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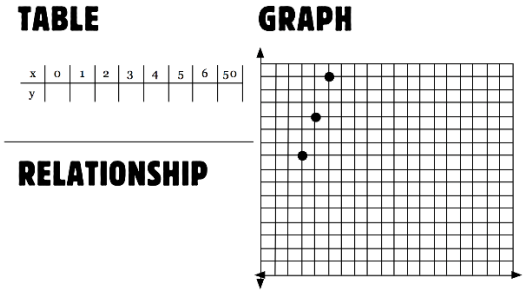

Justify and Critique Activity: Algebraic Relationships in Two Variables

Overview

Current standards in mathematics require that students be able to "construct viable arguments and critique the reasoning of others" (Common Core Standards, Standards of Math Practice 3). Further, "mathematically proficient students . . . justify their conclusions, communicate them to others, and respond to the arguments of others." This activity has students justifying and making arguments for their solutions to higher-order thinking math questions, and it has students questioning or critiquing the solutions of their classmates.

This Justify and Critique activity is on the middle school mathematics content of algebraic relationships in two variables, and is aligned with *Go Math: Middle School Grade 7* (Houghton Mifflin Harcourt, 2014). The questions used in the activity are taken from the "argument-based mathematics reasoning" question set and activity, produced by Argument-Centered Education. Note that 'critique' does not mean exclusively 'contradict.' 'Critique' can mean agree but with a difference, a variation, or a slight difference in explanation. The important thing is that there are competing ideas in play.

Method and Procedure

(1) Students should be put in pairs. Then each pair should be assigned another pair that they will be matched against for this activity.

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(2) Each group of four students (two pairs) should be assigned one of the higher-order thinking problem-pairs below:

(A) Problems 2 (14.1, p. 433) & 4 (14.1, p. 434)

(B) Problems 5 & 6 (14.1, p. 435)

(C) Problems 12 & 13 (14.1, p. 438)

(D) Problems 14 (14.1, p. 438) & 6 (14.1, p. 441)

(E) Problems 4 (14.1, p. 442) & 15 (14.2, p. 444)

(F) Problems 16 & 17 (14.2, p. 444)

(3) Using problems 10 & 11 (14.1, p. 438), and any of the justification and critique questions from the list below, the instructor should model for the students both a justification of their solution to this problem and a critique of that justification.

(4) Each pair should solve both problems, and should take through their justifications for their solutions. If the problem calls for graphing, each pair should graph out their answer on paper. Each pair should also take notes for their presentation of either a justification of their solution to the problem, or a critique of their matched pair's solution.

(5) Each problem has a justification question and a critique question which the student pair assigned to that problem should read and be prepared to respond to. The questions are below, and can be printed and cut out on strips of paper and distributed to the appropriate student pairs.

(6) The first group of students should then be called up to the front of the class to conduct their justification and critique. One pair should be selected by the instructor to go first answering and justifying their answer to problem 2 (14.1, p. 433). The other pair should then ask them the justification question, which the first pair should answer. Then the second pair should be asked by the instructor the critique question, and the second pair should answer it.

(7) The tables are turned for the next problem, number 4 (14.1, p. 433). The second group should solve this problem and justify their solution. The first group should

then ask the second the justification question. The instructor should then ask the first group the critique question.

(8) Student pairs should be allowed to use a document camera, under the instructor's supervision, in order to demonstrate their work.

(9) Each group of students should go up to the front of the class to participate in the Justify and Critique activity, in turn. Occasionally, the instructor should ask students who are observing questions to check for their understanding and to involve them in the on-going learning project.

(10) A separate rubric can be used to assess student pairs' justification and critique and the mathematical reasoning they conducted and communicated. Or the activity can be conducted without a formal or direct assessment component.

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Justification and Critique Questions for Each Problem

Problem 2 (14.1, p. 433)

Justification	Can you explain that in a different way?
Critique	Do you agree with the reasoning the other pair provided to justify their answer? Was there anything missing or not exactly correct in their justification?

Problem 4 (14.1, p. 434)

Justification	Can you explain your reasoning to get to your solution in a different way?
Critique	Can you come to the same answer but using a different method or different reasoning to get there? How does your reasoning compare with the other pair's reasoning?

Problem 5 (14.1, p. 435)

Justification	What broader principle or rule does your reasoning seem to suggest is generally true in math?
Critique	What do you think about what the other pair just said? How solid and thorough was their reasoning?

Problem 6 (14.1, p. 435)

Justification	Is there a more likely or more probable cause for the association?
Critique	Can you come up with a real-world example that more clearly and probably demonstrates a relationship as expressed in the graph between height and reading level? Why is your example clearer?

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Problem 12 (14.1, p. 438)

Justification	Walk us through your steps. Where did you begin, and how did you get to the next step? Then the step after that . . . ?
Critique	If you were to question the other pair's reasoning to get to their solution, what would you focus on? How could you create a critique of their reasoning? Now, ask the other pair to respond to this critique.

Problem 13 (14.1, p. 438)

Justification	How would you approach a similar problem – for example, can a scatter plot have a linear association that is neither positive nor negative? Try to do that problem now.
Critique	Do you think that there is some aspect of the other pair's mathematical reasoning that is unnecessary, untrue, inapplicable, or unjustified?

Problem 14 (14.1, p. 438)

Justification	What broader principle or rule does your reasoning seem to suggest is generally true in math?
Critique	Would this reasoning be clear to a younger student or a person your age relatively new to math? What portion of the argument or reasoning might they not understand or not agree with, if any?

Problem 6 (14.1, p. 441)

Justification	Why did you decide to use this method (or process) of solving the problem?
Critique	Can you summarize in your own words the mathematical reasoning the other pair just described? Which statement of math reasoning – yours or theirs – do you think is clearer? Why?

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Problem 4 (14.1, p. 442)

Justification	Can you explain your mathematical process for solving this problem to the class? Clarify for everyone why it works.
Critique	Do you agree with the reasoning offered by the other pair to argue for their mathematical processes? If you had to find a flaw in their reasoning, what could you come up with? Now ask the other pair to respond.

Problem 15 (14.2, p. 444)

Justification	Why is your solution true?
Critique	Can you arrive at the same answer but using a different way of justifying it, or argument for why it is true? Whose justification do you think is clearer or more complete?

Problem 16 (14.2, p. 444)

Justification	Is your mathematical reasoning true for all similar problems? Are there any exceptions that you can identify where your reasoning would not apply?
Critique	If someone were to question the other pair's reasoning or strategy in coming to their solution, what might they focus on? What critique might they try to make?

Problem 17 (14.2, p. 444)

Justification	What broader principle or rule does your reasoning seem to suggest is generally true in math?
Critique	Do you think that there is any aspect of the mathematical reasoning that the other pair provided that is unnecessary, untrue, inapplicable, or unjustified?
