“Urban Environmental Health Issues Meet Algebra”

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“Going Green” is a new buzz phrase in the media recently. Students see and hear about ways to reduce their impact on the planet. In this unit, I want them to learn about potential health risks from common pesticide products in order to make informed decisions about their use and consider “green” alternatives. In the process of learning about health risks from pesticides, I will interject mathematics.

According to the EPA governmental website, the term pesticide covers many categories of substances depending on the type of pest they target, or the method in which they are produced (i.e. chemical pesticides versus biopesticides). Some examples of pesticides that students might recognize are Algicides (kills algae), Defoliants (kills leaves on trees), Disinfectants/Sanitizers, Fungicides (kills fungus) , Herbicides (kills plants), Insecticides, Repellents, and Rodenticides (kills rodents). To make the unit relevant to my students, I selected four specific categories of common household pesticides (three insecticides and one herbicide): Insect Repellents, Ant and Roach Killers, Pet Flea and Tick products, and Lawn and Garden Weed Killers.

My high school, in accordance with the school district, has instituted a Literacy Initiative for the upcoming school year for all grade levels and all classes in an effort to improve scores on the high-stakes DSTP (Delaware State Testing Program). As the initial part of my unit, I will develop “Before, During, and After” reading activities for articles that

provide background information about the history of pesticide use, ingredients of specific products, as well as "green" alternatives. These activities will not only satisfy the district and school Initiative, but also provide connections between mathematics and other disciplines.

Some of the ingredients in the pesticide categories I selected are better known than others, and have much information published about their toxic effects on humans. Insect Repellants often contain the ingredient commonly known as DEET, which has caused reactions ranging from rashes to seizures and death. Household Ant and Roach Killers may contain chlorpyrifos, an organophosphate chemical that affects the nervous system. Frontline® Flea and Tick Killer's active ingredients are firpronil and (S)-methoprene, both of which have relatively low toxicity. A popular Weed Killer, RoundUp®, contains the chemical Glyphosate, which inhibits the synthesis of amino acids, and therefore prevents the formation of necessary proteins in plants. I found it interesting to note that some reports have suggested that the Inert Ingredients in pesticides may also cause reactions in some people.

There are three methods of exposure to pesticides: Oral (by mouth – food or water), Dermal (skin contact), and Inhalation (breathing/air). There may be limits set for each method of exposure, typically based on some "average" size person. Limits may also be defined for acute (short-term) or chronic (long-term) exposure, including cumulative effects, if known. This is where the mathematics will appear in my unit! I will have students adapt exposure limits stated for a given size individual to his/her own size

(reinforce proportional reasoning!), as well as for small children. Several articles emphasize the fact that small children are at greater risk for pesticide poisoning because of their size, limited diet, and tendency to put things in their mouths.

Exposure limits are stated in terms of contaminant level, given in mass or volume, per kg of body weight per unit time. I will use the context of pesticide exposure limits to teach the skill of converting units by Dimensional Analysis. Students will be able to convert from metric to British units (i.e. grams to pounds) and extrapolate to very long or very short periods of time. Dimensional Analysis is a useful skill that helps students keep track of units and determine which operation (multiplication or division) to use in both math and science classes.

I would also like to include some of the chemistry involved in pesticide exposure, depending on the science background of my students. If appropriate, students will use chemical formulas to convert from mass to moles of contaminant, and possibly calculate the amount of end products (metabolites) found in the body following exposure. Also, depending on the level of my students, I may be able to relate the amount of end products in the body based on half-life data to the study of exponential and logarithmic functions.

Finally, mathematically, I would like to guide students through formulating risk estimates for products they use at home and/or on the job. However, this is an area that I need to study more before including it in my unit.