“BRIDGE THE GAP”--- REFLECTIONS ON WHOLE-CLASS INTERACTIVE TEACHING

Luqian Zhou

<luqianzhou@hotmail.com>
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Introduction

Pearson (1989) suggests that teaching is intended to create learning, and this seems a reasonable starting position. Mathematics teaching is intended to create the learning of mathematics.[1] Over a century an impressive array of researchers has been contributing to the effective teaching methodology relating to children’s learning of mathematics. The focus of many studies has shifted from the instructivist approach to the constructivist approach, highlighting learning is seen in terms of the student or the class constructing mathematical ideas for themselves. Constructivism encourages educators to recognise their students' strongly held preconceptions and to provide experiences that will help them build on their current knowledge of the world (Duit & Confrey, 1996). [2]

What is mathematics teaching? What is the best way to teach? Mathematics educators from all over the world are delving deeply into the desirable teaching strategies, which engage students with the cognitive demand and thus result in more widely effective mathematical learning. The “whole-class interactive teaching” method recommended by The Mathematics Enhancement Project (MEP) which was developed by the Centre for Innovative in Mathematics Teaching (CIMT) at the University of Exeter has shaped or coloured teachers’ new educational experience in mathematics classrooms in stark contrast to the traditional teaching methods adopted currently.

The Numeracy Task Force (DfEE 1998) has placed some emphasis on whole class teaching.

> "Inspection evidence and the experience of the National Numeracy Project point to an association between more successful teaching of numeracy and a **higher proportion of whole class teaching.**" (para 41 p19)

They also go on to assert:

> "Some of the countries that do best in international comparisons, such as Japan and Korea, report a high frequency of lessons in which children work together as a class, and respond to one another." (para 42 p19)

In the Summary of recommendations, the Task Force include:

"devoting more time in mathematics lessons to direct communication with pupils, particularly by teaching the whole class together…" (p 2)[3]

Review of my teaching in China and the UK

Mathematics education in different countries is strongly influenced by cultural and social factors that build goals, beliefs, expectations, and teaching methods. Different cultures and societies have different philosophies regarding the teaching and learning of mathematics. I'm lucky to experience teaching in China and the UK and witness the different teaching styles and strategies, which have a great impact on children's learning of mathematics.

1. "Interactive Whole Class Teaching" in China

1) Class Size and the Scheme of Work

The school I had been teaching in for three years is a key primary school in Suzhou. In contrast to the set system in the UK, Chinese students learn the same topic using the same textbooks at all times. While UK classes are often no more than 25-30 students, in China many classrooms have 45-60 students. Large class sizes necessarily mean less flexibility in room arrangements, and thus most Chinese classrooms have students sharing small desks and sitting in rows. The class I had comprised 52 students. I had been teaching them from Y1 to Y3, following a more uniform and systematic curriculum. At the beginning of each term, we had the district mathematics team meeting in which involved all the maths teachers in the same area. We discussed the difficult teaching points and exchanged the teaching strategies and ideas of a particular topic. At the same time, we were given the uniform scheme of work for the whole term since all schools used the same textbook. This scheme of work consisted of the strict teaching hours and the date for each mathematics topic that arranged systematically and in depth. It also pointed out the date for exams and holidays gave two to three flexible lessons for teachers in case some teachers couldn't complete the teaching task due to school activities. After we got the scheme of work and teacher's reference book, which stated the objectives and some recommended teaching ideas of each lesson; we started to plan every lesson carefully considering the possible learning difficulties the students might have.

2) "Four-step" Teaching Procedure

My students had one 45-minute maths lesson every day. Maths teaching in my school basically followed the teaching method that we called "Four-Step" Teaching Procedure.

Revision It's very important to revise the main point learned in previous lessons. In Year 1 and Year 2, we focused on arithmetic. "Number cards" involving addition, subtraction, multiplication and division were my starting point of every lesson. To

speed up the children's mental calculation was the main task for us. I used various activities, such as "Driving My Train", " Maths Relay", and etc. in which students stood up and give answers one after another. A star or a red flower was given as the praise to the fast groups. On one hand, my students were motivated because they loved competition. On the other hand, they practised their mental calculation every day. At the end of Year 1, the students had oral and written tests on one and two digit number arithmetic calculation. In my school all students must get no more than two errors in 60 questions and the time limit was less than three minutes. In 1998 and 1999, I had two students who completed all 60 questions in only 52 seconds! 95% of my students got all correct answers within two minutes.

The second teaching feature in my school was to revise the relative skills and concepts needed for the new lesson. Therefore the students had another opportunity to refresh the concepts they had learned and could understand and construct the new skills and mathematical concepts easily.

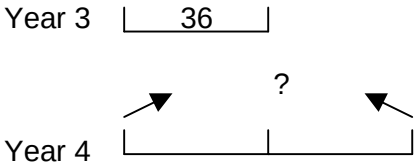
Presentation This step can well represent the striking "interactive whole class teaching" in Chinese classrooms. It includes innovative elicitation for the new topic, the coherent presentation strategies and the "teacher-student" dialogue that monitors the progress of learning.

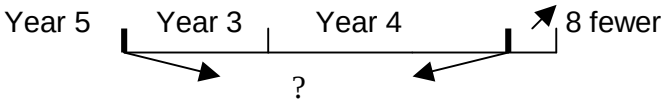
I would like to use a specific example to illustrate this step. The aim of the lesson was to analyse the quantitative relations of the given information and solve the word problems. The activity I used to introduce the new topic was asking my students to guess how many apples in the bag. They had to ask me questions, such as " Is it less than the number of students in my group?" "Is it an even number?" and etc. My students were very curious to know the exact number of apples I had. They kept asking questions and got to know that the information I gave had quantitative relations of each other. I found the whole activity aroused their interest in learning and the atmosphere created in the classroom was lively and exciting.

Then I presented the first word problem on the board.

The students in Red Star School were planting trees. Year 3 had planted 36 trees. The number of the trees Year 4 had planted was as twice as the trees Year 3 had planted. Year 5 had planted 8 trees fewer than the total number of the trees of Year 3 and Year 4. How many trees had Year 5 planted?

"Can you draw some lines to present the information of this problem?" I asked my students to tell me what to draw first and how to present the number of the trees Year 5 had planted. After their answers I showed the following diagram on the board.





“Which problem can we solve first according to the given information?” “How can we work out the number of the trees Year 5 had planted?” I elicited my students to solve the problem step by step and required them to use precise oral maths language to explain the working out.

After the explanation it was time for students to write down their working out. At the same time I asked two students to work on the board.

Student A:36＋36 x 2－8　　Student B:36 x（ 2＋1 ）－8

＝36＋72－8　　＝36 x 3－8

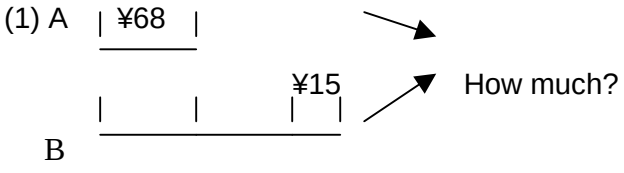
＝108－8　　＝108－8

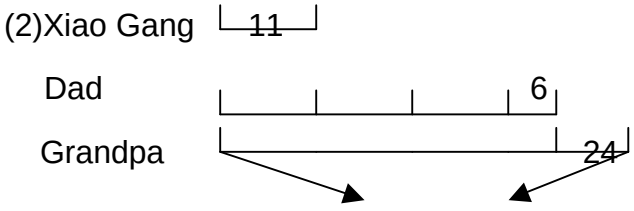
＝100　　＝100

There were two different ways to solve this problem. These two students explained how they were thinking and why they used such way to work out the problem. It revealed to all the students that we could use different ways to solve the same mathematical problem. Then the students checked if the answer was correct.

Consolidation Before I gave my students more problems to work at, I summarised the main points of solving such word problems. Firstly, “Reading”---Read the whole problem carefully and underline the relevant quantitative information. Secondly, “Thinking”--- Think about the given information and figure out what can be worked out first. Thirdly, Write down the working out clearly and precisely. Fourthly, check the answer. When I was teaching word problems, I often followed this teaching strategy: Reading-Thinking---Working out---Checking answers. I felt that it was very helpful for my students to develop their mathematic logic and tackle the same step of the question at all times during the lesson.

Then I gave my students various kinds of problems to practise. One of the exercises was to ask students to explain the diagrams first and then work them out.





How old?

Summary & Homework I always gave my students different kinds of questions to practise after the new lesson. In China, students must complete all the class work and homework assigned by teachers. Teachers always give the work back the next day.

2. My First Year in the UK

To my great surprise maths teaching in the UK is very different from that in China. During my first year in a mixed community secondary school I noticed that there was a strong investigational approach, group work dominated, calculators were used unrestrictedly. My students tended to ask for help anytime in the lesson. Another noticeable feature of the British maths teaching is that students are grouped in accordance with their mathematical ability from Year 7. I believe the purpose of doing so is to develop mathematical skills and knowledge at students' own level and learning pace. It's very essential to meet their individual needs. However, many low ability students have lost their confidence from early years in school because of the grouping and teachers' comments. Unconsciously we mark those students as the ones below our standard and give them more individualised teaching and easy work, thinking that they cannot cope with the standard work. Not surprisingly may we find that some Year 8 students can't even do the work which should be learnt long time ago. Little by little, the ability gap between able students and these low sets students is getting bigger and bigger. A great number of students failed in maths learning or develop their growing hatred towards this interesting and important subject. Should we ask ourselves, "Is it partly due to our traditional teaching approach? Is that what we expect from our good intention of meeting individual needs?" David and Clare Mills[4] pointed out that huge differences were discovered in the way mathematics was taught in comparison with the students' academic performance in Hungary, Germany, Switzerland, Flemish Belgium and the Pacific Rim. It was found that successful countries invariably used interactive whole class teaching rather than the individualised teaching then current in British schools.

How can we make the best learning of our students and narrow down the gap by pushing our low ability students to meet our standard objectives? Whole class interactive teaching studied in University of Exeter and the striking test results of MEP schools has convinced us that we can change our teaching routines to make learning meaningful, visible and applicable.

Looking back on the whole class teaching in other coutries, Tibor Szalontai[5] enlightened us with the attractive main features of Hungarian teaching.

- Whole class interactive teaching- pupils kept together as far as possible (but with natural ways of differentiation)- effective lessons.
- Harmonic proportion of whole class activity and individual work (which is always followed by whole class discussion again: report-reasoning-arguing, debate-feedback-agreement-feedback-self-correction-praising, evaluation-teachers' extra comments or extension)-spoken and written abilities-clear mathematical language-frequent mental calculation.

- Flexible and sensitive diagnostics by feedback questioning during both the whole class activities and the discussions after the individual work. (Who agrees/disagrees with X? How did you think? How could you guess it? Where did you get the idea from? What did you write? Why did you think this? Who did this/other way? Who got this/other result? Is it correct/incorrect? Why?,etc.)
- Investigations. Development of (mathematical thinking). Manipulative and demonstrational rules, models – but less 'free playing' than in the 'new mathematics'- realistic problems.
- Focus on psychology of learning- internalisation – differences between the genders in different age cohorts – use of both sides of brain (moving or imaginational thinking of right hand side part and logic or conceptual thinking of left hand side part) – complex use of advantages of different learning theories.

The question now put forward is how we can learn from other successful countries and apply the essential parts of whole class interactive teaching to our present mathematics education system. As all other mathematics teachers, I believe an environment needs to be created through which all students can have the opportunity to gain access to mathematics, learn mathematical skills, develop an ability to apply mathematics in everyday circumstances and experience joy in being able to do and understand mathematics.

MEP strategies reveal the essence of this method and recommend the following.[6]

1. Prepare everything before the lesson
2. Begin by reviewing homework
3. Warm up with mental arithmetic
4. Tell pupils the aim of the lesson
5. Give clear, precise instructions
6. Work through examples on the board interactively
7. Encourage as many pupils as possible to work at the board
8. Vary the questioning
9. Insist on mathematical precision in oral and written work
10. Correct mistakes and misconceptions as they arise
11. Monitor the progress of every pupil
12. Vary the pace and activities

13. Use enthusiasm and humour

14. Praise pupils

15. Summarise the lesson

16. Set homework clearly (should be linked to the next lesson)

“Is it possible to combine my Chinese whole class teaching style and the MEP interactive teaching strategies into my English class?” I try to implement my whole class interactive teaching in every lesson by reviewing homework. At first, my students were not used to it as they had been used to the individual teaching style. But after I constantly encouraged my students to work on the board, varied the pace and activities and praised their good work, they started to like the way I teach and became very active in my lessons.

Application of Whole Class Interactive Teaching

Now I work in a Catholic boy school teaching across abilities from 11 year olds to 16 year olds. The ethos of the department was different from any I had yet experienced and I could see that it would be challenge to adapt my mainly whole class interactive style to this new ethos. The lessons I saw all had a similar structure. They started with an initial exposition then the class would be set work, usually from a text book, and then the teacher would walk round talking to the pupils individually.
However, I’m convinced myself that I can apply the whole class interactive teaching in my class. “Emphasis on understanding pupil attainment linked with a willingness to experiment with different styles of teaching can lead to a steady growth in knowledge about teaching and learning maths.” (J. Ridgeway 1988) [7]

I set myself some teaching aims. One of them is to find ways to make maths less daunting, give it meaning and connect it with our real life. The Numeracy Strategy would tell me what to teach but meanwhile I need to find the link between each topic and find the best ways to avoid blunt knowledge intake. Ridgeway described two main ways that new knowledge is fitted in with existing thoughts and knowledge. The first of these is assimilation where the way that new information is perceived is heavily dependent on present knowledge and conceptual structures. Accommodation is when the new information is so different from what was already understood that it forces the learner to change their existing knowledge and conceptual structures. "To foster accommodation it is necessary to provide dramatic examples which violate current concepts and to provide these examples in quantity." (Ridgeway 1988)
Major leaps in understanding come about by accommodation. One way to bring this about would be if "Pupils are encouraged to make mistakes and are seduced into errors which they reflect upon and remediate for themselves or with the teachers help," (J.Ridgway, 1988). Backhouse, Haggarty, Pirie & Stratton agree with Ridgeway and suggest that cognitive conflict should be used to force learners to reject flawed methods. They also warn against teaching that will only necessitate assimilation. "Beware of giving lots of easy practice questions on which learners develop their own defective methods." (Backhouse, Haggarty, Pirie, Stratton, 1992).

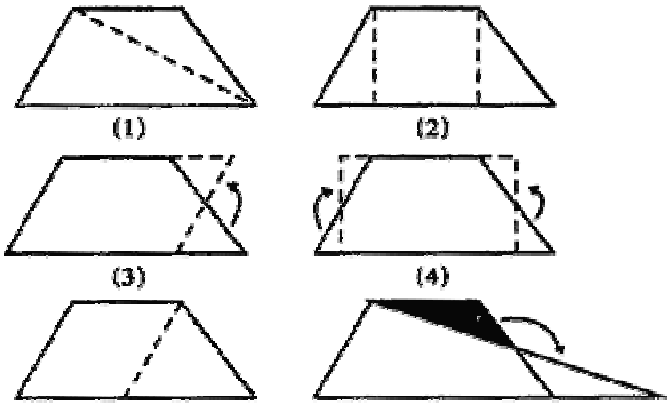
The Shell Centre adds that as well as being unproductive too many similar practice questions are boring for both high and low attainers. [8]

However I believe that teaching that only promotes one of these two kinds of learning is flawed. If one only put pupils in situations where the number of counter examples to what they would predict with misconceived methods is small then they might use this to refine their preconceived ideas but they would never truly irradiate their misconceptions. However if they are confronted constantly with situations that challenge their beliefs it will be hard for any conceptual structures to form. In the long run they might be able to develop a misconception free understanding of the topic. Unfortunately the high levels of confusion that would fill the interim period might stop them from ever reaching that goal.
One must use assimilation to allow correct new knowledge to fit in with what the learner already knows. "Look for meaningful links with other mathematics. This is important because relation learning is more efficient than instrumental learning,"[9] (Backhouse, Haggarty, Pirie, Stratton, 1992). I taught my Year 8 students how to calculate the area of trapeziums. The topic that they were on before it was areas of triangles and parallelograms. Thus revising how to calculate areas of triangles and parallelograms first enables students to link their present knowledge with the new topic. “Learning is concerned with making and strengthening links in their minds between new knowledge and what they already know,” [10](Backhouse, Haggarty, Pirie, Stratton, 1992).

I started my lesson by asking, “How many 2-D shapes have we learnt before? How can we calculate areas of triangles and parallelograms?” Then I presented some triangles and parallelograms for my students to work out their areas. Next I presented a trapezium on OHP and asked if they could work it out as well. Some students looked puzzled and I introduced the topic by hinting to convert the trapezium to the shapes they had learnt before. I prepared some identical trapeziums and gave them out. I asked my students to put them together to see what kind of shape they could make. One student came to the board and showed us that he could make a parallelogram. My students were very interested in coming to the front and demonstrated their shapes. Then I let them discuss in pairs what relations they could find between a trapezium and a parallelogram.
“The base of the parallelogram is equal to_____. Its height is equal to_____. The area of each trapezium is_____ of the area of the parallelogram we make.”

“Can you work out the formula to calculate the area of a trapezium?” My students could easily find out the formula after the discussion. In order to consolidate this new knowledge, I continued to ask, “What does (base + top) represent? Why does it need to be divided by 2?” When all my students understood the formula and knew how to use it to work out the area of trapeziums, I gave them some exercises to do and invited a couple of students to show their working out on the board.

After a brief summary I extended the topic by asking my students to think about whether they could use other ways to get the formula. I changed my whole class teaching into group work. I divided my students into groups of four and gave them some trapeziums and scissors. After fifteen minutes, some groups worked out the new methods to find the formula. Then I demonstrated the following ways on OHP.



Each group explained how to use their own ways to find out the formula. Finally I concluded that whatever methods we use, the formula of area of trapezium is (base + top) ÷ 2.

I moved to the textbook afterwards and set some more exercises as consolidation. The whole lesson was very exciting and my students learnt the new skills from their previous knowledge. Interestingly, I found the extension was not so difficult as I thought because with interactive whole class teaching and the varied activities, my students were encouraged to develop their mathematical thinking and assimilated their new knowledge smoothly.

Conclusion

The core belief of British early years provision is that children should move at their own, individual pace. In effect this always means facilitating the faster progress of the more privileged and able. It is considered inevitable that more privileged or more able children will move ahead of their less advantaged peers. As a result, many children who feel themselves falling behind begin withdrawing from the educational process. The difference gap has become bigger and bigger. How to bridge the gap to push those less able students to achieve higher in their maths learning? A great number of studies have shown us that the adoption of “interactive whole class teaching” plays a major role in transformation of the maths education. Yet anyone familiar with teaching will recognise that any phrase such as 'interactive whole class teaching' will have a multiplicity of interpretations in classrooms. Some might be effective, some not, but the rhetoric itself will not ensure effectiveness.

I strongly hold that a successful maths teacher should have beliefs about pupils, mathematics, teaching and the strategies he uses. It is possible for us to enhance effective learning by providing the chance for more interactions with more children in our daily class. On the other hand, whole class interactive teaching strategy, I believe, doesn’t rule out the effective use of group work and other forms of learning. Some research indicated that small-group work is more effective for higher cognitive skills

like problem solving. It convinced me in "area of trapezium" lesson I discussed above. The teaching strategies recommended by MEP guide us towards the exploration of successful maths teaching. This is a long road full of challenges. Perhaps in a long term it might not prove as fruitful as it does in other successful countries. However, more importantly, we must keep reflecting the way we teach and how to teach interactively. It's not the literal understanding of whole class interactive teaching but rather how you use it to enhance effective learning which really seems to count.

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