

Action Research: "Thinking Outside The Box"

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Question: "Do students retain the concept of surface area through the use of manipulatives compared to learning equations to find surface area?"

Dina van Hiele-Geldof and Pierre van Hiele developed a model of thinking as they taught grades 7-9. The model includes the following levels: Level 0: Visual, Level 1: Analysis, Level 2: Informal Deduction, Level 3: Deduction, Level 4: Rigor. Middle grade students need to focus on levels 0, 1, and 2. To move through the levels, the van Hiele's prescribed geometry instruction to move through the following phases: a- inquiry, b- directed orientation (sequencing activities), c- explication (students express views/questions about investigations, d- free orientation (students find own resolve to tasks, e- integration (students form relationships and internalize new thoughts).

This model is the basis of the development of our project. Our goal was to have students internalize the concept of surface area.

Project: Students were grouped into threes and given a handout with the following task:

'Recently Coca Cola changed the packaging of their 12 packs of soda, making a 'refrigerator pack.' While the package is convenient for the consumer, what implications does it have for the price of production? Today you will compare the old and new packaging.'

Challenge 1: Find the surface area of the old packaging. Try to do this making only 3 measurements. Explain your reasoning in complete sentences.

Challenge 2: Find the surface area of the new packaging. Try to do this making only 3 measurements. Explain your reasoning in complete sentences.

Challenge 3: Explore other possibilities for how 12 cans could be packaged in boxes. Try various arrangements to see if you can find the one that uses the least amount of material. Keep a record of the dimensions of boxes you have tried and the surface area of each on the back of this paper. You should try as many arrangements as you can create. When you think you have found the best one, your group will construct that box out of poster board. Your group will present your packaging idea to the class tomorrow.

As students received their old and new empty boxes, some knew immediately to measure the length, width, and height as their three measurements. We had them come tell us the three measurements before they proceeded.

Many groups began multiplying the three measurements and announcing the product as

the surface area. We then asked what is the area of one side? This continued for each side until we had the area of all six sides. Students were then realizing that they needed to add all the areas together in order to find total surface area. At this point, students realized that their first multiplication did not match the new surface area.

There was 100% participation. Students were very hesitant about writing sentences describing their results. All measurements were in centimeters. The measurements of the old packages ranged from 1860 to 2344.6 sq. cm. That was a 484.6 sq. cm variation. The new package measurements ranged from 2176 sq. cm to 2402 sq. cm. This was a 226 sq. cm difference.

The designed containers varied from rectangular prisms to triangular prisms to trapezoidal prisms. The surface areas ranged from 1752 sq. cm to 3042 sq. cm. This was a 1290 sq. cm difference.

To design a new container, students used actual pop cans. (For future projects we recommend using empty cans.) In using poster board to design, students soon learned to measure from the corner first to get all sides included in one board. One group formed a circle. With a little pushing, they formed a triangle of 6 cans. Then they placed 6 cans on top. This group had a triangular prism and also had the smallest surface area. They decided that it would be hard to stock boxes in triangular prisms.

From past experiences, students would be presented with equations for surface area and volume. They would also have models to use for applying these equations. However, students seemed to confuse the concepts of surface area and volume by worrying if they had the correct equation.

Did this activity help students to better understand the concept of surface area? I used two assessments to answer this question. First, the test over this chapter. In one part of this test, students had an opportunity to choose 3 out of 6 problems. Most chose the surface area problems over the volume problems. Most students showed how to break down the measurements of each side and add them together. Any students who had wrong answers did so in computational errors.

The second assessment was choosing three students of various abilities. Each student was presented with a rectangular prism and a triangular prism. When asked to explain how to find the surface area of each solid, each student was able to explain in detail. I also asked, "What is a reason you might need to know the surface area?" Most responded, "to see how much cardboard is used to make it."

This project has proved to me that students can acquire geometrical concepts better through an exploration of figures. Finding a common object to use for exploring makes the project more familiar to the students.

Thinking Outside the Box

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Challenge 1:

Find the surface area of the old packaging. Try to do this making only 3 measurements! Explain your reasoning in complete sentences.

Challenge 2:

Find the surface area of the new packaging. Try to do this by making only 3 measurements. Explain your reasoning in complete sentences.

Challenge 3:

Explore other possibilities for how 12 cans could be packaged in boxes. Try various arrangements to see if you can find the one that uses the least amount of material. Keep a record of the dimensions of boxes you have tried and the surface area of each on the back of this paper. You should try as many arrangements as you can think of. When you think you have found the best one, your group will make that box out of poster board. You will present your packaging idea to the class tomorrow.