

Abstract

Project STEP. The objective of the National Science Foundation-funded Science and Technology Enhancement Program (STEP) is to provide training within the field of secondary education to engineering and science graduate students with the goal that the fellows will continue to bring their expertise to high school classrooms throughout their careers. This is facilitated through a year-long collaboration of the graduate fellow and a team of four teachers within a given high school.

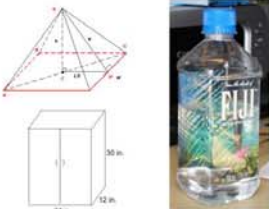
Fellow responsibilities. As a fellow, I am to design lessons pertaining to a topic within the established curriculum, placing the content within the context of engineering, my personal research, and Cincinnati, demonstrating to the students that their current studies are applicable to their daily lives.

The lesson. Students will be acting as packaging engineers, a novel type of engineer. To illustrate the relationship between surface area and volume, they will determine the surface area and volume of two water bottles with identical shapes but varying sizes. They will determine the packaging efficiency of square vs traditional gallon cartons of milk into boxes. Students will be able to relate to this concept as students see milk containers everyday. This lesson pertains to my research as I study the bacteria *E. coli* O157:H7. The relationship between surface area and volume is the reason that bacteria the size of humans are not found in the environment

Assessment. Analysis of the identical pre- and post- activity quiz given to two classes indicated that content knowledge increased by an average of 19% in Class One and 31% in Class Two. Individual results categorized by class and student can be found in the results section.

Introduction

Pyramids and rectangular prisms are seen everyday



How much air will be shipped using the jug versus the box?



Problem: Although class material is routinely put within the context of everyday life, the students often ask when they will use geometry.

The lesson: Students will act as packaging engineers to determine the surface area and volume of water bottles and milk containers.

Activity

To gain their attention, the objects used in this lesson were inspired by the pictured student who routinely drinks water bottled in rectangular containers.



During the group activity, students:

- Had fun examining the 500 and 1000 ml rectangular water bottles
- Measured the bottles to calculate the surface area and volume



- Discovered that certain angles in the shape complicated the calculations

- Calculated how much air would be shipped in a box containing milk packaged in the traditional gallon jug versus boxes.

Student Feedback

Class One

Liked best:

- I learned how volume and surface area go hand in hand
- That it dealt with real life situations
- That we could apply geometry to an actual job that exists

Liked least:

- Working out all those math problems
- The homework
- Use something besides water bottles

Rate your level of learning:

	A lot	A little	None
Class One	27%	59%	14%
Class Two	41%	59%	0%
Combined	34%	59%	7%

Did this lesson increase your confidence about your ability to learn math/science?

	Definitely	Sort of	Not sure	No
Class One	9%	64%	5%	23%
Class Two	32%	64%	0%	5%
Combined	20%	64%	2%	14%

Class Two

Liked best:

- Learning about packaging in a way that was fun too
- We got to work outside the usual on paper/pre-determined answer
- That the answers could vary a little

Liked least:

- Estimating the volume of a gallon milk carton
- The bottles were awkwardly shaped

Rate your interest in engineering:

	Very	Somewhat	Unsure	None
Class One	0%	36%	50%	14%
Class Two	9%	45%	32%	14%
Combined	5%	41%	41%	14%

Did this lesson affect your interest in engineering?

	Increased	Decreased	No effect
Class One	5%	5%	91%
Class Two	27%	0%	73%
Combined	16%	2%	82%

Figure 1. Student feedback. Immediately following the activity, students completed anonymous feedback forms.

Assessment Results

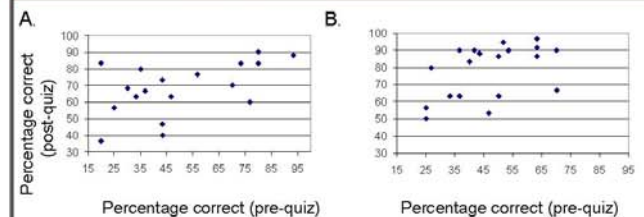


Figure 2. Post-quiz results. A) Class one and B) Class two completed a quiz both before and after the activity. The percentage correct on the pre-quiz (x-axis) is plotted versus the percentage correct on the post-quiz (y-axis). Each diamond represents the both pre- and post-scores of one student.

Conclusions

- Students enjoyed:
 - having a physical object to work with
 - thinking about the material within the context of everyday life
- Students were frustrated because:
 - measurements required judgment calls
 - the milk jug did not fit any given equation
- Ultimately, forcing students out of their comfort zone allowed them to think about geometry in a new way

Acknowledgments

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