Journal of Mathematics Education
June 2009, Vol. 2, No. 1, pp.145-158

A Study on the Ability of Sixth Grade Students in Tibetan Areas to Solve Math Problems

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The findings of the study in Tibetan areas in China, which is about sixth grade students' mathematics understanding and mathematics proficiency, show that students' calculating ability is much greater than their ability to understand mathematical conceptions and to put them into practice. There are various reasons for this, such as pedagogical methodology, language used in the teaching process, the family background of students, environmental factors, teaching materials, and so on. This study holds that the solution is to improve the current pedagogical methodology and the content of teaching materials, as well as enhance teachers' training and promote teaching environment.

Key words: language in teaching, teaching model, Tibetan areas, environmental factors, mathematical model.

Introduction

The New Mathematics Curriculum Standards (EMCS) for Full-time Compulsory Education (Pilot Manuscript) pointed out, "mathematics teaching is a process of interaction and development between teachers and students or among students to improve students' learning as well as teachers' teaching during mathematics activities, and a process of interpretation and application in which students can abstract mathematical models from practical problems." The EMCS were gradually implemented from the lower grades in Tibetan areas in 2003. When we investigated the adaptability of the EMCS in the Tibetan areas, mathematics teachers in primary and secondary schools issued a general report that they did not know how to teach the new textbook because of its reduced content. They usually finished their teaching content in a very short time. Students had not enough corresponding exercises to complete in class as the previous textbook. Additionally, teachers in the Tibetan areas reported that the EMCS that was put into practice increased the burden on teachers. There were neither textbooks nor supplementary materials suitable for students in the Tibetan areas, nor teachers' training for the new textbooks. Teachers who had no deep understanding of the EMCS might meet the challenge for the practical implementation of EMCS by teaching their students how to work out a problem, rather than actively take the initiative to explore suitable teaching methods to get better teaching effects.

One of the research questions of the study is whether the teacher is clear in the class. The question is based on the principle of students' grasping mathematical concepts, calculating skilfully and applying what they have learned (Wu, 2006). Teaching methods play an important role in the understanding of mathematical concepts. However, teachers in the Tibetan areas do not accept the training to enter into the spirit of the EMCS. Therefore, the creativity and ability of students are not really developed. The aims of the study are:

(1) to investigate students' ability of calculation, analysis, understanding, and application;
(2) to probe into the means to change the present situation in order to really improve teaching effects;
(3) to discuss the extent to which teaching environment influences students' achievements, and
(4) to study the effect of teaching methods on the development of students' thought.

Method

Subjects

The subjects of the study came from Hezuo Tibetan Middle School and Hezuo No. 2 Middle School in Gannan Tibetan Autonomous Prefecture in Gansu Province (Notes: the city of Hezuo, set up in 2000, is the official site of Gannan government. Hezuo Tibetan Middle School is called HTMS for short and Hezuo No. 2 Middle School called H2MS for short in the following passage). A mathematical test for the sixth grade students was conducted at the end of August, 2008, on the first grade students who were the freshmen of HTMS and H2MS. There are five classes in HTMS, in three of which the main language for teaching is Tibetan (All the courses are taught in Tibetan except Chinese and English， so we call this teaching model Model I, i.e. "T + C".) , and in the other two the main language for teaching is Chinese (All the courses are taught in Chinese except Tibetan language， so we call this teaching model Model II, i.e. "C+T".). We gave out and got back 220 test papers, 137 of which came from

“T+C”, and 83 from “C+T”; we got 157 test papers from H2MS (All the courses are taught in Chinese， so we call this teaching model Model III, i.e. “C”.).

Instrument

The instrument of the study is a test paper which consists of seven calculations in the form of fractions or decimals, and an open-ended problem. The instrument (see the appendix) is a modified version of Zhonghe Wu’s in his study of “Research design on understanding mathematics and mathematical proficiency” (Wu, 2006).

The requirements of these problems are as follows: Calculate these items; construct your own model to solve these problems on the basis of understanding; and create a real life context of the applied problem. The major aims of these problems are to test students’ skill in working out these problems step by step, to understand the sense of mathematics, and to test students’ ability of application in practice. The test consists of two parts. The purpose of the first part (from item 1 to item 7) is to test students’ achievement, and the purpose of the second part (item 8) is to test students’ cognitive ability and the development of divergent thinking and thinking quality.

Methods of Analysis

The investigation is based on interpretivist epistemology. Both qualitative and quantitative methods were used to analyse and discuss students’ skills in solving mathematical problems. Due to the research aims of testing students’ solutions to a problem, understanding of the sense of mathematics, and ability of practical application, the measures taken to achieve the aims are as follows: We analysed the data collected to find out whether students can work out the correct answers by using reasonable procedures, whether students can construct their own reasonable mathematical models to get the correct answers from the models, whether students can understand the sense of mathematics well and create a reasonable real life context of the applied problem, and whether students can work out the open-ended problem with a certain method, and at the same time can interpret the problem by using all possible methods and make a corresponding schematic diagram.

Results and Discussion

Most of the freshmen in H2MS come from the city of Hezuo, and most of them come from cadre families. 34% of them are Tibetans. They have been influenced by Han culture since their childhood and so most speak Chinese at home. They put their signatures on the testing papers because the papers were given out after school and finished at home. Students handed in the papers the next day. On the contrary, all students in HTMS were boarders, and the testing papers were finished in the night class during 1 to 1.5 hours. In order to have students complete the papers independently, we did not require students to put their names on their papers. Therefore, there were 17 students of “T+C” not putting their names, which took 12.4% of the total, while there were 34 students of “C+T” not putting their names, which took 41% of the total. The proportion of not putting their names might have a great relationship with their achievement, which showed their personal ability and confidence in solving problems.

Quantitative Analysis

The scores of “T+C” are higher than those of the other two models in items 1, 2, 3, 4 and 5, while the scores of “C” are higher than those of the other two models in items 6, 7, and 8. The total scores of “C” are the highest, and those of “C+T” are the lowest. The total scores of “C” are 0.34 higher than those of “T+C”, and 11.52 higher than those of “C+T” (Note: Students of “C” finished their work at home, and might accept the help of their family members.). The total scores of “T+C” are 11.18 higher than those of “C+T”. The scores of “T+C” are 2.32 higher than the mean score, and the scores of “C” are 2.66 higher than the mean score. Comparing item 1 and item 3, the scores of item 3 are lower than those of item 1, for the reason that though both items are on the operation of fraction addition, greater numbers cause more errors. The scores of “C” are higher than those of the other two models in the open-ended problem (Note: Item 8 has several answers). The results of the study are shown in Table 1 and Table 2. Table 1 presents the mean of each item and total in each teaching model (TM). Table 1 presents the correct rate of working out each item with reasonable procedures.

Table 1

Mean of Each Item and Total

				Part I				*Part II*	
TM	1	2	3	4	5	6	7	8	Total
T+C	10.95	10.5	10.51	11.12	11.12	8.76	9.11	8.88	80.96
C+T	10.12	7.37	9.54	10.55	10.41	5.2	7.52	9.06	69.78

C	10.62	9.17	10.47	10.24	10.39	9.48	9.71	11.2	81.3
Total	10.63	9.26	10.28	10.63	10.66	8.28	9.01	9.89	78.64

Table 2

Correct Rate of Working out Each Item（%）

TM	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
T+C	91.24	87.6	87.6	92.7	92.7	73	75.9	55.5
C+T	84.3	61.4	79.5	88	86.8	43.3	62.7	56.6
C	88.5	76.4	87.3	85.3	86.6	79	80.9	70
Total	88.6	77.2	85.7	88.6	88.8	69	75.1	61.8

Discussion over the Items Worked Out with Certain Procedures

Most students gave the examples of fraction addition and subtraction like "An object is divided into several parts, then take some out". But most examples had not the same unit, and reasonable explanation could not be made.

> In regard to the operation of addition and subtraction, in which numbers have two digits after the decimal point, most examples were about doing shopping or the price of products. Even some examples gave the price of products with three digits after the decimal point, like "Here are 24.275 yuan, and each person is given 1.25 yuan. How much can each person get?"

Some students described the number of people, pencils, baskets, and glass beads with fractions and decimals. For example, "In the school shop, one pencil costs 2/3 Yuan, and one notebook 5/7 Yuan. How much does Xiao Ming spend buying one pencil and one notebook?" Another example is shown in Figure 1.

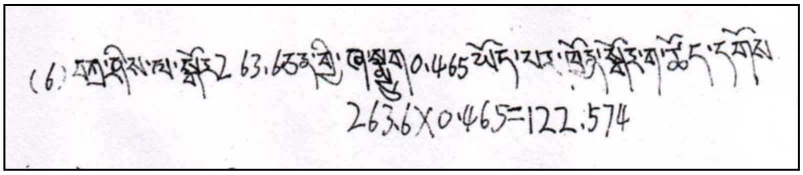

Figure 1. **Sample 1.**

Figure 1 showed us the question, "Zhaxi has 0.465 pencils which are worth 263.6 Yuan, and how much do these pencils cost?

In some examples, the sum of parts is more than the whole. For example, "The teacher assigns some homework. Xiao Ming does 4/5 at first, and then finishes 3/7 after dinner. How much does he finish?"; "Students of the fourth and fifth grades do an exercise. Students of the fifth grade finish 4/5, while students of the fourth grade finish 3/7. How much do the two classes finish? (See Figure 2)"

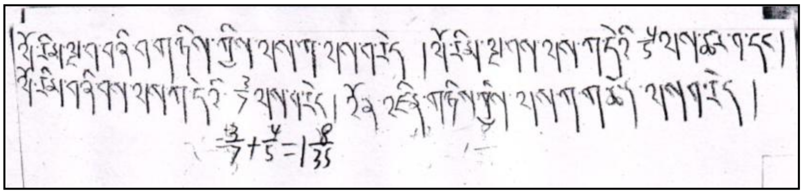

Figure 2. **Sample 2.**

Students in the Tibetan areas regard "ratio" as "difference," because in Tibetan, "compare A with B" can be understood as "what is the difference between A and B?" Students could provide some examples about fraction subtraction and decimal division, but most of them are not practical, which means that students do not know about the real objects. For example, "There are three baskets of apples. First 1/2 of them are sold, and then 2/3 of the rest are sold. How many are the rest?" This example is not conformable to the requirement. Another example, "Dad's weight is 24.275 kg, and he is 1.25 times as mine, so I weigh 19.45 kg.

In short, few students could give examples which have a relationship with real life. Most of the examples were not practical. The fact that those mathematical problems had nothing to do with real life showed that teachers paid more attention to doing exercises than practical application.

Students' understanding and solution to some questions showed that lower scores did not mean lower intelligence or lower competence. Some students who got lower scores could give some reasonable examples. For example, "I have a piece of cookie, and Zhaxi has a piece of cookie as well, but Garang has no cookie. So I divide my cookie into three parts, and Zhaxi divides his cookie into seven parts. Then I take out two parts and Zhaxi takes out five parts to give Garang. How many parts does Garang have?"; "In 2006, Cairang took much ghee (name of product) to sell in the city. The price was 0.465 yuan per jin (half a kilogram) (Note: It is not the practical price.), and the ghee was 263.6 jin. How much did Cairang get when he got home?" Some reasonable model diagrams and examples are as follows (Figure 3-Figure 7):

The example in Figure 5 is "There were 3 tons of coal. 1/2 ton was carried away the first time, and then 2/3 of the rest was carried away the second time. How much coal was left? The example in Figure 6 is "The cloth was 3 meters long. 1/2 meter was used to make trousers, and 2/3 meter to make a coat. How many meters long was the rest?”

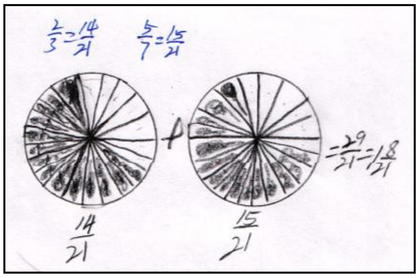

Figure 3. **Sample 3.**

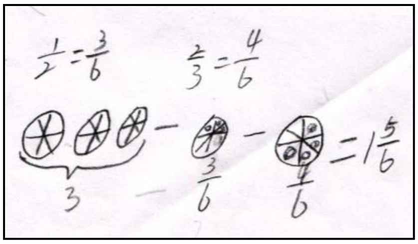

Figure 4. **Sample 4.**

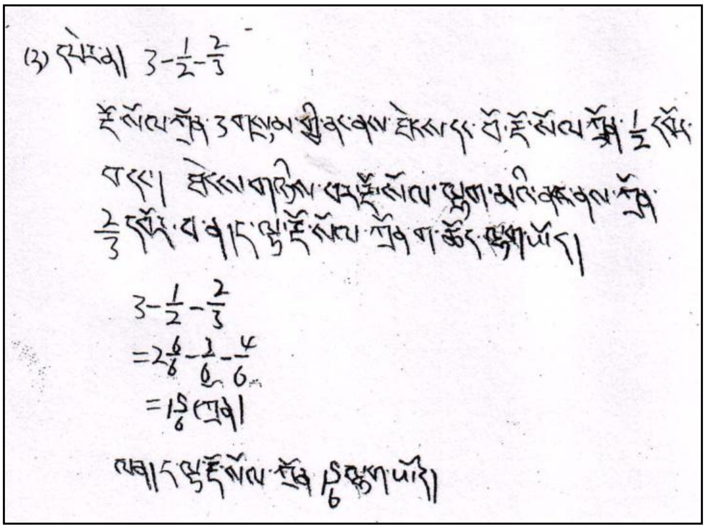

Figure 5. **Sample 5.**

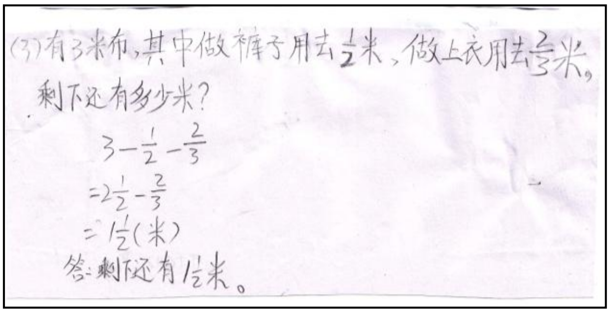

Figure 6. **Sample 6.**

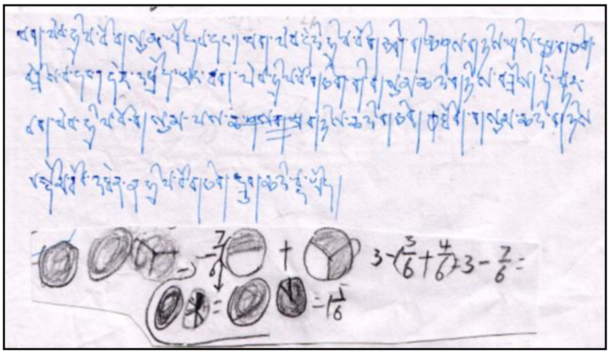

Figure 7. **Sample 7.**

The example in Figure 7 is "One of the three cakes is divided into two parts, and one part is eaten. Another of the three cakes is divided into three parts, and two parts are eaten. At last, the rest of the cakes are one and five sixth."

Discussion over Mathematical Model Diagrams

Figure 8 shows that two fractions whose units are not the same are added or subtracted, and the unit "1" is not the same, either. Bigger denominators have bigger units.
Figure 9 shows that though the unit "1" is the same, two fractions' units are not the same, but the sum has the same parts.

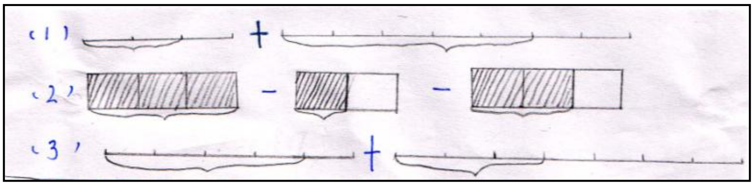

Figure 8. **Sample 8.**

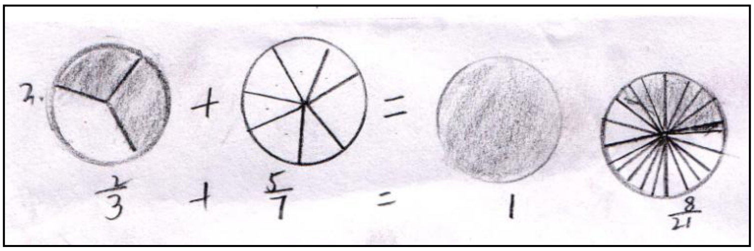

Figure 9. **Sample 9.**

There were plenty of students who did the operation of addition and subtraction with the integral concept. Some parts in a formula do not belong to the same kind (See Figure 10 and Figure 11).

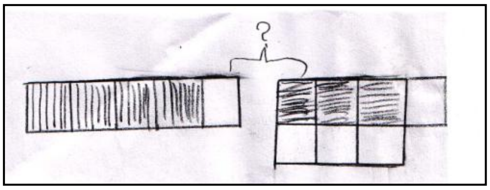

Figure 10. **Sample 10.**

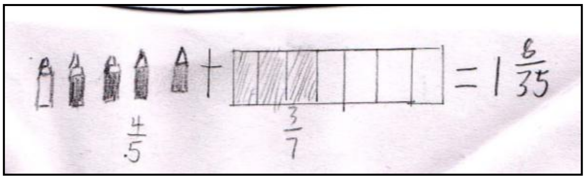

Figure 11. **Sample 11.**

Figure 12 and Figure 13 present that students use different graphs to stand for two fractions.

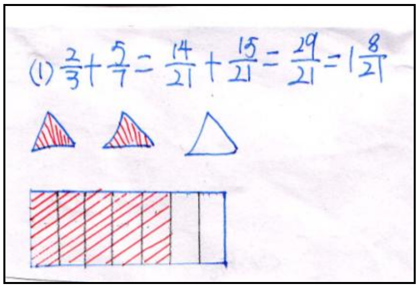

Figure 12. **Sample 12.**

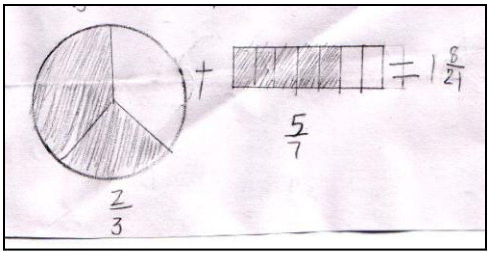

Figure 13. **Sample 13.**

Figure 14 shows that students can use graphs to express fractions, but do not know how to get the sum or the difference.

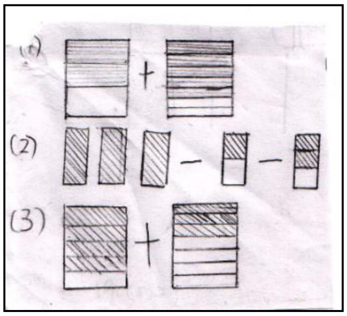

Figure 14. **Sample 14.**

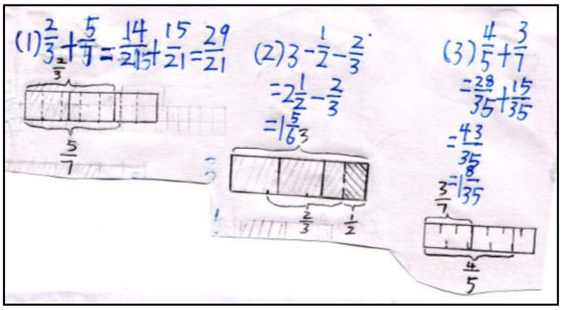

Figure 15. **Sample 15.**

Figure 15 shows that though students can use superposed figures to explain addition and subtraction with the same units, they cannot get the correct answers.

The students of the “T+C” model created more practical examples than the students of the “C+T” model, while the students of the “C+T” model created more practical examples than the students of the “C” model. In practice, few students of the “C” model could create practical examples and model diagrams. The findings show that the students of the “C” model were halfhearted, conservative, and not confident, while the students of the “T+C” model were frank, honest, confident, and willing to tell teachers their thoughts.

None of students could provide reasonable model diagrams of fraction multiplication and division.

Only one student got 3 kinds of results of item 8, 4:1, 4:3, and 4:1, and gave a reasonable explanation (See Figure 16).

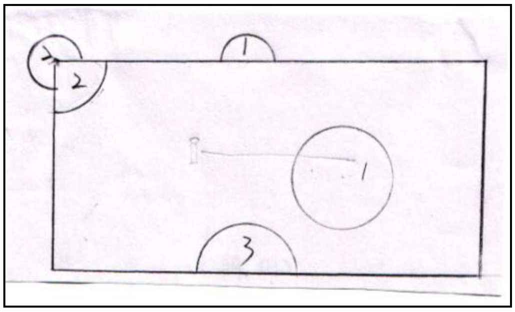

Figure 16. **Sample 16.**

Figure 17 shows the examples of the correct operation of subtraction and division with reasonable model diagrams.

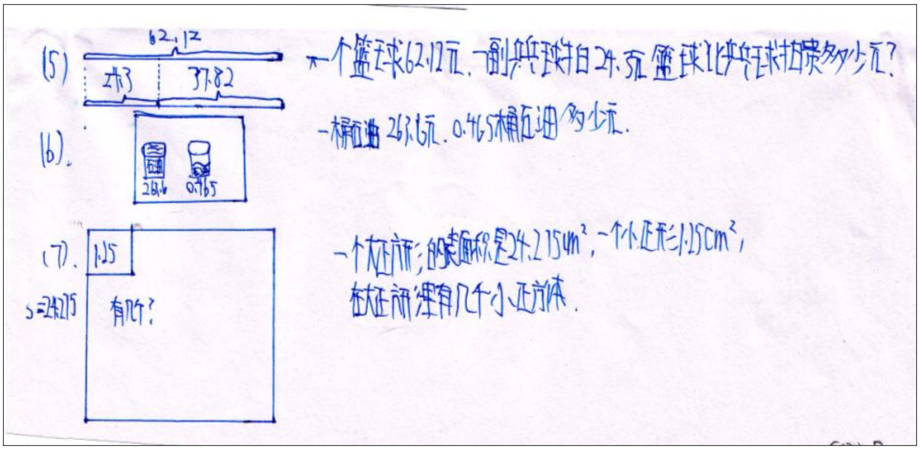

Figure 17. **Sample 17.**

Implications

Application of Traditional Teaching Methods

Since the new round of curriculum reform in 2001, mathematics teachers have been trained for the application of the new curriculum. The significant changes of some teachers' educational philosophy and teaching methods have taken place in classroom instruction and tutoring outside class. However, in order to meet the entrance examination and to complete the teaching plan, teachers try to go for the unlimited expansion of the teaching content, and increasing the difficulty of teaching. The actual situation of big classes, small classrooms, more content, less materials, high targets, and low starting point causes the formalization of the new teaching methods. Therefore, the teaching objectives cannot be achieved. Students are often thrown into bewilderment in class and teachers cannot control the situation. Mathematics learning in Tibetan schools, from primary to high school, is to do a large number of exercises based on imitation. Overall, the teaching methods in these schools are mainly teacher-centered. In addition, there are not enough teaching aids in the class; teachers in Tibetan schools have limited knowledge of bilingual teaching and how to design activities which students can take part in actively. Some teachers try to divide the whole class into groups of 6 or 8 to carry out teaching activities. However, the teaching activities are not models of cooperation or interaction, but teachers still carry out the traditional teaching method---the cramming teaching method. Teachers try their best to employ the real objects and some examples to attract students, but their efforts are fruitless. As a result, what teachers do in class is read item by item from the textbook. Students just say "Yes" (or "Right," "I know," "I see," "I understand") to show their understanding in reply to teachers' questions whose answers must be "Yes".

Acute Shortage of Supplements to Textbooks

In Tibetan areas, not only are teaching methods traditional, but also high-quality supplements and guidance materials to textbooks are seriously short. Teachers' teaching skills need improving. Therefore, it is rather hard for students to learn well. All the situations mentioned above increase the high risk of failure in education. Teachers do not base their teaching plans on modern teaching theories, and do not pay attention to students' different intelligences and learning styles. They teach students knowledge relying on textbooks. The main teaching strategies are mechanical memory and repetition. As a result, students passively study and spend the whole class taking notes and copying what the teacher writes on the blackboard. They have little time to ask questions and exchange their thoughts in class. Besides, students' textbooks are the replicas of Chinese textbooks, in which there are no rich illustrations familiar to Tibetan students. The language used in the textbooks is special Tibetan instead of the plain language used every day. The examples in the textbooks are like foreign culture to Tibetan students. Students have no opportunity to become aware that, as learners, they should develop the skills of reasoning, solving mathematical problems, and exchanging information.

Limitations of Learning Environment

Tibetan students have high ability for cooperation, and their learning strategy generally adopted is to ask for help. It is easy for them to get help because the students who belong to the same nationality are frank. Their firm friendship makes them to be willing to provide help to each other so as to let them face less difficulty. The survey we did in their teaching time showed that the teaching method basically used in class was only the teacher-centered approach. And there was no assessment or encouragement to students' performance. It was very difficult for teachers to carry out activities, even more difficult for them to do cooperative learning, in a class with 50-70 students.

Some implications can be gotten from the background discussed above. Firstly, teachers' training for bilingual teaching and technical support for teaching are required to promote teaching effects in Tibetan schools. Secondly, learning and exchanging environments, in which teaching effects can be improved, need to be provided for teachers and students. Thirdly, teachers and students should be provided as many supplements to textbooks as possible to expand their knowledge.

Suggestions and Further Studies

Strengthen Teachers' Training

As is known to all, a teacher's teaching methods are gradually formed from the absorption of others' methods which have been well recognized. The form of a teacher's teaching methods bears some relationship to personal learning experiences, personal ideas, personal values, teachers' encountered, the current state of the living environment, and the social, cultural, historical and political environment. Strengthening teachers' training is a necessary way to change the status of teaching. In the training scheme, some considerations which must be taken into account are as follows: First, teachers need effective training--- competence-based training. Second, training must have cultural and educational features. Third, training must have specific instruction and management in the classroom. Fourth, training can be conducted in schools so as to provide teachers with the opportunity to practice more effectively and more specifically. Training can improve teaching methods and make teachers play the role of "presentation instead of teaching" (Pang, 2003) in the teaching process.

Develop Mathematical Materials Suitable for Students in the Tibetan Areas

The local government and some relevant departments should organize professionals and invest a lot of money to compile teaching materials and supplements which are suitable to Tibetan students in the aspect of their mind and thinking. We find that, during our participation in the compilation of materials for training primary mathematics teachers, teachers who do not work in the front line or are off teaching for many years participate in the development, compilation, and translation of teaching materials. Those teachers are not familiar with students' performance and thinking at present. As a result, they have a negative impact on, or even are obstacles to, the development of teaching materials.

In short, the three aspects of "teachers, materials, and classes" should be treated as the organic integration to improve the basic education for the reason that teachers (the soul) direct students to study materials (the heart) in the class (paradise) so that students can acquire a certain amount of knowledge, and their intelligence and thought can be developed.

Further Studies

Which kind of language used in a mathematics class is the most effective in elementary, junior and senior high schools in which two or more cultures co-exist? What kind of professional training should mathematics teachers receive?

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Appendix

A Questionnaire---Approaches to Solve Mathematical Problems

Name________ Sex______ Age_________ Address

The primary school you went to

The language used in teaching in your primary school

Part I. Calculate the following 7 items according to requirements.

(1) $\frac{2}{3}+\frac{5}{7}$， (2) $3-\frac{1}{2}-\frac{2}{3}$， (3) $\frac{4}{5}+\frac{3}{7}$ ， (4)21.25+9.89+1.62，

(5)62.12－24.3， (6)263.6×0.465， (7)24.275÷1.25．

Requirements：

(a) Calculate these items；

(b) Based on your understanding, construct your own model to show your computing procedures；

(c) Create a real life context to apply the item.

Part II.

(8) A horse with a 10 meters long rope is tied in a rectangular meadow, and a cow with a 5 meters long rope is tied outside the rectangular meadow. What is the proportion of meadow areas which the horse and the cow can feed respectively? (Note: Think over the problem according to the real life, and draw the diagram in solving the problem.)

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