Rich Mathematical Task – Grade 6 – *Pizza Delivery*

Task Overview/Description/Purpose:

- In this task, students will determine the path of a pizza delivery robot and the overall distance the robot will travel in order to develop a mathematical understanding of the coordinate plane and distances between points.
- This task is designed to deepen understanding of identifying and locating points on the coordinate plane and finding distances between two points.

Standards Alignment: Strand – *Computation and Estimation*

Primary SOL: 6.8 The student will a) identify the components of the coordinate plane; and b) identify the coordinates of a point and graph ordered pairs in a coordinate plane.

Related SOL (within or across grade levels/courses): 6.3ac, 6.6ab

Connected Computer Science SOL: 6.1ab, 6.2, 6.3

Learning Intention(s):

- **Content –** I am learning about the coordinate plane and how to use distances between two points to solve practical problems.
- **Language-** I am learning how to explain the location of ordered pairs and horizontal and vertical distances on the coordinate plane.
- **Social –** I am learning how to explain my strategy and work to others so I can refine my strategies for problem solving.

Success Criteria (Evidence of Student Learning);

- I can represent ordered pairs on a coordinate plane.
- I can find the vertical or horizontal distance between two points.
- I can justify my process and report my conclusions.
- I can justify why my chosen route is the best route for the robot.
- I can make suggestions and utilize suggestions made by my peers to make revisions to my work and thinking.

Mathematics Process Goals

Problem Solving	• Students will use ordered pairs and vertical and horizontal distances on the coordinate plane to model a practical situation.
Communication and Reasoning	• Students will justify verbally and with mathematical evidence how they know their route is the best for the robot. This incorporates an understanding beyond the mathematics to incorporate the idea that the route should be the shortest to deliver the pizza in the most efficient way.
Connections and Representations	• Students will use the coordinate plane and ordered pairs to find their distances and represent their route. The sequel provides an opportunity for students to represent their understanding and thinking using robots, drones, or online coding programs.

Task Pre-Planning

Approximate Length/Time Frame: 45-60 minutes

Grouping of Students: This task would be best completed with students working independently at first to find a route and then work collaboratively to determine which route is the best for the robot. Consider grouping students based on formative assessments to have a mix of readiness levels within groups.

Materials and Technology:

- Virtual Implementation Google Slides
- Coordinate plane
- Linking cubes
- Number Lines
- Robots, Drones, or online coding programs like Scratch, Tynker, or Python (for the sequel)

Vocabulary:

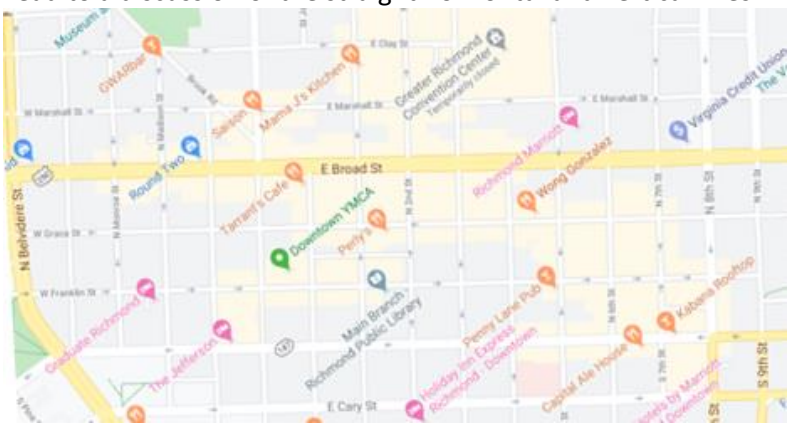
- Ordered Pair
- Origin
- Coordinates
- X-axis
- Y-axis
- Coordinate Plane
- Quadrant I, II, III, and IV
- Horizontal Distance
- Vertical Distance

Anticipate Responses: See Planning for Mathematical Discourse Chart (Columns 1-3)

Task Implementation (Before)

Task Launch

- Ask students the following questions:
  - Who likes pizza?
  - What is important to you when you get a pizza or other food delivered?
  - When a company delivers food, what are some things they need to think about?
  - What would be important for a company when determining a delivery route?
- Show students the map of downtown Richmond. Ask students what they notice and wonder about the map. Lead to a discussion of the straight horizontal and vertical lines.



- Show students this video. Stop at approximately 1:30: Ask students what they wonder.
- Tell students that today, they are going to be partnering with a company in Richmond that is using this new technology to deliver pizzas. Their role will be to help the company determine the route for the deliveries.

Task Implementation (During)

Directions for Supporting Implementation of the Task

- Monitor – Teacher will listen and observe students as they work on task and ask assessing or advancing questions (see chart on next page)
- Select – Teacher will decide which strategies or thinking that will be highlighted (after student task implementation) that will advance mathematical ideas and support student learning

Task Implementation (Before)

- Sequence – Teacher will decide the order in which student ideas will be highlighted (after student task implementation) during the closure discussion.
- Connect – Teacher will consider ways to facilitate connections between different student responses

Suggestions For Additional Student Support

- Have graph paper and other manipulatives available in a central location so that students can get what they need, as they need it. See supporting documents for graph paper, as well as a grid with Pizza House already located.
- Some students get stuck at one way of thinking and finding only one path. Asking questions like "How confident are you?" and "What would convince someone?" will help students get past this point.
- For students with motor processing difficulties, allow them to communicate the reasoning in other ways such as video recording or typing answers.
- For students with attention challenges ask student to restate the problem or important information.
- For students who need academic language support, consider the use of a visual word wall or reference sheet for students to use horizontal, vertical, ordered pair, and coordinate plane.
- For students who need more support in justifying their thinking, you may choose to provide them with the sentence frames below.
    - What I know about the problem is…
    - My method for solving the problem was…
    - I know that my route is the best route because...
    - The total distance the robot will travel for my delivery route is…
- For ELs with first language literacy, try to provide prompt, or parts of prompt, in their home language

Suggestions for a Sequel/Extension

- Option 1: Use tape to make a coordinate plane on the floor. Have students place markers on the coordinate plane to represent the delivery location. Have students use block programing to program robots or drones to "deliver" the pizza by following their route.
- Option 2: Use an online program like Scratch, Tynker, or Python to have students create the city and program their route. If using Scratch, use this template as a starter (it can only be opened in Scratch).

Task Implementation (After)

Connecting Student Responses (From Anticipating Student Response Chart) and Closure of the Task:

- Based on the actual student responses, sequence and select particular students to present their mathematical work during class discussion. Some possible big mathematical ideas to highlight could include:
    - Common misconceptions
    - Using the coordinate plane to count the distances to using the ordered pairs to calculate the distances
- Connect different students' responses and connect the responses to the key mathematical ideas to bring closure to the task. Possible questions and sentence frames to connect student strategies:
    - How are these strategies alike? How are they different?
    - Where do you see _____'s strategy in _____'s strategy?
    - How does _____'s picture relate to _____'s symbols?
    - Why is this important?
- Consider ways to ensure that each student will have an equitable opportunity to share his/her thinking during task discussion. Some possible ways to do this are to-
    - Assign roles like time keeper, task master, material fetcher, and recorder of strategies to each member of the group.
    - Ask students get in groups after working independently. Provide each person 1 minute to explain their route and thinking to the group.

Task Implementation (Before)
Teacher Reflection About Student Learning:
• Teacher should use the chart on the next page with the anticipated student solutions to monitor which students are using each strategy as well as record any additional strategies encountered. The sequence of tasks will inform what will come next in instruction to further student ideas and thinking. Form small groups to address misconceptions that are not addressed in the class debrief. • Information gathered from the task rubric could identify small groups for later instruction, identifying specific students to partner with one another, and/or identifying students who need more teacher modeling and think alouds.

Rich Mathematical Task – Grade 6 – *Pizza Delivery*

Planning for Mathematical Discourse

Mathematical Task: Winning the Game

Content Standard(s): SOL 6.8ab

Anticipated Student Response/Strategy *Provide examples of possible correct student responses along with examples of student errors/misconceptions*	**Assessing Questions:** *Teacher questioning that allows student to explain and clarify thinking*	**Advancing Questions:** *Teacher questioning that moves thinking forward*	**List of Students Providing Response** *Who? Which students used this strategy?*	**Discussion Order - sequencing student responses** • *Based on the actual student responses, sequence and select particular students to present their mathematical work during class discussion* • *Connect different students' responses and connect the responses to the key mathematical ideas.* • *Consider ways to ensure that each student will have an equitable opportunity to share his/her thinking during task discussion*
Anticipated Student Response: I don't know what to do?	• What is the question asking you? • What information do you have? • What do you notice? • What do you wonder? • What do you predict the solution might look like?	• What could you use to model the problem? • What do you predict the solution might look like? • What is a too low estimate for the distance? What is a too high estimate for the distance?		
Anticipated Student Response: Student goes in order of the delivery A, B, C… etc.	• Explain to us your thinking. • If you were the owner of Pizza House, what would be important for you when finding a route?	• How might you represent your route visually?		
Anticipated Student Response:	• What are the important pieces of information in the problem?	• Where would it make sense for the robot to start/end?		

Rich Mathematical Task – Grade 6 – *Pizza Delivery*

Anticipated Student Response/Strategy *Provide examples of possible correct student responses along with examples of student errors/misconceptions*	**Assessing Questions:** *Teacher questioning that allows student to explain and clarify thinking*	**Advancing Questions:** *Teacher questioning that moves thinking forward*	**List of Students Providing Response** *Who? Which students used this strategy?*	**Discussion Order - sequencing student responses** • *Based on the actual student responses, sequence and select particular students to present their mathematical work during class discussion* • *Connect different students' responses and connect the responses to the key mathematical ideas.* • *Consider ways to ensure that each student will have an equitable opportunity to share his/her thinking during task discussion*
Student doesn't start and/or end at Pizza House				
Anticipated Student Response: Student plots the points as (y,x)	• Can you explain to us your thinking? • What do you know about ordered pairs and the coordinate plane?	• Would labeling your axis help you think about this problem differently?		
Anticipated Student Response: Student finds a route but it is not the shortest.	• Does this approach seem reasonable to you? Why? • How confident in your answer are you?	• What other routes could the robot travel?		
Anticipated Student Response: Student correctly determines the shortest route of 38 blocks.	• How confident in your answer are you?	• How can you convince someone that your route is the best route?		

Pizza Delivery

Name_____ Date_____

Pizza House is testing a robot delivery service in downtown Richmond to deliver pizza orders. Downtown Richmond is set up like a grid making it easy for the robot to find its way around by traveling north (up), south (down), west (left), or east (right) in straight lines. The robot can hold 5 orders per route and will need to start and end at Pizza House. The following are the locations of Pizza House and each delivery in relation to City Center (0,0):

- Pizza House: (7,4)
- Delivery A: (-3,0)
- Delivery B: (-6, 2)
- Delivery C: (7, -2)
- Delivery D: (0,4)
- Delivery E: (-3, -2)

A. In what order should Pizza House program the deliveries so that the robot will make all the deliveries in one route? Provide evidence and explain your thinking.

B. What is the total distance that the robot will travel for this delivery route if each unit is equivalent to one city block? Provide evidence and explain your thinking.

Rich Mathematical Task – Grade 6 – *Pizza Delivery*

	Advanced	Proficient	Developing	Emerging
Mathematical Understanding	Proficient Plus: • Uses relationships among mathematical concepts	• Demonstrates an understanding of concepts and skills associated with task • Applies mathematical concepts and skills which lead to a valid and correct solution	• Demonstrates a partial understanding of concepts and skills associated with task • Applies mathematical concepts and skills which lead to an incomplete or incorrect solution	• Demonstrates little or no understanding of concepts and skills associated with task • Applies limited mathematical concepts and skills in an attempt to find a solution or provides no solution
Problem Solving	Proficient Plus: • Problem solving strategy is efficient	• Problem solving strategy displays an understanding of the underlying mathematical concept • Produces a solution relevant to the problem and confirms the reasonableness of the solution	• Chooses a problem solving strategy that does not display an understanding of the underlying mathematical concept • Produces a solution relevant to the problem but does not confirm the reasonableness of the solution	• A problem solving strategy is not evident or is not complete • Does not produce a solution that is relevant to the problem
Communication and Reasoning	Proficient Plus: • Reasoning is organized and coherent • Consistent use of precise mathematical language and accurate use of symbolic notation	• Communicates thinking process • Demonstrates reasoning and/or justifies solution steps • Supports arguments and claims with evidence • Uses mathematical language to express ideas with precision	• Reasoning or justification of solution steps is limited or contains misconceptions • Provides limited or inconsistent evidence to support arguments and claims • Uses limited mathematical language to partially communicate thinking with some imprecision	• Provides little to no correct reasoning or justification • Does not provide evidence to support arguments and claims • Uses little or no mathematical language to communicate thinking
Representations and Connections	Proficient Plus: • Uses representations to analyze relationships and extend thinking Uses mathematical connections to extend the solution to other mathematics or to deepen understanding	• Uses a representation or multiple representations, with accurate labels, to explore and model the problem • Makes a mathematical connection that is relevant to the context of the problem	• Uses an incomplete or limited representation to model the problem • Makes a partial mathematical connection or the connection is not relevant to the context of the problem	• Uses no representation or uses a representation that does not model the problem • Makes no mathematical connections

Supporting Documents