

Grade 4 Mathematics Lesson Plan

Wednesday, June 26, 2013, Period 5
Daisan Terajima Elementary School
Grade 4, Classroom 1
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Research Theme Nurturing students who can think on their own:
Exploring teaching approaches that incorporate critical thinking

Rationale for the research theme

This academic year is the third year of the full implementation of the new National Course of Study. Our goal is to develop “solid learning” in our students through improvements of teaching. An ongoing challenge is we can improve ourselves so that students will acquire and master “basic and foundational knowledge and skills” and develop the abilities to “reason, judge, and express own ideas” necessary to use their knowledge and skill in their everyday situations.

During the last academic year, we focused our attention on helping students to develop their problem solving ability. Our focuses on lesson improvement were on students’ ability to understand problems and their independent problem solving. As a result, students are developing the disposition to solve problems independently. This year, we are also examining the way to improve group discussion by attending to students’ language development.

When students encounter a problem, they must interpret the problem. They must also think about how they might tackle the problem. They need to think about how to express their ideas, as well as listening to other students’ ideas and make sense of them. We hope to nurture students’ ability to reason and express themselves by letting students engage in these rich language activities and becoming aware of diverse perspectives.

Vision of Ideal Students

[Lower Grades] As they listen, they can compare their own ideas and those of others and recognize their strengths.

[Intermediate] As they listen to others ideas, they can judge the viability and recognize their strengths.

[Upper Grades] Students can interpret their own and others ideas in light of mathematical power and deepen their understanding of the strengths of various ideas.

Mathematical power here includes usefulness (easy to use), conciseness (simple), generalizable (can be used in many settings), accuracy, efficiency, extendable (applicable) and beauty.

In the Intermediate Department, we emphasize thinking logically and developing arguments with clear rationale. Our goal is for students to experience strengths of each other’s ideas through language activities in which they will examine the viability of each other’s ideas.

1 Name of the unit

“Let’s explore various quadrilaterals”

2 Goals of the unit

1. Students will understand the meaning of perpendicular and parallel lines and how to draw them.
2. Students will understand the definition and properties of trapezoids, parallelograms, and rhombi and how to draw them.
3. Students will understand the characteristics of diagonals of quadrilaterals.

3 Evaluation standards

[Interest, Eagerness, and Attitude]

- Students are trying to find perpendicular and parallel lines, trapezoids, parallelograms, and rhombi in their surroundings.
- Students are trying to examine perpendicular and parallel lines, trapezoids, parallelograms and rhombi based on geometric properties they have learned previously.

[Mathematical Way of Thinking]

- Students can categorize quadrilaterals based on perpendicular and parallel sides, and they can reason about their properties.

[Mathematical Skills]

- Students can draw perpendicular and parallel lines using set squares.
- Students can draw trapezoids, parallelograms, and rhombi using compass and set squares.

[Knowledge and understanding]

- Students understand the meaning and properties of perpendicular and parallel lines.
- Students understand the meaning and properties of trapezoids, parallelograms, and rhombi.
- Students understand the meaning and properties of diagonals.

4 Relationship between this unit and the research theme

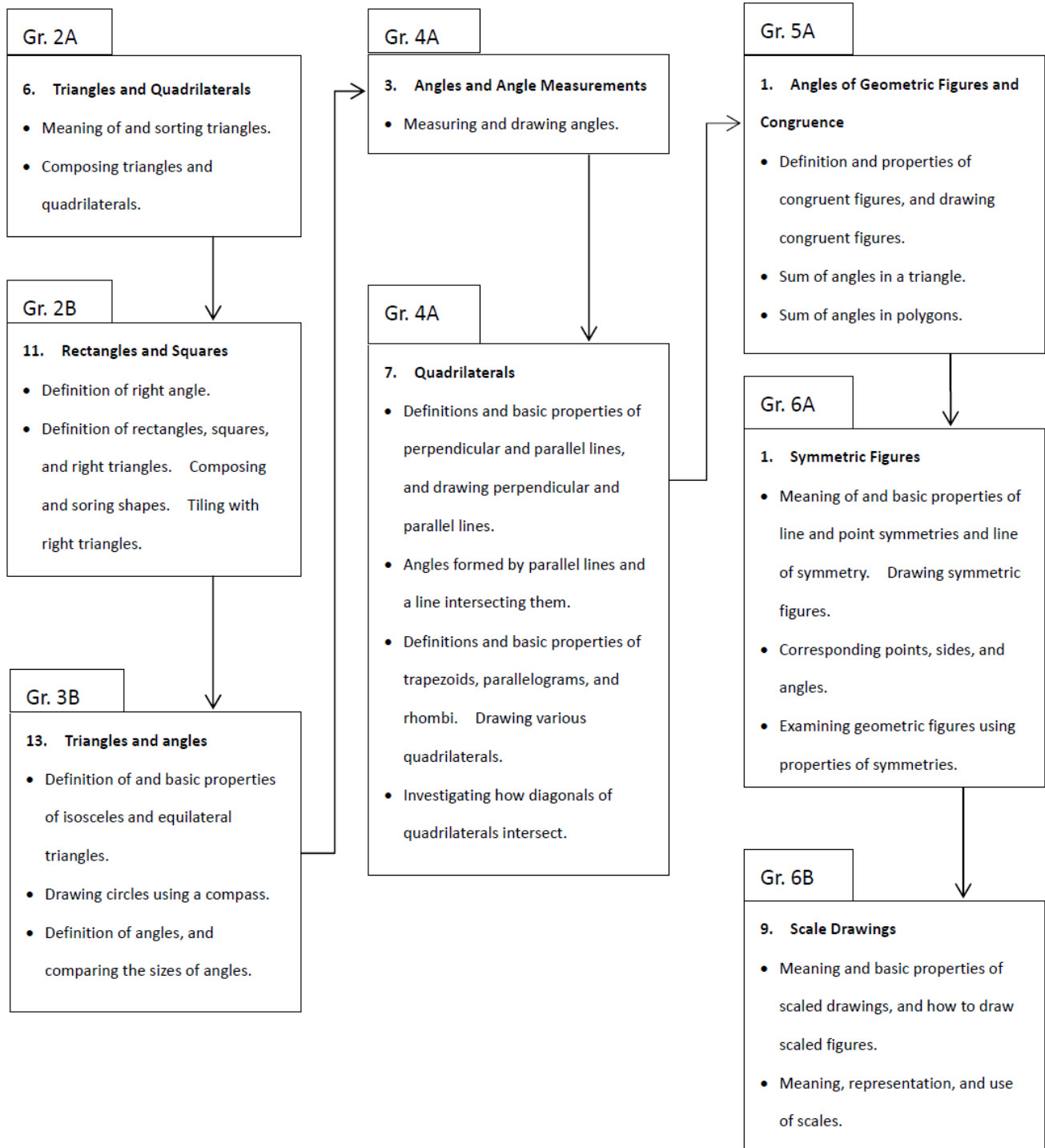
(1) About the unit

The topics discussed in elementary schools that relate to this unit are shown in the figure below.

In this unit, we will examine the relationships of 2 lines in a plane. Students will learn the meaning of perpendicular and parallel lines. Students are also expected to develop the basic understanding of properties of parallel lines. The goal is not to simply teach the vocabularies. Rather, through concrete activities, students are expected to deepen their understanding and observe their surroundings using their knowledge of perpendicular and parallel relationships and identify perpendicular and parallel lines.

As we explore quadrilaterals, we will emphasize activities to carefully observe, compose and decompose the given figures. Through those activities, we will make it more explicit about the features that define the basic geometric figures (trapezoids, parallelograms, and rhombi). An important goal is for students to investigate properties or sides and angles that are the constituent parts of quadrilaterals. Students will also investigate properties of diagonals of quadrilaterals.

Furthermore, throughout the unit, students will continue to master drawing geometric figures using appropriate tools. This is an important basic/foundational idea. Students are expected to refine their ability to draw geometric figures as they engage in the activities of drawing perpendicular and parallel lines using set squares or drawing various quadrilaterals using ruler, compass, and protractor.



(2) Current state of students with respect to mathematics

There are many students who like mathematics. Mathematics is the second most favorite subject according to a survey of our class. Specially, there are many students who enjoy calculations, but there are students who still lack computational fluency. There is also a tendency that their learning is compartmentalized -- new idea is not connected to what they have learned previously.

In the study of geometric shape, students are struggling to master skills such as drawing straight lines and using tools like compass and protractor, in part because their manual dexterity is still developing. There are many students who do not feel good about making accurate observations and grasping spatial relationships accurately, in part, because they struggle making use of their prior knowledge and observing geometric figures from multiple directions. However, students are becoming aware of the importance of drawing geometric figures accurately, and their skill levels are improving.

There are students who often give up thinking when they get stuck. On the other hand, there are students who are eager to share their ideas with others. In particular, we have been using student name cards during the whole class discussion, and students appear to enjoy the discussion time.

The first goal in today's lesson is for all students to independently solve the main problem and participate in the whole class discussion with their own ideas. Furthermore, the whole class discussion will be enriched by incorporating diagrams into this language activity. It is hoped that students' ability to reason and express themselves will be nurtured through sharing and examining the viability of each other's ideas. The experience should be enjoyable for students.

(3) Teacher's perspective (on the unit and the topic)

There are many students who feel less confident about the study of geometric figures than the study of numbers. When observing geometric figures, we must observe them from multiple perspectives. Multiple perspectives here include spatial relationships of figures, comparison of their shapes, directions from which we view the figures, and so forth. I believe a part of the difficulty students feel is because they have to identify quantities and relationships among figures which do not appear to share any commonality -- their lengths are different, they are placed at different positions, and their orientations are different.

In today's lesson, students are expected to distinguish figures as they make their points of view explicit. They will sort figures that look different or the same on the surface. They must look at the figures from a specific perspective and use the important factors from that perspective to sort the given figures. It is hoped that students can experience that there are things that become visible when they clarify their perspectives using their prior learning.

Moreover, during the whole class discussion, students are expected to understand that there are diverse ways of reasoning as they share each other's ideas. In addition, by reasoning logically as they try to understand each other, students are expected to further their ability to reason.

5 Relationship to the vision of ideal students

< As they listen to others ideas, they can judge the viability and recognize their strengths.>

(1) Independent problem solving

In order to solve problems independently, students must focus on constituent parts of geometric figures and their spatial relationships. Students should solve problems independently identifying and relating the previously learned relationships (parallel and perpendicular) and features such as lengths of sides. To support individual problem solving, students will be reminded of what they have learned in previous lessons and how they have been able to use their prior knowledge to solve new problems. I believe such an experience will be helpful in their future study as well.

(2) Use of geometric figures

"It looks like ----" is not a rationale for a viable argument. To help students examine geometric figures and identify the reasons for distinguishing them, actual shapes will be provided so that they can work with them concretely.

(3) "Based on the chosen perspective, articulate the rationale for their judgment logically."

For those students who are unsure about how to express their reasoning, provide them a sample sentence template: "I made groups of **** and #####. I used whether or not ---- is/are ●●●."

By examining the rationale and the actually sorted figures, verify whether or not there is any logical flaw or contradiction." Through this activity, we want students to experience the strengths in each other's ideas. (Critical Thinking)

6 Unit plan (15 lessons)

#	Goals	Activity	Main evaluation standards
Sub Unit 1: How lines intersect			
1	<ul style="list-style-type: none"> Students will understand the definition of perpendicular lines. Students can distinguish lines that are perpendicular from those that are not. 	<ul style="list-style-type: none"> Explore how 2 lines intersect. Create perpendicular lines by folding papers. Distinguish lines that are perpendicular from those that are not. 	<ul style="list-style-type: none"> Students are trying to explore how 2 lines intersect. (Interest, Eagerness, and Attitude) Students are thinking about how 2 lines intersect. (Mathematical Way of Thinking) Students understand the definition of perpendicular lines. (Knowledge and Understanding) Students can distinguish lines that are perpendicular from those that are not. (Mathematical Skills)

2	<ul style="list-style-type: none"> Students can draw perpendicular lines. 	<ul style="list-style-type: none"> Investigate ways to draw perpendicular lines. Draw perpendicular lines. 	<ul style="list-style-type: none"> Students can draw perpendicular lines by using set squares. (Mathematical Skills) Students understand how to use set squares to draw perpendicular lines. (Knowledge and Understanding)
Sub Unit 2: How lines are arranged			
3	<ul style="list-style-type: none"> Students will understand the definition of parallel lines. 	<ul style="list-style-type: none"> Explore how 2 lines may be arranged. Create parallel lines by folding papers. 	<ul style="list-style-type: none"> Students are trying to explore parallel lines. (Interest, Eagerness, and Attitude) Students are thinking about ways 2 lines may be arranged. (Mathematical Way of Thinking) Students understand the definition of parallel lines. (Knowledge and Understanding)
4	<ul style="list-style-type: none"> Students will know properties of 2 parallel lines. Distinguish lines that are parallel from those that are not. 	<ul style="list-style-type: none"> Investigate the width of parallel lines. Explore angles formed by parallel lines and a line intersecting them. 	<ul style="list-style-type: none"> Students understand the properties of parallel lines. (Knowledge and Understanding) Students understand that corresponding angles formed by a line intersecting parallel lines are congruent. (Knowledge and Understanding) Students can distinguish lines that are parallel from those that are not. (Mathematical Skills)
5	<ul style="list-style-type: none"> Students can draw parallel lines. Students can identify parallel lines in their surroundings. 	<ul style="list-style-type: none"> Investigate ways to draw parallel lines. Draw parallel lines. Look for perpendicular and parallel lines in their surroundings. 	<ul style="list-style-type: none"> Students can draw parallel lines using set squares. (Mathematical Skills) Students are trying to find perpendicular and parallel lines in their surroundings. (Interest, Eagerness, and Attitude)
Sub Unit 3: Various quadrilaterals			
6	<ul style="list-style-type: none"> Students will distinguish figures based on clear rationales. 	<ul style="list-style-type: none"> Draw various quadrilaterals on dot paper. Sort quadrilaterals. 	<ul style="list-style-type: none"> Students sort quadrilaterals by examining their constituent parts. (Mathematical Way of Thinking)

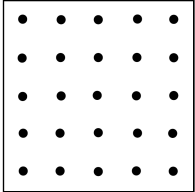
7	TODAY'S LESSON <ul style="list-style-type: none"> Students will discuss their ideas by making their rationales explicit. Students will understand the definitions of trapezoids, parallelograms and rhombi. 	<ul style="list-style-type: none"> Discuss the rationales for their sorting. Students will learn the definitions of trapezoids, parallelograms, and rhombi. 	<ul style="list-style-type: none"> Students can discuss sorting of geometric figures with clear rationales. (Mathematical Way of Thinking) Students understand the definitions of trapezoids and parallelograms. (Knowledge and Understanding)
8	<ul style="list-style-type: none"> Students will summarize the properties of trapezoids, parallelograms and rhombi. 	<ul style="list-style-type: none"> By organizing the properties visually, students will understand the properties of each type. 	<ul style="list-style-type: none"> Students understand quadrilaterals based on their constituent parts. (Knowledge and Understanding)
9	<ul style="list-style-type: none"> Students will draw trapezoids and parallelograms. 	<ul style="list-style-type: none"> Think about ways to draw trapezoids and parallelograms and actually draw them. 	<ul style="list-style-type: none"> Students can draw trapezoids and parallelograms. (Mathematical Skills)
10	<ul style="list-style-type: none"> Students will draw rhombi. 	<ul style="list-style-type: none"> Think about ways to draw rhombi and actually draw them. 	<ul style="list-style-type: none"> Students can draw rhombi. (Mathematical Skills)
Sub Unit 4: Diagonals			
11	<ul style="list-style-type: none"> Student will understand the definition of diagonals. Students will explore properties of diagonals in various quadrilaterals. 	<ul style="list-style-type: none"> Draw diagonals. Investigate diagonals of various quadrilaterals. 	<ul style="list-style-type: none"> Students understand the definition and properties of diagonals. (Knowledge and Understanding)
Summary of the unit			
12	<ul style="list-style-type: none"> Students will recognize that quadrilaterals are used in various situations in their surroundings. 	<ul style="list-style-type: none"> Look for quadrilaterals in their surroundings. 	<ul style="list-style-type: none"> Students are trying to find quadrilaterals in their surroundings. (Interest, Eagerness, and Attitude)
13	<ul style="list-style-type: none"> Students will work on "Review" and solidify their understanding. 	<ul style="list-style-type: none"> Work on "Review." 	<ul style="list-style-type: none"> Students understand the content of the unit. (Knowledge and Understanding)
Mathematical Activities			
14	<ul style="list-style-type: none"> Students draw quadrilaterals using the properties of circles and diagonals. Students will make various shapes using Tangrams. 	<ul style="list-style-type: none"> Draw quadrilaterals using circles. 	<ul style="list-style-type: none"> Students can explain properties of quadrilaterals using their diagonals. (Mathematical Way of Thinking) Students are trying to make various shapes by using the characteristics of each piece of Tangrams. (Knowledge and Understanding)
15	<ul style="list-style-type: none"> Students will design tiling patterns using parallelograms, trapezoids, and other quadrilaterals. 	<ul style="list-style-type: none"> Design tiling patterns using quadrilaterals. 	<ul style="list-style-type: none"> Students are thinking about ways to tile using quadrilaterals.

7 Goals of today's lesson (Lessons 6 & 7 /15)

- Students will discuss how they sorted quadrilaterals by making clear their rationales.
- Students will deepen their ways of mathematical thinking as they listen to each other's ideas and verify the rationales and the results of sorting match.

8 Flow of the lessons (Lessons 6 & 7 / 15)

Flow of Lesson 6

	Content and Main <i>Hatsumon</i>	Anticipated Responses	Evaluation	Instructional Steps
Understanding the problem	<ul style="list-style-type: none"> ○ Draw quadrilaterals. 1. By connecting 4 dots on dot paper, draw quadrilaterals. <ul style="list-style-type: none"> • Shapes that are enclosed by 4 straight segments are called quadrilaterals. <div style="border: 1px solid black; padding: 5px; margin: 10px 0;"> general quadrilateral, parallelograms (2), trapezoids (2), square, rectangle, rhombus (2) </div> <ul style="list-style-type: none"> 2. Let's make groups of quadrilaterals. You will be sharing how you grouped them, so be prepared to explain your sorting. 	1.1 Students will draw quadrilaterals using dot paper. 1.2 Students are not sure how to use dot paper. 2.1 Students understand the task. 2.2 Students don't understand the task.	<ul style="list-style-type: none"> ○ Students can connect 4 points on dot papers using straight segments. (Worksheet) 	Prepare sets of cut out quadrilaterals for each student (general quadrilateral, 2 different parallelograms, isosceles trapezoid, general trapezoid, 2 types of rhombus, rectangle, and square). Prepare a set to be used on the blackboard. Students will put away their dot papers in an envelope. <div style="border: 1px solid black; padding: 5px; margin: 10px 0;">  </div> 2.2 Individually work with these students.

Plan	<p>3. Have you thought about how you might group these shapes? Use your tools like set squares, compass, and protractor, instead of just how they look.</p>	<p>3.1 I'm going to look at their sides. 3.2 I will look at their angles. 3.3 I will compare their sizes. 3.4 I'm not sure what to do.</p>	<p>3.1 & 3.2 They are able to look at the constituent parts of the quadrilaterals. 3.3 & 3.4 They are unable to look at the constituent parts of the quadrilaterals.</p>	<ul style="list-style-type: none"> ○ Help students clearly identify what feature to focus on. ○ Remind students to use tools such as set squares and protractors instead of just focusing on the appearances. <p>3.3 & 3.4: Help students to look at the constituent parts of quadrilaterals.</p>
Individual problem solving	<ul style="list-style-type: none"> ○ Sort the given quadrilaterals. <p>4. Let's make groups with these quadrilaterals. Make sure you can explain why some quadrilaterals belong in the same group.</p> <ul style="list-style-type: none"> • Tell students to write their answers in their notebooks. <div style="border: 1px solid black; padding: 5px; width: fit-content;"> <ul style="list-style-type: none"> a. rectangle b. parallelogram c. general quadrilateral d. rhombus e. trapezoid f. parallelogram g. square h. rhombus i. trapezoid </div>	<p>4.1 Based on parallel sides. (a, b, d, f, g, h), (e, i), and (c)</p> <p>4.2 Based on right angles (a, g) and the rest</p> <p>4.3 Based on the lengths of sides (g, h) and the rest</p> <p>4.4 Based on their appearances</p> <p>4.5 Based on parallel sides (b, g) and the rest</p> <p>4.6 Cannot explain the rationale</p> <p>4.7 Cannot make groups</p>	<p>4.1 - 4.3 Students are able to sort quadrilaterals with clear rationales.</p> <p>4.4 Students' verification is incomplete.</p> <p>4.5 Grouping does not match the rationale.</p> <p>4.6.1 Students cannot tell what to focus on. 4.6.2 Students are sorting at random.</p> <p>4.7.1 Students do not know what to do. 4.7.2 Students do not know what to focus on.</p>	<ul style="list-style-type: none"> ○ Encourage students to use tools such as set squares, compass, and protractor. <p>4.1, 4.2, & 4.3 Encourage them to think about different ways of sorting.</p> <p>4.4 Encourage students to use tools such as set squares, compass, and protractor.</p> <p>4.5 Check what follows from the rationale.</p> <p>4.6.1 Ask them what they can focus on. 4.6.2 Suggest what to focus on.</p> <p>4.7 Suggest students to focus on right angles.</p>

Flow of Lesson 7

	Content and Main <i>Hatsumon</i>	Anticipated Responses	Evaluation	Instructional Steps
	<ul style="list-style-type: none"> ○ Know how to sort quadrilaterals with clear rationales. 5. From your notebooks, here are the ways you made groups with these quadrilaterals. <ul style="list-style-type: none"> • based on the number of groups 	<p>5.1 I think my grouping is there.</p> <p>5.2 I wonder if you can make groups that way.</p>	<p>5.1 Students are listening carefully so that they can identify where their own ideas belong to.</p> <p>5.2 Students are trying to think about the rationale behind grouping.</p>	<ul style="list-style-type: none"> ○ Display only the number of groups students made. <p>5.2 Encourage students to think about what rationale will give you a particular number of groups.</p>

Whole Class Discussion	<p>○ Students will share their rationales for making groups.</p> <p>6. Let's have the sharing time. Please place a green card with the idea that matches yours, and place a yellow card on ideas you are not sure about.</p> <p>Number of groups</p> <p>1 2 3 4 5 6</p> <p>Rationale</p> <ul style="list-style-type: none"> lengths of sides relationship of sides angles 	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin-bottom: 10px;"> I made groups of **** and #####. I looked at whether or not -- is/are ●●●. </div> <p>6.1 I made groups of {a, g} and {b, c, d, e, f, h, i}. You can make 2 groups if you check if there is a right angle.</p> <p>6.2 I made groups of {c} and {a, b, d, e, f, g, h, i}. I grouped them by whether or not there are parallel sides.</p> <p>6.3 I made groups of {e, i}, {a, b, d, f, g, h} and {c}. You can make 3 groups if you check if there is 1, 2 or no pair of parallel sides.</p> <p>6.4 I made groups of {c}, {e, i}, {a, b, f}, and {d, g, h}. I looked at the sides of equal lengths.</p> <p>6.6 I made groups of {a}, {b, f}, {c}, {d, h}, {e, i}, and {g}. I looked for parallel sides, perpendicular sides, and sides of the same length.</p>	<p>6.1 Students are sorting quadrilaterals based on right angles.</p> <p>6.2 Students are sorting sort quadrilaterals based on the presence of parallel sides.</p> <p>6.3 Students are sorting quadrilaterals based on the presence and the number of parallel sides.</p> <p>6.4 Students are sorting quadrilaterals by whether or not opposite sides are equal lengths.</p> <p>6.5 Students are sorting quadrilaterals based on the presence and the number of equal sides.</p> <p>6.6 Students are sorting quadrilaterals based on the presence of parallel sides, perpendicular sides, and lengths of sides.</p>	<p>○ In order to facilitate discussion with own positions, use name cards.</p> <ul style="list-style-type: none"> same idea -- green not sure -- yellow <p>When all yellow cards are removed, we can conclude that all students understood the method of sorting.</p> <p>○ Instruct students to use tools such as set squares and protractors and their previously learned skills to guide their sorting, not just based on the appearances of the figures.</p> <p>○ Instead of students explaining their own ideas, let other students think about others methods.</p> <p>○ Students who came up with the idea should try to give hints to other students.</p>
Summary of the lesson	<p>○ Announce what we will be studying in the next lesson.</p> <p>In the next lesson, we will look more carefully at the grouping method based on parallel sides in quadrilaterals.</p>	<p>○ Students will listen to what they will be learning in the next lesson.</p>	<p>○ Did students understand what they will be learning in the next lesson?</p>	<p>○ Using the completed blackboard, bring students' attention to the methods that used parallel sides.</p>