

Geometry Working Group

A report on the meeting at the University of Bristol, 15th November 1997

Convenor: Keith Jones, University of Southampton

A comparison of the teaching of geometrical ideas in Japan and the US

The release of a videotape of typical geometry teaching in Japan and the US allows a comparison to be made of the teaching methods typically employed. While the typical US lesson emphasised skill acquisition, the typical Japanese lesson focused on the solving of complex problems through pupil exploration and presentation.

The results of the Third International Mathematics and Science Study (TIMSS) indicate that year 9 pupils in England score in line with or very slightly below the international mean in geometry while countries such as Japan and Singapore score far better (Keys *et al* 1996 p37-38). While there are inevitably a range of factors affecting such relative achievement it is now possible to compare what actually goes on in typical mathematics classrooms in a number of countries through an innovative video study. As part of TIMSS a representative sample of year 9 mathematics lessons in three countries were video-taped, including 50 in Japan, and 81 in the United States (Stigler and Hiebert 1997). A major aim of this video study is to compare actual mathematics teaching methods and the release of a video tape containing footage of a number of lessons allows us to compare the teaching approaches in a typical Japanese geometry lesson with those of a typical US geometry lesson.

The typical year 9 US geometry lesson provided on the video tape is on angles, and begins with the teacher presenting four figures containing intersecting lines drawn on the board. The students are asked to find the angles with the teacher helping with the first four by asking questions and providing information. The pupils are then asked to find the rest. Following this introduction the teacher goes over the homework and then hands out a worksheet titled "Types of Angles (Continued)" that contains two sample problems with solutions and 15 problems which ask for the angles shown in the drawings to be found. The teacher introduces the worksheet by working through the first few problems. While the pupils work individually on the rest of the problems, the teacher circulates around the room, assisting as necessary. Two of the problems cause a number of pupils difficulty so the teacher stops the class and goes over these particular problems. The teacher concludes the lesson by announcing the topic for the next day and informing students of the dates for the next test.

The typical year 9 geometry lesson in Japan begins with the teacher using a large-screen computer to remind the class how to obtain the area of a triangle constructed between a pair of parallel lines, something they found out in the previous lesson. The teacher then draws a figure on the board representing two pieces of land, each piece owned by a pupil in the class. The boundary is a line bent in the middle. The owners would like to make the boundary straight without changing the areas of the two pieces of land. The teacher asks where he should draw the boundary. After a brief question and answer session to clarify the problem, and several predictions by the pupils, the teacher asks the pupils to work on the problem, saying "First of all, please think about it individually for three minutes." The pupils work individually on the problem while the teacher circulates around the room, observing and assisting students. Because the task for the pupils is to develop a method to solve the problem, the teacher mainly gives hints to the students rather than showing them what to do. For about ten minutes, the pupils discuss the problem with each other, the teacher, or a student teacher who is in the classroom. The teacher then asks everyone to return to their seats and attend to pupil presentations. While a series of pupils explain their solutions, the rest of the pupils and the teacher ask questions and request clarifications. The teacher reviews and clarifies the pupils' methods and asks how many pupils used each method. The teacher then presents a follow-up problem, which is to change a quadrilateral into a triangle without changing the area. The teacher ends the lesson by suggesting that, for homework, the students try to change other polygons, such as pentagons, into triangles with equal areas.

Overall, the video study indicates that, when comparing the steps typical of Year 9 geometry lesson in Japan with that in the US, the emphasis on *understanding* is clearly evident in the Japanese lesson. The typical Year 9 mathematics lesson on geometry in Japan has the following format:

- Teacher poses a complex thought-provoking problem.
- Pupils struggle with the problem.
- Various pupils present ideas or solutions to the class.
- Class discusses the various solution methods.
- Teacher summarizes the class' conclusions.
- Pupils tackle a similar problem.

In contrast, an emphasis on skill acquisition is evident in the steps apparent in the US geometry lesson, where the following format was typical:

- Teacher instructs pupils in a concept or skill.
- Teacher solves example problems with the whole class.
- Pupils practise on their own while the teacher assists individual students.

A summary of the comparison of teaching approaches in mathematics between US and Japan mathematics classrooms, based on the TIMSS classroom video study, is as follows:

Typical Year 9 U.S. mathematics lesson

- is with a class set by ability
- relies on a textbook
- focuses on developing a mathematical skill
- devotes most available time to practising routine procedures
- features isolated tasks

Typical Year 9 Japanese mathematics lesson

- is with a mixed-ability class
- begins with a complex problem
- focuses on developing mathematical thinking
- devotes most time to mathematical reasoning and understanding
- makes explicit links between concepts

Yet other TIMSS data reveal that there are also striking differences between the working lives of teachers in Japan and America (Peak 1996). For example, with a 30 period teaching week, mathematics teachers in the US most commonly reported teaching *26 periods per week*. *Japanese teachers reported teaching 16 periods*. In addition, Japanese schools are typically designed with one very large teachers' room, in which all teachers have their main desks, and the seating is arranged so that all teachers from a particular subject sit near one another. Stigler and Hiebert (1997) suggest that the Japanese approach of forming "lesson study groups" whose express purpose is to evaluate and revise lessons collaboratively is also an important contributing factor in the success of Japanese pupils in mathematics. More details of both teaching methods and lesson planning in Japan are given in Becker and Shimada (1997).

Notes

1. The TIMSS Videotape Classroom Study is directed by James W. Stigler, University of California, Los Angeles. For more information see: <http://nces.ed.gov/timss/video.asp>
2. The VHS VIDEO containing examples from eighth-grade mathematics lessons in the US, Japan, and Germany is in US video format and lasts 72 minutes. It is available free from: National Center for Education Statistics, 555 New Jersey Ave., Suite 402A, NW, Washington, DC 20208; Telephone: (202) 219-1333; Fax: (202) 219-1736; Email: TIMSS@ed.gov

References

Becker, J. P. and Shimada, S. (1997), *The Open-ended Approach: a new proposal for teaching mathematics*. Reston: NCTM [originally published in Japanese in 1977].

Keys, W., Harris, S. and Fernandes, C. (1996), *Third International Mathematics and Science Study, First National Report. Part 1: Achievement in Mathematics and Science at Age 13 in England*. Slough: NFER.

Peak, L. (1996), *Pursuing Excellence: a study of U.S. eighth-grade mathematics and science teaching, learning, curriculum, and achievement in international context*. Washington, DC: United States Department of Education.

Stigler, J. W. and Hiebert, J. (1997), Understanding and Improving Classroom Mathematics Instruction: an overview of the TIMSS video study. *Phi Delta Kappan*, 79(1), 14-21.

BSRLM Geometry Working Group

The geometry working group focuses on the teaching and learning of geometrical ideas in its widest sense. The aim of the group is to share perspectives on a range of research questions which could become the basis for further collaborative work. Suggestions of topics for discussion are always welcome. The group is open to all.

Contact: Keith Jones, University of Southampton, Research and Graduate School of Education, Highfield, Southampton, SO17 1BJ, UK.

e-mail: dkj@soton.ac.uk

tel: +44 (0)23 80 592449

fax: +44 (0)23 80 593556

<http://www.crme.soton.ac.uk>