

Lesson 2

Learning ratios and proportions through scale drawings.

Required resources:

- 1/4" and 1/2" graph paper
- rulers
- yardsticks
- scissors
- a variety of blueprints, designs and maps

Objectives

Student will be able to:

1. develop a conceptual understand of a ratio as a comparison between two numbers
2. understand that a proportion is an equivalent relation between two ratios
3. understand that scale drawings are ratios
4. measure the dimensions of a room
5. measure various objects in the room
6. make a scale drawing of the classroom
7. place scale model furniture in a room

Procedures

- Introduction (10 minutes): The word 'scale' will be written on the chalkboard and discussed for meaning. Students will come up with as many ideas as possible (weight, temperature, and maps) and the teacher will write them on the board. A map will be examined with its scale identified as ratios.

Introductory questions:

How does the ratio affect the size of the map?

What would happen if the ratio were different?

Other maps with different scales will be examined.

- Reading Blueprints (20 minutes) Students will work in groups. Each group will be given an identical copy of a blueprint and a ruler and be asked the following questions:
 1. What is the scale factor of the blueprint?
 2. What will the dimensions of each room be, if the house is built as designed?
 3. What is the overall length and width of the house?
 4. What would the overall dimensions be, if the scale factor was $\frac{3}{16}$? (*note: rather than $\frac{1}{16}$*)
 5. Can you predict what the dimensions of the other rooms would be, given a $\frac{3}{16}$ scale factor?
 6. Develop a general formula for converting blueprint measurements(c) to actual dimensions (d) for any scale factor (a/b)

- Full class discussion (15 minutes) will be held, comparing the resulting measurements from each group. Each group's formula shall be written on the chalkboard and explained. The teacher will ask students to try each algorithm for the following situations: (scale factor = $\frac{2}{9}$; blueprint measurement of 6), to see if they all agree. The class shall choose the 'best' one. If no group has developed an algorithm similar to the "Cross Product Property of Proportions", it shall be developed on the chalkboard, using measurements from the blueprint. (i.e. If $\frac{a}{b} = \frac{c}{d}$, then $ad=bc$)

- Measuring the Classroom (10 minutes) Students will work in pairs. Each pair will use a yardstick and record the measurements for the length and width of the room, table, teacher's desk, chairs and cabinets. Measurements will be compared for accuracy/consistency.
- Floor Plans (30 minutes): The teacher will hand out individual copies and project the *Sample Furniture* overhead to the entire class, and challenge the students to discover the appropriate scale factor which would be required to use the paper furniture as representations of the existing furniture in the classroom. Every student will then draw a floor plan of the classroom on whichever graph paper they choose, which corresponds to the scale factor which was previously determined. When the floor plan is complete, students will be asked to represent the current furniture arrangement of the classroom using the paper models.
- For the final 5-10 minutes (if time is available), students will work in their pairs to “re-design” the classroom for a different furniture arrangement. Pairs can be selected to present their ‘designs’ to the rest of the class and point out the advantages or disadvantages of such an arrangement.
- Homework: Each student will be asked to re-design the existing classroom as a veterinarian's office given the following equipment/furniture list and measurements:

Examination Table	30” x 66”
Counter	2’ x 8’
Scale	1’ x 1’
Chair	18” x 18”
Cage	24” x 32”
Waste basket	12” x 18”
Medical Waste Container	15” x 24”
Cabinet	24” x 36”
Desk	27” x 48”

Mathematical Value of the lesson

This lesson involves many important computational skills, such as multiplication and division of fractions. It also requires students to use variables and solve for a missing variable. More importantly, this lesson introduces students to both enactive and iconic representations of ratio and proportion. The entire lesson is developed on the basis of problem solving: the students are presented with inquiries and objectives (determining a scale factor, taking/recording measurements, developing a formula, etc.). They are not given prescribed directions, and the goal is that the students develop their own phenomenological basis for the cross product and reciprocal properties of proportions. Finally, the lesson requires and develops students' skills in visualization and spatial awareness.

Connection of this lesson with other subject areas

This lesson continues with the unifying theme of the unit - i.e. using graphic designs, in the form of maps and blueprints, to explore ratios and proportions. As a result, students will have the opportunity to explore career choices (and the math skills they require) in engineering, architecture, cartography, construction and interior design.

The lesson also continues the connection with the visual arts established in the first lesson, as students are expected to create graphic representations and manipulate models by hand. Towards the end of the lesson, students are asked to utilize their own creativity, as they are asked to develop their own ideas for a better classroom design. This aesthetic element of graphic design is further continued in the homework assignment.

Finally, the lesson can also be connected to social studies (i.e. currency exchanges), Music (Harmonic Means) and Science (optics; converting measurements and forces).

Connection of the lesson with other lessons in the unit

This lesson is designed to follow directly from the student's introduction to Graphic Design in the first lesson. In that lesson, students were able to examine numerous 'designs' representing the work of architects, graphic artists, interior designers, fashion designers, etc. The 'introduction' provides a connective element from the first lesson (the maps), and is designed to provide a transition to the concept of size, scale and proportionality. The first lesson also established a hands-on connection to the art and drawing skills/concepts which are central to the unit. On day one, students were introduced to the concept of rendering a 3-dimensional subject on a 2-dimensional surface. They were also given the opportunity to "draw" a larger version of an existing rendering by using the proportional grid method.

In the third lesson, students will continue to further explore the properties of proportions established in this lesson. First, students will share with the class their veterinarian office designs on an opaque projector. The teacher will then introduce the mathematical terminology and move to a purely symbolic exploration of the examples. The measurements from the homework exercise will be used to demonstrate the Cross Product Property of Proportions on the symbolic level. Students will explore other properties (Reciprocal Property and Interchange Means) through symbolic representation, as well. These fundamental math skills will provide students with the ability to make discoveries about Fibonacci numbers and the golden ratio in Lesson 4 and Proving Similar Triangles in Lesson 5.

This lesson also provides a very important foundation for the student's conceptual exploration of similarity in Lesson 5. Students will be exposed to various computer software programs (both desktop publishing and Geometer's Sketchpad, which allow for manipulation of geometric figures. Students will have the opportunity to create similar shapes, take measurements of corresponding parts and set up ratios to describe the relationship of the corresponding parts. The ratios will be computed through the use of a spreadsheet program (like Excel) and the students will examine patterns to develop their own theory and definition of similarity.

The manipulation of geometric shapes (in the form of paper furniture) also connects with the manipulations later created with the aid of computers; and sets the stage for the students' final projects. The projects are to be original creations for the design of a product, building or other artistic endeavor.

The students' creativity is nurtured and developed throughout the unit by carefully chosen activities which develop from the purely representational renderings of the first lesson through the vets office assignment, and into work with a stronger creative element.

Finally, the unit continually focuses on the real-world applications of ratios and proportions to numerous careers. Architecture shall remain the primary focus, and students will examine the use of proportions in that career from the design process through cost estimation and even in the construction phase. The mathematical concepts (and computational skills with fractions) shall be continuously supported throughout. In addition to the field of architecture, students will gain practical exposure to possible careers in Art (both Graphic and Fine), Photography, Theatrical Set Design, Costume Design, Interior Design, Landscape Design, Fashion Design, and Printing.