UNIT LESSON

Prior to Day 1, give the following assignment

> Assignment #1
>
> Last night George and Barbara had to take their baby to the hospital. He was very ill. After the doctor examined the baby, she determined the type of medication which she thought would be the most helpful in facilitating the baby's recovery. What information do you think the doctor would need in order to determine the proper dose of the medicine?
>
> In order to answer this question, I encourage you to browse the internet, ask any family and friends, phone a pharmacist or other health professional. On your paper, make a list of the items of information regarding the baby you think may be important to determine proper dosage.

DAY 1

Materials: newspapers, masking tape, meter sticks, string, scissors, and calculators

Divide the class into groups of 3 or 4 students per group. Students will remain in their group throughout the week for this unit. Each group will keep the artifacts of this unit's work in a folder.

Debrief on students' responses to previous assignment, perhaps by having each group list the different items they came up with on the board. Collect their individual papers, and use this as assessment tool #1 with the following rubric:

0 - no list provided

1 - a list provided

2 - a list provided which shows superior effort or thought

Whole group discussion: While reviewing the students' lists, share with the class that there are certain circumstances in which the dosage of a drug is calculated depending on the body surface area of the patient. This is done for some drugs for infants and children. Often the doses for a child are small, and a slight change in amount of the drug can have a large impact. (The computations based on body surface are is also used in adults for chemotherapy drugs and calculations of fluid volume after open-heart surgery, burns, or renal disease.)

In the work of this unit we will:

* review computing area of rectangles and circles
* calculate the surface area of a rectangular solid and a cylinder
* address the calculation of the body surface area of a person

Group activity: Each group is instructed to use the materials provided to construct a model of five rectangles with the given areas: 1 square meter, 2 square meters, 12 square centimeters, 36 square centimeters, and 1 1/2 square meters.

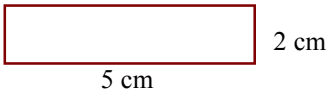
The teacher will not give specific directions regarding how to do this task, but instead would move among the groups, giving feedback and facilitating, and avoiding direct instruction. (Often I tell groups that for a specified period of time, I will only answer their questions with another question. Of course, my intent is that my return question will be provocative and will help move the group past their barrier without giving anything away.)

Whole group instruction: Discussing the models they made, we will look at the length of the side of the rectangles. In advance I will have have prepared several different shaped poster board models of a rectangle of 12 square centimeter area: a

1 by 12, a 2 by 6, and a 3 by 4. Review the facts: (1) that the lengths of the sides are different, but the area is the same , and (2) a quick way to calculate the area of a rectangle is to multiply the measurements of length and width.

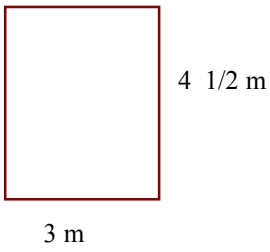
Group activity: Each group is given a traditional worksheet with questions akin to those below. Their instructions are that they are to work toward each member in the group being able to successfully complete the problems. Calculators are available to facilitate the problems involving decimals and fractions.

Example 1: Find the area of the rectangle drawn.



Example 2: Find the area of a rectangle with length 6 meters and width 3 meters.

Example 3: Find the area of the rectangle drawn.



Example 4: Find the area of a rectangle whose length is 5.2 meters and width is 0.6 meters.

Assignment #2

Make a model or a drawing to illustrate your answer to each of the questions below.

1. How many square centimeters are in a square meter?

2. How many square centimeters are in half a square meter?

3. How many square centimeters are in 3 1/2 square meters?

4. How many square centimeters are the same as 0.4 square meter?

DAY 2

Materials: all materials listed for Day 1, shoe boxes, and cylindrical oatmeal boxes

Collect previous assignment and assess using the following rubric:

0 points - no work attempted or answers provided without supporting model or drawing

1 point - work attempted with answers including supporting models or drawings that are incorrect or do not display an understanding of the question and answer

2 points - one or two questions answered correctly with supporting models or drawings that displays an understanding of the question and answer

3 points - three or four questions answered correctly with supporting models or drawings that displays an understanding of the question and answer

4 points - all five questions answered correctly with a supporting model or drawing which displays an understanding of the question and answer

Debrief on this assignment later in the week, after it has been graded and returned, so that the teacher can see where the deficiencies are and can remediate within the context of the group.

Group Activity: After the teacher demonstrates how a piece of string and a pencil may be used to draw a circle, the model from the previous day (the rectangle whose area measures 1 square meter) should be returned to each group. Ask them to use the materials provided to complete the following tasks.

1) Make a model of a circle whose area is about the same as the rectangle of 1 square meter area.
2) Make a model of a circle whose radius measures 40 centimeters.
3) Make a model of a circle whose radius measures 1 meter.

Compare the results among the groups.

Whole group instruction: Review the following: (1) Area is measured in square units even when the shape is not a rectangle, (2) The area of a circle is calculated using the formula of radius times the square of pi. Provide a worksheet to each group requiring the calculation of the area of circles of different sizes, given the measures of the radius. Decide which approximation for pi the class will use and to what decimal place answers will be rounded. (I prefer to have students use the calculator button to approximate pi and then round to tenths.) Ask each student to complete his work on the worksheet, and compare answers with group members before turning it in.

Group Activity: Give each group either a shoe box or an oatmeal box and a strip of adding machine tape. (The adding machine tape given to a group should have an area either slightly more or slightly less than the surface area of the box.) Each group is to guess, with consensus within the group, and record their guess in

writing as to whether they think the paper could cover box with no gaps of box showing though. The ground rules include that the paper could be cut and taped onto the box. Masking tape cannot be used as a mechanism for covering a gap. After their guess is recorded, the group should try and see if they can achieve the goal of covering the box with paper.

At the conclusion of this activity introduce the terminology of rectangular solid, cylinder, and surface area. Point out the contrast to rectangle, circle, and area. Ask the students to record on the same paper as their guess, how they think they could determine in advance if the paper would cover the form, without actually cutting the paper. Their group response should be written in paragraph form, using complete sentences.

Assignment #3

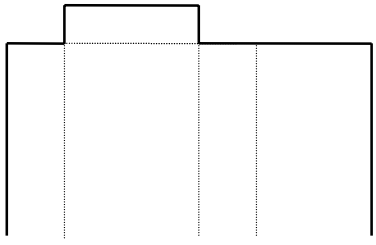
Make a model of a rectangle whose area is about the same as the surface area of your leg from ankle to knee.

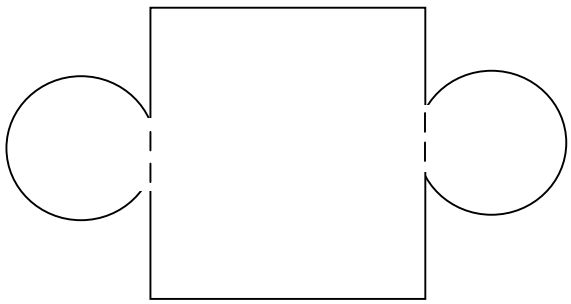
DAY 3

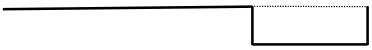
Materials: poster board, tape, meter stick, and scissors

Begin with a demonstration of students' previous assignment, encouraging several students to wrap their rectangular paper around their lower leg.

Group Activity: Provide two net diagrams for each group similar to those shown below:







Net diagram #1

Net diagram #2

Have the group trace both net diagrams onto the posterboard and cut each one out. Then have the students fold on the dashed lines and tape the forms so that they will make a model of a rectangular solid and a cylinder. Have each group answer the following questions in writing:

1) Before folding and taping, what combination of two-dimensional shapes were modeled by net diagram #1?
2) How can you find the area of each of the shapes?
3) Before folding and taping, what combination of two-dimensional shapes were modeled by net diagram #2?
4) How can you find the area of each of the shapes?
5) After folding and taping, what is the surface area of the three-dimensional model made from net diagram #1?
6) After folding and taping, what is the surface area of the three-dimensional model made from net diagram #2?

Whole class discussion: Debrief on the previous activity, reinforcing the two concepts that the surface area of a rectangular solid is the sum of the areas of its faces, and the surface area of a cylinder is the sum of the area of a rectangle and two circles.

Group Activity: Create a net diagram which will fold into a cylinder with the following characteristics: a height of 20 cm and circular bases each with radius 6

cm. Create another net diagram which will fold into a rectangular solid with a length of 14cm, a width of 8 cm, and a height of 5 cm. Cut out each net diagram, trace the outline onto poster board and fold and tape it into the appropriate three-dimensional figure. Find the surface area of each model, showing the work clearly on paper.

Assignment #4

1.Explain, writing in paragraph form, how to find the surface area of a shoe box and of a can of soup.

2. Draw a sketch of a rectangular solid. Label the lengths of the edges. Find the surface area of the form, showing your work clearly.

3. Draw a sketch of a cylinder. Label the height and the radius of the circular base. Find the surface area of the form, showing your work clearly.

DAY 4

Materials: poster board, scissors, meter sticks, string, tape, spherical balloons

Assignment #4 is collected and assessment made using the following rubric:

0 points - no work done
2 points - question number 1 is complete and accurate in both parts
4 points - questions 1 and 2 are complete and accurate
6 points - each of the three questions is complete and accurate

Group Activity: Each group is to create a model of a person from the neck down using only 2 types of form: (1) models of rectangular solids and (2) models of cylinders. The "head" will be modeled by a balloon. The group members are to make the out of poster board and tape. Desks may be moved aside so that the creations can be placed on the floor.

Assignment #5

Answer in complete sentences and explain your answer to the following question fully.

Who would have a greater body surface area, a tall thin man or a short fat man?

Bonus: Research any or all of the following items:
- What is the definition of a sphere?
- Draw a sketch of a sphere?
- Give three examples of objects that are spheres.
- What formula is used to calculate the surface area of a sphere?

DAY 5

Group Activity: Each group, upon completing the model begun on the previous day, finds the body surface area of their creation, from the neck down. Work should be clearly shown on paper. Each group will be presenting their methods and results to the class.

Final Assessment: Each student, with the group's portfolio available and all collected papers graded and returned, responds to the following questions, writing in paragraph form.

What have you learned in this unit? Pick at least three things.

(1) Describe in detail a mathematical concept you have learned. Give a specific example and explanation.

(2) Tell about something that you have learned about yourself as a student. Explain clearly with examples.

(3) Include something that you have learned about working with others in a group. Explain clearly with examples.

Bonus: What is your body surface area approximation? Show with diagrams and labeling the measurements you would use for the approximations of your body using the forms we have used in this unit. You may have a week to complete this and turn the bonus in.

Rubric for final assessment:

0 points - nothing turned in
1 point - responses to questions fail to demonstrate an understanding of the question, answers provided are inappropriate
2 points - responses to questions demonstrate some understanding of the questions, and answers are somewhat appropriate
3 points - responses to questions demonstrate a good understanding of the questions, and answers are well developed
4 points - responses to questions demonstrate an superior understanding of the questions, and answers are exceedingly well thought out

INTEGRATION

This unit connects with other mathematics, with other disciplines, and with work of the real world. Determining surface area, set in the context of body surface area, is connected to solving problems by using ratios and proportions. For example, the following problems could be addressed as an extension/connection of the work completed.

Example 1 – If a drug is to be administered at 250 mg per meter squared of body surface area, how much of the drug should be prescribed for a patient whose body surface area is 0.57 m^2 ?

Example 2 – Convert 35 pounds to kilograms.

Connections could easily be made to the use of unit multipliers to solve problems such as the following two examples

Example 1 – How many kilograms is 12 lbs 10 oz?

Example 2 – A nurse is to give a drug at the rate of 3 mg per kilogram to a child weighing 82 lb. The bottle of elixir contains 880mg/100mL of the drug. How many milliliters of the elixir should he give?

This unit would also provide an opportunity to connect to the use of charts, tables, and graphs to see relationships among quantities. A student might be given the height, weight, and body surface area of twenty people. Organizing the data and looking for trends would be a rich activity.

The body surface area unit has some interesting connections to science. In addition to those topics that we might classify both as science and mathematics, like taking measurements and conversions of units, the connections abound with science regarding such things as the chemistry of drugs and the biology of disease.

Connections could be made to social studies setting via the history of the apothecary, the medicine men of Indian lore, or the many uses and abuses of prescription drugs. When our problem solving is set in an authentic context it is easy to imagine the numerous related topics in many different subject disciplines .