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**Class type:** Math (HSE prep) **Student level (by CCR):** Level E

**Lesson topic:** Interpreting Functions

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| **Description of a CCR-aligned formative assessment** |
| 1. **What is the purpose of the lesson?**   What do you want students to understand or be able to do by the end of this lesson? What are the real-life purposes that make this topic relevant to students? Which CCR standard(s) (at the level) are you focusing on?  Students will:  Apply the skills of brainstorming and rubric development to understand how to use a graph for modeling relationships between an independent variable and dependent variable  Interpret functions by figuring out the appropriate function and graphing the results of a race to interpret the functions of speed (time and distance). |
| 1. **How will teacher and students know progress or success when they see it?**   What can you and they look for to know if students are learning the standard? What can you (and they) look for to know if students can apply the standard to carry out real purposes?  When the students can create a function for a scenario and then draw general graphs to model and explain the behavior of the function the students are showing proficiency. |
| 1. **What kind of tool/process would capture evidence of understanding or performance?**   Is this knowledge that might be demonstrated by a quiz, discussion, Q&A, etc.? Is this a skill to be performed and assessed with a checklist or rubric? Is the tool/process usable as part of or immediately following instruction?  We willuse two related tools (carousel brainstorming and rubric creation) to assess student development in interpreting functions through the use of graphs. The **carousel brainstorming** activity will incorporate the vocabulary associated with the CCRS F.IF.4 with a teacher-facilitated discussion. Including the graphing of a three-legged race example allows students to practice using graphs to model functions, share ideas and ask questions to create a rubric that will provide criteria to determine that their work meets CCRS F.IF.4.  We’ll also create a rubric together. |
| 1. **How would you use the tool/process?**   How would you involve students in creating or understanding the tool/process? How would you use the information gleaned from the tool to give feedback to students?  See the two processes below. |

**Carousel brainstorm on CCR-associated function/graphing vocabulary**

Carousel brainstorming is a strategy used to help students access new information or review what they have learned through movement, conversation, and reflection in a collaborative exchange of ideas.

Vocabulary:

x-intercept increasing positive slope maximum symmetry

y-intercept decreasing negative slope minimum domain

end behavior range

periodicity

Procedure:

1. Using 5 sheets of chart paper, the instructor writes the vocabulary words (one column per sheet).
2. Place one sheet of chart paper on each of five tables. Have the students/small groups begin by standing in front of different tables. Each student/group will have the opportunity to add ideas to each sheet of paper. Explain the responsibilities of each group member to participate in communicating ideas and showing respect for each other’s ideas.
3. Set a timer for 3 minutes for the students to generate and record their ideas. At time, each student/small group moves to the next sheet of paper, reads the ideas, and adds additional ideas. Continue until all students/small groups have had an opportunity to add ideas to each paper.
4. When complete, post the charts on the wall for students to view. The teacher will use these charts to **describe** what the students as a group already know about each related vocabulary word and how it relates to graphing and functions. The teacher will at the same time **evaluate** what is missing or what needs clarification.

**Creating a Rubric**

To build on current student knowledge of the standard, the instructor will hand out the following standards continuum to inform class discussion of how learning about graphing functions develops.

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| **Previous standard(s) needed** | **Focus standard for lesson** | **Builds toward next standard(s)** |
| **(8.F.1)** Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is the set of ordered pairs consisting of an input and the corresponding output.  **(8.F.3)** Interpret the equation y = mx + b as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. For example, the function A = s2 giving the area of a square as a function of its side length is not linear because its graph contains the points (1,1), (2,4) and (3,9), which are not on a straight line. | (F.IF.4) Interpret functions that arise in applications in terms of the context.  For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. For example, for a quadratic function modeling a projectile in motion, interpret the intercepts and the vertex of the function in the context of the problem.\* [Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.] | Exceeding standards of proficiency is shown by being able to teach the concept to another person and use and apply the skill across a variety of contextualized math scenarios.  **(F.IF.5)** Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.\*  **(F.IF.6)** Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.\* |

As a group project, the teacher will facilitate the creation of a function equation for the following scenario and then graph those equations to provide comparisons for the development of an exemplar rubric. *Bob and Davis are competing against their mothers in a three-legged race at the County Fair. The mothers decide to give the boys a head start of 6 feet. The pairs stand side by side and tie their touching legs together with tube socks. When the race starts the boys move along at a rate of 2 feet per second and the mothers move at 3 feet per second. How long will it take for the mothers to overtake the boys? How far will they have traveled? Compare what happens to the graphs If, when the mothers catch up to the boys, the boys speed up to 4 feet per second.*

After working through this example, assess ability to extend this to other real-world examples. Ask, “In what other situations could you graph results to see how one variable is dependent on another and that changes in a set pattern?” Look for answers related to money (wages, interest), distance and time, the regularity of weather patterns, how pool balls travel toward a pocket when hit, etc.) Evaluate their answers and provide feedback and additional discussion questions and practice.

Creating a rubric requires students to articulate what proficiency in the standard means. Students can then use it as a study guide in working through multiple types of functions.

1. Describe purpose and organization of a rubric. Discuss how to determine what is important, what criteria will be used for assessment and on what scale.
2. Use the charts created in the Carousel Brainstorming session to collaboratively determine and circle 5 of the most important ideas on each chart.
3. Next, discuss and rank the top 3 ideas to create the rubric.
4. Evaluate the rubric and make suggestions for additions to ensure that it fully captures the standard (F.IF.4), so that it will be useful for their continued progress towards proficiency.
5. Provide students with an opportunity to assess the usefulness of the rubric by using it to evaluate other graphs, such as graphs about simple and compound interest and trajectories of objects. Provide feedback about what to look for in their graphs based on the CCR standard.

**Rubic/Study Guide for Interpreting Function (created with students)**

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| **TOPIC** | **MINIMALLY MEETS ST.** | **MEETS STANDARD** | **EXCEEDS STANDARD** |
| x-intercept  y intercept | Has identification of ordered pairs, but the graph does not cross either the x or y axis | Identifies x and y axes,  Shows the points where the lines cross each axis if applicable | For all graph is complete the first time |
| increasing  decreasing  end behavior  periodicity | Graph doesn’t show if the function is going up or down. | The graph shows where the lines are going up, down, where they repeat and predict how the graph continues  Shows a difference between linear equations and acceleration (for continuum the variety of equations sin, cos, quadratic etc) |  |
| slope  (positive and negative) | No line drawn to indicate the slope | Identifies when and where the slope is negative (decreasing) or positive (increasing) |  |
| maximum and minimum | Does not correctly identify the maximum or minimum | Correctly identifies appropriate maximum or greatest number of the function and minimum or lowest number of the function |  |
| symmetry  domain  range | Incorrectly graphing the x and y coordinates. | Understands coordinate points where the domain is x and the range is y.  Shows symmetry if available | Graph has an appropriate domain in relation to the function (for ex., does not go into negative areas for time before a race) |