**Lesson Study Team Name & Participants: Rat Pack: Maria Cox, Lora Davis, Josh Johnson, Matt Noga, Penny Parker**

**Research Question(s):** How do we develop students’ problem solving skills using rich word problems.

**Title:** Robots and Cell Phones

**Lesson Goal/Objectives:**

**SOL 8.3** The student will solve practical problems involving rational numbers, percents, ratios, and proportions.

**Research Lesson Date:** October 26, 2011 **Lesson Time: 9:00 AM**

**School:** Stonewall Middle School **Grade:** 8

**Research:**

The basis for our group’s lesson is to involve students in a meaningful activity that they can understand in real terms. The problem involves explicit and implicit relationships among the variables. Students will be given the time and resources to explore and discover different methods of solving the problem, as they work together in groups. The focus is to follow the key principle concepts of teaching proportional reasoning, as described in *Developing an Essential Understanding of Ratios, Proportions & Proportional Reasoning* (2010). The goal is to set a high standard for instruction, wherein lessons are designed to be challenging, but where students feel supported in their own methods of discovery and not that they are expected to follow only one specific strategy.

Another key principle is the formulation of significant assessment tools. In our lesson, we include a warm-up to first assess the students’ understanding of explicit relationships. At the conclusion of our lesson, we administered a short assessment on their understanding of implicit relationships among the variables, requiring a higher level of understanding of proportional reasoning and the relationship among the various terms in the problems.

In developing our primary lesson, the group also followed the steps outlined by Van de Wall in *Teaching Student-Centered Mathematics, Volume III* (2006). Van de Wall describes eight steps that should precede all planning in a problem-based lesson; 1) articulate the ideas you want students to learn from this lesson; 2) modify the lesson to your students and what they may or may not already know or understand; 3) identify the specific tasks you want them to accomplish, but keep it simple and at their level; 4) predict what answers you think they will find; 5) let students know they will need to articulate and explain their work; 6) start the lesson providing some direction, as we will with our warm-up; 7) identify what might be a challenge for many students, and be prepared to provide the minimum guidance so they can discover the answers on their own; 8) consider how the students can best share their ideas and work, whether that is presenting to the entire class or sharing with the table next to them, as we will do in our lesson.

**Relationship between this Lesson and Mathematics Content Standards for VA SOL: vertical and horizontal connections:**

**Foundational Objectives:**

**SOL 7.4** The student will solve single-step and multi-step practical problems, using proportional reasoning.

**SOL 6.1** The student will describe and compare data, using ratios, and will use appropriate notations such as , *a* to *b,* and *a:b.*

**Essential Questions and Understandings:**

How do proportions show a relationship of equality between two ratios?

How can proportional reasoning be used to solve practical problems?

Students will understand that there are different ways to represent the proportional reasoning used to solve a problem.

Students will understand that proportions use ratios to show a relationship of equality.

**Problem:** If three robots make 17 cell phones in 10 minutes, then 12 robots can make how many cell phones in 45 minutes? (Attachment #2)

|  |  |  |  |
| --- | --- | --- | --- |
| ***Lesson Flow:******Instructional Activities*** | ***Anticipated Students’ Responses*** (What are the anticipated misconceptions or barriers?) | ***Teaching Remarks***(Conceptual supports, questioning or strategies for scaffolding & differentiation) | ***Key Points to Evaluate Student Learning***(Probing Questions) |
| Materials Needed: manipulatives: tiles, fraction blocks, graph paper, poster paper, markers, problem copiesLesson:Warm-up: (See attachment #1) Following the written warm-up, the teacher will orally prompt the students with a question such as: “If it takes two of you 20 minutes to clean the room, do you think it would take more students more or less time?”Review group problem solving norms.Introduce problem. Ask students to work on the problem independently for approximately 10 minutes.Students will be directed to get in their groups and share their work on the problem. They should decide on a solution to present to the class. If there are different ways that the problem was solved, students will be encouraged to include these on their presentation.Teacher will use questioning to clarify thinking during their oral presentations.Closure: Exit slip (see attachment #1) | Students may not recognize that more robots will take less time to make the same number of phones.They may struggle with the relationship of three different variables.Students may think that there is a direct relationship (more workers take more time to make more phones)A list of possible student responses is attached to the lesson as attachment #3. | “Be sure to choose any of the manipulatives that you think might help you.”“Did anyone begin solving it differently?”“What would happen if you only looked at two variables at a time?” | “Can you explain your reasoning?”“What made you go in that direction to solve the problem?”“What processes did your group use to get to a final answer?” |

**Attachment #1**

Warm-up Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

![MC900442163[1]]()SHOW ALL YOUR WORK! October 26, 2011

Last weekend Mr. Smith’s class made money taking turns working the concession stand at the football and soccer games. After five hours they earned $200. How much money would they raise if they worked 13 hours?

![MC900441428[1]]()Exit Ticket Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Write in full sentences! October 26, 2011

Look back at the warm-up problem. How was it the same or different from the robot problem that you just did? Write two or three sentences to explain your answer.

**Attachment #2**

![MC900311156[1]]()

If three robots make 17 cell phones

In 10 minutes, 12 robots can make how

![MC900441450[1]]()

many cell phones in 45 minutes?

**Attachment #3**

**SOLUTIONS**

If 3 robots can make 17 cell phones in 10 minutes, how many cell phones can 12 robots make in 45 minutes

Ratio Table One:

|  |  |  |  |
| --- | --- | --- | --- |
| **Robots** | **Cell Phones** | **Minutes** | **Explanation** |
| 3 | 17 | 10 | given |
| 3 | 76.5 | 45 | Multiply cell phones and minutes by 4.5 |
| 12 | 306 | 45 | See that 3 times 4 is 12, so multiply cell phones by 4 as well |

Another ratio table:

|  |  |  |  |
| --- | --- | --- | --- |
| **Robots** | **Cell Phones** | **Minutes** | **Explanation** |
| 3 | 17 |  10 | given |
| 12 | 68 | 10 | Multiplied robots and cells phones by 12 |
| 12 | 306 | 45 | Multiply cell phones and minutes by 4.5 |

Ratio Table/Unit Table

|  |  |  |  |
| --- | --- | --- | --- |
| **Robots** | **Cell Phones** | **Minutes** | **Explanation** |
| 3 | 17 |  10 | given |
| 1 | 17/3 | 10 | Divide cell phone and robots by 3 |
| 1 | 25.5 | 45 | Multiply cell phones and minutes by 4.5 |
| 12 | 306 | 45 | Multiplied robots and cells phones by 12 |

Two Tables:

|  |  |  |
| --- | --- | --- |
| **Robots** | **Cell Phones** | **Explanation** |
| 3 | 17 | given |
| 6 | 34 | double |
| 12 | 68 | Double again |

|  |  |  |
| --- | --- | --- |
| **Hours** | **Cell Phones** | **Explanation** |
| 10 | 68 | Previous table |
| 20 | 136 | double |
| 30 | 204 | multiply original by 3 |
| 40 | 272 | Multiply original by 4 |
| 50 | 340 | Multiply original by 5 |
| 45 | 306 | Halfway between 40 and 50 |

Different way of scaling up and down

|  |  |  |  |
| --- | --- | --- | --- |
| **Robots** | **Cell Phones** | **Minutes** | **Explanation** |
| 3 | 17 | 10 | given |
| 6 | 34 | 10 | Multiply robots and cell phones by two, leave minutes alone |
| 9 | 51 | 10  | Multiply the original values of robots and cell phones by three  |
| 12 | 68 | 10 | Multiply the original values of robots and cell phones by four |
| 12 | 136 | 20 | Multiply the last line by 2 for cell phones and minutes |
| 12 | 272 | 40 | Double again |
| 12 | 544 | 80 | Double again, see it is too large |
| 12 | 408 | 60 | Find the middle of 40 and 80 to be 60, do the same for cell phones, still too high |
| 12 | 340 | 50 | Find the middle of 40 and 60 to be 50, do the same for cell phones, still too high |
| 12 | 306 | 45 | Find the middle of 40 and 50 to be 45, do the same for cell phones, this is our target |

Proportion

$$\frac{3 robots}{17 cell phones}= \frac{12 robots}{x cell phones}$$

$$3x=20$$

$$x=68 cell phones$$

Using this information, build another proportion

$$\frac{68 cell phones}{10 minutes}=\frac{x cell phones}{45 minutes}$$

$$10x=3060$$

$$x=306 cell phones in 45 minutes$$

Another Method:

Get to 15 minutes in the table, by realizing that 10/2 = 5 so 17/2 = 8.5 if you add them together you get 3 robots making 25.5 cell phones in 15 minutes

Now create a new table using that information

|  |  |  |  |
| --- | --- | --- | --- |
| **Robots** | **Cell Phones** | **Minutes** | **Explanation** |
| 3 | 25.5 | 15  | From above |
| 12 | 102 | 15  | Multiply robots and cell phones by 5, leave minutes alone |
| 12 | 306 | 45 | Multiply the cell phones and minutes by three  |

One more way: two tables

|  |  |  |  |
| --- | --- | --- | --- |
| **Robots** | **Cell Phones** | **Minutes** | **Explanation** |
| 3 | 17 | 10  | given |
| 12 | 68  | 10  | Multiply robots and cell phones by 3 |
| 12 | 272 | 40 | Multiply the cell phones and minutes by four, see not enough minutes need five |

|  |  |  |  |
| --- | --- | --- | --- |
| **Robots** | **Cell Phones** | **Minutes** | **Explanation** |
| 3 | 17 | 10 | given |
| 3 | 8.5 | 5 | Divide cell phones and minutes by 2 to get those five minutes |
| 12 | 34 | 5 | Multiply the robots and cell phones by 4 to get the work 12 robots do in 5 minutes  |

Now add the final line for cell and minutes of the two tables:

You get 12 robots make 306 cells do 45 minutes

Drawing

The students will figure out that 1 robot can do 5 2/3 cell phones in 10 minutes.

Draw this 4 times to show 12 robots in 10 minutes

So they can see that 12 robots can make 68 cells, I circles the parts that make one cell phone.

Now what they could do is multiply this by 4 to get 40 minutes. Then they could work on drawing to figure out those extra five minutes by doing something like this:

So each robot can make 2 ½ + 1/3 cell phones, or 3 robots can make 8.5 cells phones in 5 minutes.

Using that information they could repeat the process they did before of copying 4 times like so:

Doing so they can count the pieces and see that 12 robots can make 34 cell phones in 5 minutes, so they add that to the 272 cells phones that 12 robots can make in 40 minutes to get 306 cell phones in 45 minutes.