Grade 7 Mathematics Lesson Plan
*Revised version

Date: Thursday, June 23, 2016, 11:30 - 12:40
Tokyo Gakugei University International Secondary School
Grade 7 Homeroom 2, 26 students (9 boys, 17 girls)
Teacher: HONDA, Chiharu

1       Name of the Unit       How to observe phenomena

2       Goals and Contents of the Unit

        The mathematics curriculum at our school consists of the four domains, "Algebra/Functions," "Geometry," "Probability/Statistics," and "Discrete Mathematics." In the domain of "Algebra/Functions," the focus is on the use of functions in mathematical modeling. The basic approach is to investigate to investigate those models using technology while making connections among the 4 types of representations - actual phenomena, graphs, tables and equations.
        This unit, Ways to observe phenomena,  is in the Algebra/Functions domain. In this unit, students will represent patterns in change in various phenomena, particularly relationships of 2 quantities in recursive relationships, using tables, graphs and equations. In addition, we want students to be able to use those representations in observing phenomena mathematically.
        There are 3 sub-units in this unit: "S.1 Tables and graphs," "S.2 Repeating relationships," and "S.3 Algebraic expressions/equations and linear equations." In "S.1 Tables and graphs," students organize data from a variety of phenomena using tables and graphs so that they can grasp patterns of change in those situations. In "S.2 Repeating relationships," students represent the relationship between 2 quantities in recursive relationships using tables and graphs and use them to solve problems. In "S.3 Algebraic expressions/equations and linear equations," through activities to change the values of independent variable, we introduce the use of letters and have students think about the usefulness of algebraic expressions/equations. Students will also engage in activities of representing situations using algebraic equations generally and concisely as well as interpreting given equations.

3       Unit Plan (S.1 Tables and graphs, total of 4 lessons)

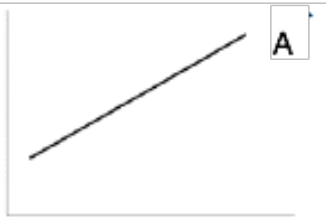| Lessons | Theme | Contents |
|---|---|---|
| L1 - L3 | Let's make a box with the largest capacity | Make a box with the largest capacity from a sheet of paper. Because the capacity will be a cubic function of a length, the 7th grade students cannot express the relationship using an algebraic equation. Students will actually create boxes and gather data Students will learn about tables and graphs as they organize the data in tables and graphs to solve the problem. |
| L4 Today | Let's make a graph of motion | Through the activity to create graphs of the relationship between time and distance using graphing calculators and motion detectors, students will interpret and create graphs of phenomena. |

4        About Mathematics

In the study of functions in secondary schools, it is important to relate phenomena with tables/graphs/equations. However, because we tend to examine functions based on their types, students do not have many opportunities to examine directly the correspondence between phenomena and their graphs. Considering the positioning of this unit explained in section 2 above, the goal is for students to grasp the way quantities change by creating and interpreting graphs that show the relationship between time and distance. Specifically, students will be corresponding the changes in directions and speed of the motion with graphs. In our school's curriculum, the study of the meaning of function is in Grade 8. In today's lesson, because the distance will be fixed when time is fixed, this activity can serve as a foundation for understanding the meaning of functions.
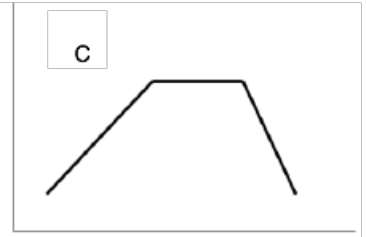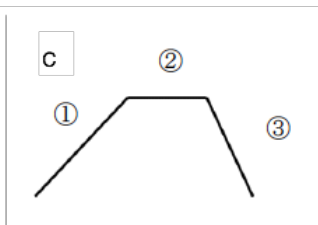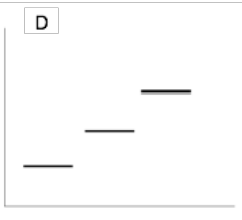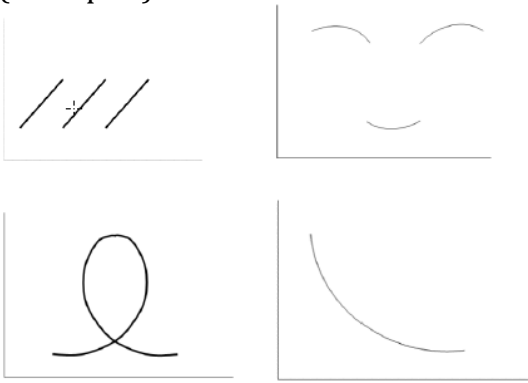
5        Today's Lesson

(1)      Goals of the Lesson
   o   Students will understand that the slope of graph represents the speed.
                                                          [Knowledge and Understanding]
   o   Students will think about how they need to move to create the given graphs and actually create them.
                                                          [Investigation of patterns]
   o   Students can explain the relationship between motions and graphs using appropriate words.
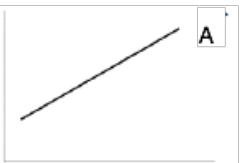                                                          [Communication]

(2)      Flow of the Lesson

| Min. | Learning Activity (*Hatsumon* (T), Anticipated response (S)) | Points of consideration (·) and Assessment (□) |
|---|---|---|
| 5 | T1:  I'm going to connect this device to the graphing calculator. When I move in front of this device, the motion will be represented as a graph. Let me try one.<br><br>T will walk at a constant speed in front of the motion detector. <br><br>T2: What do the vertical and horizontal axes tell us?<br>S1:  I think the horizontal axis is for time and the vertical axis is for distance between you and the device.<br>T3:  Why did you think so?<br>S2:  When you walked things that changed are time and distance. | • Have students think about what quantities are represented on the vertical and horizontal axes without being told the name of the device, that is, motion detector.<br><br>• Have students record their own idea(s) in the handouts.<br><br>• If S2's ideas do not come from students, ask them to identify what are changing. |

| | | |
|---|---|---|
| 10 | T4:  Is that really so? How can we know?<br>S3:  What if you change the speed of your walk? For example, why don' you walk slower (faster)?<br>S4:  Don't move.<br>T5:  What will happen to the graph? How can you know that the horizontal axis represents time and the vertical axis distance?<br>S5:  I think the graph will look like B. The reason is that graph B shows that at the same time, the distance for B will be shorter than that for A. If the vertical axis represents time, then graph B shows that the distance will be greater in B than in A.<br><br>[Posing the Problem] | • S4's idea is something to be discussed in groups therefore it will not be discussed at this point.<br><br><br>□ Do students understand that the slope represent the speed? [Knowledge and Understanding] |
| 15 | T6:  How should we move so that we can make Graph C. Please write your idea on the worksheet.<br><br>[Investigation]<br><br>S6:  Slowly move away from the device, stand still for a few seconds, then move closer quickly.<br>[Reason]<br>This graph is made up of 3 parts. (1) This shows that I am moving away from the device. (2) shows that the distance is not changing even though time passes. (3) I'm moving closer to the device. Because the incline is steeper here, I am walking faster. | • Have students record the motion and the explanations on the worksheet.<br><br>• For students who cannot think of the motion, tell them that graphs can be sorted based on the way you move.<br><br>• Direct students' attention on the slopes of the graph and the segment where the graph is parallel to the horizontal axis. |
| 20 | T7:  Let's check. (Have some students demonstrate.) | • Make sure students understand |

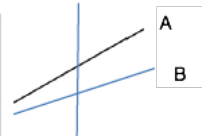| | | |
|---|---|---|
| 25 | T8: Next, try to make Graph D while collaborating with your team mates.<br>S7: Work in groups.<br><br>(Incorrect answer)<br>• 3 students standing still at 3 different locations.<br>(Correct answer)<br>• 1 student can make the 3 parallel segments, but there are also slanted segments that connect between them.<br><br>T9: If you made Graph D, discuss in each group what graphs you want to create. (Have them draw the graphs they want to create.) Think about how you should move to create the graphs you came up with then try it.<br><br>[Sharing]<br>Have groups share the graphs their groups decided to create.<br>(Examples)<br><br><br><br>[Summarize]<br>T10: Please write your reflection on today's lesson.<br>S8: I understood that the slope of graphs is representing the speed.<br>S9: I understood that we can make a graph of the relationship between time and distance because the distance changes as the time changes.<br>S10: Because the graph is a straight line when we move at a constant speed, I want to try to create curved graphs.<br>S11: I am puzzled why the graph our group decided to create couldn't be drawn. | how to use the graphing calculators and the motion detectors. Each group will operate one set of devices.<br>• Check those groups who were able to create Graph D.<br>• If groups end up with graphs that look different, have them think about what made their graphs different from Graph C.<br>□ Students will think about how they need to move to create the given graphs and actually create them. [Investigation of patterns]<br><br>□ Students can explain the relationship between motions and graphs using appropriate words. [Communication]<br><br>• Even if groups come up with graphs that are not possible, let them think about it without telling them. For the graphs that cannot be made, have them think about the reason why they can't make the graph by attending to the relationship between time and distance. This will become the foundation for the concept of functions.<br><br>• Have them write their reflections on the worksheet.<br>• Make sure students write about the relationship bewteen the phenomena and graphs.<br>• Call on 1 or 2 students and have them read their reflections.<br>• Collect the worksheets and use them to assess students' investigations of patterns and their communication ability. Return the worksheets before the next lesson. |

Positioned in left margin: 35, 45

## 6 Board Plan
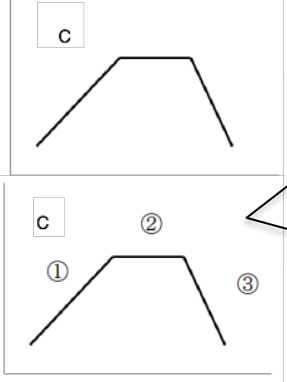
6/23 Let's make graphs by moving around

**A**

What do the axes represent?
Horizontal: Time
Vertical: Distance from the device

Why: Those are the only 2 changing quantities.
Really?
   Walk more slowly.

**A**
**B**

The distance at the same time is shorter in B than in A.

Let's make Graph C

**C**

**C** ②
①          ③

There are 3 parts in the graph.
① Gradually moving away.
② Standing still.
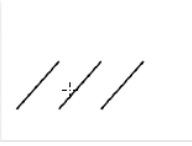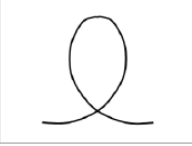③ Move closer quickly.

Let's make Graph D as a group

**D**

3 people standing equal distance apart. Starting from the person closest to the device sit down after 2 seconds.
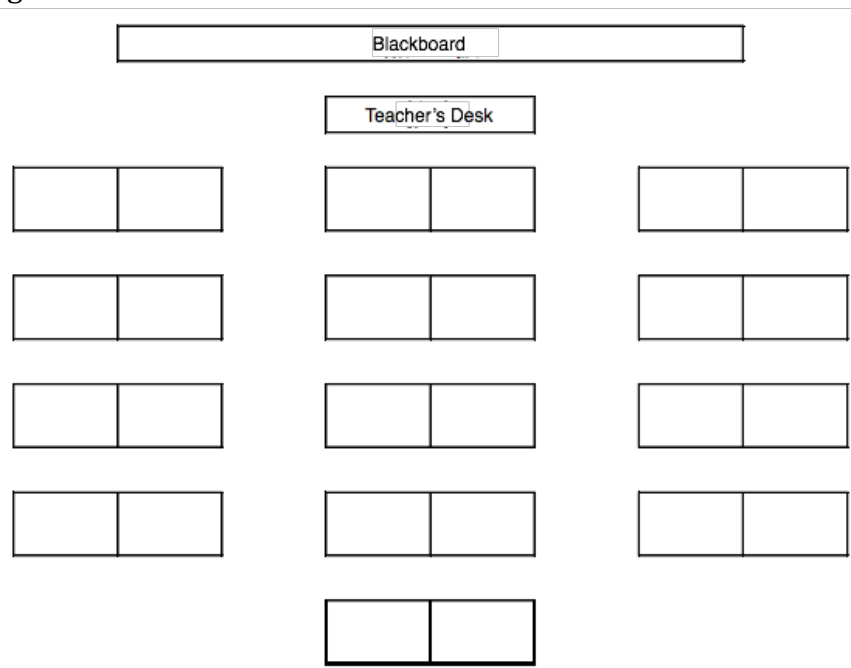
Graphs we want to make

Group [   ]

/ / /

Group [   ]

## 7 Seating Chart

Blackboard

Teacher's Desk

During the group work, 4-5 students will form a group