Rich Mathematical Task – Algebra I - *Bicycle Savings*

Task Overview/Description/Purpose:
• The purpose of this task is to determine the components of a line, including y-intercept (b) and slope (m) and demonstrate the changes in the parent function (y=x) when the components are changed. • In this task, students will interpret a graph and its components and identify how changes in the y-intercept and the slope can affect the graph. Students will be able to compose a graph demonstrating transformations defined by these changes. Students will also be able to write the equation of a line when a graph, y-intercept, slope, or points are given. Finally, students will be able to use the skills practiced creating a situation that can be represented by a linear function. This task can be used to assess students on their abilities to accomplish these tasks after instruction or as a supplementary task.

Standards Alignment: Strand – *Equations and Inequalities*	
Primary SOL: A.6 The students will **a) determine the slope of a line when given an equation of the line, the graph of the line, or two points on the line;** **b) write the equation of a line when given the graph of the line, two points on the line, or the slope and a point on the line; and** **c) graph linear equations in two variables.** **Related SOL (within or across grade levels/courses): 7.10abcd; 8.16**	
Learning Intention(s): • **Content** - I am learning to create and identify the equation of the line using a variety of components to include the graph, slope, and y-intercept as well as understanding how a line can be transformed when the components of the parent function ($y = x$) are affected. • **Language** - I am learning how to use mathematical terms when justifying how a line is transformed. • **Social** - I am learning to collaborate with my peers to discuss comparisons and explain my ideas logically.	
Success Criteria (Evidence of Student Learning): • I can determine the equation of a line when given a graph, points on the line, y-intercept, and slope, and graph a line when components of the parent function change. • I can graph a new line when components of the parent function ($y = x$) are affected. • I can create a situation that can be represented by a linear function.	
Mathematics Process Goals	
Problem Solving	• Students will apply problem solving strategies to determine the equation of a line and how it is affected when changes are made to the parent function (y=x).
Communication and Reasoning	• Students will communicate the thinking process for identifying the changes made to a parent function when components of the line are changed. • Students will communicate the thinking process for creating a situation that can be represented by a linear function.
Connections and Representations	• Students will use multiple representations to explore their situation and use models to support their thinking.

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Task Pre-Planning	
Approximate Length/Time Frame: 50-55 minutes	
Grouping of Students: This task can be used as an introductory or summative assessment. **Introductory** - Students can be combined in groups of at least three but no more than four. Consider pairing students with social needs with students who have strong social skills to encourage sharing ideas and observations. Students with language needs should be paired with students with high level understanding of the mathematical terminology and concepts used (Consider Mastery Levels of prerequisite knowledge: Beginning, Developing, and Accomplished). Create groups that contain at least one student from each of the three levels when possible. Students will read the task and work as a group to determine the components of the line and how the parent function will be affected based on the changes in values. Time should be factored in to allow for sharing ideas. **Summative** - Students can be expected to complete the task individually then pair in groups of no more than three to compare solutions and justifications. Consider similar groups to those suggested for Introductory assessment.	
Materials and Technology: • Graph Paper • Rulers • Graphing Calculator • DESMOS • Colored Pencils or Markers • Desmos Activity- https://teacher.desmos.com/activitybuilder/custom/5faf2fae19667838c1aae717	**Vocabulary:** • Y-intercept • Slope • Parent Function • Linear Function • Transformation • Equation of a Line
Anticipate Responses: See the Planning for Mathematical Discourse Chart (columns 1-3).	

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Task Implementation (Before)

Task Launch:

- List and display as a class, situations in which students have had to save money. Encourage students to discuss how much they started with, how they determined how often they could put money away, and how long it would take.
- Ask students how their savings would be affected if they had money saved already? If they could only save a smaller amount per week? Larger?

Task Implementation (During)

Directions for Supporting Implementation of the Task

- Monitor – The teacher will observe students as they work independently on the task. The teacher will engage with students by asking assessing or advancing questions as necessary (see attached *Question Matrix).*
- Select – The teacher will select students to …
- Sequence – The teacher will select 2-3 student strategies to share with the whole group. One suggestion is to look for one common misconception and two correct responses to share.
- Connect – The teacher will consider ways to facilitate connections between different student representations.

Suggestions For Additional Student Support

- Provide students with oral directions.
- Allow students to give oral justifications in place of writing.
- Allow students to use a graphic organizer labeling the components of a linear equation.
- Provide highlighters for students who need assistance with interacting with the text.
- Provide start up sentences for students who have difficulty with providing justifications either written or orally.
    - *The components of the equation are represented by___________ as the slope and ___________as the y-intercept.*
    - *If Sarah already has _____________saved, the graph will…*
    - *The strategy I used to solve is_________________.*
    - *I changed the______________ which represents_____________ and causes the parent function to_____________.*
- Allow students who are having difficulty coming up with an idea for part two use a variation of the ideas collected at the beginning of the class.

Task Implementation (After) ***15 minutes***

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

- After observing the student responses, select students to present their methods for solving the problems in Part 1. Consider students who have the correct answers but different methods, but also students who have good methods, but incorrect answers.
    - Things to look for:
        - common misconceptions (i.e. switching slope and y-intercept)
        - Students who understand how to write equations but do not graph accurately
        - Students who do not understand how changing different components affect the line differently.
- Compare and contrast student answers to determine what strategies may still need to be identified.

- How are the strategies alike? How do they differ?
- Why is it important to know and understand?
- How does this relate to what you already understand about linear equations?
- ___________________’s strategy could have also been solved by_______________?

- Identify and discuss important vocabulary words to help make connections to the task.
  - Components of an equation
  - Transformed
- Create equitable opportunities for sharing work.
  - Gallery Walk prior to classroom discussion on strategies.
  - Turn and Talk with other groups
  - Four Corners (based on common answers)
- Return to the success criteria to close the activity. Have students reflect on their progress using the criteria as a whole group or individually.

Teacher Reflection About Student Learning:

- What process did students go through to determine what strategy to use? Did this lead them to the correct answer? What were the common errors or misconceptions? (Use the Connection to Task Rubric to consider multiple solution pathways, possible misconceptions, and level of understanding based on student ideas.)
- How will the evidence that resulted from the student work further instruction?
  - What will come next, based on the responses and level of understanding from the task? (i.e., group students together who had similar misconceptions and review that concept only with each group).
- Are the students able to explain their work in writing, verbally, or orally?
- Do the students understand the vocabulary that supports their knowledge of the SOL standard?

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Planning for Mathematical Discourse

Mathematical Task: Bicycle Savings

Content Standard(s): A.6

Teacher Completes Prior to Task Implementation			Teacher Completes During Task Implementation	
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: Student is unable to start.	• Student A - Provide student with a graphic organizer highlighting the components of a linear equation. • Student B - Ask what mathematical terms that we have been working on might help in identifying the components of the equation of a line. • Student C-Ask the student how the graph can be used to identify the components of the equation of a line.	• How do you determine the slope of a line when using a graph? • How do you determine the y-intercept when using a graph? • How is the graph affected when you change these components?		
Anticipated Student Response: Student is having difficulty completing Part 1, question 2.	• How much did Sarah originally start with and how do you identify that starting point on the graph? • Ask student to identify the original starting point (*y*-	• How does having money prior to saving affect your graph? • How does the graph change?		

	intercept) and have student describe how that will be affected if Sarah started with $5.			
Anticipated Student Response: Student is having difficulty completing Part 1, question 3.	• What component of the equation of the line is being affected by Sarah saving $2.50 a week? • How would you demonstrate this change on a graph?	• How does the graph change based on the increase in the amount of money saved? • How will this affect Sarah's ability to reach her goal?		
Anticipated Student Response: Student is having difficulty creating a similar situation in Part 2. (Encourage students not to do an example with saving money.	• Have students consider examples that can be increased or decreased (i.e., time, money, measurements, cost). • What real life situation can you use to create a situation like part 1? • How can time, money, measurement, etc. be affected? For example, something can take more/less time. • Consider brainstorm completed as a class prior to task implementation, but have students change the variables.	• Identify the components of the equation of a line in your example, how can you alter those values to transform your line?		

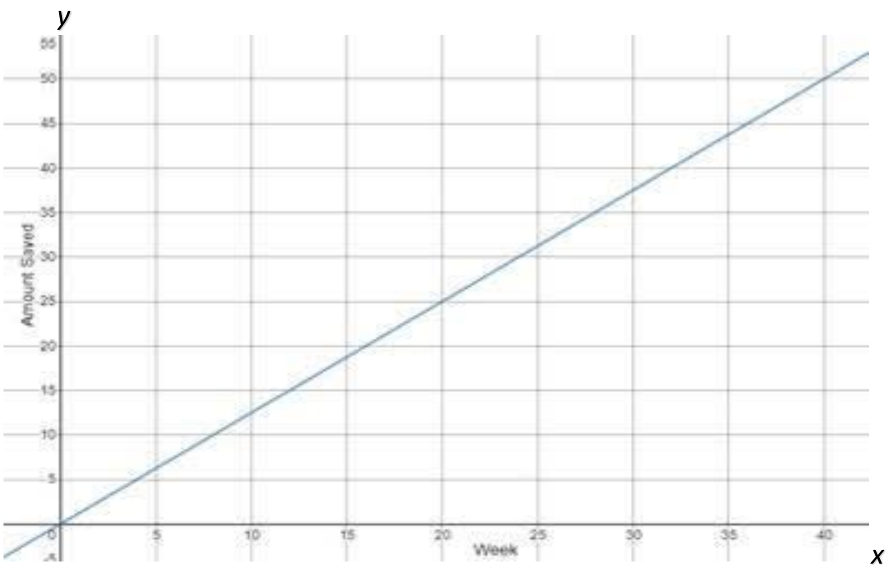
NAME ____ DATE ____________________

Bicycle Savings

SOL A.6

- Use the parent function $y = x$ and describe the transformations defined by changes in the slope or y-intercept (c).

Part 1:



Sarah is saving $1.25 a week to purchase a bicycle. The graph shows the amount she will have saved.

1. Write the equation of the line represented in the graph. Describe how the components of the equation represent the situation.
2. What would happen to the graph if she already had $5.00 saved? Represent this situation on the graph provided. Write the equation of the line represented in the graph. Describe how the components of the equation represent the situation.
3. What would happen to the graph if she saved $2.50 a week? Represent this situation on the graph provided. Write the equation of the line represented in the graph. Describe how the components of the equation represent the situation.
4. How would the graph change if she already had $5.00 saved AND started saving $2.50 a week? Represent this situation on the graph provided. Write the equation of the line represented in the graph. Describe how the components of the equation represent the situation.

Part 2:

1. Create a situation that can be represented by a linear function.
2. Describe the components of the equation and how they represent the situation.
3. Graph the linear function.
4. Change the situation so that one of the components of the equation is transformed.
5. Describe which component was changed and how this would affect the graph.
6. Graph the transformed linear function.

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Rich Mathematical Task Rubric

	Advanced	Proficient	Developing	Emerging
Mathematical Understanding	Proficient Plus: • Uses relationships among mathematical concepts or makes mathematical generalizations	• 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 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 well developed or 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	• Problem solving strategy displays a limited 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 • Does not produce a solution that is relevant to the problem
Communication and Reasoning	Proficient Plus: • Reasoning or justification is comprehensive • Consistently uses precise mathematical language to communicate thinking	• Demonstrates reasoning and/or justifies solution steps • Supports arguments and claims with evidence • Uses mathematical language to communicate thinking	• 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	• Provides no correct reasoning or justification • Does not provide evidence to support arguments and claims • Uses 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