b. The development of their operational ability is not parallel with the perceptual development. The former is far behind the latter in intellectual age.

c. The psychological development is not parallel with the intellectual development. To be compared with their intellectual development, their psychological development is far behind their intellectual age.

Our analysis on the relationship between the gifted children's non-intellectual factors (diligence, hardworking, will-power and toughness) and their academic achievement in linguistics, mathematics, English, physics and chemistry proves: the non-intellectual

factors are directly proportional to the academic achievement. As the gifted children become older, this phenomenon is more and more obvious: it is particularly obvious in their junior high years. The said disequilibrium affects not only their further developing mathematical ability, but also their physical and emotional development. In order to promote a harmonious development, proper measures should be taken in educating these gifted children. Stress should be laid on offsetting their weaknesses. We have taken the following measures:

1. Enhance in-class reading, comprehension, and oral and written ability in mathematics.

When introducing a new definition, a theorem, a formula or a law, we request students to read it aloud and then to recite it, and we also call their attention to analysing the important definitions and theorems. Apart from that, they are requested to write in standard form and language when answering written questions.

2. Enhance practise in using the number form combined method and lay stress on operational exercises such as

hand-making geometrical models.

3. Invite parents to school.

We ask parents to cooperate with the school, and together, we form a joint effort to help students overcome their difficulties. According to individual differences and with the students consent, we adopt different measures for individual students to solve their problems in time.

Analysis of Results

Results and analysis of mathematics teaching contents and lesson hours

The Gifted Class in its 4 years study has completed the contents required in the curriculum for the 5th and the 6th primary schools grades and for the 6 middle schools years, using only 882 hours compared to 1480 hours require or the above mentioned 8 years, which is only 60% of the total. At the same time, the class learn 100 hours more contents than it is required in the curriculum. It proves that the correct implementation of accelerated teaching program suits mathematics study of the gifted children.

Results and analysis of different tests.

Table 1 is the SAT-M test results between Chinese and American students under 13 years old. SAT-M is a test to

achieve the title " Mathematically Talented Child " are far more advanced than those from the United States and Shanghai. Table 2 is the comparison of

Table 1 SAT-M Testing Results Comparison between Chinese and American Students
(Total points 800)

| | X | | SD | | >700 | | % for those tested |
|--------------------|-----|------|-----|------|------|------|--------------------|
| | boy | girl | boy | girl | boy | girl | |
| First gifted class | 687 | 694 | 44 | 32 | 13 | 6 | 54% |
| Shanghai | 630 | 614 | 60 | 57 | 15 | 6 | 14.5% |
| America | 417 | 383 | 89 | 74 | 50 | | 0.20% |

determine mathematical abilities, and it is principal research method of Johns Hopkins University in its study on the gifted talents. In 1985 and 1987, China organised students who performed well in mathematics study, from the key middle schools and primary schools in Beijing and Shanghai, to do the test. We can see that the average results of the boy group of the 1st Gifted Class is 3.0 points higher than that of the American boy group, 0.95 higher than that of the Shanghai boy group. The average results of the girl group of the class is 4.2 points higher than that of the American girl group and 1.4 points higher than that of the Shanghai girl group. And the students who have passed the results of > 700 points to

lesson hours and results between groups of the 1st Gifted Class during high school period. Statistics show that the students of Group A had more self study capability. They both learned well and fast. During the whole teaching course, 3 students of Group A returned to Group B, and 2 students of Group B joined Group A. It shows that under the condition that after the students have a certain knowledge basis, group teaching can be effective. Practice shows that the students in Group A welcome this way of teaching. They say that "Studying in Group A, we have more time for independent study and collective discussion. We are able to communicate with each other and to learn mathematics more effectively."

Table 3 is the comparison of the First Gifted Class with its counter part class in respect of their test results on creation ability. As for uniqueness and simpleness, the average results of the class is better than the compared

Beijing, in a 4-year continuous observation of the students of the Gifted Class, has reached the conclusion that, they grew faster during their puberty and their "height, weight and other aspects are in accordance with regular physical

Table 2 Comparison of teaching hours and results between Groups of the First Gifted Class

| | Solid Geometry | | | analytical Geometry | | |
|-----------------------|----------------|------|--------------|---------------------|------|--------------|
| | X | SD | lesson hours | X | SD | lesson hours |
| Group A (N1=12) | 95.6 | 4.1 | 15 | 85.2 | 8.2 | 24 |
| Group B (N2=21) | 84.3 | 10.0 | 21 | 72 | 10.4 | 32 |
| Difference | 11.3 | -5.9 | -6 | 13.2 | -2.2 | -6 |
| Difference Appearance | P<0.01 | - | - | P<0.01 | - | - |

counter part class over 0.01 level.

The above 3 results comparison show that our teaching methods for the gifted children are successful to meet the needs of the gifted children in their study of mathematics.

While listing the above mentioned results in mathematics teaching, we are glad to point out that the home work quantity is suitable for the Gifted Class during its 4 years study. The Middle School and Primary School Health Centre of the West City District of

development of the children and teenagers. No harm has been observed during the period of the special education in program. After 4 years' education, the students of the Gifted Class have developed well in self-confidence, independence, conscious strength, moral character and self-control.

Problems

1. Under present educational system in China, the education for the gifted

children still face great pressure of winning to go to a better school concept of education from the part of society and parents, which affects the implementation of our educational methods.

2. There are no complete text books to widen, deepen, and strengthen the mathematics teaching which results in unstable results of the practice.

Table 3 Comparison of Creation Ability Test Results(X) of the First Gifted Class with its Counter Part Class

| | smoothness | uniqueness | $\sum x$ | difference appearance |
|---|------------|------------|----------|-----------------------|
| 1st Gifted Class of Beijing No. 8th Middle School (N1=33) | 17.4 | 16.9 | 34.3 | P<0.01 |
| 1st grade the Experimental High School of Capital Teachers University (N2=43) | 14.3 | 13.4 | 27.7 | |