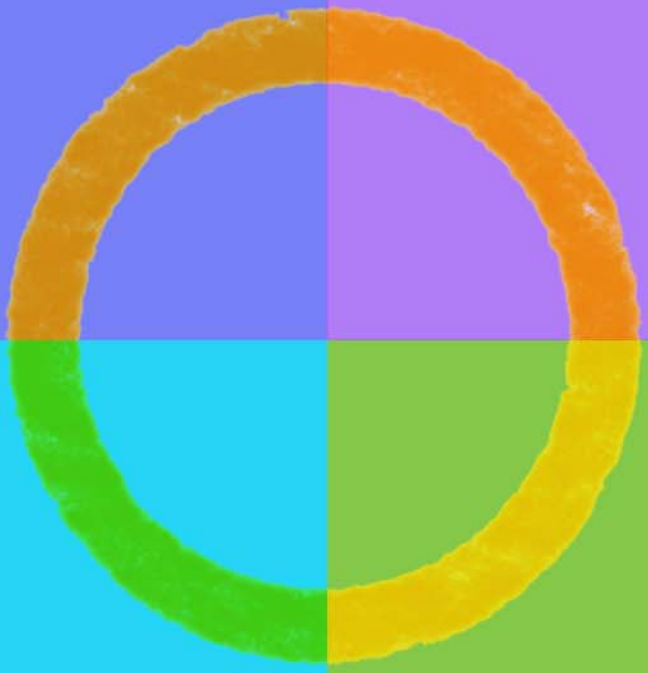
Going Beyond the Basics

Math Lesson Plans



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Going Beyond the Basics Lesson Plans

"We should be educating all students according to a common academic expectation; one that prepares them for both postsecondary education and the workforce." (ACT, 2006) [1]

Lesson Plans for the Going Beyond the Basics Classroom

Both research and data from national databases such as O*NET and Career InfoNet support the need for adults to have higher-level skills in writing, reading, and mathematics, as well as decision-making, problem-solving, and critical thinking skills, if they are to be successful in today's workplace.

The benefit of **Going Beyond the Basics** is to not only provide students with the skills needed to obtain a GED diploma, but also to assist them in attaining the academic and problem-solving skills viewed as necessary by employers. Through the use of authentic materials and problem-focused learning, GED programs can better prepare students for the real world. The integration of workplace academic skills is necessary for all students, not just those who wish to enter the workplace immediately following the obtaining of the GED diploma. By possessing higher-order skills in workplace writing, contextual mathematics, and reading workplace materials, as well as critical thinking and problem solving, students can not only improve those skills necessary for the workforce, but also for postsecondary education.

The **Going Beyond the Basics** curricula structure should be used with all students – whether their goal is to continue in the classroom or in the workplace. Creating an inextricable link between GED exit expectations and the intellectual challenges that graduates invariably will face in credit-bearing college courses or in high-performance, high-growth jobs is a lofty, but necessary goal for all educators. The commonly held belief that students going directly into the workforce do not need the same rigorous curricula of those students entering college is no longer supported by the research. Employers require the same types of knowledge and skills for their entry-level workers as is required for college-bound students.

This book includes twenty-four lesson plans. Eight plans have been developed for each of the following academic areas: mathematics, writing, and reading. The **Going Beyond the Basics** lesson plans provide the teacher with a beginning step to implementing the pedagogy that supports the **Going Beyond the Basics** model. Although developed for a specific academic area, the lessons integrate additional skill areas necessary for higher-order problem solving and critical thinking. All of the lessons are easily incorporated into a GED curriculum and provide the type of authentic skills necessary for "going beyond the basics."

[1] ACT. (2006). *Ready for college and ready for work: Same or different?* Retrieved from the World Wide Web on 11/21/06 at: http://www.act.org/path/policy/pdf/ReadinessBrief.pdf.

Mathematics Lesson 1: Just a Part of Everyday Life!

Going Beyond the Basics

Sample Occupations That Require These Skills: Salesperson, Consultant, Repairman, Realtor

Lesson Objective(s)

Students will be able to:

- Identify information needed to solve a word problem
- Identify the appropriate operation(s) and compute workplace problems
- Apply number operations and number sense to workplace problems

Concepts/Skills Covered in This Lesson

- Number operations and number sense
- Problem-solving skills
- Decision-making skills

Materials Required for This Lesson

- Handout A: Don't Forget My Mileage Check!
- Handout B: What Job Should Sandra Choose?
- Handout C: Graphic Organizer for Mathematical Problem Solving
- Handout D: Pros and Cons Graphic Organizer
- Internet access to a mileage program, such as MapQuest
- Road maps of Florida
- Chart paper, markers

Instructional Activities

Computation, problem-solving, and critical thinking skills are necessary in solving everyday problems. Have students share with the class how they solve problems. Write down the strategies that they use on the board or chart paper.

Working in pairs, have each team read ***Handout A: Don't Forget My Mileage Check!*** and determine what the problem is asking for, what information is needed to solve the problem, and how the problem can best be set up. Have students use ***Handout C: Graphic Organizer*** to identify the information needed to solve the problem. Students should place the appropriate information in the provided tables, compute their answers with their partners, and then compare their answers with other teams. Discuss reasons for different answers if the teams do not agree with one another. One reason for different answers could be the use of different mileages based on what was used to obtain the number of miles from one place to another. MapQuest could differ slightly from the mileage obtained from a road map.

Have teams again work to solve a common problem that faces most people – what job should I take? Working in pairs, each team should read ***Handout B: What Job Should Sandra Choose?*** Have students complete ***Handout C: Graphic Organizer***. Students may wish to summarize their ideas (personal opinions, as well as fiscal information) on ***Handout D: Pros and Cons*** before sharing their decision with the class.

As students work on their decision, make sure that they consider how much extra time Sandra will need in order to travel to and from work each day. Students will also need to consider how much time to allow for childcare and still be able to get to work on time. Have students compare Job A (local job) to Job B (job in the city). Have students identify the different mathematical skills necessary to compare the two job offers. Have students discuss which job offer is better fiscally for Sandra at this point in her life and why.

Evaluation Provide students with workplace problems where number operations and number sense are used. Examples can be used from the Micron Mathematics in the Workplace website at: http://www.micron.com/k12/math/numop/index. **Extension** Pair students in the class. Have them brainstorm situations where they need to use decimals and basic computation to solve everyday problems. Have each pair write a word problem for another pair of students. Exchange problems, solve, and discuss results.	**References** **MapQuest** http://www.micron.com/k12/math/mapquest.com **Math Toolkit. Texas Center for Adult Literacy and Learning (TCALL)** http://www-tcall.tamu.edu/toolkit/eh07.html **Micron Math in the Workplace** http://www.micron.com/k12/math/

Handout A: Don't Forget My Mileage Check!

Christopher has been hired as a sales representative for a national book company. His office is based in Dallas, TX, but his job requires a lot of travel each month. In order to be reimbursed for his mileage, he must submit an expense report. He is reimbursed $0.485 cents for each mile he drives to work. Use a map or a program on the Internet, such as MapQuest, to calculate the number of miles driven. Use Dallas as Christopher's base and each drive as a round-trip.

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	1 Tyler	2	3	4 Fort Worth	5	6
7	8 Waco	9 Lebanon	10	11 Fort Worth	12	13
14	15	16 Paris	17	18 Abilene	19	20
21	22 Plano	23	24	25 Austin	26	27
28	29 Waco	30	31			

Complete the following mileage form for Christopher.

Date	**Destination**	**Number of Miles Round Trip**	**Cost Per Mile**	**Total**
			TOTAL MILEAGE COST	

Texas Mileage Chart

All mileage originates from Dallas, TX

Abilene	181
Austin	197
Fort Worth	34
Gainesville	70
Lebanon	25
Paris	105
Plano	19
Waco	97
Wichita Falls	138

Handout B: What Job Should Sandra Choose?

Sandra is a single mother of two pre-school aged children. After completing many job applications and going on many interviews, she has just received two exciting job offers! The first is with a local organization that offered her a starting salary of $10.50 per hour, plus benefits for a 40-hour work week. The second job offer is with a large, international organization in a neighboring city. This organization offered her $11.75 per hour, also with benefits.

Sandra needs to consider her options. Her childcare provider lives in her neighborhood and charges $5.00 per hour. Sandra does not have a car so she will need to rely on public transportation to get to work. Bus fare to the first job would cost her $1.00 each way and take her approximately 15 minutes to get to work. To go to the city, Sandra would need to take a bus and the Metro, which she estimates would be at least an hour each way and would cost her $5.75 round trip each day.

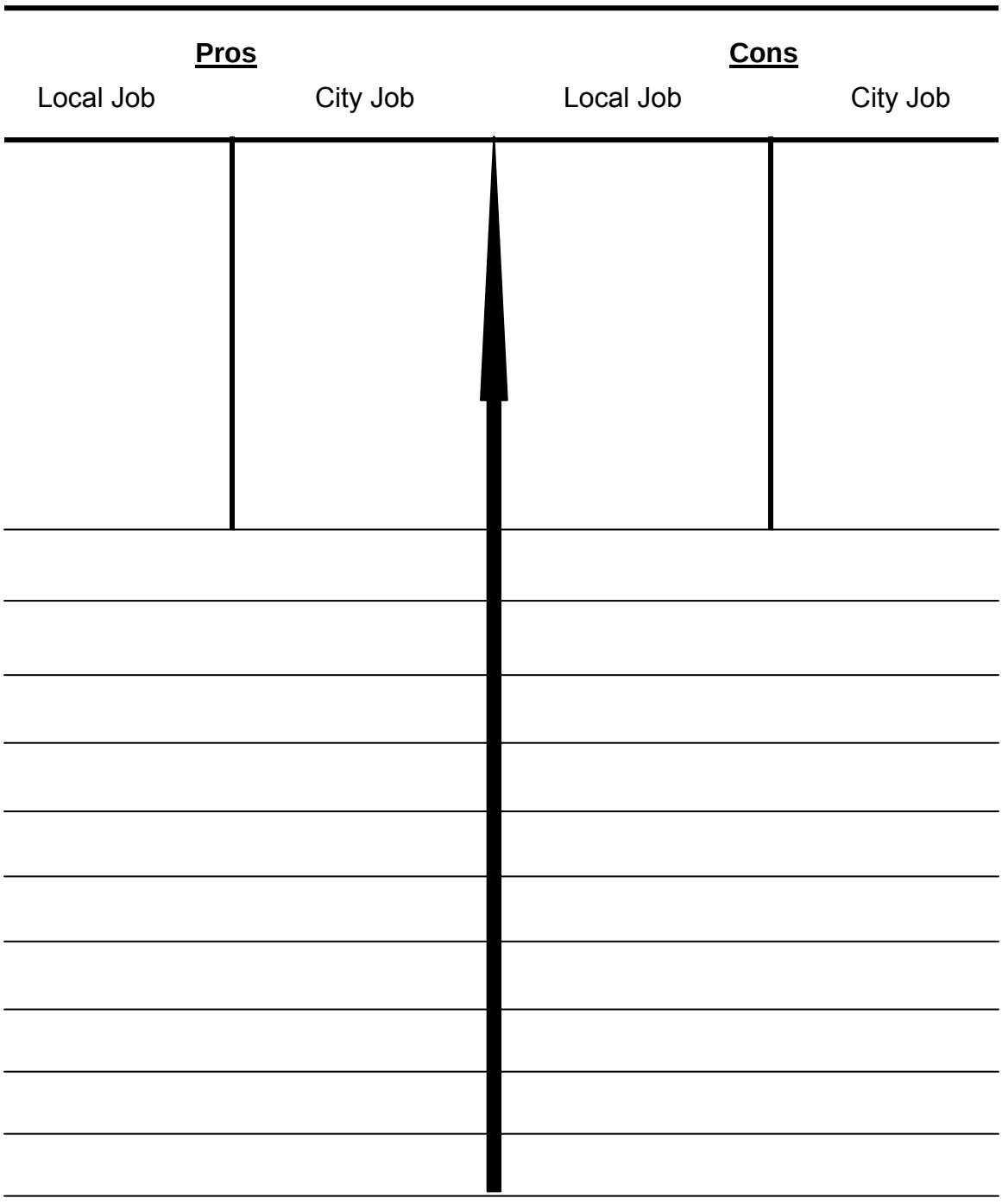
Compare what Sandra's net weekly salary would be after she deducts her weekly expenses for child care and transportation. Which job should Sandra choose? Why?

Handout C: Graphic Organizer for Mathematical Problem Solving

Main Idea (in your own words)	
Question	Draw a Picture/Graph/Table
Pertinent Facts	Irrelevant Information
Relationship Sentence (no numbers)	
Equation (number sentence)	
Estimation (without computing)	
Computation	
Answer Sentence	

Handout D: Pros and Cons Scale

The Issue:



Mathematics Lesson 2: Estimation

Going Beyond the Basics

Sample Occupations That Require These Skills: Traffic Patrol Officer, Pediatrician, Farmer, Cosmetologist, Restaurant Manager or Cook, Landscaper, Contractor or Carpenter, Basketball Official

Lesson Objective(s)

Students will be able to:

- Apply different estimation strategies to mathematical problem solving
- Apply estimation skills to check for the reasonableness of a workplace problem
- Use formulas to check estimation skills

Concepts/Skills Covered in This Lesson

- Estimation
- Use of charts to document information
- Application of formulas to workplace problem solving

Materials Required for This Lesson

- Handout A: Tally Sheet
- Handout B: Sawtooth Lumber Sales
- Handout C: Estimation Strategies
- Materials for estimation, such as paper, cards, coins, beans, sugar cubes, paper clips, beads, blocks, etc.

Instructional Activities

Introduce the lesson by showing students two sets of coins. Tell them the value of one set. Have them estimate the value of the other. Chart the students' responses. See who came closest to the actual value of the coins. Next, have the students close their eyes and raise their hands when they think one minute has elapsed. Repeat the activity, but now tell the students when a half-minute has elapsed. Share with students their results. Now have the students place four note cards on their desk or table edge-to-edge. Have them estimate how many note cards it would take to cover their desk. Chart the students' responses.

Have students share with the class how they calculated (estimated) their answer to each of the above scenarios. Chart the different types of estimation skills that they used.

Ask the class to list situations where an exact number or amount is very important.

Possible answers might include:

- Giving or receiving change during a purchase
- Measuring the space in which you need to fit a refrigerator
- Adding the correct amount of an ingredient to a recipe

Then ask for suggested situations where an approximate number or amount is all you need, such as:

- Explaining how long it takes to mow the yard
- Guessing the number of pills in a nearly empty bottle
- Determining the number of miles to your destination

Discuss the need for good estimation skills in the workplace, as well as when completing mathematical problems on the GED Test. Provide students with examples of estimation strategies that they can use. (Examples of estimation strategies are included in ***Handout C: Estimation Strategies***.) Have students practice each of the strategies using whole numbers.

Form groups of two to four students. Give each group three sets of small objects (beans, sugar cubes, beads, blocks, paper clips, etc.) that are identified as Item A, Item B, and Item C. Each group should receive 100 units of Item A, 75 units of Item B and 200 units of Item C. Give each student an individual tally sheet (***Handout A: Tally Sheet***). Have students estimate the number of items in each group. Students may use different estimation strategies, but cannot count individual items. Have students check their estimates. Students should record all data.

Debrief the activity by asking the following questions:

- What are different ways to estimate the data?
- Which estimates were correct?
- Was there a pattern to what types of estimates were correct?

Provide students with a workplace scenario in which they must first estimate the answer using mental math and estimation strategies. Have students write down their answers. Next, have them calculate the exact answer. Discuss how close students' estimates were to the actual cost.

Handout B: Sawtooth Lumber Sales is an example of a workplace scenario that requires students to use estimation, calculation, and problem-solving skills. Provide students with adequate time to solve this problem. Students may wish to work in small groups or independently. When debriefing the activity, provide time for students to discuss the necessity of estimation skills at their personal workplace or in their daily lives.

Evaluation

Have students estimate the answers to sample math problems prior to calculating the exact answer. Discuss any discrepancies between the answers. Provide practice with estimation skills when teaching math lessons.

Extension

Help students to develop estimation skills by giving "flash quizzes." Using an overhead projector, flash a math problem, such as 72367 + 1228, on the screen and have students estimate the answer without any written computations. Grade the quiz together by asking students to determine a reasonable range of estimates for each problem. "Flash quizzes" can include number operations types of problems, as well as estimating geometric properties such as area.

References

Assessment Resource Banks (ARBs) in English, Mathematics, and Science
http://arb.nzcer.org.nz/nzcer3/maths/cei.htm

Estimation, Accuracy, and Error
http://www.kendallhunt.com/uploads/2/TTEstimation.pdf

Teaching Estimation Strategies: Teacher's Guide
http://www.sde.ct.gov/sde/lib/sde/Word_Docs/curriculum/mathgoal/Book_Grades_9-12/Chapter_8_Word_Problem_Estimation_References/Teacher_Guide.doc

Handout A: Tally Sheet

	Item A	Item B	Item C
Description			
Estimation			
Actual Count			

Answer the following questions

- What are different ways to estimate the data?

- Which estimates were correct?

- Was there a pattern to what types of estimates were correct?

Handout B: Sawtooth Lumber Sales

Micron Workplace Math. Retrieved from the World Wide Web at:
http://www.micron.com/k12/math/numop/saleslum.aspx

Occupation: Lumber Broker Salesman who arranges for the transfer (sale) of manufactured lumber from the manufacturer (sawmill) to a user for a fee/commission.

Problem:

A lumberyard in Salt Lake City wants to buy a truckload of lumber to replenish their inventory. They need two different sizes of dimensional lumber in various lengths. The lumber is shipped from Coeur d'Alene, Idaho. Your problem is to give a quote to the lumberyard on the cost of the shipment.

Lumber is sold by a standard unit of measure called a board foot. A board foot is described as a piece of lumber 12 inches wide by 1 inch thick by 1 foot long. Various sizes of lumber are converted to this common unit of measure by use of a factor.

The factor is found by using the formula:

thickness x width / 12 = the board footage in a 1-foot piece

Therefore, a 2 x 4 x 1-foot piece would equal a .6667 board foot (2 x 4 / 12). For 2 x 10, the factor would be 1.6667. (2 x 10 / 12)

Sawtooth Lumber Mill works in quantities of 1,000 board feet. The mill is asking $380.00 per thousand board feet for the 2 x 4 boards and $440.000 per thousand for the 2 x 10 boards. This cost does not include the cost of transportation or the broker's profit. The broker's profit is determined at 4% of the delivered cost.

A standard truck can haul 48,000 lbs. of lumber. The lumber ordered weighs 2,000 lbs per thousand board feet. Thus, the customer is in effect asking for approximately 24,000 board feet.

The customer wants the order divided 50% of 2 x 10 boards and 50% of 2 x 4 boards, or approximately 12,000 board feet of each size.

The truck needs $1.25 per loaded mile to haul the load. It is 650 miles from Coeur d'Alene, Idaho to Salt Lake City.

The customer wants the following lengths:

2 x 4s	200/8'	200/10'	200/12'	400/14'	400/16'
2 x 10s	80/8'	80/10'	160/14'	160/16'	

1. What is the total number of board feet being delivered?
2. What will the total cost be to haul the wood?
3. What is the total cost for the wood?
4. What will the broker's fee be?
5. What price should the broker quote that will also include her profit?
6. Estimate the answer and then calculate the exact answer. Is the answer reasonable based on your estimate?

Handout B: Sawtooth Lumber Sales Solution

1. Shipment composition: obtain a running total of the lineal footage, and then multiply the total by the factor for the board size to get the number of board feet.

2 x 4s:
(200 x 8) + (200 x 10) + (200 x 12) + (400 x 14) + (400 x 16) = 18,000
18,000 feet x .6667 (factor for 2 x4 s) ≈ (is approximately) 12,000 board feet
2 x 10s:
(80 x 8) + (80 x 10) + (160 x 14) + (160 x 16) = 6240
6,240 feet x 1.6667 (factor for 2x10s) = 10,500 board feet

From this, it is determined that what the customer wants will fit on one truck.

2. Figuring the freight:
The truck needs $1.25 per loaded mile to haul the lumber. The total distance for shipping is 650 miles.

650 miles x $1.25/loaded mile = $812.50
$812.50 / 22.5 (thousands of board feet) = $36.11 or ~ $36.00 per thousand board feet.

3. Cost of the wood:
The price is determined by the cost of the material at the source plus the freight plus the broker's profit.

2 X 4: 12,000/1,000 = 12 (Board feet in thousands) 12 X $380.00 = $4560.00

2 X 10: 10500/1,000= 10.5 (Board feet in thousands) 10.5 X $440.00 = $4620.00

Total Cost of Wood = $9180.00

4. Broker's Fee: The broker's fee is 4% of the cost of the wood with freight charges added.

(812.50 + 9180.00) X .04 = (9992.50)(.04)= $399.70

5. Quoting a price:
The price is determined by the cost of the material at the source plus the freight plus the broker's profit.

812.50 + 9180.00 + 399.70 = $10,392.70

Verbal quotes are given over the phone 40 to 50 times a day. Once the price is agreed upon verbally, the deal is considered complete. The ability to estimate accurately is very important. Quote too low and you lose money, quote too high and you're not competitive. The size of the broker profit leaves little room for error.

Handout C: Computational Estimation Strategies

1. Front-End Strategy – This strategy focuses a person's attention on the "front end", or left-most digits of a number. Because these digits are the most significant, they are the most important for forming an estimate.

    a. Add, subtract, or multiply numbers, such as the following:

    4,316
    1,529
    986

    b. Estimate quotients.

    Front-End Process for Division

	5
Place the first digit of the quotient.	7 3,684
Determine the place value of the quotient.	5 - -
Place the first digit of the quotient.	7 3,684
Adjust.	500+

2. Clustering Strategy – The clustering strategy is useful for those problems that are often encountered everyday. This strategy can be used when a group of numbers "clusters" around a common value.

School Attendance

Monday	6,849
Tuesday	7,491
Wednesday	7,318
Thursday	6,749
Friday	7,008

Since all of the numbers are close to each other, use clustering to estimate the total attendance. Estimate and *AVERAGE* the number and then multiply the *AVERAGE* by the number of values.

3. Rounding Strategy – This strategy is powerful and efficient for estimating the product of two multi-digit factors. First, find the numbers. Second, compute with the rounded numbers. Discuss what happens if both numbers are rounded up or down, as opposed to rounding one up and one down. This is called adjusting.

    24 x 78 = about 20 x 80 or 1,600
    24 x 78 = more than 20 x 78 or 1,560
    24 x 78 = more than 20 x 70 or 1,400
    24 x 78 = about 25 x 80 or 2,000

4. Compatible Numbers Strategy – This strategy refers to a set of numbers that can be easily "fit together". Look for pairs of numbers that "fit together" to make numbers that are easy to compute.

    27
    49
    38
    65
    56
    81

    Look for numbers that add up to 100 (e.g. 27 + 81 is approximately 100, 49 + 56 is approximately 100, etc.). The sum is about 300.

5. Special Numbers Strategy – This strategy is similar to the compatible numbers strategy. Be on the lookout for numbers that are near "special" values that are easy to compute mentally. Special values include powers of ten and common fractions and decimals.

Problem	**Think**	**Estimate**
7/8 + 12/13	Each near 1	1 + 1 = 2
23/45 of 720	23/45 near ½	½ of 720 = 360
9.84% of 816	9.84% near 10%	10% of 816 = 81.6
103.96 x 14.8	103.96 near 100 14.8 near 15	100 x 15 = 1500

Adapted from the ***National Council for Teachers of Mathematics***.

Mathematics Lesson 3: Rate/Time/Distance: Where Do We Go From Here?

Going Beyond the Basics

Sample Occupations That Require These Skills: Travel Agent, Air Traffic Controller, Transportation Planner, Law Enforcement Officer, Emergency Responder, Race Car Driver, Pilot

Lesson Objective(s)

Students will be able to:

- Compute rate, time, or distance using an algebraic formula
- Graph an equation and determine a value that fits their data
- Identify inverse relationships
- Apply tools used in the workplace, such as a graphing calculator

Concepts/Skills Covered in This Lesson

- Algebraic formulas
- Graphing
- Equations
- Inverse relationships

Materials Required for This Lesson

- Stopwatches
- Measuring tool in metrics
- Graph paper
- Calculators
- Paper/pencil
- Handout A: Overview of Students' Times and Rates
- Handout B: Where Do We Go From Here?
- Handout C: Graph Paper

Instructional Activities

Students are often asked to describe change in various contexts when studying algebraic concepts. This type of mathematical skill is necessary in order for students to accurately describe changes in varying workplace scenarios.

Introduce the activity by asking students how they determine speed if they do not have a tool such as a speedometer? Ask students if they can figure out their walking speed without this type of tool. How?

Introduce the activity by writing the following formula on the board:

$$d = r \times t$$

Discuss that this formula (rate x time = distance) can provide people with information on how rapidly something is moving without using a tool such as a speedometer. Have students brainstorm how they may use this formula in daily life and in the workplace. If students have to travel as part of their job, they probably use this formula to figure out how long it will take from one worksite to another. The formula is also used by airlines to calculate the time of arrival for flights. Discuss that there are many uses for this type of formula.

Tell students that they will explore the distance = rate x time equation by solving for either rate or time, as well as exploring what happens when distance is a constant in the formula.

Activity

Measure a straight line path 20 meters in length in the hallway, parking lot, gym, or open space. Mark the beginning and end of the path with masking tape. Select four students to assist in obtaining the data. Identify two of the students as the timers and provide each of them with a stopwatch.

Have each student in the class walk the length of the 20-meter straight line path. Students should walk at a constant pace. If a few students would like to speed walk or run, that is fine as long as they keep the same basic pace for the 20 meters. A wide variety of rates will provide more interesting data.

One timer should stand at one end of the 20-meter path and call "Start" as a student begins to walk. Both timers should start their stopwatches at the same time. The other timer should stand at the end of the path and call "Stop" as the student reaches the end of the 20-meter path. Both timers should try to stop their stopwatches at the same time.

Have the third student use a calculator to average the two times. A fourth student should record the walker's name and time (to the nearest hundredth of a second) on the chart. (***Handout A: Overview of Students' Times and Rates***) The teacher should also have each student record his/her personal time. Repeat the activity until all students in the class have traveled the 20-meter path.

Have each student use the formula of r x t = d to solve for their rate in meters per second. If a graphing calculator is available, have a student enter the data for every student into the calculator, making sure to keep the data for each student paired. If a graphing calculator is not available, have students graph the data with rate (m/s) on the x-axis and time (s) on the y-axis. ***Handout C: Chart Paper*** should be provided.

Have students debrief the activity by answering the questions on ***Handout B: Where Do We Go From Here?***

Evaluation

Provide students with sample workplace questions to assess whether they can calculate the answer for each missing variable. Example: r x t = d where the student solves for r (rate) or t (time).

Sample question:
Your speedometer is incorrect, and you need to know your actual speed. If you travel one mile in 45 seconds, how fast are you driving?

Extension

Have students work in small groups. Ask each group member to calculate how long it takes to travel to work or school and the distance that is traveled. Have the group work cooperatively and determine the average speed in miles per hour for each student's morning commute. As a group, discuss variables that may increase or decrease the time required to get to one's location.

References

Distance, Rate, and Time. Drexel University
http://mathforum.org/dr.math/faq/faq.distance.html

Understand Distance, Speed, and Time Relationships. NCTM
http://standards.nctm.org/document/eexamples/chap5/5.2/index.htm

Handout A: Overview of Students' Times and Rates

	Student Name	Distance (m)	Time (s)	Rate (m/s)
1		20		
2		20		
3		20		
4		20		
5		20		
6		20		
7		20		
8		20		
9		20		
10		20		
11		20		
12		20		
13		20		
14		20		
15		20		
16		20		
17		20		
18		20		
19		20		
20		20		
21		20		
22		20		
23		20		
24		20		
25		20		
26		20		
27		20		
28		20		
29		20		
30		20		

Handout B: Where Do We Go From Here?

1. What formula is used when solving for d? For r? For t?

2. Can the value of the independent variable (rate) be zero in this problem situation? Why or why not?

3. Are rate and time inverse relationships? Why or why not?

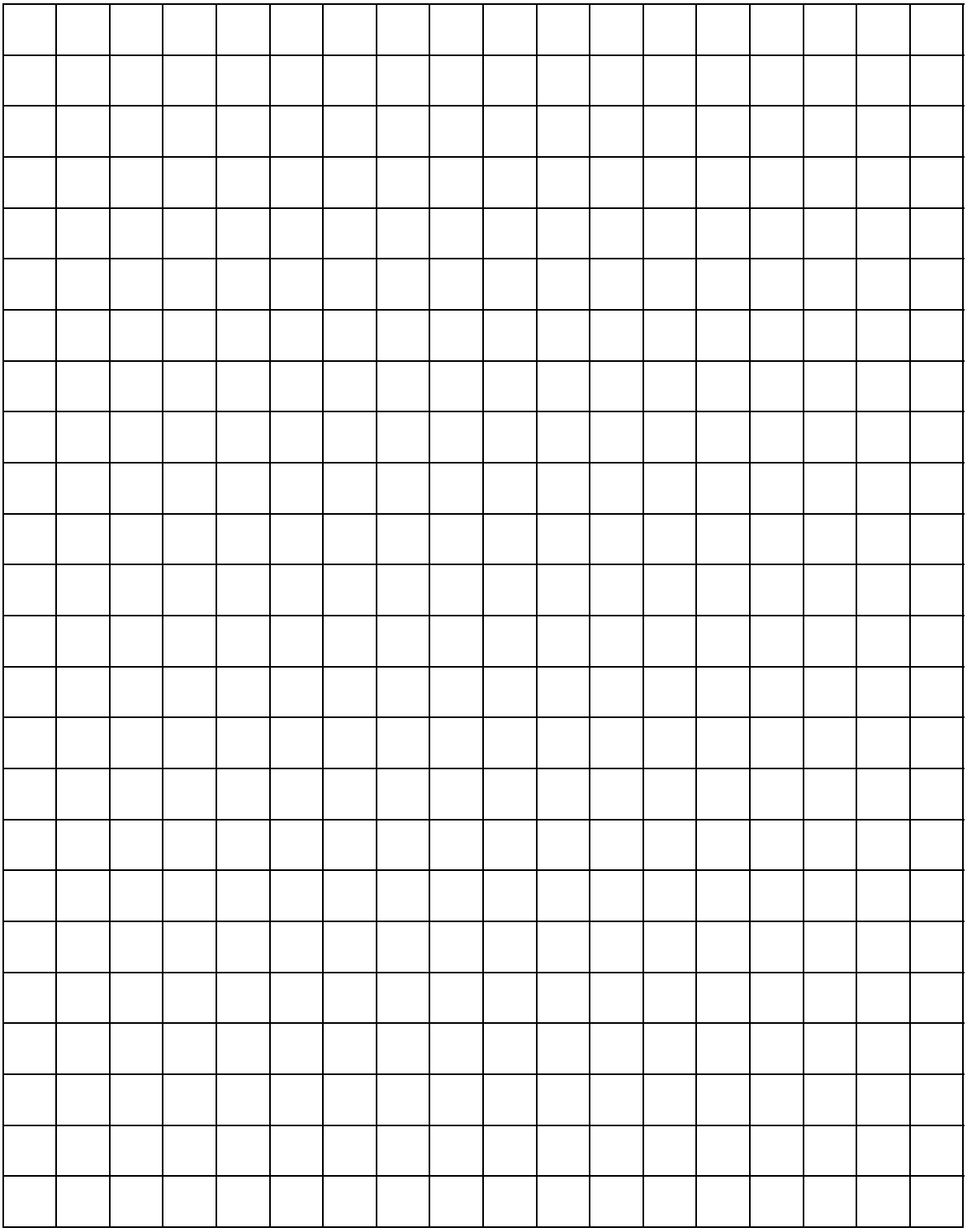
Handout B: Where Do We Go From Here? Answers

1. r x t = d
   r = d/t
   t = d/r

2. If a student's rate is 0 m/x, the student is not moving and cannot walk the 20 meter distance.

3. Yes. When the rate increases, the time it takes to walk 20 meters decreases. When the rate decreases, the time it takes to walk 20 meters increases. This is how

Handout C: Graph Paper



Mathematics Lesson 4: Measurement: It's Important!

Going Beyond the Basics

Sample Occupations That Require These Skills: Seamstress, Physician, Nurse, Carpenter, Construction Worker, Architect, Surveyor, Manufacturer

Lesson Objective(s)

Students will be able to:

- Accurately measure several common objects
- Determine whether a product meets correct specifications
- Use math to solve workplace problems and communicate effectively

Concepts/Skills Covered in This Lesson

- Measurement
- Number operations and number sense
- Problem-solving skills
- Visualization skills

Materials Required for This Lesson

- Handout A: Does It Fit?
- Handout B: Using Measurement in the Workplace
- Pairs of items for students to assess their measurement accuracy, such as a bracket and a bolt, two sizes of boxes, a book and a cover, etc.
- Six-inch shop rulers divided into 1/32 of an inch

Instructional Activities

Begin the lesson by asking students the following questions and recording their answers on the board or chart paper:

- Why is the correct measurement of products important?
- Have you ever purchased a product that was not correctly measured?
- What are some difficulties or consequences resulting from "imperfect" manufactured products?

Give each student a six-inch shop ruler and several objects to be measured, such as two different boxes, bolts and nuts, nails and boards, etc. Discuss that each inch on a six-inch shop ruler is divided into 32 parts or 1/32 of an inch. When measuring products, accuracy is absolutely necessary. This means that measuring with a shop ruler will require that students add and subtract the marks to achieve a set dimension and dependent on the object, reduce fractional terms.

Distribute to students the objects to be measured. Have the students measure each item and write their measurements on a sheet of paper. Using their measurements, have students decide whether or not the items will "fit" by completing ***Handout A: Does It Fit?***. To evaluate their measuring skills, have each student try to "fit" the smaller item into the larger. Did they measure correctly?

Pair students to work on a real-life measurement scenario. Have each team complete ***Handout B: Using Measurement in the Workplace***. Have the teams share their answers with the class and the process they used to solve the problem.

End the lesson with students listing the different ways in which measurement is used in the workplace. Help students to identify both linear measurement, such as length and width, and liquid measurement, such as liters and milliliters. Health care professionals use measurement on a daily basis when prescribing or administering medicines and when taking a person's vital signs, such as heart rate and

blood pressure.

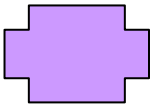
Evaluation

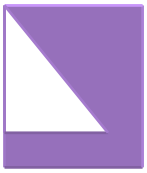
Check that students use measurement tools correctly and obtain accurate results within 1/32 of an inch. Have students use their measurements to figure the perimeter and area of each shape. Teachers may wish to allow students to use calculators and the fraction key function or to change fractional measurements into their decimal counterparts.

Extension

In the workplace, items are often not squares or rectangles. Students need skills in measuring irregular shapes. Have students measure irregular shapes and calculate perimeter and area. Have students decide how best to partition a shape in order to obtain a more accurate measurement.

Examples:





References

Learning and Teaching Measurement (2003)
The National Council of Teachers of Mathematics, Inc. Reston, VA.

Handout A: Does It Fit?

Box 1 is _____ high, _____ long, and _____ wide.

Box 2 is _____ high, _____ long, and _____ wide.

Will Box 1 fit into Box 2? _____

The head of the bolt is _____ in diameter.

The opening in the bracket is _____ in diameter.

Will the bolt fit into the opening? _____

Will the head of the bolt be large enough to keep the bolt from slipping into the opening?

_____

The nail is _____ long.

The board is _____ thick

Will the nail go completely through the board? _____

The book is _____ long and _____ wide.

Will a front cover measuring _____ x _____ fit the book properly?

Handout B: Using Measurement in the Workplace

Danielle is self-employed as an interior decorator. A client is requesting a new set of curtains for her kitchen. Before Danielle quotes a price to her client, she needs to calculate the cost of the fabric that has been selected.

The window dimensions are: 6' wide, 4' long. The finished width of the curtains will be 3 times the window width. The curtains will have two gathered sections with a 3" hem at the bottom and a 1" hem on each side.

The uncut fabric is 54" wide and costs $15.99 per yard. Fabric is sold by the yard with partials in 1/2, 1/4, or 1/3 yard. Danielle will need to add 1/2 inch for seam allowances (where the fabric is sewn together) on sides, top and bottom and an additional 6" for a curtain-rod pocket at the top.

Draw a picture to illustrate the problem.

How much fabric is needed?

What is the cost of the fabric needed?

Why is it important for Danielle to have accurate measurements of the window?

Handout B: Using Measurement in the Workplace Answer

The following is a step-by-step process for solving the problem:

Find the dimensions of the window in inches.
Window width: 6 x 12 = 72"
Window length: 4 x 12 = 48"

Multiply the width times three (curtain width is three times the width of the window) and divide by two for two curtain sections
72" wide x 3 = 216" total width of the curtains
216" ÷2 sections = 108" width of each section

Add the side hems and seam allowances to the width of one section.
108" + 2" (2 side hems) + 1" (2 seam allowances) = 111"
111" represents the cut fabric width

Because the fabric width is 54" long, 3 fabric widths will be required for one section (111 inches). This will add another seam or 2 additional seam allowances. The cut fabric width will now be 111" + 1" = 112".

To make the curtains, 5 fabric widths will be required. (2 widths plus a few inches for each section) Rather than buying 3 widths for each curtain, Danielle can buy 2 for each curtain and share the extra width.

Curtain length = window length + hem + seam allowance + rod pocket
48" + 3" + 1" + 6" = 58" (fabric length per curtain)

For the curtains, 5 lengths of fabric will be needed. Each length will be 58" long.
58" x 5 = 290" ÷36"/yd = 8 yards + 2 inches

Danielle must purchase 8.25 yards, since .25 is the smallest division possible

Cost of fabric: 8.25 yards x $15.99 (cost per yard) = $131.92

Mathematics Lesson 5: Does It Fit? – Pythagorean in the Workplace

Going Beyond the Basics

Sample Occupations That Require These Skills: Carpenter, Construction Worker, Architect, Surveyor

Lesson Objective(s)

Students will be able to:

- Calculate the side of a triangular shaped figure through the use of the Pythagorean Theorem
- Apply the formula to different types of problems
- Identify where the theorem can be successfully used and/or implemented in real-life situations

Concepts/Skills Covered in This Lesson

- Application of Pythagorean Theorem to real-life types of problems
- Personal understanding of why this theorem works and how it can assist in workplace situations
- Calculation of squares and square roots
- Problem-solving and decision-making skills

Materials Required for This Lesson

- Carpenter's triangle, such as the following (sometimes called a carpenter's square)

- Copies of questions/scenarios that require the application of the Pythagorean Theorem
- Graph paper and pens/pencils
- Measurement tools – tape measurers, yardsticks, rulers
- Handout A: Dan Roman Construction

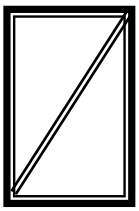
Instructional Activities

Start the lesson by having students discuss how they use math formulas in their daily lives. Explain that there are many different types of formulas that people use to solve real-life problems. Ask the students whether they have ever had to use a formula about a triangle. Students who have made home renovations or who work in carpentry may respond that they have to work with triangles. Have them explain what they do and why it is important to them.

Show students a carpenter's triangle or a picture of a carpenter's triangle if one is not readily available. Share with students that this tool is used by carpenters to ensure that their walls are "square." Discuss what is meant by a square wall. If a carpenter's triangle is available, have students use it to see if the walls in the classroom are square. They may also want to check to see if a leg on a desk or table is square with the floor. Give them time to explore common objects in the room. If the students discover objects that are not square, ask them what they think is wrong with the object?

Next, discuss whether students have ever had to *get an object through a window or doorway when the object was taller than the window or doorway. What was the object? How did the student figure out whether it would fit or not?* (Example: Having to move a mattress or a large cabinet through a doorway that was shorter than the object to be moved.)

Have students make a sketch of a door and a large object being moved through that door. Student sketches should look something like the following, with a rectangle for the door and a line or double line representing the mattress or other object.



Discuss that a right triangle has been formed in the sketch. Have students identify what makes a right triangle unique (a 90º angle) and the parts of the right triangle (hypotenuse and legs).

Explain that right triangles have special properties that make it easy to calculate their dimensions. Provide students with graph paper and have them draw a right triangle in the center of the paper with legs of 3 units and 4 units, respectively.

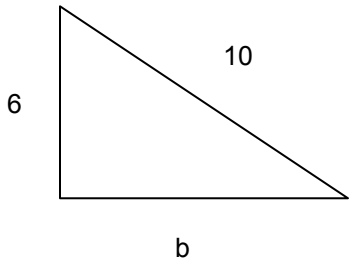
Write the formula $a^2 + b^2 = c^2$ on the board. Have students discuss how this theorem can be used to solve real-world problems. Problems from the websites in the reference list can be used for practice. Have students use the formula to compute the answer for the triangle they used in the first problem. The sides were 3 units by 4 units.

$a^2 + b^2 = c^2$
$3^2 + 4^2 = c^2$
9 + 16 = 25
Square Root of 25 = 5

The length of the hypotenuse is 5, which matches one side of the largest square.

Have students use graph paper to draw a variety of triangles with different dimensions. Have them use the formula to determine the hypotenuse of each triangle. After calculating, have them measure to check for accuracy.

Students should also be able to find one leg of a right triangle if the other leg and hypotenuse are provided. Draw and label the following triangle on the board or overhead and have students determine how to find the value of b.



$a^2 + b^2 = c^2$
$6^2 + b^2 = 10^2$
$36 + b^2 = 100$
$b^2 = 100 - 36$
$b^2 = 64$
$b = 8$

Divide the class into small groups and provide them with ***Handout A: Dan Roman Construction.*** Have the students solve the workplace problem and share their findings with the class.

Have students brainstorm additional examples of how the formula for the Pythagorean Theorem is used in the workplace. (Examples: A builder could use the Pythagorean Theorem to calculate how many shingles are needed for a roof based on its slope. A baseball fan could use the theorem to find out how far a ball would have to be thrown from first to third base. A roofer could figure how tall a ladder would need to be to reach a second story.)

Evaluation

Throughout the lesson, monitor that students are able to construct the figures correctly and verbalize their findings. Students should be able to apply the Pythagorean Theorem to different types of real-world problems. Provide students with GED-type questions or real-life situations that require them to apply the formula.

A sample real-life situation to assess student

References

Pythagoras was a Greek philosopher who made important developments in mathematics, astronomy, and the theory of music. The theorem now known as the Pythagorean Theorem was known to the Babylonians 1,000 years earlier, but Pythagoras may have been the first to prove it. The following are beginning resources and activities for the Pythagorean Theorem.

learning and application of the Pythagorean Theorem is as follows: *You are a new employee with the Pythagorean Construction Company. Your boss has given you a piece of plywood with dimensions that are 1.2 m x 2.4 m. You would like to be able to pass the plywood through a window that is 1 m by ¾ m. You really don't want to tell your new boss that you can't do what he is asking. Can you pass the plywood through the window? Why or why not? Explain your reasoning.* Answer: Yes, it will just fit as long as it is not too thick. The diagonal of the window is 1.25 m. Some students may see that 3:4:5 is a multiple of ¾:1:1.25.	**Math in the Workplace. Micron** http://www.micron.com/k12/math/geometry/carpenter.aspx **Discovering the Pythagorean Theorem: An Activity for Discovering the Pythagorean Theorem. Oswego City School District, Oswego, NY.** http://regentsprep.org/regents/math/fpyth/TAactive.htm **Demonstrate the Pythagorean Theorem. Nova Online** http://www.pbs.org/wgbh/nova/proof/puzzle/theorem.html **How Many Shingles? PBS Teacher Source** http://www.pbs.org/teachersource/mathline/concepts/outdoors/activity1.shtm **The Pythagorean Puzzle. Illinois Institute of Technology** http://www.iit.edu/~zwicker/lesson3.htm **Picking Pythagoras. Developed by A. Sabitino, Jr. National Teacher Training Institute. Educational Broadcasting Organization.** http://www.wnet.org/edonline/ntti/resources/lessons/m_picking/index.html **Pythagorean Lesson Plans. Developed by Challen, J., Romano, C., Swain, K., & Spivey, K., Science and Education** http://jwilson.coe.uga.edu/EMT668/EMAT6680.F99/Challen/Pythagorean/index.html **Pythagorean Puzzle. Nova Online** http://www.pbs.org/wgbh/nova/proof/puzzle/ **Ward, R. Latitude and Longitude: A Real Life Example of the Pythagorean Theorem** http://www.ed.arizona.edu/ward/Latitude/pythag.html **What's My Angle? Hands-On Math.** http://www.dpgraph.com/janine/mathpage/myangle.html **The Pythagorean Theorem and Baseball. Nova Online** http://www.pbs.org/wgbh/nova/proof/puzzle/baseball.html

Handout A: Dan Roman Construction

Micron Workplace Math. Retrieved from the World Wide Web at:
http://www.micron.com/k12/math/geometry/carpenter.aspx

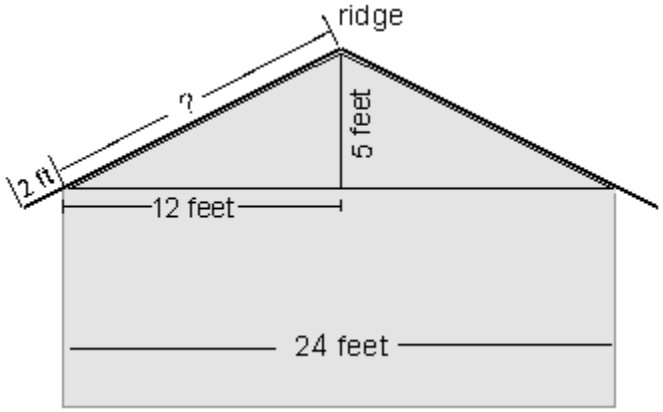
Occupation: Framing Contractor/Carpenter

Problem:

A customer would like a bonus room to be added to an existing home. The new room is to be 26' x 24' with an 8' ceiling and a 2' roof overhang. The ridge of the roof is to be centered over the 24 foot wall and 5 feet above the top of the wall of the bonus room.

Assuming the builder uses standard 4' x 8' plywood sheets, determine the following:

1. How many plywood sheets will be needed to cover the walls of the bonus room (not accounting for doors or windows)?
2. How many plywood sheets will be necessary to cover the roof over the bonus room?



Handout A: Dan Roman Construction Solution:

1. To find out how many sheets will be necessary for the four walls, divide the area of the walls by the area of plywood sheet (not allowing for doors or windows).

   26’ x 8’ (2 walls) + 24’ x 8’ (2 walls)

   4’ x 8’ plywood sheet

   (2 x 208 sq ft.) + (2 x 192 sq. ft.) / 32 sq. ft. =

   416 sq. ft. + 384 sq. ft. / 32 sq. ft. =

   800 sq. ft / 32 sq. ft. =

   25 sheets of plywood for the walls

2. To find out how many sheets will be necessary for the roof, divide the total area of the roof (two equal sides) by the area of a plywood sheet. The ridge of the roof is 26 feet and the overhang is 2 feet. The height of the roof is 5 feet. Find the area of each side of the roof by using the Pythagorean Theorem to calculate the length from the ridge to the edge ($a^2 + b^2 = c^2$), adding the overhang, and multiplying the total length by the width (ridge).

   $5^2 + 12^2 = C^2$

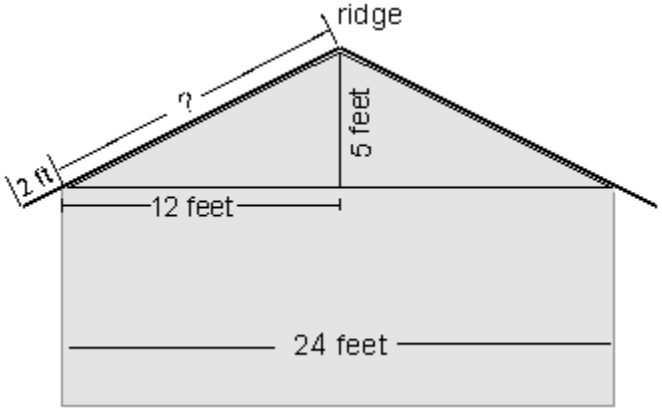
   $25 \times 144 = C^2$

   C = 13 ft.

   Roof area: (2' + 13') x 26' = 390 sq ft x 2 (both sides) = 780 sq ft

   Now divide by the plywood sheet dimension:

   780 sq. ft. /2’ x 8’ sheets = 24.375 or 25 sheets of plywood for the roof



Mathematics Lesson 6: Statistics in the Workplace

Going Beyond the Basics

Sample Occupations That Require These Skills: Bookkeeper, Teacher, Stock Broker, Banker, Statistician, Researcher, Entrepreneur

Lesson Objective(s)

Students will be able to:

- Compute the mean, range, median, mode, probability, and standard deviation using workplace problems
- Work as a team to collect and analyze data
- Design and execute appropriate illustrations to show the mean, range, median, mode, probability, and standard deviation of the data they collect

Concepts/Skills Covered in This Lesson

- Calculation of mean, range, median, mode, probability, and standard deviation
- Solving workplace problems
- Teamwork and communication skills
- Interpretation of data
- Decision-making skills

Materials Required for This Lesson

- Earning statements from a fictitious employee for the past six weeks
- Die
- Picture of divided highway
- Set of problems based on the workplace, such as the number of parts produced daily for several days on an assembly line of a manufacturing firm or the number of letters mailed out each day for the past several days from a company
- Clipboards for each team
- Checklist for groups to evaluate their data collection
- Handout A: Micron Technology, Inc.

Instructional Activities

Introduce the lesson by discussing with students that employees are often asked to participate in meetings where decisions are based on the data. When employees are unable to correctly interpret data, decisions are often made that are not in the best interest of either the company or the employee. This lesson will review with students the calculation of probability, mean, range, median, mode, probability, and standard deviation and require that students apply the concepts to a workplace scenario.

Roll a die and ask the students what the chances are of rolling a “one” on the next roll. Explain that probability is the likelihood of an event occurring and an important statistical concept. Ask what the chances are of rolling an odd number. An even number. Explain that there are six sides to a die and that each side is equally likely to be turned up after the die is thrown. The probability that the side with one dot lands up is 1 in 6 or 1/6.

Write the following formula for probability on the board:

$$P = \frac{\text{number of favorable ways}}{\text{total number of ways}}$$

Explain that the secret to using a formula is to substitute numbers for the words. Provide students with sample numbers to practice using the formula. Ask students how they would feel if they got 90 out of 100 items correct on a test. How would an employer feel if 10 out of 100 cars would have to be returned because they were defective? Point out that probability is important for quality control in a manufacturing

plant.

Next, tell students to think about what their average take home pay is per month. (Be sure to let students know that they should not state what their wages are out loud.) Ask them how they calculated their wages. Did they add up their take home pay for each month and then divide it by the number of months per year? Discuss that this process of averaging is called the mean. Demonstrate the concept by working through several sample problems on the board. Make sure to use work-related or real-life examples.

Example:
How many cars does the local car rental agency rent per day?

Explain the term range – the difference between the greatest value (number) in a group and the least value. Use the numbers from the previous exercise to demonstrate the concept of range.

Show students a picture of a divided highway and ask them to define what the strip of grass between the two sides of the highway is called – a median. Lead the participants to discuss the similarities between the two sides of the highway, such as there are usually the same number of lanes on each side. Explain that the median is the number at which half the values in a sample fall above and half below.

Finally, explain the concept of mode. Mode is the most frequently used number in a sample population.

Activity

Divide the class into teams of four. Have each team assign the following roles to group members: recorder, reporter, facilitator, and timekeeper. Together the teams are to find the answers to Handout A.

Have the teams prepare their information for reporting. The report should include a written summary and a graphic display(s) of the information similar to that found in workplace data reports.

Evaluation

Have students complete ***Handout B: What's My Grade?*** Discuss the different formulas that were used to calculate the various statistics requested.

Extension

Have students identify where and how statistics are used in their workplace. Have students develop statistical problems based on the workplace, such as the number of parts produced daily for several days on an assembly line or the average tip left by customers during a week at a local café. Use the problems in class to review the use of statistical analysis.

References

Micron Workplace Mathematics
http://www.micron.com/k12/math/

Southern Lincs Workforce Education Lab
http://slincs.coe.utk.edu/gtelab/find.html

Handout A: Micron Technology, Inc.

Micron Workplace Math. Retrieved from the World Wide Web at:
http://www.micron.com/k12/math/algebra/qual1.aspx#solution

Bill works at Micron Technology, Inc. in the Semiconductor Manufacturing Quality Control Department. Bill's department tests different programs and strategies in order to monitor device yields, failure rates, and repair rates. As part of Bill's job, he must interact with the various engineering and product groups to optimize device yields and minimize costs, as well as provide a failure analysis report.

Today, Bill must create a method control chart which includes the mean or average reading obtained while monitoring a fabrication process, as well as the standard deviation. Standard deviation is a statistical measure of the range of variance or *deviation* from the average. It describes uniformity: the smaller the number, the more uniform the readings; the larger the number, the greater the deviation.

Read the following problem situation and answer the questions regarding mean and standard deviation. Next, create a method control chart that Bill can use to report his findings.

Problem:

To create a method control chart for quality control, the following numbers were collected while monitoring a fabrication process at Micron. To ensure quality control, Bill needed to use his statistical skills to identify the mean of the different readings, as well as the standard deviation or how much difference occurred between the highest and lowest readings.

Readings Collected
3.05
3.02
3.03
2.97
2.98
3.10
2.94
3.06

What is the mean of the above set of numbers?

What is the standard deviation (SD) of the set of numbers?

$$SD = \sqrt{\frac{\Sigma (X_i - M_1)^2}{n-1}}$$

Where X_1 is given numbers
M_1 is mean
n is number of values

Handout A: Micron Technology, Inc. Solution

Mean (M_1) = sum (□) of readings ÷# of readings

$$M_1 = \frac{\square}{n}$$

$$M_1 = \frac{3.05 + 3.02 + 3.03 + 2.97 + 2.98 + 3.10 + 2.94 + 3.06}{8}$$

$$M_1 = \frac{24.15}{8} = \mathbf{3.02}$$

Standard deviation is a statistical measure of the range of variance or *deviation* from the average. It describes uniformity: the smaller the number, the more uniform the readings; the larger the number, the greater the deviation.

Deviation = difference between the reading (X) and the average of the readings (M_1)

$X - M_1$

Standard deviation (SD) = square root of the mean (M_2) of the squares of the difference or *deviation* of each reading with the mean (M_1) of the readings (X_i)

$$SD = \sqrt{\frac{\square(X_i - M_1)^2}{n-1}}$$

Reading X_i	**Deviation $X_i - M_1$**	**Squared Deviation $(X_i - M_1)^2$**
3.05	3.05 - 3.02 = **.03**	.0009
3.02	3.02 - 3.02 = **0**	0
3.03	3.03 - 3.02 = **.01**	.0001
2.97	2.97- 3.02 = **-.05**	.0025
2.98	2.98 - 3.02 = **-.04**	.0016
3.10	3.10 - 3.02 = **.08**	.0064
2.94	2.94 - 3.02 = **-.08**	.0064
3.06	3.06 - 3.02 = **.04**	.0016

$SD = \sqrt{M_2}$ **= .053** The readings varied only .053 (higher or lower) than the average of the readings.

Handout B: What's My Grade?

It is the end of the semester and Ms. Sully must complete the required report on her students' grades. The following is a chart of the end-of-the-semester grades for each student. Using the following information, assist Ms. Sully in completing her report.

Name of Student	Semester Grade
Jennifer A.	84
Dean C.	88
Sully G.	96
Jeannie G.	78
Simion H.	79
Dell J.	60
Francis K.	94
Kell L.	68
Bill M.	91
Foley N.	98
Jen O.	74
Paul O.	79
Saul Q.	85
Robero R.	84
Tom S.	89
Vic T.	84

What is the mean score for Ms. Sully's class?

What is the mode?

What is the range of grades?

What is the median?

Using the formula for probability and the semester grades listed above, what is the probability that a student would obtain an 84 as a semester grade?

$$P = \frac{\text{number of favorable ways}}{\text{total number of ways}}$$

Mathematics Lesson 7: Interpreting Workplace Graphics

Going Beyond the Basics

Sample Occupations That Require These Skills: All occupations use graphics in the workplace

Lesson Objective(s)

Students will be able to:

- Read and interpret graphics from the workplace
- Create graphs to show information in a clear and concise manner
- Apply graphic information in order to make workplace decisions

Concepts/Skills Covered in This Lesson

- Types of graphic displays: pictograph, circle/pie chart or graph, bar graph, line graph, and charts and tables
- Use of data to create graphs
- Teamwork skills necessary to complete a task

Materials Required for This Lesson

- Pictures from a newspaper or magazine
- Sample graphs created from workplace production data (or from workplaces in which students are currently employed)
- Graphs from newspapers and magazines
- Samples graphs from workplaces in which students are currently employed (examples: safety manuals, insurance information)
- Sample profit statements from students' workplaces or other reports that show data for multiple weeks, months, or years
- Handout A: Creating a Sample Chart for the Data
- Handout B: Creating Different Types of Graphs to Display Data
- Handout C: Analyzing Data Displays
- Handout D: Choosing the Right Graph
- Chart paper and different colored markers

Instructional Activities

Introduce the lesson by dividing students into teams of four. Give each team a different photograph or picture from a newspaper or magazine. Explain that the picture is a snapshot of a specific time and place. Have the teams assign roles to each team member: recorder, reporter, timekeeper, and facilitator. Give the teams about three minutes to develop a news story that explains what is happening in the snapshot. Have the teams report their story to the class.

Next, discuss that a graph is also a snapshot of information about a certain subject at a certain time. Graphs make it easier to develop comparisons and draw conclusions. In the workplace, graphic information is often used to not only show information in a clear and concise manner, but also to provide information used to make business decisions.

Have students brainstorm where they have seen graphs. Sample answers may include: newspapers, magazines, training manuals, workplace bulletin boards, and television weather reports. Document their answers on chart paper and post them in the room.

Display samples of the five basic types of graphs: pictograph, circle/pie graph, bar graph, line graph, and charts and tables. Provide a short explanation for each type of graphic.

- Pictograph – uses pictures or symbols to display information. The pictograph generally has a key to show the value of each symbol. To obtain data, one counts the symbols on a selected line of the graph and then computes the value.
- Circle Graph (pie chart) – uses a circle that is divided into segments or sections. A circle graph is used to depict parts of a whole.
- Bar Graph – Uses thick bars to show information. Bar graphs can be drawn with the bars

running up and down (vertically). The bars are placed at equal distances along the horizontal axis that runs across the bottom of the graph. Bar graphs can also be drawn with the bars running from left to right (horizontally). The bars are placed at equal distances along the vertical axis on the left side of the graph. Bar graphs are often used to compare and contrast information.

- Line Graph – one or more thin lines are drawn that extend across the graph. A line graph also uses values along a horizontal and a vertical axis. A line graph is most useful in showing trends and developments over a period of time.
- Charts and Tables – show specific values by listing numbers and words in columns and rows. Charts are most often used to compare values of one item with another. A table provides a list of words and numbers written in rows and columns. Columns are read vertically. Rows are read horizontally.

Assign each team a sample workplace graph accompanied by a worksheet that has been developed for that graph. Sample questions on the worksheet could include the following:

- What type of graph is pictured?
- What does the graph depict?
- In what type of occupations might this graph likely be used?
- During what month did a particular event occur?
- What was the total number of a specific item mentioned during a certain month or year?

After each team has completed the questions, tell them that they will now be using text to create a graphic display that provides clear and concise information from which decisions can be made at the workplace. Begin this part of the lesson by reading the following paragraph.

The emergency room (ER) is keeping a record of all incoming calls. The ER wants to improve their customer service in order to be designated a superior facility. The staff was reviewing the morning call information. The first 30 minutes of the day, three calls came into the ER. That was from 5:30 – 6:00 a.m. From 6:00 – 7:00 a.m., six calls were answered. During the remaining hours until noon, 36 calls were received: six calls from 7:00 – 8:00 a.m., 18 calls from 8:00 – 9:00 a.m., 21 calls from 9:00 – 10:00 a.m., 26 calls from 10:00 – 11:00 a.m., and 15 calls from 11:00 a.m. until noon. During the first hour and a half and between 8:00 – 9:00 a.m., all calls were answered within 10 seconds. The rest were answered within 20 seconds. Between 9:00 – 10:00 a.m. 81% were answered within 10 seconds and 100% were answered within 20 seconds. Between 10:00 and 11:00 a.m., 88% were answered in 10 seconds, and 96% were answered within a minute. Four percent of the calls rang over a minute, or the caller hung up prior to the phone being answered. From 11:00 a.m. until Noon, 87% of the calls were answered within 10 seconds; 93% were answered within 20 seconds; and the rest of the calls were answered within 30 seconds.

The staff looked again at the information and shook their heads. Were they doing well or not? That was the ultimate question.

Explain that businesses, such as hospitals, keep information on all incoming calls. The purpose may be to improve customer service or it may be a requirement of governmental regulations or a policy developed by the company. Regardless, the ER staff has data that needs to be clear and concise if it is to be useful.

As a group, discuss the usability of the data in the current paragraph format. Students should identify that material presented in this way makes it difficult to make comparisons between the numbers of calls received at different hours.

To assist students in creating a graphic to display the data, have each team create a chart that synthesizes the information (***Handout A: Creating a Sample Chart for the Data***). When they are done, review the data and discuss as a group how this format is easier or more difficult to use. If there are differences between data included in the charts, discuss students' rationale for identifying specific data to include.

Next, have each team create four different types of graphs to display some or all of the data displayed in

the chart (***Handout B: Creating Different Types of Graphs to Display Data***).

Have each team present their graphs to the class and discuss any difficulties they may have encountered in developing each graph.

Debrief the activity by having students identify a specific graphic that they use in the workplace or at home for each graphic discussed in the lesson.

Evaluation

Have students complete ***Handout C: Analyzing Data Displays***. Students should compare and contrast the different types of graphic organizers used in today's lesson. Tell students to be specific when identifying the pros and the cons of each graph. Students should be prepared to support their statements.

Extension

Have students bring a sample of each type of graph studied and complete ***Handout D: Choosing the Right Graph***.

References

Charts and Graphs
http://42explore.com/graphs.htm

Learning Resources. Graph Types
http://www.statcan.ca/english/edu/power/ch9/first9.htm

Selden, A. & J. Examining How Mathematics is Used in the Workplace. The Mathematical Association of America
http://www.maa.org/t_and_l/sampler/rs_6.html

Handout A: Creating a Sample Chart for the Data

The emergency room (ER) is keeping a record of all incoming calls. The ER wants to improve their customer service in order to be designated a superior facility. The staff was reviewing the morning call information. The first 30 minutes of the day, three calls came into the ER. That was from 5:30 – 6:00 a.m. From 6:00 – 7:00 a.m., six calls were answered. During the remaining hours until noon, 36 calls were received: six calls from 7:00 – 8:00 a.m., 18 calls from 8:00 – 9:00 a.m., 21 calls from 9:00 – 10:00 a.m., 26 calls from 10:00 – 11:00 a.m., and 15 calls from 11:00 a.m. until noon. During the first hour and a half and between 8:00 – 9:00 a.m., all calls were answered within 10 seconds. The rest were answered within 20 seconds. Between 9:00 – 10:00 a.m. 81% were answered within 10 seconds and 100% were answered within 20 seconds. Between 10:00 and 11:00 a.m., 88% were answered in 10 seconds, and 96% were answered within a minute. Four percent of the calls rang over a minute, or the caller hung up prior to the phone being answered. From 11:00 a.m. until Noon, 87% of the calls were answered within 10 seconds; 93% were answered within 20 seconds; and the rest of the calls were answered within 30 seconds.

The staff looked again at the information and shook their heads. Were they doing well or not? That was the ultimate question.

Directions: Read the above scenario regarding phone calls to the emergency room. The information is very confusing when written in a paragraph format. Create a chart below to make the information more understandable.

Emergency Room Incoming Calls

Handout B: Creating Different Types of Graphs to Display Data

With your team, create the following types of graphs to display the data. Remember, you may not be able to include all of the data in a specific type of graph. Be prepared to explain why you selected the information used. Create the following types of graphs:

- Circle Graph (Pie Chart)
- Bar Graph
- Line Graph
- Compound Bar Graph

Handout C: Analyzing Data Displays

It is important to understand why certain graphic displays are clearer to read for certain types of data. With your team, brainstorm the pros and cons of each type of graph that you developed. Document your ideas in the chart below. Select the graph that your team feels best provides data that can be accurately and easily analyzed. Be prepared to share your graph and the reasons for your choice with the class. If your team created a different type of graphic display, include that in the chart as well.

Compare/Contrast Graphic Organizer

Type of Graph	Pros (Information Clearly Shown)	Cons (Information Left Out)
Chart/Table		
Pie Chart		
Bar Graph		
Line Graph		
Compound Bar Graph		

Handout D: Choosing the Right Graph

Directions: Find a sample of each of the following types of graphs. Then analyze whether or not each type of graph is effective in depicting each descriptor.

	Bar Graph	Pie Chart	Line Graph	Pictograph	Organizational Chart	Flow Chart
Whole and Its parts						
Simple Comparison						
Multiple Comparisons						
Trends						
Frequencies						
Sequences						

Reading and Interpreting Workplace Graphics
Going Beyond the Basics

Sample Answers for Activities

Handout A: Creating a Sample Chart for the Data

Sample Chart for Emergency Room Incoming Calls

Time of Day	No. of Calls	% of Calls Answered within x Seconds					
	Answered	***10***	***20***	***30***	***40***	***50***	***60***
5:30 – 6:00 a.m.	3	100	100	100	100	100	100
6:00 – 7:00 a.m.	6	100	100	100	100	100	100
7:00 – 8:00 a.m.	6	83	100	100	100	100	100
8:00 – 9:00 a.m.	18	100	100	100	100	100	100
9:00 – 10:00 a.m.	21	81	100	100	100	100	100
10:00 – 11:00 a.m.	26	88	96	96	96	96	96
11:00 – Noon	15	87	93	100	100	100	100

Handout B: Creating Different Types of Graphs to Display Data

Graphs will differ in appearance dependent on each team's analysis of the data. Make sure that all graphs are titled and labeled appropriately. Each team should be prepared to present their graphs to the class. Each member should be responsible for presenting a specific graph.

Handout C: Analyzing Data Displays

Compare/Contrast Graphic Organizer

Type of Graph	Pros (Information Clearly Shown)	Cons (Information Left Out)
Chart/Table	Easier to read than paragraph information. Provides lots of data. Can locate data easily.	May be difficult to compare and contrast different data. Often too much information.
Pie Chart	Clearly shows parts to whole, such as the percentages of when call came into the ER compared to the timeframe identified (from 5:30 – 12:00).	Difficult to compare and contrast multiple sets of data. Can be awkward when data does not fit well into percentages or parts of a whole.
Bar Graph	Shows comparison information clearly, such as the hours when the most calls came into the ER.	When using single bars in the graph, compares and contrasts only one set of information, such as number of calls per hour.
Line Graph	Shows trends, such as peak call hours clearly.	Difficult to document and analyze multiple sets of information, such as number of calls and amount of time taken to answer each call. Can be deceiving if x and y axis use different spacing for time and numbers.
Compound Bar Graph	Shows multiple comparisons, such as number of calls within a specific number of sections	All compare and contrast information can be included, but may be difficult to follow multiple bars.

Handout D: Choosing the Right Graph

	Bar Graph	Pie Chart	Line Graph	Pictograph	Organizational Chart	Flow Chart
Whole and Its parts	No	Yes	No	Maybe	Yes	Maybe
Simple Comparison	Yes	Yes	Maybe	Yes	Maybe	No
Multiple Comparisons	Yes	No	Maybe	Maybe	No	No
Trends	Maybe	No	Yes	Maybe	Maybe	No
Frequencies	Yes	No	Yes	No	No	Maybe
Sequences	No	No	Maybe	No	Yes	Yes

Mathematics Lesson 8: Graphics Credibility in the Workplace

Going Beyond the Basics

Sample Occupations That Require These Skills: All occupations use graphics in the workplace

Lesson Objective(s)

Students will be able to:

- Distinguish between the visual impact of graphs and the information given by the numbers used on the graphs
- Compare and interpret scale for a graphic
- Determine the best scale to use on a graph so that the data is clearly communicated

Concepts/Skills Covered in This Lesson

- Graphic scale
- Uses of data to persuade
- Types of graphs
- Teamwork skills necessary to complete a task

Materials Required for This Lesson

- Handout A: Two Graphs: Two Sets of Data?
- Chart paper and markers
- Newspapers, magazines, and workplace graphs
- Computer lab and graphic programs (if available for student use in developing graphs)

Instructional Activities

Introduce the lesson by discussing that a critical component of graphic literacy is appraising the reliability of material that is used. Tell students to visualize two line graphs – one with a fairly flat line and the second with a gradually rising line. Tell students that both graphs contain the same statistics, only the scales are different. Ask students to share what they think both graphs would be telling them.

Next, provide students with a scenario in which they must answer specific questions related to data.

Sample Scenario

Two candidates are running for election. Candidate A wishes to be re-elected based on his/her creative employment plan. Candidate B wishes to show that Candidate A's employment plan has not been effective. Which graph should each candidate use?

Show students the two sample line graphs in **Handout A**. Ask them the following questions:

- Which graph would a candidate in office use to show the status of unemployment during his/her term? Why?
- Which graph would be used by the opponent? Why?

Have the students take the actual numbers from the graph and place them in a chart. Next, have students compare and discuss the numbers and answer the following questions:

- What is different and what is the same between the two graphs?
- What impact is each candidate hoping to achieve?
- How is that goal reflected visually?
- What causes graphs with the same data to look so different?

Divide the class into teams of two to four students. Have each team locate a set of statistics. Students may wish to use an almanac, encyclopedia, newspaper, or statistics from the workplace. Have each team produce two graphs with different visual impacts. Regroup the class. Have half of the team present an argument using one graph, and the other half present the opposite argument with the other graph.

Let the whole class vote on which graph reflects the statistics best and why. The type of graph developed should be based on the data that is being shared.

Teachers may wish to incorporate computers with production of the graphs, thus, allowing students to try different various visual displays without the drudgery of hand drawings. Most computer graphing applications can take statistics that are entered into the program and develop them into a variety of visuals, such as Microsoft Excel.

As a follow-up activity, find graphs in the media and have students analyze the focus of the graph. Have students use the same numbers and recreate a graph to support an alternative focus.

Evaluation

Provide students with GED-type questions and have them select the correct graph to answer the question. Include graphs where the scale is different from one graph to another.

Extension

Have students create folders with different types of real-life graphs cut from magazines and newspapers. Students should paste the graphs into the file folder and create ten GED-type questions for each graph. Ensure that the answers to the questions are accurate.

To practice skills in analyzing graphs, have students circulate through each of the different folders so that each student has answered the questions from each graph folder.

References

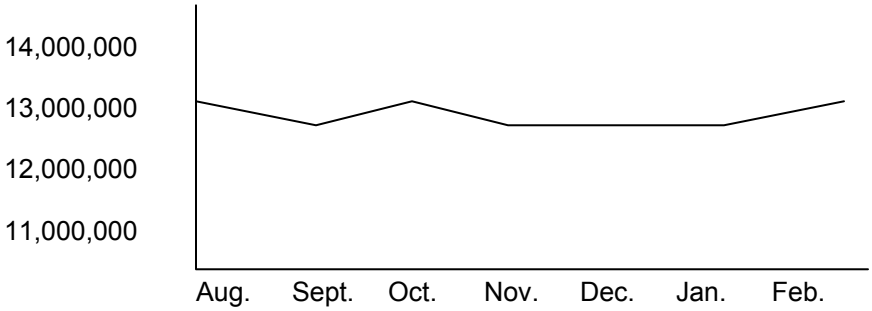
Charts and Graphs
http://42explore.com/graphs.htm

Learning Resources. Graph Types
http://www.statcan.ca/english/edu/power/ch9/first9.htm

Selden, A. & J. Examining How Mathematics is Used in the Workplace. The Mathematical Association of America
http://www.maa.org/t_and_l/sampler/rs_6.html

Handout A: Two Graphs: Two Sets of Data?

Graph A: Unemployment Numbers



Graph B: Unemployment Numbers