TITLE: DEFICIENCIES AND MEGADOSES

Student/Class Goal
Many of the health decisions in students' lives are based on inequalities rather than equations.

Outcome (*lesson objective)*
Given a lower bound, an upper bound, and dosage amounts for two variables, students will construct an algebraic inequality to represent the relationship between the variables and the bounds. Students will then solve this inequality and graph it on the X-Y plane.

Time Frame

2 hours

Standard *Use Math to Solve Problems and Communicate*

NRS EFL 5-6

Number Sense	Benchmarks	Geometry & Measurement	Benchmarks	Processes	Benchmarks
Words to numbers connection	5.1, 6.1	Geometric figures		Word problems	5.25, 6.26
Calculation		Coordinate system	5.7, 6.7	Problem solving strategies	
Order of operations	5.3, 6.3	Perimeter/area/volume formulas		Solutions analysis	5.27, 6.28
Compare/order numbers		Graphing two-dimensional figures		Calculator	
Estimation		Measurement relationships		Math terminology/symbols	5.29, 6.30
Exponents/radical expressions		Pythagorean theorem		Logical progression	
Algebra & Patterns	**Benchmarks**	Measurement applications	**5.13, 6.13**	Contextual situations	**5.31, 6.32**
Patterns/sequences		Measurement conversions	**5.13, 6.13**	Mathematical material	
Equations/expressions	**5.16, 6.16**	Rounding		Logical terms	
Linear/nonlinear representations	**5.17, 6.17**	**Data Analysis & Probability**	**Benchmarks**	Accuracy/precision	
Graphing	**5.18, 6.18**	Data interpretation		Real-life applications	**5.35, 6.36**
Linear equations	**5.18, 6.18, 6.19**	Data displays construction		Independence/range/fluency	5.36, 6.37
Quadratic equations		Central tendency			
		Probabilities			
		Contextual probability			

Materials
Vitamin D Task Handout
Vitamin E Task Handout
Folic Acid Task Handout
Teacher Answer Sheet
Vocabulary Sheet

Learner Prior Knowledge
Students should know how to convert between units and be familiar with the **number line**. Students should also know how to solve **algebraic equations**.

Instructional Activities
Step 1: Review (or introduce) the concept of **scientific notation**. Review basic number line problems such as $3 \leq x \leq 6$ and $3 \leq x < 6$, making sure to emphasize the difference between an open dot (< or >) and a closed dot (≤ or ≥).

Step 2: Go over **systems of equations**. Start with a simple example like $x + y = 4$, $x – y = 2$ and then move onto more challenging examples. Present the substitution method (solve for x or y in one equation and then plug it into the other equation) and the synthesis method (multiply one or both equations so that a variable has opposite coefficients and then add the equations). For example, using the synthesis method to solve $2x + 3y = 7$, $5x - 2y = -1.5$, you could multiply the first equation by 5 and the second equation by -2 and then add the two equations to get $19y = 38$. Thus, $y=2$ and $x = (1/2)$. After you solve the system, plot both lines

on the X-Y plane and ask what the intersection represents (it should be the point (1/2, 2) that you just found).

Step 3: Keep the same two original equations on the board, but change the equals signs into greater than or equals. (e.g., $2x + 3y \geq 7$, $5x - 2y \geq -1.5$). Ask if anyone has any ideas on solving this new system of equations. Show how you can solve for either x or y in each equation and then shade above (y is greater than), below (y is less than), to the left (x is less than), or to the right (x is greater than) of the line. If BOTH equations must be satisfied, then the answer will be the region of the X-Y plane that is shaded twice. Discuss how this means that the answer is a region instead of a point like in Step 2.

Step 4: Put the following problem on the board: $3 \leq 2x + 5y \leq 7$. Ask for ideas on how students would approach this problem. Show how this can be broken up into two inequalities ($3 \leq 2x + 5y$ and $2x + 5y \leq 7$) and then solved as in Step 3. Make sure you plot this on a graph. Ask students to list at least one **integer pair** solution in the shaded region (e.g., (0,1)).

Step 5: Introduce the context. Tell your students about the general concept of **deficiencies** and **megadoses** (basically that our bodies are sensitive to too much *and* too little of many important vitamins and minerals). This can get complicated because a vitamin can be present in different forms, each of which may have a distinct potency level. Explain that scientists have derived a measurement unit named IU (International Unit) to handle this problem. The lower limit of IU of a particular vitamin or mineral that nutritionists recommend for each person is the Recommended Daily Allowance (RDA). The upper limit considered to be safe is the Tolerable Upper Intake Limit (TUIL). Tell students that the contents of this lesson are based on the most accurate information available, but that that this lesson does not take the place of official medical advice. Certain people have health conditions that will require taking less than the RDA or more than the TUIL of a vitamin and so students should consult their doctor before making any changes to their diet.

Step 6: (I do) *Teacher models the solution process on the Vitamin D Task*. Spend a few minutes becoming familiar with Vitamin D as a group before going through the task questions. Use the Talk Aloud procedure as you work through each of the first four questions. (Option for advanced groups: When you create the number line for Question #2, create and label intermediate places on the line also. For example, the IU side of the line could be labeled at every 1,000 IU, and then the microgram side would be labeled at every 25 micrograms). Question #4 is complicated and would be a good opportunity to implement Polya's 4-step problem-solving strategy using the Talk Aloud procedure.

Step 7: (we do) *Teacher and students collaboratively work through the Vitamin E Task*. Begin with the Vitamin E source chart and discuss whether students are eating natural sources of Vitamin E. Then read through the benefits, as well as the dangers of deficiency and megadoses. When you get to the conversions, this will be the first time most of the students will have encountered a split conversion. Remind students that this is why most nutrition labels use IU for vitamins and minerals instead of a standard weight (in other words, the IU give us a single measure for comparing different sources of Vitamin E with different potency levels). Questions #1 and #2 are very similar to what students watched you do in the Vitamin D task, so try to see if they can handle these steps (with the help of your prompts when necessary). As you are talking through Questions #3 and #4, make sure you point out that #3 is an equation and #4 is an inequality. For #4, make sure you work through a 2-variable inequality (in other words, consider the two together instead of separately – see the Teacher Answer sheet for an example of this).

Step 8: (you do) *Students independently work through the Folic Acid Task*. Depending on your class dynamics, either partner students together or have them work individually. Before you pass out the task, explain that you want the students to tackle this problem as independently as possible. After passing out the handouts, walk around the room silently monitoring the students' progress. When you see them run into difficulties, try not to answer their questions directly; instead, remind them of similar situations from the first two tasks. Question #4 is the most difficult. Refer them to go back through Question #4 from the Vitamin E task before prompting them with answers.

Step 9: Have each student (or pair) share both the process they used and their final comparisons. Encourage students to discuss the pros and cons of alternative approaches taken. In this case, there is only one correct answer for each question, although students may have different representations for #4. When students disagree, do not immediately provide the correct answer; allow each student or pair to try to convince the other first.

Step 10: *Making it relevant.* Have students brainstorm specific vitamins or minerals that they want to investigate in their diet (see "Next Steps" below for an optional assignment).

Assessment/Evidence (*based on outcome)*

Steps 8 and 9 will serve as evidence of student mastery. During Step 8, the teacher should actively listen to partner discussions for

signs of understanding or of misconceptions. If students are working alone, the teacher should have students speak out loud as they solve the problem. During Step 9, allow students the opportunity to modify their solutions based on what they learn from watching others present their solutions.

Exit Slip: For Vitamin C, the RDA is 90 mg and the TUIL is 2000 mg. A popular energy drink contains 1000 mg of Vitamin C, and a serving of broccoli contains 90 mg.

1. Write an inequality for the number of energy drinks and broccoli servings you could have to stay between the RDA and TUIL.
2. Graph the inequality.

Teacher Reflection/Lesson Evaluation
Not yet completed.

Next Steps
If students take any supplements, have them research the RDA and TUIL for each one, and then estimate their average daily intake. If they are not already taking supplements, have them research a common one like Vitamin C or Calcium and see how their natural daily intake compares to the desirable range. See websites below for research starting points.

Technology Integration

This article provides a more thorough discussion about the concept of deficiencies and megadoses:
http://www.arthritistoday.org/nutrition-and-weight-loss/vitamin-and-mineral-guide/too-many-vitamins-minerals.php

The Mayo Clinic is one of the most reputable sources of health information in the world. This following link takes students to the Vitamin E information page, but they can easily search for other vitamins or minerals in the search box:
http://www.mayoclinic.com/health/vitamin-e/NS_patient-vitamine/DSECTION=dosing

Purposeful/Transparent
Students are concerned about their health, but do not (and should not) always trust the messages they are given about how much vitamins they need. In this lesson, students learn to calculate appropriate vitamin dosages by using algebraic inequalities.

Contextual
This lesson hits on dosages of vitamins and minerals, one of the few topics applicable to everyone's life. The issue becomes even more important given the ubiquitous presence of energy drinks, energy bars, fortified foods, and supplements.

Building Expertise
This lesson builds on students ability to read a number line, understand a simple inequality, and solve a basic system of equations. Students must combine these three skills to solve systems of inequalities. The final step of plotting the graphs forges connections between algebraic and graphical representations.

Deficiencies and Megadoses: Vocabulary Sheet

Algebraic equation – an equation that includes at least one unknown variable.

Deficiency – a problematic condition where the body is not receiving an adequate amount of a specific vitamin or mineral.

Integer pair – a coordinate on the X-Y plane, where both the x-value and y-value are integers. For example (2, -7) would be an integer pair, but (0.5, 3) would not.

Megadose – a problematic condition where the body is receiving too much of a specific vitamin or mineral.

Number line – a line on which each point represents a real number.

Scientific notation – a numeric format where the base number, which is greater than or equal to one and less than 10, is multiplied times a power of ten.

System of equations – a set of at least two algebraic equations with the same value for each variable.