Whole class interactive teaching in mathematics

Aidan Harrington

Cheadle Hulme College, Stockport

> Aim

To record, define and refine effective structures, strategies and activities which exemplify effective whole class teaching of mathematics.

> Dimensions of this Case Study

The teachers involved were drawn initially from 5 and, later, 6 secondary schools. Each teacher worked with several classes across the ability range in KS3.

> Summary of Findings for this Case Study

Effective whole class interactive teaching:

- promoted high levels of articulation in pupils of all abilities;
- required a focus on key mathematical ideas and misconceptions;
- necessitated a significant shift in the teacher’s role;
- necessitated an in-depth focus on a small number of significant problems; and
- necessitated working publicly with pupils’ beliefs and difficulties.

A research project funded by the Teacher Training Agency as part of the Teacher Research Grant Scheme 98/9

Introduction and background

Eight years ago the Mathematics department at the Manchester Metropolitan University (MMU) began to investigate Mathematics' teaching in Hungary. A number of local teachers became interested in the high levels of mathematical attainment, whole class teaching, impressive levels of classroom discussion and students' willingness to discuss their mistakes or difficulties, seen there. Ideas were exchanged with visiting Hungarian educators and some of the Manchester group visited Hungary for week-long visits.

Initially a small number of teachers were involved in developing these ideas in their classrooms. To increase numbers a letter was sent to local school mathematics departments, known to be interested in developing their practice. The first meeting in 1998, one year before the TTA project, attracted about twenty five teachers. This number dropped until only five schools were involved. Another school joined the project later.

The project

The group met once every half term at the MMU. The label 'whole class interactive teacher' (WCIT) emerged in a variety of contexts and for simplicity was adopted as a label for the type of teaching the group wished to investigate and develop. It became apparent, however, that there were many interpretations of what constituted a whole class interactive lesson.

Definitions were recorded and refined through sharing lesson descriptions, visiting colleagues' lessons and watching recorded lessons on video. The process of developing a vocabulary for the project and of developing shared meanings was crucial.

Following the initial meetings, several questions emerged:

- what were the structures (including homework) that typified whole class teaching;
- what were the strategies and activities that teachers used in whole class contexts;
- what teacher actions and strategies could promote learning in mathematics and acquisition of numeracy skills;
- what teacher actions and strategies could promote students' use of imagery; and
- what teacher actions and strategies could promote students' understanding of and ability to engage with, proof and justification?

Video was used to record lessons where new ideas were being tried. These lessons were analysed by the group and theories were refined, before returning to the classroom.

Key findings of the project

Much of the following is illustrated more fully, with classroom examples, in the full report.

Over the course of the project some key ideas around each of the five findings were identified.

1) Whole class interactive teaching encouraged a culture of working publicly with pupils' beliefs and difficulties

Videotape of lessons from Hungary and Japan showed pupils sharing ideas and working as a whole class on each other's difficulties. Pupils were regularly asked to come to the front and demonstrate their mathematics to the rest of the class e.g. by offering solutions to set problems and homework questions. Our research schools adopted this idea, and it became quite common for lessons to begin with one or more pupils being asked to put their solutions to a problem on the board and then discuss these with the class. Pupils' sensitivities to this exposure emerged as an issue for the group. An important and helpful distinction was made between the pupils and their mathematics; the pupils put their mathematics rather than their personalities into the public domain. This proved liberating for the students. We began to find a way of working which encouraged a culture of co-operation and mutual support, in which pupils were willing to expose and explain their ideas and difficulties.

2) Whole class interactive teaching necessitated an in-depth focus on a small number of significant problems.

- For teaching to be effective pupils needed to have sustained engagement with a small number of problems where in-depth discussion was essential.
- Explanation followed by exercises did not generally encourage pupils to engage with mathematics. Passive acceptance of 'handed down' mathematics was discouraged.
- Activity had not to be confused with engagement. Pupils could be physically or verbally active without any serious engagement with the mathematics.
- Pupils' partial understandings, beliefs, feelings, instincts and misconceptions needed to be explored. The tasks provided needed to be seen as

problematic and worth resolving. The teacher needed to recognise that the mathematics might not be obviously embedded in the task.

- Teachers needed to focus on issues and concepts rather than just techniques. Whilst techniques and rules were important they had to be seen as a partial, rather than a complete outcome of lessons.
- The task needed to be reasonably transparent even if the concept or content was hidden. The goal was to provide a problem that was easy to access but which was mathematically challenging.
- Pupils needed to be allowed to fall into traps. False generalisations were often a sound device for eventually recognising the correct generalisation.

3) Whole class interactive teaching focused on key mathematical ideas and misconceptions.

We realised early in the project, from classroom observation and video that for whole class interactive teaching to be effective, teachers' stances towards mathematics, pupils' beliefs and conceptions needed to change. It was vital, in replacing exercises as a means of developing pupils' mathematics, that a clear sense of purposeful engagement in mathematics was retained. The problems posed had to engage pupils, provide experience of essential and significant mathematics and an opportunity to challenge beliefs and conceptions. It was also important that the engagement had a sense of direction. For example teachers needed to develop:

- an awareness of pupils' beliefs and misconceptions through their own classroom experiences, sharing ideas with colleagues and through reading;
- an awareness of key mathematical ideas over and above the learning of algorithms;
- an awareness of tendencies in themselves, for example, to jump in to correct pupils, take over explanations and explain away difficulties; and
- strategies for designing problems which allowed pupils access to, and sometimes forced awareness of, key mathematical ideas. Such problems needed to tap into pupils' beliefs and be rich enough to provide a significant link to the mathematics.

4) Whole class interactive teaching promoted high levels of articulation in pupils of all abilities.

The emphasis here was on pupils of 'all abilities'. We found that pupils, even in lower ability groups, were willing to discuss their mathematics openly. This was confirmed by OFSTED inspectors in one of the research schools and reinforced our understanding that whole class interactive teaching was not simply a way of working with already able and articulate pupils.

The following teaching strategies were found to be essential:

- valuing pupil contributions without necessarily judging them;
- recognising when to facilitate discussion and when to intervene;
- developing high level questioning and prompting skills; and
- insisting on the use of correct mathematical language where appropriate.

Within the environment created by the teacher, pupils were encouraged to debate and discuss their own mathematical ideas and images, and were pushed to produce the best possible explanations and justifications of their work. This work suggested that all pupils could benefit from such an approach.

5) Whole class interactive teaching necessitated a significant shift in the teacher's role.

How does a teacher plan for a whole class interactive lesson and prepare for a lesson that seems on the surface to be about responding in the moment? The previous points indicated that attention needed to be given to the question or questions to be used. What was not clear was how to prepare for being spontaneous.

It became apparent that the nature of lesson preparation had to change. Teachers needed to:

- be able to respond to what they heard rather than having a predetermined script;
- recognise that pupils' misconceptions or generalisations with only limited applications needed to be challenged;
- develop a repertoire of additional questions and questioning skills; and
- increase their repertoire of activities and questions in order to enable pupils to gain insights into the topic being studied.

We found that the sensitive use of specific, well-chosen questions allowed pupils access to an ever-widening sense of generality, and that the teachers had to lead the pupils in a delicate dance with the particular, in order for them to gain a sense of the general.

Conclusion

It is likely that many would claim the above ideas as characteristic of their own teaching. Indeed, for some, this may be the case. However, our experiences and the literature suggested that too many mathematics lessons were dull and repetitive. In many lessons outside the research project, the main object for the teacher was to refine his or her explanations so that the class could follow the given example. Discussions were used solely to clarify confusion concerning procedures. Common sense told us that such a way of working was ineffective and yet, despite international comparisons reinforcing the message that we were not doing well, it persisted. Year after year teachers returned to the same topic as if it had never been taught. We sought a productive alternative and ways of working effectively with whole classes. As a group we gained much professionally from our collaboration.

An important issue to emerge from this research was the empowering effect of video as a research tool. Teachers seeing themselves for the first time felt they were being confronted by an intimate stranger. Such insights helped colleagues move forward. The use of video also facilitated the development of a common framework and vocabulary for describing classroom activity. It presented individuals with opportunities to work on ideas used by others, more effectively than would have been possible by observation alone or through mere conversation.

Although we do not claim to have developed a panacea for effective teaching we know ourselves, from video evidence, to be better practitioners than at the outset. Our pupils have become more effective learners and communicators than they were before. An important finding for us all was recognition of the need to be aware. As teachers we feel the requirement to sensitise ourselves to the choices that are available to us. To develop as teachers we need to become alert to the opportunities that present themselves in the moment. We acknowledge that such watchfulness is hard to sustain.

Methodology

The teachers' group used a range of research and development strategies including, reading, classroom observation and peer discussion to identify and refine approaches to whole class interactive teaching (WCIT) in KS3. These were then recorded and analysed using video, peer observation and group discussion. From this data, the effective structures, strategies and activities of WCIT were identified and put into practice. Their impact provided data for further refinement at future meetings of the teachers' group, in an iterative cycle.

Teacher effectiveness was judged on the basis of pupils' achievement and ability to utilise appropriate images and justify conjectures and decisions articulately. Pupil achievement, measured by their ability to engage in mathematical problems, was found to be beyond that expected for their age.

Further reading

Andrews, P., *Looking behind the rhetoric: some new insights from Hungary, Mathematics Teaching, 166 or 167, in press,* 1999.

Askew, M., *Recent research in Mathematics Education (5-16), Wiliam, D.* OFSTED 1995.

Gattegno, C., *The common sense of teaching mathematics, Educational Solutions,* 1974.

Hart, K., *Concepts in Secondary Maths and science,* 1983.

Mason, J., *"A personal view" in Mathematics Teaching, Issue 163,* June 1998.

Pimm, D., *Symbols and meaning in school mathematics,* Routledge 1995.

Stigler, J.W., Lee, S-Y. and Stevenson, H., *Mathematics classrooms in Japan, Taiwan, and the United States. Child Development, 58 (5), pp 1272-1285,* 1987.

Tahta, D., *"Lucas turns in his grave', in Pimm, D. and Love, E. (eds.) Mathematics, Teachers and Children* , Hodder and Stoughton 1988.

Schools involved:

Bramhall High School, Stockport
Cheadle Hulme College, Stockport
Flixton School, Trafford
Kingsway School, Stockport
Roundwood Special School, Manchester

Contact

Aidan Harrington: 0161 485 7201
Cheadle Hulme College
Woods Lane
Cheadle Hulme
Stockport
SK8 7JY
www.teach-tta.gov.uk

Publication number 158/9-00
Further copies of this summary are available from
TTA publications 0845 606 0323