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AUTHOR Caldwell, Frank W., Jr.
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ABSTRACT

Although high schools typically concentrate on preparing students to enter baccalaureate degree programs, it is estimated that by the year 2000 more than 70% of the jobs in America will not require a four-year college degree. The Tech Prep program is designed to provide technically oriented backgrounds to the middle fifty percent of high school students who may not pursue a four-year college degree but choose a two-year trade, technical, or community college program. The mathematics component of Tech Prep, Applied Mathematics (AM), was created by a consortium of 42 states and the Center for Occupational Research and Development. AM consists of 25 competency-based units covering basic math skills, geometry, algebra, quality control, and trigonometry. The learning materials for each unit include a 10-15 minute video program, a student text, a teacher text, mathematics laboratory activities, practical problem-solving exercises, and glossary. In the AM classroom, the teacher is a facilitator, the students actively participate, work in groups, and are allowed to use calculators. Tech Prep students who have completed AM courses will enter two-year colleges much better prepared than general mathematics students and will be used to this teaching approach. Two-year college mathematics faculty, therefore, will need to adapt to the new techniques and methods of teaching. Eight sample laboratory activities are appended. (KP)

Laboratory Activities in Tech Prep.

Frank W. Caldwell Jr.

Paper presented at the Annual Conference of the American Mathematical Association of Two Year Colleges (19th, Boston, MA, November 18-21, 1993)

LABORATORY ACTIVITIES IN TECH PREP

The fastest growing occupations in the 1990s include such occupations as nursing, computer science, law enforcement, engineering technician, banking and insurance, and office machine repair. Most require some form of postsecondary education and training, but few require baccalaureate degrees for entry. The Commission on the Skills of the American Workforce estimates that more than 70% of the jobs in America will not require a four-year college degree by the year 2000. In spite of this, typical high schools continue to concentrate on preparing students to enter baccalaureate degree programs.

The Tech Prep program is a course of study designed to meet the needs of the middle fifty percent of high school students who may not pursue a four-year college degree but a two-year trade, technical, or community college program. The program is designed to meet the need for high school graduates to have more technically oriented backgrounds. Through a blending of academic and vocational courses, Tech Prep prepares students for advanced courses required by two-year technical and community colleges.

The foundation of the Tech Prep program is a series of courses in applied mathematics, applied science, and applied communications. Applied Mathematics, the mathematics component of the Tech Prep program, was created by a consortium of 42 states and the Center for Occupational

Research and Development (CORD). Twenty-five competencey-based units were developed to be infused into existing courses or to be taught as a stand-alone course. These twenty-five units include three preparatory units reviewing fractions, decimals, and percents with the help of calculators; five units on basic math skills such as problem-solving techniques, estimating answers, measuring, and dealing with data; three units on basic geometry; 10 units on basic algebra skills; two units on quality control; and two units on trigonometry. It was originally intended that all 25 units be covered in one year. Field tests indicated that only 18 units could be covered in one year. Eleven additional units were developed to build more content in the areas of algebra, geometry, computer applications, and statistics. The 36 units provide material for a two-year sequence. Students who complete the two-year sequence should be prepared to enter intermediate algebra.

The learning materials for each unit of Applied Mathematics consist of a 10 to 15 minute video program, a student text, a teacher text, mathematics laboratory activities, practical problem-solving exercises, and a glossary. The video introduces the unit and exhibits people in the workforce using the mathematics concepts and skills to be learned and studied in the unit. The mathematics concepts are explained in the text reading material which includes student activities to encourage active student participation. Each unit contains at least three hands-on mathematics laboratory activities. Each unit contains 30 to 40 problems from the areas of agriculture and agribusiness, business and marketing, health occupations, home economics, and industrial technology. Teachers may choose to involve students in one or more of the laboratory activities and may choose to assign any number of the problems provided in the unit.

During the 1991-92 school year, the author worked with three different Applied Mathematics classes at Fort Mill High School in Fort Mill, South Carolina. Two to three days per week he observed the classes and assisted the teacher and students whenever possible. This was a real learning experience for the teacher, the students, and for the author because the classroom activities were very different from the traditional lecture-discussion method of teaching and learning mathematics.

In the Applied Mathematics classroom, the teacher is a facilitator rather than a lecturer. The students are actively participating in all of the learning activities in the units. The students use calculators from the first day of class. Cooperative learning is heavily stressed as the students work in groups in the mathematics laboratory activities and in the problem-solving sessions.

Are there ramifications of the Tech Prep program for two-year college mathematics programs? The author thinks there are several ramifications. Students who have completed the Applied Mathematics courses should enter technical and community colleges much better prepared mathematically than students who have taken only general mathematics in high school. They should be familiar with scientific calculator operations. They should have had some experience with the use of rulers, protractors, scales, calipers, and other types of measuring instruments. They should be able to construct and interpret statistical graphs. They should have a knowledge of how specific mathematics concepts and skills are used in business and industry.

Will two-year college mathematics instructors need to change their approaches to teaching mathematics? Are students who are accustomed to an active hands-on approach to learning mathematics going to sit quietly and pay attention to a mathematics instructor if he/she lectures for an entire class period? Two-year college mathematics instructors are going to have to deal with these issues. If they are not already doing so, they will probably need to incorporate some active hands-on learning activities and cooperative learning activities into their mathematics classes. The Tech Prep program is an impressive program that presents challenges to two-year college mathematics departments to adapt to new techniques and methods of teaching mathematics.

The author has adapted several Applied Mathematics laboratory activities to the mathematics classes he teaches at a two-year technical college. Most of the two-year technical college students that the author has taught have not completed the Applied Mathematics courses in high school and have not been familiar with mathematics laboratory activities. Many of these students have not been able to measure a line segment to the nearest sixteenth of an inch or to the nearest tenth of a centimeter correctly, have not been able to measure an angle with a protractor correctly, and have not been able to use a scientific calculator; many have never seen a vernier caliper or a micrometer caliper. The author is hopeful that hands-on mathematics laboratory activities will impart to students mathematical and technical skills that they can use outside the mathematics classroom. Some of mathematics laboratory activities that the author has used with his mathematics classes are appended to this report.

Period of a Pendulum

The period of a pendulum is the time it takes for a complete back-and-forth swing. Obtain from your instructor a meterstick and a small weight attached to a string. Adjust the length of the string to make a pendulum of each length in the table below. For each pendulum length, use a watch with a second hand to measure the time it takes for 10 complete swings. Divide this time by 10 to get the time for one complete swing. Enter this time in the table.

Length	Period	Length	Period
10 cm		60 cm	
20 cm		70 cm	
30 cm		80 cm	
40 cm		90 cm	
50 cm		100 cm	

Using a sheet of coordinate graph paper, construct a horizontal axis for the length of the pendulum and a vertical axis for the period. Plot the points for the lengths and periods, and join these points with a smooth curve.

From your graph, estimate the length of a pendulum with a period of one second. Vary the length of your pendulum until you achieve a period of approximately one second. Compare the length of your pendulum with the estimate from your graph.

The period T of a pendulum with a length L is given by the formula

$$T = 2\pi\sqrt{(L/g)},$$

where g is a constant equal to 980 cm/sec^2. Using this formula, calculate the period for a pendulum of length 75 centimeters. From your graph estimate the period of a pendulum of length 75 centimeters. How does the estimated value from the graph compare to the value calculated using the formula?

Ratio and Proportion

In this activity, you will use proportions to make a scale drawing of the classroom floor.

Measure the length and width of the classroom to the nearest inch and write these measurements below.

Measure the length and width of the instructor's desk and the distance from one corner of the desk to each of the two nearest walls to the nearest inch. Write these measurements below.

Make appropriate measurements to the nearest inch to locate the position of the door in the wall, and write these measurements below.

Draw a floor plan of the classroom, showing the position of the instructor's desk and the position of the door. To draw the floor plan, use the measurements you made and a scale of 1/4 inch to 1 foot.

Maximizing the Area of a Garden

Suppose you have 80 meters of fence which you are going to use to enclose a rectangular garden. Will the area of the garden vary as the width of the garden varies?

Complete the table below by calculating the lengths and areas of rectangular gardens using the widths given in the table.

Width of garden	Length of garden	Area of garden
5 m		
10 m		
15 m		
20 m		
25 m		
30 m		
35 m		
40 m		

Using a sheet of coordinate graph paper, construct a horizontal axis for the width of the garden and a vertical axis for the area of the garden. Plot the points for the widths and areas and, join these points with a smooth curve. Using your graph, estimate the maximum area and the dimensions of the garden with the maximum area.

Let w represent the width of the garden. Write an equation for the area A of the garden in terms of w.

Using your graph, estimate the dimensions for a rectanglar garden with an area of 250 square meters.

Using your equation for the area of the garden, determine the dimensions of a garden with an area of 250 square meters.

How do the dimensions estimated from your graph compare with the dimensions determined using your equation?

Measuring Line Segments

In this activity, we are going to measure line segments to the nearest sixteenth of an inch and to the nearest tenth of a centimeter.

We can use the fact that 1 inch = 2.54 centimeters to convert from inches to centimeters and vice versa.

Example 1. Convert 7 inches to centimeters.

$$\frac{7\ \text{in}}{1} \times \frac{2.54\ \text{cm}}{1\ \text{in}} = 17.78\ \text{cm}$$

Example 2. Convert 12 centimeters to inches.

$$\frac{12\ \text{cm}}{1} \times \frac{1\ \text{in}}{2.54\ \text{cm}} = 4.72\ \text{in}$$

Example 3. Convert 5 yards to meters.

$$\frac{5\ \text{yd}}{1} \times \frac{3\ \text{ft}}{1\ \text{yd}} \times \frac{12\ \text{in}}{1\ \text{ft}} \times \frac{2.54\ \text{cm}}{1\ \text{in}} \times \frac{1\ \text{m}}{100\ \text{cm}} = 4.572\ \text{m}$$

Measure the length of each of the following segments to the nearest sixteenth of an inch. Convert each measurement in inches to the nearest tenth of a centimeter. Then measure the length of each segment to the nearest tenth of a centimeter. Write all measurements on this paper, including the appropriate units.

Similar Triangles

Construct △ABC as follows. Draw segment AB 3 inches long. Construct ∠A so that m∠A = 50° and ∠B so that m∠B = 45°. What is m∠C?

Measure segment AC and segment BC to the nearest sixteenth of an inch.

AC =   BC =

Construct △DEF as follows. Draw segment DE 5 inches long. Construct ∠D so that m∠D = 50° and ∠E so that m∠E = 45°. What is m∠F?

Measure segment DF and segment EF to the nearest sixteenth of an inch.

DF =   EF =

Find the ratio of AB to DE, and express this ratio as a decimal rounded to the nearest tenth.

Find the ratio of AC to DF, and express this ratio as a decimal rounded to the nearest tenth.

Find the ratio of BC to EF, and express this ratio as a decimal to rounded to the nearest tenth.

△ABC and △DEF are similar triangles. Segments AB and DE are corresponding sides of the two triangles. Similarly segments AC and DF are corresponding sides, and segments BC and EF are corresponding sides. What is true about the corresponding sides of two similar triangles?

Calculating Volumes of Solids

For each of the solid figures listed, use a vernier caliper to make the measurements necessary to calculate the volume. Write the measurements on this paper and indicate the type of measurement made such as width, length, height, diameter, etc. Calculate the volume and write the volume on this paper. Use appropriate units.

1. Rectangular solid

2. Cylinder

3. Cone

4. Sphere

5. Pyramid

6. Triangular prism

Standard Deviation

Obtain a sample of eight "identical" marbles and a sample of eight "identical" 1-inch machine bolts from your instructor. Use a micrometer caliper to measure the diameter of each marble, and enter each measurement in the table below. Calculate the mean of the eight measurements. Complete the table and calculate the standard deviation of the eight measurements.

Measure the diameter of each machine bolt, and enter each measurement in the table below. Calculate the mean of the eight measurements. Complete the table and calculate the standard deviation of the eight measurements.

Marbles

Diameter x	$x - \bar{x}$	$(x - \bar{x})^2$

$\bar{x}$ =

s =

Machine Bolts

Diameter x	$x - \bar{x}$	$(x - \bar{x})^2$

$\bar{x}$ =

s =

Which sample has the greatest standard deviation?

Why should the sample of machine bolts have a smaller standard deviation than the sample of marbles?

Reaction Times

In this activity, we are going to measure reaction times. One member of a group will hold a meterstick at the 100-cm end. Another member of the group should place his/her hand at the bottom of the meterstick with thumb and forefinger each about two centimeters to the side of the 0-cm mark and look only at the bottom of the meterstick. When the person holding the meterstick drops it, the other person catches it as quickly as possible by pressing his/her thumb and forefinger together.

The length of the meterstick from the 0-cm end to the catch position is proportional to the elapsed time from the moment of drop to the moment of catch. For each drop, read the millimeter mark that is just visible above the thumb. Use this reading as an indication of reaction time. A lower reading indicates a faster reaction time.

Have each member of the group catch the meterstick three times. Record the meterstick readings for each catch.

When all groups have completed their measurements of reaction times, write the meterstick readings for the entire class on the chalkboard.

Determine the mode and median of reaction times for the entire class. Using a calculator with statistics keys, calculate the mean and standard deviation of reaction times for the entire class.

Calculate the mean and standard deviation of reaction times for your group. How do the mean and standard deviation for your group compare with those for the entire class?

Divide the reaction times for the entire class into convenient classes, and make a histogram of the reaction times for the entire class.