LEARNING INTENTION(S): What does it mean to solve an equation that contains multiple variables? How can I use descriptions and units associated with variables to guide my thinking about solving such equations?

REVIEW:

Elvira, the cafeteria manager, likes to keep track of the things she can count or measure in the cafeteria. She hopes this will help her improve the efficiency of the cafeteria. To remind herself to keep track of important quantities, she has made a table of variables and descriptions of the things she wants to record. Here is a table of things she has decided to keep track of.

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>MEANING (description of what the symbol means in context)</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$S$</td>
<td>Number of students that buy lunch in the salad line</td>
<td>STUDENTS</td>
</tr>
<tr>
<td>$W$</td>
<td>Number of students that buy lunch in the sandwich line</td>
<td>STUDENTS</td>
</tr>
<tr>
<td>$P$</td>
<td>Number of students that buy lunch in the pizza line</td>
<td>STUDENTS</td>
</tr>
<tr>
<td>$F$</td>
<td>Number of food servers in the cafeteria</td>
<td>SERVERS</td>
</tr>
<tr>
<td>$M_T$</td>
<td>Number of minutes it takes to serve lunch to all students</td>
<td>MINUTES</td>
</tr>
<tr>
<td>$C$</td>
<td>Number of classes in the school</td>
<td>CLASSES</td>
</tr>
<tr>
<td>$P_L$</td>
<td>Price per lunch</td>
<td>DOLLARS</td>
</tr>
<tr>
<td>$A$</td>
<td>Avg. Class Size</td>
<td>STUDENTS PER CLASS</td>
</tr>
<tr>
<td>$R$</td>
<td>Lunch Revenue (Total $ Made)</td>
<td>DOLLARS</td>
</tr>
<tr>
<td>$T$</td>
<td>Total # of students who eat lunch</td>
<td>STUDENTS</td>
</tr>
<tr>
<td>$D_F$</td>
<td>Revenue per server</td>
<td>$/SERVER</td>
</tr>
<tr>
<td>$M$</td>
<td># of Minutes to serve Students</td>
<td>MINUTES/STUDENT</td>
</tr>
</tbody>
</table>

Elvira has written the following equation to describe a cafeteria relationship that seems meaningful to her. She has introduced a new variable $A$ to describe this relationship:

$$A = \frac{S + W + P}{C}$$

1. What does $A$ represent in terms of the school and the cafeteria? Record this information in the table above.

   **Average Class Size**

2. Using what you know about manipulating equations, solve this equation for $S$. Your solution will be of the form $S' = \text{an expression written in terms of the variables } A, C, W, \text{ and } P$.

   \[ A \cdot C = S + W + P \implies S = A \cdot C - W - P \]

3. Does your expression for $S$ make sense in terms of the meanings of the other variables? Explain why or why not using the unit column.

   Yes; Students who buy salad equals Students - Students (Salad, Sammy, Pizza) - Students (Salad, Sammy, Pizza)
Here is another one of Elvira's equations: \( R = P_L(S + W + P) \)

4. What does \( R \) represent in terms of the school and the cafeteria? Record this information in the table above.

5. Using what you know about manipulating equations, solve this equation for \( P_L \).

\[
P_L = \frac{P}{S+W+P}
\]

6. Does your expression for \( P_L \) make sense in terms of the meanings of the other variables? Explain why or why not using the unit column.

Yes; cost of lunch equals

\[
\text{dollars} = \frac{\text{cost}}{\text{students eating lunch}}
\]

7. Elvira notices that she uses the expression \( S + W + P \) a lot in writing other expressions. She decides to represent this expression using the variable \( T \), so that \( T = S + W + P \). What does \( T \) represent in terms of the school and the cafeteria? Record this information in the table on the front page.

\( T = \text{total # of students who eat lunch.} \)

Elvira is having a meeting with the staff members who work in the lunchroom. She has created a couple of new equations for the food servers:

\[
D_F = \frac{T \cdot P_L}{F} \quad M = \frac{M_T}{T}
\]

8. a. What does \( D_F \) represent in terms of the school and the cafeteria? Record this information in the table above.

\( \text{Avg. Port of }$ collected per food server. \)

b. Solve this equation for \( P_L \). Describe why your solution makes sense in terms of the other variables using the unit column.

\[
D_F \cdot F = T \cdot P_L \Rightarrow P_L = \frac{D_F \cdot F}{T}
\]

9. a. What does \( M \) represent in terms of the school and the cafeteria? Record this information in the table on the front page.

\( \text{Amt of time available to serve students.} \)

b. Solve this equation for \( T \). Describe why your solution makes sense in terms of the other variables using the unit column.

\[
M \cdot T = M_T \Rightarrow T = \frac{M_T}{M}
\]

10. One of the staff members suggests that they need to write expressions for each of the following. Using the variables in the table, what would these expressions look like?

a. The average number of students served each minute.

\[
\frac{S+W+P}{M_T} \quad \text{or} \quad \frac{T}{M_T}
\]

b. The average number of minutes students wait in the pizza line.

\[
\frac{P}{M}
\]