Observations of classroom practice…Using the Open Approach to teach mathematics in a grade six class in Japan
Lloyd Munroe, Hiroshima University, Japan

Introduction
Research in mathematics classroom practices covers a wide range of themes. These include the social, pedagogical, and academic routines. “Mathematics classroom practice refers to the teaching and learning of mathematics that take place inside the classroom” (Mok, 2012). The classroom practices described in this article refer to the day-to-day routines of both teacher and students inside the classroom. Japanese students have maintained high averages in international tests such as Trends in International Mathematics and Science Study (TIMSS) and Programme for International Student Assessment (PISA). This makes Japan’s education system most attractive to researchers interested in studying the “Open Approach” as it is this approach to the teaching of Mathematics to which Japan’s success in the subject has been attributed.

The term “open ended problem” was developed in Japan by Shigeru Shimada and his team in the early 1970s. An open ended problem is one designed in such a way that it results in multiple solutions or it elicits from the learners various way of arriving at a solution. These real life problems create an opportunity for students to learn something new as they seek to solve the given problem (Becker & Shimada, 1997).

The open approach is a teaching method that is based on “Constructivism.” This theory suggests that each student can learn mathematics on the basis of his or her own experience, learning style, and rate of cognitive development (Piaget, 1972). Vygotsky’s Zone of Proximal Development (ZPD), which is used to explain the difference between what students can do alone as opposed to what they can do with assistance from others, also contributes to the theoretical integrity of the open-ended approach method.

This paper aims to outline best practices seen in Japanese classrooms in which the Open Approach mentioned by Becker and Shimada (1997) and Nohda (1995).

Methodology
The research was conducted by observing the principles of the open approach as used in a co-educational class of thirty, Grade-six Japanese students. Activities in the mathematics class were centered around problem solving. The classes were videotaped every day for two consecutive weeks. The teacher and selected students were also interviewed towards the end of the third month.

Quantitative and qualitative data were obtained from the questionnaire and interviews respectively. The software, QDA Miner, was used in the qualitative analysis of field-notes. Five major codes including student, teacher and lesson development were used to analyze the data. The coding categories were devised based on suggestions by Bogan and Biklen (1992).
A classroom observation guide suggested by Athew, Christensen and Copper (1992) in “The Structured Classroom Interactions Schedule (SCIS): A Validation Study,” was created for the observation of the lesson. See Figure 1 below.

**Observations**
The format of a typical mathematics lesson is similar to the description given by Becker, et. al. (1990). Table 1 below compares the general structure of a lesson as presented by Becker, et al. (1990) and Lloyd (2012). The lesson normally begins with the teacher stating his personal experience about the related topic or with him presenting a scenario, which leads to students answering a question or simple recapping of information from previous lessons.

The students were enthusiastic and cooperative, and approached learning in a business-like manner. Usually, all students are seated with their books and pencil-cases on the desks before the class begins. Preparations for class include sharpening many pencils removing the need to do so during the session. Each student sits behind a single desk normally arranged in rows and columns. During group work, students occasionally shift their desk to form groups of four. Students seemed to be mindful that they had to take responsibility for their own learning and so remained attentive and focused as they sought to carry out assigned tasks. The Japanese word “gannbatte” (speaking to others) or “gannbarimasu”(speaking about oneself), which means “do your best” is often heard among students in the class. The word is used to encourage oneself as well as others. It implies that while admitting the task is difficult, “with some effort, it can be done.” No one is teased for making mistakes or for displaying a lack of understanding. Students are respectful to the teacher and to each other. They stand and bow to the teacher before and after the session.
Table 1. Outline of a typical mathematics lesson

<table>
<thead>
<tr>
<th>Time in minutes</th>
<th>Becker 1990</th>
<th>Lloyd 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Student rising and bowing</td>
<td>Student rising and bowing</td>
</tr>
<tr>
<td></td>
<td>Introducing the session(student)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Reviewing previous day's problems</td>
<td>Reviewing previous day's problems</td>
</tr>
<tr>
<td></td>
<td>or introducing a problem to be solved</td>
<td>or introducing a problem to be solved</td>
</tr>
<tr>
<td>5</td>
<td>Discussing the problem to verify</td>
<td>Discussing the problem to verify</td>
</tr>
<tr>
<td></td>
<td>understanding</td>
<td>understanding</td>
</tr>
<tr>
<td>5</td>
<td>Individual work</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Discussion on progress</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Pair/group work</td>
<td>Pair/group work</td>
</tr>
<tr>
<td>20</td>
<td>Comparison and discussion of</td>
<td>Comparison and discussion of</td>
</tr>
<tr>
<td></td>
<td>proposed solutions</td>
<td>proposed solutions</td>
</tr>
<tr>
<td>5</td>
<td>Summing up by teacher</td>
<td>Summing up by teacher</td>
</tr>
<tr>
<td>5</td>
<td>Assigning homework</td>
<td>Assigning homework</td>
</tr>
</tbody>
</table>

An excerpt taken from a typical lesson is given below. “T” represents teacher and “S” represents students. The excerpt begins at the point of transition from introduction of the lesson to individual work.

T: Please read the question.
S: (Reading) “600 ml of juice is in the bottle, this is 2/3 of the volume of the bottle. How many ml will fill the bottle?”
T: Do you understand the question now?
S: Yes.
T: O.k. try to solve the question, you can choose any way to solve it.

Individual work/group work
The teacher encouraged students to seek help if needed. Students worked individually until they got “stuck,” then they sought help from others. The teacher challenged students to use different methods to solve the problem. He walked among the desks observing students at work. After about 3 minutes the teacher stopped the students and asked them to share what they did.
Toro: I think we should find what would be 1/3 of the amount.

Other students gave similar statements. The teacher asked the students to recheck their work or continue. After 2 minutes:
T: Who wants to share with us what they have done?

Six students raised their hands.
T: Naka?

Naka went to the board and wrote 600 ml on top of the shaded part of the bottle.
T: Who else has done something?

Fuji went to the board and wrote $\frac{2}{3}$ to label the 600 ml and $\frac{1}{3}$ for the empty space on the diagram. Mada then wrote: $600 \div 2 = 300$.

T: Why did Mada write this? Please discuss with your neighbor.

Students stood in randomly arranged groups to discuss the problem. The teacher walks among the groups observing students and asking guide questions.

Student’s presentation/explanation
After about 3 minutes the teacher asked Niko to explain.

Niko: 600 is for 2 parts and we want one part…… 300 is $\frac{1}{3}$ of the amount in the bottle.

The teacher wrote $\frac{1}{3}$ beside 300 on the board and asked,

T: “What can we do now?”
Student: Multiply 300 by 3.

The teacher did this and wrote 900 on the board.

The problem is solved. Normally, discussions of the problem would end here as the goal of solving the problem was achieved. In the open approach method however, students are encouraged to discuss their ways of solving the problem. This provides additional opportunities for all students to fully understand the mathematical concepts involved in solving the problem. The lesson continued with an extensive discussion of the various ways in which the students solved the problem. The teacher invited the students in turn to show and explain their solution on the board. The diagram below shows the solutions of some students.

![Figure 2: Students’ solutions](image)

Mako and Kon were able to explain their methods to the class but Sato was not. The students agreed that Sato took his method from a comparison diagram (similar to Mako’s solution). After giving students a brief time to think, the teacher called on Oka to explain. (Excerpts from the lesson continues)
Oka drew the “Cross Diagram” on the board-(see figure below.
Oka: That is as far as I got.

Other students raised their hands.
T: Tou, do you have something to add?

Tou went to the board and filled in the other sections on the diagram.
Oka (speaking to Tou): How did you get 1?
Tou: From 2/3 multiplied by 3/2.
Naka: I know that a number divided by itself gives 1 but...
Sato: And number times its inverse gives 1.

The teacher repeated this, drew lines and wrote multiply by 3/2 on Tou’s solution diagram.

![Diagram](image)

Figure 3: Progression of discussion

T: (speaking to the class) Do you remember this from previous lesson?

Sato went to the board.
Sato: It is difficult for me to understand divide by a fraction so I remember to invert it and multiply.
Oka: Yes, I remember now; dividing by 4/5 is the same is multiply by 5/4.
Sato: Yes, like that.
Jerry: Oh; so Sato only show the top part (of Mako’s diagram)...? I see……
Tou: Yes

Students and teacher continue to discuss the solutions given by students.

**Facilitating students’ learning**
One of the main practices observed was the way in which the teacher facilitated the individual students’ learning. Japanese teachers use “Kikan-Shido” which means “between desk instruction” to guide individual students. During Kikan–shido, the teacher walks in between desks, carefully observing and providing guidance where necessary both in individual and group activity. Clarke, et.al. (2007) state that kikan-
shido has “four mutually exclusive principal functions: (i) monitoring student activity; (ii) guiding student activity; (iii) organization of on-task activity, and sometimes; (iv) social talk.”

Figure 4. Between-desk instruction (Kikan-shido).

In Kikan-shido, the teacher changes his posture while assisting individual students. He will stoop beside the desk or lean towards the student while checking the student’s work. He uses questions to help students identify errors in their work or to guide them when they are unable to go any further with the solution. In cases where many students have similar errors, the teacher writes the information on the board and includes the class in the discussion. During one interview, the teacher commented, “If I see many students struggling with a particular step or methodology, I will ask them to stand and discuss with others. It is their duty to find the person with a methodology similar to their own and discuss with that person.”

The Kikan-shido observed in this class is unique in that:

1. During a lesson, students who understand, after completing the task, are expected to stand and wait to be called on by those who are in need of assistance. The teacher stressed that, “Those who do not understand should ask those who do.” In the interview, the teacher stated that it is better for those who do not understand to ask for help as it puts them in charge of their own learning and reduces the likelihood of them being teased or ridiculed.

2. The second form of uniqueness stems from the first. Here, the teacher asks all students to stand and discuss with others. Students are free to move about the class to ask questions and share with others. There are no set groups nor is there a maximum number of students for a group. Students are free to join any group discussion, or simply to stand and listen. The teacher also moves about the class to monitor and guide each group.

The teacher appears to be always mindful of students’ movements and the nature of their discussions. He makes mental notes of different strategies seen so as to selectively call on students to show their method on the board.
Using questions to guide students thinking

The teacher uses open questions to guide students’ thinking. His questions transition from a concrete or practical concept to a more general or abstract thinking. After asking a question, he gives students time to think before accepting answers. This method of questioning is supported by Ontario (July 2011). Here it is stated that, “While ‘yes/no’ questions tend to stunt communication and do not provide useful information, open questions are effective in supporting learning as they allow the students to think critically about what they are doing” (p. 3).

The teacher does not show favoritism or gender bias in the class; he tries to include all students in class discussions. One way in which he does this is by allowing students to call on each other to answer a question. That is, after giving students time to think about a question, the teacher calls on student ‘A’ who gives an answer then calls on student ‘B.’ Student ‘B’ after giving his / her answer calls on student ‘C.’ This may be repeated several times before the teacher intervenes.

The data shows that 60% to 80% of the questions asked by the teacher in a given lesson are open questions. “Closed questions” are used primarily to reinforce facts or to clarify what someone has said.

Use of board

The teacher writes salient and selected information on the board and also directs students where on the board they should write. Information written on the board is never erased during the lesson, the teacher will write on a mobile board if necessary. Small button shaped magnets are used to attach papers with prepared information on the board. These prepared sheets serve multiple purposes; they reduce the time it would take to write information or draw pictures on the board, thus increasing work and discussion time. They also allow the teacher to keep students’ attention, making it easier for him to manage the class. Student’s names are placed beside their suggestion as they write on the board. Placing the student’s name on the board brings a sense of ownership for the method or suggestion given. This increases the student’s self-worth as a valued member of the class and assists in discussion as students can direct their question to the person who gave the method or suggestion.

The teacher uses colored chalk to emphasize and show connections between information and concepts on the board. He also uses regular and irregular shapes such as circles and stars to highlight important points during explanations. This makes it easier for students to understand the concepts being explained.

Summary and reflection

The teacher gives a detailed summary of each lesson for 5 to 10 minutes before it ends. He does this by stating the objective (a lesson normally has one objective), the main points of the discussion and by giving recommendations for further study. For example, in summarizing the lesson above, the teacher compared Mako’s and Kon’s solutions, highlighting the merits of each while mentioning any attendant conceptual errors. He also asked students to pay close attention to Sato’s method, as they would encounter it in the future. After summarizing the lesson, the teacher asks students to write in their books/ journals what they thought about the lesson. Some students have a different book for this purpose.
Observations of classroom practice...Using the Open Approach to teach mathematics in a grade six class in Japan

Conclusion
The classroom practices observed in these lessons have great potential for engaging students in critical and creative thinking. The “Open Approach” to the teaching of mathematics has proven to be an effective strategy for increasing students’ understanding of taught concepts and their performance in the subject. Students are taught positive attitudes and behaviors and are made aware of the fact that they should take responsibility for their own learning. Irrespective of gender, students are treated equally and are expected to participate and perform equally well in all class activities.

References


Lloyd Munroe
Hiroshima University, Japan
munroelloyd@yahoo.com