This instructor's manual for workplace trainers contains the materials required to conduct a course in pre-statistical process control. The course consists of six lessons for workers and two lessons for supervisors that discuss the following: concepts taught in the six lessons; workers' progress in the individual lessons; and strategies for helping workers continue to develop the skills taught in the course. The following materials are provided: lesson plan, learning activities based on real-life situations, handouts, assessments (including pretests and posttests), and transparencies. Each lesson plan contains objectives, a list of materials needed, classroom setup information, and detailed instructions for conducting all activities. Lessons cover the following topics: learning and working together; arithmetic review; decimals and percentages; descriptive statistics; basic statistics; and control charts. (MN)
Pre-Statistical Process Control:
Making Numbers Count!

Funded by the
National Workplace Literacy Program
Pre-Statistical Process Control (SPC) prepares workers to successfully participate in continuous process improvement initiatives by providing an understanding of key SPC concepts and how they relate to the quality worksite. Basic math concepts and principles are introduced to prepare the worker who may have limited numeracy skills for implementing SPC concepts.
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Math for Statistical Process Control

Making Numbers Count

Lesson 1

Learning and Working Together

Winning at Work
Lesson Description

Group learning, interaction, and problem-solving are the main thrusts of this module. Throughout the lessons in this module, the instructor should encourage employees to work together and to help one another not only in the activities provided but also on the job and outside of the work environment.

The first lesson is designed to help employees begin to overcome their fears to speak their opinions. The lesson begins with an ice-breaker: The employees introduce themselves to one another and to the instructor.

This lesson also spurs employees to think about establishing positive connections between their private lives and their work lives. Class discussions begin, understandably, with job-related goals, but employees should be encouraged to expand their discussions to personal and community issues.
Lesson 1: Learning and Working Together

**Objectives**

By completing this lesson, employees will be able to:

1. **Become** acquainted with their coworkers and superiors.
2. **Describe** their jobs to the class, as well as the jobs that precede and follow in the normal progression.
3. **Describe** their specific roles and explain how they contribute to making the final product.
4. **Tell** why their company makes the products it does and explain the products' value from the consumers' point of view.
5. **Describe** the connection between their private lives and their work lives.
6. **Describe** the larger picture of their work environment.
7. **Explain** why Statistical Process Control (SPC) is important to the welfare of the company and how SPC contributes to their own job security.

**Materials Needed**

**Forms**
- "PreTest"
- "Learner Enrollment"

**Hardware**
1. Overhead projector
2. Transparency markers
3. Company's product catalog and/or advertising brochures
4. Company organization chart
5. Memo from President or Vice President
6. Articles and videotapes on SPC and on Edward Deming (one particularly good source is the Annenberg Foundations videotape interview with Edward Deming)

**Handouts**
- "Getting to Know You" (Handout 1)
- "My Job Is..." (Handout 2)
- "The Company Team" (Handout 3)

**Classroom Set-up**

**Total Time: 90 minutes**
- Opening- Large Group/Partners 25 min.
- First Activity- Large Group 20 min.
- Second Activity- Large Group 20 min.
- Third Activity- Large Group 15 min.
- Ending- Large Group 10 min.

**Key**

- Hardware
- Transparencies
- Handouts
- Large Group
- Small Groups
- Discussion
- Sign-in Sheet

Lesson 1: Learning and Working Together

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**Activities**

**Opening: 25 Minutes**

1. **Welcome** employees. **Ask** them to fill out name tags. Have refreshments available if possible.

2. **Introduce** yourself. Briefly **tell** the class about your background, your hobbies, and your interests, as well as why you are working on this project.

3. **Explain** the general goals and objectives of the six lessons in the PRE-SPC module.

4. Have the students fill out "Learner Enrollment" form.

5. **Handout** "Pretest”. **Explain** that they should do their best. **Explain** that you **do not** expect them to know the answers, and they will take this test again at the end of the module.

6. **Explain** that in this first exercise the employees will get to know their classmates. **Tell** employees they will work in pairs to interview one another; then each employee will introduce her or his partner to the rest of the class. **Encourage** them to speak up and to express themselves clearly. **Assure** employees that the exercise will be both informative and fun.
Getting to Know You

In this exercise you'll get to know your classmates better.

Use the questions below to interview a partner. Then your partner will interview you. At the end of class, you will use the answers on this filled-out worksheet to introduce your partner to the class. Then your partner will introduce you.

First name __________________________ Last name __________________________

Nickname (Friends call me?) __________________________

Three coworkers names __________________________

Mother's name __________________________

Father's name __________________________

Husband's or wife's name __________________________

Children's names __________________________

Favorite foods __________________________

Favorite singer __________________________

How did you hear of the company? __________________________

How long have you worked at the company? __________________________

Name of supervisor __________________________
Activities

Opening: (continued)

7. **Group** employees into pairs. *(Note: If there is an odd number of employees, create one group of three partners.)*

8. **Distribute** "Getting to Know You" to each employee and **project** it on the overhead. **Explain** that the worksheet will help them to interview their partners.

9. **Demonstrate** how to complete the form:
   
a. Choose an employee for the demonstration.

b. Give that employee a copy of the worksheet, and ask her or him to begin interviewing you by asking the first few questions.

   Allow the class time to complete their interviews. *(Note: If you run short of time, tell employees they don't have to fill out every item.)*

10. Now **have** each employee introduce his or her partner as explained in the handout instructions. **Move** things along quickly, and **encourage** everyone to speak loudly. **Assure** them there is no reason to feel bashful! **Remind** them that this is a fun project a no-risk activity!

11. After introductions have been completed, **ask** the class: "What did you learn from this exercise? Do you have any suggestions for other questions? Any other improvements?"
What is your job title?

What department do you work in?

What is the name of each part you make or assemble?

Where does the part you work on come from? (Which department or coworker?)

After you finish your work, where do you send the part you work on?

What happens if the part you get is not made correctly? What if you can't work on it or you have to fix it? What do you say to the person who sends you the part?

Do you send the bad part back?

Do you tell your boss when you get a bad part? What do you say?

Do you ever have bad parts sent back to you because they weren't made right? About how many parts are returned to you by one week?

Handout 2, Transparency 2
▼ Activities

▼ First Activity: 20 Minutes

1. **Regroup** the class into one large group again.

2. **Explain** to employees that this activity gives them an opportunity to express their opinions about what happens during the assembly process. **Tell** them the purpose is to help employees feel comfortable in describing to their coworkers (a) the jobs they do, (b) where the jobs come from, and (c) to whom they send the jobs after they complete their work.

3. **Distribute** "My Job Is..." and **project** it on the overhead. **Ask** for a volunteer to come to the front of the class to fill out his worksheet on the overhead with your help. **Tell** the other employees to follow your example as you guide the volunteer through each step of the worksheet. Be sensitive when you ask questions like "Do you say anything to the person that sent you a bad part?"

4. When they are finished, **call** on different employees to answer one or two questions. **Encourage** employees to verbalize what their jobs are all about and how their jobs fit into the "larger picture." (Note: If the company makes furniture, you might hear something like this: "I work on desk tops. The desk I work on comes from the paint department. I install the wood-laminate top and send it to the hardware department, where they put on the handle knobs")

5. **Explain** to the class that if the product goes from station A to station B to station C, for example, then B is essentially A's customer and C is B's customer. The ultimate customer is the one who pays for the product! **Say**, "At every step of the process especially at the end the company's goal is a satisfied customer!"
Activities

Second Activity: 20 Minutes

1. Arrange in advance for a guest speaker. Invite a key company representative (for example, a vice president or a manager) to address the group. Explain to the speaker that the presentation gives the company an opportunity:

   a. To stress the importance of teamwork and product quality.
   b. To convince employees that the company considers them its most valuable resource!
   c. To help employees understand (a) why their company makes the products it does, (b) why consumers value the product, and (c) how their individual jobs contribute to the final product.
   d. To offer employees a brief history of the company, its founders, its growth, its accomplishments, its goals, etc.

   (Note: If it is not possible to get a speaker, ask a company representative to write a special memo, and distribute it to the class at this time.)

2. Distribute brochures describing the company's product line, or project transparencies showing its products.

3. Project the organizational chart on the overhead. Point out key names (President, CEO, Vice Presidents, etc.); include interesting background information and accomplishments if possible, and briefly discuss their functions.
The Company Team

1. What is the name of your company?

2. What is the name of the President of your company?

3. What is the name of the visitor today?

4. What products does your company make?

5. What are these products used for?

6. Have you ever used one of these products yourself?


▼ Activities

▼ Second Activity: (continued)

4. **Mention** corporate awards *(e.g., from the Chamber of Commerce).* **Read** corporate statements related to excellence or vision or dedication to customers.

5. Briefly **review** a recent corporate end-of-year report with the class. **Use** the opportunity to explain graphs and tables to the class.

6. **Distribute** "The Company Team" and **project** it on the overhead. **Allow** employees 5 minutes to complete it. *(Note: If you wish, skip the questions that are repeated from other worksheets.)*
Activities

Third Activity: 15 Minutes

1. **Introduce** the concept of *Statistical Control Processes* (SPC) by showing one of the many videos about Edward Deming, the father of control theory. **Discuss** how Deming's theories have helped industries first in Japan and now worldwide. **Use** any of the hundreds of books and articles on Deming to add to the class discussion.

2. **Ask** employees who are familiar with Quality Control to explain how their company applies SPC principles. **Ask** them to comment on how SPC contributes to product quality. Use the discussion to underscore the ideas that Quality Control (a) is an ongoing process and (b) is the responsibility of every employee. **Encourage** employees to **discuss** both ideas. **Invite** them to offer their own ideas for improving the quality control process.

3. **Show** some control charts (*see Lesson 6 for samples*), but do not discuss them in detail. (If the company uses control charts, show real company examples.)

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Lesson 1: Learning and Working Together

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Activities

Ending: 10 Minutes

1. Ask employees if they have any questions on what was presented in this session. Ask, too, if they would like more information on any particular part of the class discussion or on any related subject.

2. If the employees did not have enough time to complete the handouts, you may ask them to bring the completed handouts to the next class. Consider inviting the employees to bring to the next class any examples of their work related to SPC and using their examples for a show-and-tell.
JobLink
Winning At Work

Math for Statistical Process Control
Making Numbers Count
Lesson 2
Arithmetic Review
Lesson Description

This lesson addresses several important goals. First, it quickly reviews basic arithmetic skills—the skills necessary to learn simple descriptive statistics and to calculate the mean and the standard deviation.

Depending on the class "mix," some employees may have mastered these skills while others are still learning. If so, then appeal to the employees' need for cooperative learning, a valuable goal in itself.

Group employees, carefully mixing the arithmetically weak with the strong. Help them to establish a rapport and a willingness to work together. Underscore that success in this company depends on workers, managers, and supervisors all working together to achieve a common goal: improving individual and company well-being.

In this lesson employees will also learn the skills necessary to use a calculator properly. And finally, employees will learn basic problem-solving skills.
Lesson 2: Arithmetic Review

Objectives
By completing this lesson, employees will be able to:

1. Perform addition, subtraction, multiplication, and division of whole numbers both with and without a calculator.
2. Use a calculator to take the square root of a number and interpret its meaning.
3. Begin developing problem-solving skills.

Materials Needed

Hardware
1. Overhead projector
2. Cuisenaire rods
3. Overhead calculator
4. Employee calculators
5. Scratch paper

Transparencies
"Reading & Writing Numbers" (Trans. 4)
"Your Turn" (Trans. 5)
"Addition of Whole Numbers" (Trans. 6)
"Subtraction of Whole Numbers" (Trans. 7)
"Addition & Subtraction of Word Problems" (Trans. 8)
"Multiplication of Whole Numbers" (Trans. 9)
"Division Problems" (Trans. 10)
"Division Word Problems" (Trans. 11)
"Square Roots" (Trans. 12)

Handouts
"Reading & Writing Numbers" (Handout 4)
"Your Turn" (Handout 5)
"Addition of Whole Numbers" (Handout 6)
"Subtraction of Whole Numbers" (Handout 7)
"Addition & Subtraction of Word Problems" (Handout 8)
"Multiplication of Whole Numbers" (Handout 9)
"Division Problems" (Handout 10)
"Division Word Problems" (Handout 11)
"Square Roots" (Handout 12)

Classroom Set-up

Total Time: 90 minutes
Opening- Large Group 15 min.
First Activity- Large Group 20 min.
Second Activity- Large Group 15 min.
Third Activity- Large Group 10 min.
Fourth Activity- Large Group 25 min.
Ending- Large Group 5 min.
Reading and Writing Numbers

In this lesson you will learn (1) to read and write numbers, (2) to add, subtract, multiply, and divide whole numbers, and (3) to take the square root of a number.

1. In our number system, we write numbers so that each place tells you "How many tens?" "How many ones?" and so on.

For example, the number 54 means that you have 5 tens (100) and 4 ones (4). Thus 54 = 50 + 4. We read this number as "fifty-four". They mean "5 tens" and four means "4 ones".

Note that the first place is "ones" and the second place is "tens". In other words, each place represents a specific number value.

2. The system allows you to express larger numbers by adding more places.

After "tens" comes "hundreds".

234 = 200 + 30 + 4

Now you have "two hundred thirty-four". The two hundred means "2 hundreds", the rest is the same as in the example above.

3. And after "hundreds" comes "thousands".

5,234 = 5,000 + 200 + 30 + 4

Now you have "five thousand two hundred thirty-four". The five thousand means "5 thousands" and the rest is the same as in the example above.

Your Turn!

Complete the following exercises:

1. Break down the number 67 into tens and ones: 67 = ____ + ____

2. Read the following number aloud: 467

3. Break down 467 into hundreds, tens, and ones: 467 = ____ + ____ + ____

4. Jim weighs 195 pounds (say "one hundred ninety-five pounds"). He could write his weight in the form 100 + 90 + 5.

   How much does he weigh? Write your weight in groups: ____ + ____ + ____

5. Now write your weight in the usual way (for example, 195: ____)

6. How do you say this number? Write it in words: ____
Activities

Opening: 15 Minutes

1. Tell the employees that this lesson is designed to review and strengthen their arithmetic skills. Explain that these skills are essential for understanding the concepts presented in this training program. Stress that these materials are designed to be easy to read and that you will try to simplify the concepts as much as possible. Underscore that the skills they will learn are critical for job success and exceptionally useful in personal life as well.

2. Distribute "Reading and Writing Numbers" and project it on the overhead. Guide employees through the explanation, use the examples to illustrate the concept of hundreds/tens/ones, and then allow employees a few minutes to complete the exercises.

3. Distribute "Your Turn".
Lesson 2: Arithmetic Review

### Subtraction of Whole Numbers

Complete the following exercises:

1. Use numbers to express 000 - 000 = 0
2. Use circles to write the meaning of 8 - 5
3. What does 13 - 5 mean? Sometimes we write this as 12
4. Subtract 46 - 12
5. Subtract 129 - 542

### How to Do

12 - 3 = 9
15 - 7 = 8
551 - 23 = 528
702 - 120 = 582

Remember: Write the numbers you are subtracting one below the other and then subtract the numbers in each column starting from the right.

---

### Addition of Whole Numbers

Complete the following exercises:

1. Use numbers to express 0 + 00 = 000.
2. Use circles to write the meaning of 8 + 5.
3. What does 12 + 5 mean? Sometimes we write this as: 17
4. Add 460 + 52 + 19
5. Add 129 + 542 + 95 + 1

### Now try adding the following:

2 + 5 =
15 + 17 =
551 + 23 =
702 + 120 + 35 + 1 =

Remember: Write the numbers you are adding one below the other and then add the numbers in each column starting from the right.

---

### Multiplication of Whole Numbers

Complete the following exercises:

1. Use numbers to express 00000000 = 00000000
2. Use circles to write the meaning of 8 x 5
3. What does 12 x 5 mean? Sometimes we write this as: 60
4. Multiply 400 x 52

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Handout 7, Transparency 7

Handout 6, Transparency 6

Handout 8, Transparency 8

Handout 9, Transparency 9

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Activities

First Activity: 20 Minutes

1. Simplify for the class the concepts of union of two sets and difference of two sets; for example, use terms such as putting together and taking away. Start with the definition of addition. Handout and project "Addition of Whole Numbers".

2. Address subtraction. Distribute and project "Subtraction of Whole Numbers". Motivate employees by using simple manipulatives (the Cuisenaire rods), and involve the employees in the exercises whenever possible. Start with hand calculations; then gradually switch over to the calculator.

   set A = (all women in the class), and set B = (all men in the class),
   set C = (all men and women in the class), then
   \# C = \#A + \#B (since A and B are disjoint sets) and is the total number of people in the room.

3. Distribute and project "Addition and Subtraction Word Problems". Have students complete worksheet, or complete as a class.

4. Introduce multiplication by placing the Cuisenaire dice, rods, and flats in rows and columns. For example, to illustrate the concept of 3 x 5, arrange the Cuisenaire blocks (dice) in 3 rows of 5 sets, as follows:

        ooooo
        ooooo
        ooooo

5. Distribute and project "Multiplication of Whole Numbers".
Lesson 2: Arithmetic Review

Division Problems

1. Use circles to express $8 \div 2$

2. Use circles to write the meaning of $8 \div 5$

3. Divide: $400 \div 40 = \phantom{000}$

4. Divide: $1259 \div 542 = \phantom{000}$

Division Word Problems

As you read the following word problems, work for the basic arithmetic information. Don't be fooled by the extra information! Follow the example:

Examples:

In the Juarez family, Juan makes $800 per week and his wife Irma makes $150 per week. What is the difference between Juan's pay and Irma's pay?

Answer: $800 - $150 = $650. The difference in pay is $650.

But we can also say that Juan earns twice as much as Irma—or that he earns 5 times what Irma earns. Note the arithmetic here:

$800 \div 150 = 5$

Thus Juan earns 5 times as much as Irma earns.

Problems:

1. Today is payday and you receive $1,200 in your paycheck. If you spend half of it for groceries and rent, how much of your pay do you have left?

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Activities

Second Activity: 15 Minutes

1. For division, reverse the technique above. On the board, write \(15 / 5 = 3\). Then say, “How can 15 be separated into 3 sets containing 5 blocks each?” Reinforce the concept by explaining that division is simply repeated subtraction.

2. Dramatize the concept by placing 12 plastic dice or coins on the overhead screen; point out to the class that there are 3 groups of 4 dice. On the board write:

\[12 \div 4 = 3\]

3. Now point out that this equation says “Group this many objects-- OOOOOOOOOOO -- into groups of four.” In other words, group these objects as follows:

\[0000 / 0000 / 0000\]

4. Next, show two numbers that do not divide “evenly,” thus giving a decimal answer. For example:

\[10 \div 4 = 10/4 = 2.5\]

In other words, the answer 2.5 means “two and a half groups of fours,” which we can represent as follows:

\[0000 / 0000 / 00\]

5. Repeat similar examples on the overhead screen. In the above example, place ten plastic dice end to end. Take a Cuisinaire that is four attached, a four-rod, and match it to the ten dice. It'll match 2 1/2 times. Distribute and project “Division Problems” and “Division Word Problems”. Have students complete.
Activities

Third Activity: 10 Minutes

1. Tell the employees that they will now have an opportunity to use the calculator. Spend a few minutes pointing out the keys. Tell them the number keys are arranged the same on all standard keypads (and telephones). Now ask them to find the plus, minus, divide, multiply, and equals keys, and point out and explain the Clear and the Clear Entry keys. (If time allows, explain constant, memory, etc.) Save for last the square root key, the purpose of this activity.

2. Instruct them to punch in 5 x 5. Ask, "Did everyone get 25? That's the right answer." Illustrate the problem on the board as follows:

   \[ 5 \times 5 = 25 \]

3. Tell them to immediately press the square root key. Say, "Did everyone now get 5? The square root of 25 is 5." Illustrate the problem on the board as follows:

   \[ \sqrt{25} = 5 \]
Square Roots

1. What is the square root of $\sqrt{16}$?

2. $\sqrt{25} + \sqrt{6} = \ldots$

3. What is the square root of $\sqrt{81}$?

4. Wallpaper border needs to be ordered for the Johnson's kitchen. The room is 20' x 15' x 20' x 15'. How much wallpaper border do you need to order?

5. The Juarez family wants to fence in a yard that is exactly square. The area of the yard is 225 square feet. How much fencing is the Juarez family going to need?

Handout 12, Transparency 12
4. Say, "You are probably wondering why and when you might use the square root key. Here's one example: Assume that you want to find the side of a square that has an area of 25 square yards. For example, calculate to solve hard square-root problems. For example, ask for the number of Cuisenaire rods-dice needed to make a square array of 20 dice. Let them struggle with this for a while, and then suggest that if fractional parts of a Cuisenaire are allowed, then we would need a little less than 4.5 dice (since 4.5 x 4.5 = 20.25)."

5. If time permits, use the calculator to solve hard square-root problems. For example, for Cuisenaire rods, ask: "How many Cuisenaire rods-dice are needed to make a square array of 20 dice?"

6. Distribute and project "Square Roots".
▼ Activities

▼ Fourth Activity: 25 Minutes

1. **Introduce** basic problem-solving. **Ask** employees to volunteer real-time problems and use their problems to establish a process for achieving solutions. In addition, **prepare** your own problems. For example:

   The packing department is allowed 20 hours of overtime each week. There are six workers in the department. One worker never wants to work overtime, but the other five are always willing to make a few extra dollars by working overtime. What is a fair share of overtime for each of these workers?

2. **Ask** the employees to answer the following questions:

   a. Can you restate the problem in your own words? (Do you understand the problem?)

   b. Can you draw a picture of the situation? (Any schematic will do—say, 5 or 6 stick figures for the workers and 20 boxes for the number of hours.)

   c. What is the question? (What are we looking for?)

   d. How do you plan to solve it? (State specifically: Subtract 1 from 6 and divide into 20)

   e. What is your solution, and does it make sense?
Activities

Ending: 5 Minutes

1. Summarize key concepts.
2. Ask for questions.
JobLink
Making Numbers Count
Lesson 3
Decimals and Percents
Winning At Work
Lesson Description

Quality control engineers at companies involved in this project suggested adding this lesson to the PRE-SPC module. At their companies, employees routinely work with decimal amounts and compute percents, ratios, and proportions as part of their jobs. Your goal here is to learn how to measure the effectiveness of quality control in manufacturing processes. These math concepts are indispensable for this purpose.

But knowing these basics pays off at home too. All of us must understand credit card interest charges, bank fees, tax payments, payroll deductions, etc.

The first topic covered in this lesson is decimals, the core of our base ten number system. Understanding decimals is essential to expressing percents and rates.
Lesson 3: Decimals

Objectives

By completing this lesson, employees will be able to:

1. **Read** and **write** decimal numbers.
2. **Perform** the basic arithmetical operations using decimals.
3. **Solve** word problems involving decimals.
4. **Read** and **interpret** percent statements correctly.
5. **Calculate** percentages using a calculator.
6. **Read** and **interpret** ratio statements accurately.
7. **Compute** basic ratios to get “unit pricing.”
8. **Solve** percent word problems.
9. **Express** work-related percent statements as meaningful operational objective.
10. **Understand** and **interpret** information expressed in the form of a rate.
11. **Calculate** rates with the aid of formulas and a calculator.
12. **Apply** their understanding of rates when they convert statistical data on the job, and represent the data on charts, models, etc.

Materials Needed

**Hardware**

1. Overhead projector and screen
2. Transparency pens
3. Cuisinaire blocks and dice (at least one set for every three employees)
4. Calculators
5. Transparent cuisinaire rods
6. Wire abacus

**Transparencies**

- “Decimal Numbers” (Transparency 13)
- “Decimal Numbers: Adding and Subtracting” (Transparency 14)
- “Decimal Numbers: Addition and Subtraction Word Problems” (Transparency 15)
- “Decimal Numbers: Multiplying” (Transparency 16)
- “Using the Calculator” (Transparency 17)
- “Decimal Numbers: Dividing” (Transparency 18)
- “Percents” (Transparency 19)
- “Rates” (Transparency 20)

**Handouts**

- “Decimal Numbers” (Handout 13)
- “Decimal Numbers: Adding and Subtracting” (Handout 14)
- “Decimal Numbers: Addition and Subtraction Word Problems” (Handout 15)
- “Decimal Numbers: Multiplying” (Handout 16)
- “Using the Calculator” (Handout 17)
- “Decimal Numbers: Dividing” (Handout 18)
- “Percents” (Handout 19)
- “Rates” (Handout 20)

**Classroom Set-up**

**Total Time: 115 minutes**

- Opening- Large Group: 10 min.
- First Activity- Small Groups: 15 min.
- Second Activity- Large Group: 15 min.
- Third Activity- Large Group: 15 min.
- Fourth Activity- Large Group: 30 min.
- Fifty Activity- Large Group: 25 min.
- Ending- Large Group: 5 min.
Decimal Numbers

1. What does the number .47 mean?
   
   \[ .47 = \_\_\_ + \_\_\_ \]

2. How do you read/write the number .47?

3. What does the number 4.07 mean?
   
   \[ 4.07 = \_\_\_ + \_\_\_ + \_\_\_ \]

4. How do you read/write the number 4.07?

Find your own examples of decimal numbers, and repeat the exercises above.

Handout 13, Transparency 13
Activities

Opening: 10 Minutes

1. Say, "In this lesson you will learn how to read and write numbers decimal numbers. You will also learn how to add, subtract, multiply, and divide decimal numbers."

2. To introduce decimals, build on the same procedure used in Lesson 2 for whole numbers. If an old-fashioned abacus is available, use it to demonstrate the meaning of "place value"; if not, on the board write the following (exaggerate the decimal point a bit):

   ... hundreds  tens  ones  tenths  hundredths  thousandths...

3. Remind the class that numbers to the left of the decimal represent whole numbers—first ones, then tens, next hundreds, and so on. Stress that numbers to the right of the decimal represent parts of numbers—first tenths, then hundredths, next thousandths, and so on.

4. Fill in a number and use it to emphasize (a) the central position that the decimal point plays, (b) the "place value" to the right of the decimal point, and (c) the place value to the left of the decimal point. For example, begin with the number 1.34. Explain that it expresses 1 whole number, 3 tenths, and 4 hundredths. Say to the class, "Read this number as 'one and thirty-four hundredths.'"

5. Distribute "Decimal Numbers" and project it on the overhead. Allow the class time to complete the exercises.
Lesson 3: Decimals and Percents

Activities

First Activity: 15 Minutes

1. Use the old-fashioned wire abacus (if available) to demonstrate addition and subtraction of decimals. **Underscore** that the procedure is the same as for whole numbers.

2. Discuss "carrying" in adding decimals and "borrowing" in subtracting decimals. **Stress** the similarity with adding and subtracting whole numbers. **Point out** that the decimal point is a separator—it divides the whole part of the number (the left side) from the fractional part, the decimal part, of the number (the right side).

3. **Involv**e the employees in the discussion. **Ask** them specific questions to make sure that they grasp the basic principles.
Lesson 3: Decimals and Percents

**Decimal Numbers: Adding and Subtracting**

1. What does $12 + 5$ mean?
   - $17$

2. Add $4.00 + 5.2 + 1.8$
   - $11.00$

3. Add $12.39 + 54 + 35 + 10$

4. What does $12 - 5$ mean? How do you write this?

5. Subtract $4.00 - 5.2$

6. Subtract $12.39 - 5.42$

**Decimal Numbers: Addition and Subtraction Word Problems**

Complete the following exercises. Follow the example.

Example:
Joan earns $225.50 per week and her with Irma makes $150.75 per week. How much money do Joan and Irma earn each week?
- Joan makes $225.50
- Irma makes $150.75
- Total: $376.25

Answer: Joan and Irma make $376.25 each week.

1. You have $1,500.00 in your checking account. Today is payday and you receive $1,245.10 in your paycheck. On your way home, you spend $187.25 for groceries. Then you decide to deposit the rest of your paycheck into your checking account. How much money do you have in your account after your deposit?

**Decimal Numbers: Multiplying**

Complete the following exercises.

1. $1.2 	imes 6$ means $1.2 + 1.2 + 1.2 + 1.2 + 1.2 + 1.2$. The sum is $7.2$. Add the numbers to get the answer.

Instead of adding all these numbers, you can multiply two numbers as follows:
- $1.2$
- $6.0$

As before, the answer is $7.2$

2. Multiply $4.15 	imes 12$
   - $49.80$

3. How repeat step 2 above but this time use a calculator. If you don't know how to use a calculator, ask someone in your group who does, or ask your instructor. You will learn how to use a calculator in the next worksheet.

Multiply using your calculator: $4.15 	imes 12$

4. Multiply $11.39 	imes 5.42$
▼ Activities

▼ First Activity: (continued)

4. **Dramatize** the need to count the number of positions in the original two numbers. **Explain** why we count by (a) using a common fraction such as a/b, (b) using the geometric definition of multiplication, or (c) placing the numbers in expanded notation and using the distributive law. **Take** the practical approach and simply state the rule. *(Note: If anyone wants a full explanation, ask her or him to meet you after class.)*

5. **Distribute** “Decimal Numbers: Adding and Subtracting”, and **project** it on the overhead. **Walk around** the room to help employees with any problems they may have.

6. **Distribute** “Decimal Numbers: Addition and Subtraction Word Problems”. **Discuss** each problem to make sure that employees understand them; then allow them time to complete these exercises.

7. **Demonstrate** how we multiply two decimals. **Stress** that the process is precisely the same as multiplying whole numbers; the “trick” lies in positioning the decimal point in the answer! **Distribute** “Decimal Numbers: Multiplying” and **project** it on the overhead.
Using the Calculator

Use your calculator to solve the following problems. Write the answers after the equals sign.
1. $3 \times 4 =$
2. $20 \times 40 =$
3. $500 \times 400 =$
4. $5,000 \times 4,000 =$
5. $30,000 \times 40,000 =$

Can you read the answers that are in scientific notation? If not, ask your instructor for help.

Now use your calculator to compute the following divisions. Write your answers after the equals sign.
1. $3/4 =$
2. $5/40 =$
3. $3/400 =$
4. $5/4,000 =$
5. $3/40,000 =$
6. $5/400,000 =$

Can you read the answers that are in scientific notation? If not, ask your instructor for help.
Activities

Second Activity: 15 Minutes

Instructor: Address decimal division later, after this lesson on calculators, so that employees will learn how to use the calculator for problem-solving.

1. Say, "We all know how convenient calculators are. They facilitate calculations and save a lot of time!" Now tell employees that in this lesson they will use the calculator to learn the rudiments of scientific notation. Explain that in calculations, especially decimal calculations, they might encounter this type of readout.

2. Explain the concept of scientific notation (at least as far as it applies to the calculator). Use an overhead calculator if available (if not, use the board or the overhead). Be sure to mention exponents.

Scientific Notation: a method of writing or displaying numbers in terms of a decimal number between 1 and 10 multiplied by a power of 10. For example: Scientific notation of 10,492 is 10,492 x 10^4 (American Heritage Dictionary)

Exponents: A number or symbol placed to the right of and above another number, symbol, or expression denoting the power to which that number, symbol, or expression is to be raised.

3. Distribute and project "Using the Calculator". Use the first exercise to teach employees to multiply with a calculator and to deal with scientific notation. Emphasize that (5000 x 4000) should read as 1.2 E 6 on most nonscientific calculators. (If it does not on your calculators, add more zeros to the numbers.) Explain this scientific notation carefully. Do the same for the division problems, which may be trickier.
Decimal Numbers: Dividing

1. Use circles to express \( \frac{1}{2} = \frac{2}{4} \).
2. Use circles to write the meaning of \( \frac{5}{6} \).
3. Divide 400 by 40 = 10.
4. Divide 120 by 50 = 2.4.

5. Juan earns $325.75 per week and Irma earns $915.50 per week. They divide their combined pay into 3 equal parts: one part for rent, one part for food, and one part for all other expenses. How much do Juan and Irma spend on rent?
Lesson 3: Decimals and Percents

Activities

Third Activity: 15 Minutes

1. Remind employees that division is simply repeated subtraction. Now tell them that they will divide decimals, and admit to them that decimal division is trickier.

2. On the overhead screen place 15 plastic cubes (or even better, paper units that you can easily cut) and ask the class to divide the 15 into two equal groups—that is, to perform the division $15 \div 2$. (Answer: 7 and one half, or $7 \frac{1}{2}$, in each group.)

3. Distribute and project “Decimal Numbers: Dividing.”
Lesson 3: Decimals and Percents

Handout 19a, Transparency 19a

Handout 19b, Transparency 19b

Handout 19c, Transparency 19c

Handout 19d, Transparency 19d

Handout 19e, Transparency 19e

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\section*{Activities}

\section*{Fourth Activity: 30 Minutes}

1. \textbf{Review} percents with the class. Include examples of how they use percents everyday as they compute interest rates, sales tax, discounts, price increases, savings, etc.

2. \textbf{Project} the plastic sheets of Cusinaire dice, rods, and flats (and to a lesser extent, the cubes) to introduce the idea of percent. (\textbf{Use} simple hand-drawn squares if the transparencies are not available.) \textbf{Group} the class into teams of two. \textbf{Distribute} the "plastic rods" (a term simpler than Cusinaire rods).

3. \textbf{Distribute} and \textbf{project} "Percents" and complete the exercises. Repeat the exercises many times with different numbers. \textbf{Experiment} with the employees by asking them to cover a (10x10) flat with 90 small dice, 100, 120... (120%).

4. \textbf{Write} \[ 25\% = .25 \] on the board, and \textbf{explain} why the percent and the decimal are indeed equivalents. \textbf{Allow} employees to use the calculator as you write on the board \[ 25\% = \frac{1}{4} = 1 + 4 = .25. \]
Lesson 3: Decimals and Percents

Rates

Sample Problem 1

Two people are traveling toward each other at a rate of 45 mph. How much will they meet? How much distance will they come in one hour?

Step 1: Understand the Problem

Two people are traveling toward each other at a rate of 45 mph. How much will they meet? How much distance will they come in one hour?

Step 2: Can the Problem Be Solved?

Yes, the problem is solvable. The solution is to add the rates of the two people.

Step 3: Solve the Problem

Distance = Rate x Time

Distance = 45 mph x 1 hour = 45 miles

Note that the answer is in miles only.

Sample Problem 2

If you are driving 45 mph, how much distance will you cover in 10 minutes?

1. Convert 10 minutes to hours: 10 minutes = 1/6 hours or 0.1667 hours
2. Multiply 45 miles by 0.1667

Distance = 7.5 miles

Note that the answer is in miles only.

Rates (continued)

Sample Problem 3

Sand high 10 pounds of premium at $1.19 per pound, 5 pounds of apples at $1.19 per pound, and 7 pounds of oranges at $1.19 per pound. How much money did Sand pay?

Step 1: Understand and Formulate the Problem

Sand bought 10 pounds of premium at $1.19 per pound, 5 pounds of apples at $1.19 per pound, and 7 pounds of oranges at $1.19 per pound. How much money did Sand pay?

Step 2: Can the Problem Be Solved?

Yes, the problem is solvable. The solution is to multiply the rate by the quantity for each item and then add the results.

Step 3: Solve the Problem

Total cost = (Rate x Quantity) for each item

Total cost = (1.19 x 10) + (1.19 x 5) + (1.19 x 7)

Total cost = $11.90 + $5.95 + $8.33

Total cost = $26.18

Answer: Sand paid $26.18.

Rates (continued)

Sample Problem 4

Using what you have learned in this course, solve the following problems. Be sure to present each step in a clear and organized manner.

1. The Pacific Toy Company has a production line of 90 workers. The "normal" rate of production for each worker on the line is 25 toys per day. Workers receive a bonus of $10 per toy for any toy that makes more than daily quota. At the end of a weekend, how many toys will FTC produce if the workers make no extra delay?

Using the given information, the number of toys produced can be calculated as follows:

- The normal rate of production is 25 toys per day.
- The number of workers is 90.
- The bonus rate is $10 per toy for any toy that makes more than daily quota.

Thus, the total number of toys produced can be calculated as:

Total toys = Normal rate x Number of workers = 25 toys/day x 90 workers = 2250 toys.

2. Historically, Visa's average service rate is 10,000 cards per hour, and MasterCard's average service rate is 15,000 cards per hour. In 1996, Visa's balance is $10.94 and MasterCard's balance is $94.27. Which balance should BNC pay off first?

To determine which balance should be paid off first, we need to compare the average service rates of Visa and MasterCard.

MasterCard's average service rate is higher (15,000 cards per hour) than Visa's (10,000 cards per hour) in 1996.

Conclusion: BNC should pay off the MasterCard balance first.
Lesson 3: Decimals and Percents

Activities

V Fifth Activity: 25 Minutes

1. Introduce the concept of rate. Say, "You use rates every day. For example, 55 mph, $1.47 per gallon, $1.34 per ounce, $1.99 per pound—all are examples of rates."

2. Explain that percent is also a rate—for instance, an interest rate of 12%.

3. Discuss rates such as the ones mentioned above and other simple, familiar rates; proceed to proportions if the class easily grasps the concept of rate.

4. Distribute and project "Rates".
Activities

Ending: 5 Minutes

1. **Summarize** the concepts taught today.
   - Decimals
   - Percents
   - Rates

2. **Tell** the students good-bye.
Math for Statistical Process Control

Lesson 4

Descriptive Statistics

Making Numbers Count
Lesson Description

The ability to read and interpret descriptive statistical graphs (tables, graphs, and charts) and draw conclusions from them is an essential skill for productive employees and intelligent citizens. In industry, perhaps as much as 90% of the statistics used are descriptive statistics.

Daily newspapers and magazines routinely communicate information by using tables, graphs, and charts because graphs present a lot of information quickly and succinctly. Likewise, companies routinely use descriptive statistics to communicate important information to their employees. Productive, promotable employees need to understand descriptive statistics as well as they understand oral and written communications.

In this lesson employees build skill in two ways: by learning to read graphs and learning to build them. This lesson is closely linked to the last lesson, on control charts.
Lesson 4: Descriptive Statistics

Objectives

By completing this lesson, employees will be able to:

1. Read, interpret, and build frequency tables.
2. Read, interpret, and build bar graphs.
3. Read, interpret, and build line graphs.
4. Read and interpret circle graphs.
5. Explain how descriptive statistics relate to quality control.

Materials Needed

Hardware

1. Overhead projector and screen
2. Transparency pens
3. Cuisenaire rods
4. Plastic or cardboard circle graphs (like pizza slices)
5. Calculators (one per employee)
6. Large scissors
7. Construction paper

Handouts

"Rainfall for the week of 3/9" (Handout 21)
"Temperature on March 9" (Handout 22)
"Costs for XYZ, Inc" (Handout 23)
"Reading Graphs and Tables" (Handout 24)
"Reading and Interpreting Tables" (Handout 25)
"Reading and Interpreting Bar Graphs" (Handout 26)
"Reading and Interpreting Line Graphs" (Handout 27a & 27b)
"Comparing Line Graphs" (Handout 28)
"Reading and Interpreting Circle Graphs" (Handout 29)
"Building Frequency Tables" (Handout 30)
"Building Bar Charts" (Handout 31)

Classroom Set-up

Total Time: 90 minutes

Opening- Large Group 10 min
First Activity- Large Group 20 min
Second Activity- Small Groups 30 min
Third Activity- Large Group 15 min
Ending- Large Group 15 min

Key

Hardware Transparencies Handouts Large Group Small Groups Discussion Sign-in Sheet
\textbf{Activities}\
\textbf{Opening: 10 Minutes}\

1. \textbf{Welcome} employees. Tell them that the opening activity will be fun, and \textbf{explain} that they will learn the basics of bar graphs. \textbf{Try} to ease employees' anxiety about this lesson.

2. \textbf{Draw} employees a bar graph such as this one:

0 Children

1 Child

2 Children

3 Children

4 or More Children

\begin{itemize}
\item 0 Children
\item 1 Child
\item 2 Children
\item 3 Children
\item 4 or More Children
\end{itemize}
Activities

Opening: (continued)

3. Explain that the class will now form a "human bar graph." Proceed as follows:
   - Ask employees to line up on one side of the room. Stand in front of them and then say, "How many of you have children?"
   - Now ask those who have no children (that is, those who did not raise their hands) to form a single file behind you.
   - Repeat this process with the "children group." Ask, "How many of you have only one child?"
   - Then ask, "How many of you have two children?"
   - Continue in this way, forming a simple "human bar graph." When finished, discuss the meaning of the "graph" with the class.

4. Repeat the exercise with other criteria, such as:
   - Number of years with this company
   - Number of years working
   - Number of years in the United States
   - By city where they reside (this is a pictograph)
   - By country of origin
   - By music preference (Classical, Country, Pop, Jazz)
Rainfall for the week of 3/9

Temperature on March 9

Handout 21, Transparency 21

Handout 22, Transparency 22
Activities

First Activity: 20 Minutes

1. Distribute and project "Rainfall for the week of 3/9".

   NOTE: If you have actual charts from the company they should be used instead of the generic charts provided.

2. Explain that this type of graph is called a bar graph. Explain how to read the graph. Say, "According to this graph the week of 3/9 we got .2 inches of rain on Sunday.

3. Ask the class,

   How much rain did we get on Wednesday?
   Which day did we get the most rain?
   Which day did we get the least amount of rain.

4. Distribute and project "Temperature on March 9."

5. Explain that this type of graph is called a line graph. Explain how to read.

6. Say, "According to this graph at 6:00 am the temperature was 56 degrees."
Lesson 4: Descriptive Statistics

Costs for XYZ, Inc.

- Administration: 15%
- Production: 10%
- Marketing: 5%
- Research: 25%
- Miscellaneous: 45%

Reading Graphs and Tables

Complete the exercises below:

1. Where will you find graphs and tables?

2. Below there are two pictures of your boss-a happy picture, and an unhappy picture. Looking at the line graphs below, predict how your boss will react to each graph as you read items a through d. Use the pictures for your predictions.

   a. How will your boss react if Graph A shows the trend in profit for your company? How will your boss react to Graph B?

   b. How will your boss react if Graph A shows the number of new customers for your company? How will your boss react to Graph B?

   c. How will your boss react if Graph A shows the number of products returned by customers for your company? How will your boss react to Graph B?

   d. How will your boss react if Graph A shows sales units for your company? How will your boss react to Graph B?
Activities

First Activity: (continued)

7. **Ask** the following questions,

   What was the temperature at 9:00 am?
   What was the temperature at 9:00 pm?
   What was the highest temperature of the day? At what time?
   What was the lowest temperature of the day? At what time?

8. **Distribute** and **project** "Costs for XYZ, Inc".

9. **Explain** that this is called a pie chart. **Explain** how to read the chart.

10. **Say**, "According to this graph, 15% of XYZ's expenses went to research.

11. **Ask**,

   How much of the costs went to Administration?
   How much of the costs went to Marketing?
   Where do most of the costs go?

12. **Distribute** and **project** "Reading Graphs and Tables".

13. Have students answer the questions on the handout. **Walk around** the room and help them answer the questions.
Activities

Second Activity: 30 Minutes

Note to Instructor: Let the employees do as much of the work as possible in this activity.

1. **Tell** employees that in this activity they will begin to build simple frequency tables, bar graphs, and line graphs.

2. **Distribute** and **project**—

   "Reading and Interpreting Tables"
   "Reading and Interpreting Bar Graphs"
   "Reading and Interpreting Line Graphs"
   "Comparing Line Graphs"

3. **Explain** that they will start with simple bar graphs and line graphs. Then they will work on more frequency tables and bar graphs. Circle graphs will be read and will be done last.
Reading and Interpreting Circle Graphs

Use the following "measuring device" to estimate how to interpret the pie charts in the questions. The small slice shown is 10% of the entire circle (sometimes we call circle graphs pie charts). So it takes 10 of the small ones make up the entire circle.

1. If you spend 40% on your salary on rent, how many of the small slices above represent your rent expense?
2. If 80% of your company's expenses go to employee wages, how many small slice does wage expense represent?
3. Consider Maria's budget breakdown: Rent $300, Food $500, Car $100, and Entertainment $100. Her total salary is $1,200. How many slices of the circle represents Rent? How many represent Food? Cash Entertainment? Your pie chart should look something like this:

Handout 29, Transparency 29
Activities

Third Activity: 15 Minutes

1. **Use** the "pizza slices" to introduce employees *circle graphs* and *pie charts*. **Start** with a slice of 10% (36°) as a measuring device.

2. To show employees how to estimate using manipulatives. If you want to be more specific, cut out an entire circle from construction paper, and **cut out** additional slices of about 36° (10% of the circle) and 90° (25% of the circle).

3. **Distribute** and **project** "Reading and Interpreting Circle Graphs".

4. Have students complete.
Building Frequency Tables

Empty your pocket change onto your desk and count it. When your instructor tells you, record the amount on the sheet below.

1. Fill in the table as your classmates tell you the amounts:

<table>
<thead>
<tr>
<th>Amount of Pocket Money ($)</th>
<th>Tally</th>
<th>Frequency (Number)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$ 0.00 - $4.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$ 5.00 - $9.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$10.00 - $14.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$15.00 - $19.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$20.00 - $24.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$25.00 - $29.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$30.00 or more</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Which category has the most money?

3. Which category has the lowest number?

Handout 30, Transparency 30
\section*{Activities}

\vspace{10pt}

\begin{itemize}
  \item[1.] \textbf{Distribute} and \textbf{project} "Building Frequency Tables". Now \textbf{take out} your pocket change and put it on your desk. \textbf{Ask} all employees to do the same. (To spare possible embarrassment, \textbf{comment} that some people don't carry pocket change. Some "zeros" help in this lesson.)
  \item[2.] \textbf{Ask} each employee to count his or her change and to wait for your instructions. When all are ready, \textbf{ask} the first employee to report the amount of change he or she has on the desk. At that point \textbf{show} all employees how to \textit{tally} in the pre-made frequency table. If these frequencies are inadequate, \textbf{choose} others and \textbf{instruct} employees to scratch out the old ones and put in your new ones (or have them tally on a different paper).
  \item[Distribute] and \textbf{project} "Building Bar Charts".

\textbf{Note:} Chances are you won't have enough data to fill in a decent frequency table. Be prepared, therefore, to "make up" some data (\textit{a phenomenon not totally unknown to statisticians}). Start again and have employees estimate the most pocket money they generally carry.
  \item[3.] \textbf{Summarize} the information from today's lesson.
  \item[4.] \textbf{Say} good-bye.
\end{itemize}
Lesson Description

This lesson introduces the basic tools of descriptive and inferential statistics, measures of central tendency (mean, median, and mode), and one measure of dispersion (range).

In the activities, employees begin with physical manipulatives and then progress to simple word problems. As they complete the activities, employees are introduced to the basic concepts and to the terms mean, median, mode, and range. Thus the lesson serves a valuable purpose in the overall objective of this module, namely, to increase the employees' ability to interpret and create control charts correctly.
Lesson 5: Basic Statistics

Objectives

By completing this lesson, employees will be able to:

1. **Define** mean, median, mode, and range.
2. **Calculate** mean, median, mode, and range.
3. **Apply** their understanding of mean, median, mode, and range to word problems.

Materials Needed

**Hardware**

1. Cuisenaire rods (preferably one set per employee, but at least enough to share in groups of two or three)
2. Transparent Cuisenaire rods (to project on the overhead)
3. A balance with multiple hooks on each side or a set of yardsticks or meter sticks (one for every two employees)
4. 200 pennies (two rolls)

**Handouts**

- "Exercises on the Balancing Point" (Handout 32a and 32b)
- "Steps in Finding the Average or Mean" (Handout 33)
- "Exercises in Finding the Average or Mean" (Handout 34a, 34b, 34c)
- "Finding the Median" (Handout 35a, 35b)
- "Steps in Calculating the Mean" (Handout 36a, 36b)
- "Calculating the Median" (Handout 37)
- "Finding the Mode" (Handout 38a, 38b)
- "Finding the Range" (Handout 39)
- "Finding the Average or Mean" (Handout 40a, 40b)

**Transparencies**

- "Exercises on the Balancing Point" (Transparency 32a and 32b)
- "Steps in Finding the Average or Mean" (Transparency 33)
- "Exercises in Finding the Average or Mean" (Transparency 34a, 34b, 34c)
- "Finding the Median" (Transparency 35a, 35b)
- "Steps in Calculating the Mean" (Transparency 36a, 36b)
- "Calculating the Median" (Transparency 37)
- "Finding the Mode" (Transparency 38a, 38b)
- "Finding the Range" (Transparency 39)
- "Finding the Average or Mean" (Transparency 40a, 40b)

Materials (cont’d)

- "Additional Exercises in Finding the Average or Mean" (Handout 35a, 35b)
- "Finding the Median" (Handout 36a, 36b)
- "Steps in Calculating the Mean" (Handout 37)
- "Calculating the Median" (Handout 38a, 38b)
- "Finding the Mode" (Handout 39)
- "Finding the Range" (Handout 40a, 40b)

Classroom Set-up

Total Time: 90 minutes

Opening - Small Groups 10 min.
First Activity - Small Groups 15 min.
Second Activity - Small Groups 15 min.
Third Activity - Small Groups 15 min.
Fourth Activity - Large Group 15 min.
Fifth Activity - Large Group 5 min.
Sixth Activity - Large Group 10 min.
Ending - Large Group 5 min.
Exercises on the Balancing Point

1. Balance the yardstick or meter stick using a pen or pencil (or your index finger). Have the other partner identify where the yardstick balances. Look at the yardstick and mark off the position. Write this number here:

   Yardstick balance position is at ___ inches.

2. While one partner continues balancing the yardstick, the other partner now places one plastic cube at the 35-inch mark (or 35-centimeter mark). Have the other partner identify the yardstick balance position. Look at the yardstick and mark off the position. Write this number here:

   Yardstick balance position is at ___ inches.

3. To balance the yardstick or meter stick, you must place the pencil (or your index finger) at the balance point. Explain the change in your partner's sound.

4. If you have a yardstick:
   \[ \frac{1 + 35 + 55}{3} \]

5. If you have a meter stick:
   \[ \frac{1 + 99 + 99}{3} \]

6. Now assume that in Exercise 1 above your findings are incorrect. Number of cubes:

   a. 4
   b. 5
   c. 6
   d. 7
   e. 8

   What is the change? Explain.

7. Now assume that in Exercise 1 above your findings are correct. Number of cubes:

   a. 4
   b. 5
   c. 6
   d. 7
   e. 8

   What is the change? Describe.

To balance the stick once more, what must you place the pencil (or your index finger) at? Complete the following math:

8. If you have a yardstick:
   \[ \frac{1 + 35 + 55}{3} \]

9. If you have a meter stick:
   \[ \frac{1 + 99 + 99}{3} \]

10. Now switch places with your partner. Experiment placing various numbers of plastic cubes along the yardstick and observe how the balance point changes. Write down where the stick balances.

   Location on the stick:
   Number of cubes:

   a. 1
   b. 2
   c. 3
   d. 4
   e. 5

   How many cubes did you place to make the stick balance at ___ inches? 10. How many cubes did you place to make the stick balance at ___ inches?
\textbf{Activities}

\textbf{Opening: 10 Minutes}

1. \textbf{Welcome} the group. \textbf{Discuss} the idea of the \textit{mean} or \textit{average} as a \textit{balancing point}. \textbf{Explain} the balance that we observe, for example, on an old-fashioned balance or on a teeter-totter.

2. \textbf{Use} the balance to demonstrate the idea of a \textit{mean}. Next, use a yardstick and small weights (or Cuisenaire rods or coins) to illustrate the physical meaning of \textit{mean} or \textit{average}. \textbf{Explain} that the point where the yardstick balances is the \textit{mean}.

3. \textbf{Distribute} and \textbf{project} "Exercises on the Balancing Point". \textbf{Instruct} employees to pair off in groups of two.
Steps In Finding the Average or Mean

To find the average or the mean, follow these steps:

1. Count how many separate numbers you are working with.
2. Add up all the numbers to find the sum.
3. Divide the sum by how many numbers.

Example: Assume you have a list of 20 numbers and they total 180. To find the average or mean of 20 numbers, apply the step above:

1. How many numbers?
   A: 20
2. What is their sum?
   A: 180
3. What is their average or mean?
   A: 180/20 = 9
\textbf{Activities}

\textbf{First Activity: 15 Minutes}

1. Distribute "Steps in Finding the Average or Mean" and project it on the overhead. Also distribute some pennies to each employee. Explain that this activity will help employees understand the concept of mean.

2. Arrange two groups of pennies on the overhead—2 pennies in one group (call this set "Ken's money") and 4 pennies in the other (call this set "Alfred's money"). The screen should look like this:

   \begin{align*}
   \text{Ken's money} & \quad \text{Alfred's money} \\
   \end{align*}

3. Point out that finding the average is essentially the same as trying to "even out" the groups of pennies so that each group has the same number of pennies.

4. Repeat the exercise with a group of 2 pennies and a group of 3 pennies. Explain the need here to split a penny in half in order to average the groups (the average of 2 and 3 is 2.5).

5. Distribute "Exercises in Finding the Average or Mean" and project these exercises on the overhead. Lead employees through the exercises.
Lesson 5: Basic Statistics

Finding the Average or Mean

- Place all your pocket change in front of you. Add up all the change you have and tell the instructor your total. Find the average or mean amount of pocket change for your group.

- Find the average height of your group. Measure your height and the instructor’s height on the board. Add all the heights together and find the average or mean height for the entire class.

- Create a problem using data from two or three people in the class, or using data from an earlier class. If you don’t have enough space here, do your calculations on a separate piece of paper.

Additional Exercises in Finding the Average or Mean

- Choose a partner. Each of you will now make up one problem that requires you to find the average or mean. Then work together to solve the problem. Your problem should:
  a. Include the average number of hours you and your partner spend on food for your families each month.
  b. Include the average number of hours you spend on your families each month.
  c. Include the average number of hours you and your partner spend on non-food items for your families each month.

- Find the other employees in your group who do the same job. Each of you will now make up a story problem that requires you to find the average or mean. Then work together to solve the problem. Your problems should:
  a. Include the average number of hours you and your partner spend on food for your families each month.
  b. Include the average number of hours you and your partner spend on non-food items for your families each month.
  c. Include the average number of hours you and your partner spend on non-food items for your families each month.

- Create similar problems using data from two or three people in your class, or using data from an earlier class. If you don’t have enough space here, do your calculations on a separate piece of paper.

Handout 35a Transparency 35a

Handout 35b Transparency 35b
Activities

Second Activity: 15 Minutes

1. Tell employees that they will now practice taking the average of numbers. Distribute “Additional Exercises in Finding the Average or Mean” and project both sheets on the overhead.

2. Explain that you will read each exercise and then give the class time to work it out.

3. Allow employees to work in pairs if you wish.

4. Walk around the room to help individuals or groups as needed. Complete as many exercises as time permits.

5. Reinforce the concepts of average and mean, and close the activity.
Finding the Median

1. What is the average of the number of rods your teacher has put on the overhead?

2. Look at the numbers 2, 10, 1, 1, 1, 1, 1, 1, 2, 3, 3 again. How well does the average represent this entire set of numbers? Explain your answer.

3. Sometimes the median, not the mean or average, is a better statistic to use to represent a group of numbers as a whole. To find the median of the numbers listed in the numbers 2, 10, 1, 1, 1, 1, 1, 1, 2, 3, 3, do this:
   a. First arrange the numbers from left to right, like this:
      1, 1, 1, 1, 1, 2, 3, 3, 10, 10
   b. Then find the middle number. Since eleven numbers are displayed, the median is the sixth number, 1.

4. Which number better represents the number of years an employee has worked for this company, the average or the median?

5. Find the AVERAGE pay for these 11 workers.

6. To find the median hourly pay for the 11 people above, (a) put the salaries in order, (b) find the middle person, and (c) read that number.

   Fred  Tony  Juan  Peg  Don  Tran  Dave  Pedro  Bob  Kim  Rosa
   $7  $20  $5  $5  $5  $5  $5  $5  $5  $5  $5

   What is the median pay?
### Activities

#### Third Activity: 15 Minutes

1. **Tell** employees that they will now learn the concept of *median*.

2. **Place** a handful of Cuisenaire rods on the overhead; choose a set that looks something like this: 2, 10, 1, 1, 1, 1, 10, 1, 2, 1, 1. (The idea is to show that the mean is not always a good measure of central tendency.)

3. First **ask** employees if they could find the mean of these rods. **Show** them the calculation on the board.

4. **Explain** that the median is at times a better measure of central tendency. **Refer** to the example above. **Say,** "Suppose these numbers represent the number of years 11 employees have been with the company. The average is about 3 years, but the median is one year, and the median is a truer measure of the number of years this group of 11 people has been with the company.

5. **Distribute** "Finding the Median" and **project** each sheet on the overhead as employees complete the problems.
Steps in Calculating the Median

To find the median, follow these steps:

1. Rewrite the data from smallest to largest.

2. If there is an odd number of data, the middle number is the median. For example, given 19 separate pieces of data, the median is 9; given 27 pieces, the median is 14, etc.

3. If there is an even number of data, the median position will be between the two middle numbers. The average of these two numbers is the median. For example, given 14 pieces of data, the median falls between 7 and 8, therefore, the median is 7.5.

Calculating the Median

Steps in calculating the median:

1. Rewrite the data from smallest to largest.

2. If the number of data is odd, the middle number is the median. Example: 1, 2, 3, 4, 5; the median is 3.

3. If the number of data is even, the median is the average of the two middle numbers. Example: 1, 2, 3, 4; the median is (2 + 3) / 2 = 2.5.

Handout 38a, Transparency 38a

Handout 38b
  Transparency 38b
Activities

Fourth Activity: 15 Minutes

1. **Use** the same data from the Third Activity, but now **compute** the median by **formula**. Conduct this activity together as a class, not in groups.

2. **Distribute** "Steps in Calculating the Median" and **project** it on the overhead. **Explain** the steps to the class.

3. **Distribute** "Calculating the Median" and **project** both sheets on the overhead.
Finding the Mode

In the following set of numbers, which number occurs most often? (The answer is the mode.)

1. Find the mode in the numbers: 2, 10, 1, 1, 1, 1, 10, 1, 1, 1

2. Find the mode of the hourly salary for the people in the table below:

<table>
<thead>
<tr>
<th></th>
<th>Juan</th>
<th>Rosa</th>
<th>Pat</th>
<th>Dan</th>
<th>Tran</th>
<th>Pedro</th>
<th>Kim</th>
<th>Bob</th>
<th>Tony</th>
<th>Dave</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salary</td>
<td>$5</td>
<td>$5</td>
<td>$5</td>
<td>$5</td>
<td>$5</td>
<td>$5</td>
<td>$4</td>
<td>$7</td>
<td>$20</td>
<td>$20</td>
</tr>
</tbody>
</table>

3. Find the mode of pocket change for the entire class.

4. Find the mode of the height of the class, including the teacher.

Handout 39, Transparency 39
Activities

Fifth Activity: 5 Minutes

1. **Explain** that the mode is the number that occurs the most. **Tell** the class, "Mode is the easiest statistic to identify." **Repeat** the exercises in the Second, Third, and Fourth Activities—this time to identify the mode. **Place** a handful of Cuisenaire rods on the overhead. **Choose** a set that looks something like this:

   2, 10, 1, 1, 1, 10, 1, 2, 1, 1

2. **Explain** that the mode provides a quick way of arriving at a measure of central tendency. **Tell** employees that the mode is not used very often in quality control.

3. **Distribute** "Finding the Mode" and **project** it on the overhead. **Lead** employees through the exercises.
Lesson 5: Basic Statistics

Finding the Range

Complete the problems below.

1. Take two equal-size plastic rods or two equal coins and place them on a yardstick one at the 1-inch mark, the other at the 35-inch mark. The range is the difference between the highest and the lowest score. In this case, there are only two scores: 35 and 1. What is the difference—the range—between 35 and 1?

2. Now move the plastic rods or coins to the 16-inch mark and the 20-inch mark. When does the yardstick balance? What is the difference—that is, the range—between 20 and 16?

3. At what other position can you balance the Cuisenaire rods or coins at the 18-inch mark? What is the range in each case?

4. Find the range of these scores: 2, 10, 1, 1, 1, 10, 1, 2, 1, 1.

5. Find the range of the hourly salary for the people listed below:
   - Juan: $15
   - Rosa: $15
   - Peg: $15
   - Dan: $15
   - Tran: $15
   - Pedro: $15
   - Kim: $15
   - Rob: $15
   - Fred: $15
   - Tony: $15
   - Dave: $20

6. Your instructor will ask everyone in the class to place his or her pocket change on the desk. As employees tell their totals, the instructor will write each amount on the board. When the instructor has written the last amount on the board, find the range of pocket change for the class.

7. Find the range of the height of your class, including the instructor. Work in pairs to measure everyone's height. After the instructor has written the heights on the board, find the range for the entire class.

Handout 40a, Transparency 40a

Handout 40b, Transparency 40b
Activities

Sixth Activity: 10 Minutes

1. Tell the class, “Range is the simplest measure of dispersion.”

2. Distribute “Finding the Range” and project it on the overhead. Lead employees through the problems.
Activities

Ending: 5 Minutes

1. **Review** concepts of median, mean, mode and range.

2. **Ask** class how they might use these new skills back at work and at home.

3. **Say** good-bye.
Math for Statistical Process Control

Making Numbers Count

Lesson 6
Control Charts
Lesson Description

This lesson begins with common examples of control processes used in everyday life (for instance, tuning an old-fashioned radio and focusing a camera) and progresses to control processes used in manufacturing operations.

All manufacturing companies try to control the quality of their processes, but quality control is not limited to manufacturing, of course. Restaurants, dental offices, supermarkets—all businesses aim for consistent quality. For manufacturers, however, quality control is especially important; indeed, manufacturing quality control is critical to the success of our national economy. This lesson helps employees appreciate their roles in and their contribution to manufacturing Statistical Process Control (SPC).
Lesson 6: Control Charts

Objectives
By completing this lesson, employees will be able to:

1. **Recognize** quality control processes in everyday life.
2. **Relate** common quality control processes with manufacturing Statistical Process Control (SPC).
3. **Interpret** a control chart.
4. **Build** a control chart.

Materials Needed

**Hardware**
1. Overhead projector and screen
2. Transparency pens
3. Dice (2 dice per group)
4. Calculators
5. A ball of string
6. Blindfold

**Transparencies**
- "Quality Control in the World Around Us" (Transparency 41)
- "Quality Control in the World Around Us - Questions" (Transparency 42)
- "A Sample Control Chart" (Transparency 43)
- "A Sample Control Chart Summary Sheet" (Transparency 44)
- "Control Chart" (Transparency 45)

**Handouts**
- "Quality Control in the World Around Us" (Handout 41)
- "Quality Control in the World Around Us - Questions" (Handout 42)
- "A Sample Control Chart" (Handout 43)
- "A Blank Control Chart Sheet" (Handout 44)
- "Control Chart" (Handout 45)

Classroom Set-up

**Total Time: 90 minutes**
- Opening- Large Group 15 min.
- First Activity- Large Group 10 min.
- Second Activity- Sm. Groups (of 3) 40 min.
- Third Activity- Large Group 20 min.
- Ending Activity- Large Group 5 min.
Quality Control in the World Around Us

Follow your instructor's directions for this exercise.

Have you seen old-fashioned radios? Listeners tuned them very carefully, turning the tuning knob from a little to the left, then a little to the right, then left again and right again, each time adjusting the knob slightly, moving in smaller and smaller increments until the tuning was "just right."

Whenever listeners changed stations, they had to repeat this process to make sure their radios did not "shift" from the broadcast signals.

Sound-mixing studios still use this method today to make tapes and CDs. Sound engineers use very sensitive gauges that tell them when the sound is "just right," that is, when the gauge is in the middle. There are many other examples of quality control in everyday life.

You are using quality control when you adjust the focus on your camera, the time on your watch, the volume, brightness, or contrast control of your TV set, the speed of your car, the brightness of a lamp, the amount of sugar in your coffee and the amount of salt in your soup.

Consider quality control in your everyday life, then answer the following questions.

1. Name two quality control processes that you use in everyday life.
2. Why do tape and CD manufacturers use sensitive sound equipment to keep the sound "in control?"
3. Why is it important to have a camera in focus before taking a picture?
4. Name two automatic process controls that you use in everyday life.
Activities

Opening: 10 Minutes

1. Welcome group.

2. Distribute and project "Quality Control in the World Around You". Deliberately leave the transparency out of focus. Wait until an employee points out the transparency is out of focus; then play with the adjustment knob, deliberately keeping the image out of focus by going slightly past the focus point in each direction several times. Finally, focus the image properly. Now say to the class, "Adjusting the knob on this projector is an example of quality control."

3. Instruct the class to read the Handout along with you as you read it aloud; stop as necessary to explain or discuss words.

4. Distribute and project "Quality Control in the World Around Us Questions". Answer the questions.

5. Draw a picture of a sound gauge on the screen; point out that the sound is best when the needle is in the middle—the process is "in control."
Activities

First Activity: 10 Minutes

1. Tell employees they are about to play a brief game. Proceed as follows:

2. Ask them to stand up. Then ask for four volunteers. Have the volunteers work in pairs; instruct each pair to hold a long piece of string so as to form a path a little narrower than a normal sidewalk. Make the path as long as the room will allow (say, 12 to 20 feet long).

3. Ask the volunteers to hold the strings taut, parallel, and close to the floor (or on the floor). (Note: If string is not available, place tiles on the floor or arrange two long tables or a row of chairs as your path.)

4. Ask for another volunteer to walk the path; then blindfold the volunteer. Tell him or her to walk the length of the path without touching the strings. Instruct the class to yell “Stop! You’re out of control!” whenever the blindfolded employee touches the string.

5. Next, ask another volunteer to guide the person down the middle of the path. Instruct the class to cheer and applaud whenever the blindfolded employee makes it to the other side.
Lesson 6: Control Charts

A Sample Control Chart

Control Chart

UCL

LCL

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Sample Number

Handout 43, Transparency 43
Activities

First Activity (continued):

6. **Explain** the parallels between this simple game and a control chart: In a manufacturing process, the control chart helps keep within the acceptable tolerances of quality. In the game, the blindfolded person is the "product" coming down the assembly line. When the group yells "Stop!" the line is stopped until the problem is fixed, until the blindfolded person is in the middle of the lane again.

7. **Distribute** and **project** "A Sample Control Chart". **Explain** the details of the control chart. **Explain** that there are x-bar charts, where x-bar (it's actually x-bar-bar, since it's the mean of the sample means, called the grand mean) is the line that shows the process is in control, and there are R (Range) control charts where the range is the in-control middle line.

8. **Point out** the following:
   
   a. The middle of the process is the midline of the control chart, the x-bar-bar line.
   
   b. The lines on either side represent the two strings in the exercise:
      
      - **LCL** = *Lower Control Limit*. In a soda bottling operation, for example, the LCL could indicate that the bottles are being underfilled, which would certainly cause customer complaints.
      
      - **UCL** = *Upper Control Limit*. If the bottles are overfilled, the company loses money; furthermore, overfilling could cause a problem with the capping process.
      
      - **Repeat** the same procedure for the R-chart.

   c. If possible, show control chart examples from the company. If it is not possible, have a sample control chart made up to show the class.
Lesson 6: Control Charts

A Sample Control Chart Summary Sheet

<table>
<thead>
<tr>
<th>Sample n</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
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<td>Value</td>
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</tr>
<tr>
<td>Total n</td>
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</tbody>
</table>

Transparency 44

Lesson 6: Control Charts

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\section*{Activities}

\subsection*{Second Activity: 40 Minutes}

1. **Explain** to the class that the dice game “craps” provides insights into the concept of a control chart. **Describe** briefly the game of craps if you are familiar with it; if you are not, simply **tell** employees that in the game, players throw the dice and wager on the numbers that will appear (the “number” is the sum of the spots that show faceup). Thus throwing a 3 and a 5 gives the number 8.

\textit{(Note:} On average, 7 is the number that shows up most of the time. Thus we will say the system is in control if the average of five throws of the dice is 7 plus or minus an “error” of 1 (for a sample of 5 throws, the standard deviation is about 1.08). In other words, 6, 7, and 8 are the in-control numbers, and 2, 3, 4, 5, 8, 10, 11, and 12 are the out-of-control numbers).\textit{)}

2. **Tell** them you will show them the process and then will let them try the game in groups of threes.

3. **Project** “A Sample Control Chart Summary” on the overhead, and **explain** to the class that when completed, their work will look like the transparency. **Tell** employees they will:

   a. Take 16 samples of a “manufacturing process.”
   b. Mark the time they take each sample.
   c. Toss the dice five times and then find:
      
      \begin{itemize}
      
      \item The sum.
      \item The average.
      \item The range for each column.
      \end{itemize}
   d. Repeat this process 8 times
<table>
<thead>
<tr>
<th>Sample Control Chart Summary Sheet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
</tr>
</tbody>
</table>
Activities

Second Activity (continued):

4. **Stop** when employees get to the 8th column. Now **show** them how to “load” one of the dice. *(Important: Loading the dice is crucial to this lesson! When a machine on the assembly line “slips a gear” or has some other mechanical failure, the control chart is generally the first proof of this problem. By loading the dice, of course, the employees cause the problem. **Mention** random real-life events such as getting a flat tire when you least expect it. **Explain** that control charts are designed to identify such problems.) Load the dice as follows:

   a. **Turn** one die to the face with 5 dots.
   b. **Tape** a tiny bit of sticky paper on the middle dot, covering the middle dot and thus turning the “5” into a “4.” Now there are two 4s!
   c. Next, using an overhead pen mark an extra dot on the “3” face of the same die making it into a “4.”
   d. Now this die has the following faces: 1, 2, 4, 4, 4, 6, instead of the usual 1, 2, 3, 4, 5, 6.

5. When you finish, **project** “A Sample Control Chart Summary” on the overhead. **Ask** an employee to come to the front to help you.

6. With the help of the employee, **demonstrate** how to fill out the chart:

   a. **Record** the time that the process starts—first the hour next to the word “Sample” and then under the number 1.
### Control Charts

#### Handout 44

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>9</td>
<td>10</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>13</td>
<td>14</td>
<td>15</td>
<td>16</td>
</tr>
</tbody>
</table>

A Blank Control Chart Sheet

---

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Activities

Second Activity (continued):

b. **Ask** the employee to roll the dice on the table, and **record** the sum in the first position: Sample #1, Toss #1.

c. **Proceed** to fill in the first column; **explain** that this is the first of 16 throws.

d. **Find** the average of the first column (add the five numbers and divide by 5). Make sure the employees follow your procedure!

Find the Range using this formula:

\[ \text{Range} = \text{Maximum Value} - \text{Minimum Value} \]

6. **Ask** employees to form groups of three.

7. **Distribute** “A Blank Control Chart Sheet” to each group.

8. **Instruct** employees to fill in the first 8 columns using the same procedure you used. **Walk around** the room to help each group.

9. When all 8 columns are filled, **stop** the groups and **direct** employees to “load” the dice.

10. **Repeat** the process with the loaded dice. Fill in the rest of the chart beginning with the ninth column.
Lesson 6: Control Charts

Handout 45, Transparency 45

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Activities

Third Activity: 25 Minutes

1. Immediately after completing the Second Activity, distribute “Control Chart” to each group, and project it on the overhead.

2. Direct the employees to plot the 16 means on the control chart. Start them off by plotting the first few points.
Activities

Ending: 15 Minutes

1. **Review** the main points from the lesson. Make sure to emphasize the importance of quality control in the workplace.

2. **Ask** "Where could or do you use these concepts at work?"

3. **Summarize** all six lessons.

4. **Distribute** "Posttest" and "Learner Assessment". Have employees complete.

5. **Say** good-bye.
Pretest/Posttest

On the blank line, write the letter of the correct answer.

1. SPC stands for:
   a. Set Production Content
   b. Statistical Process Control
   c. It does not stand for anything

2. Whole numbers are represented by:
   a. tens, hundreds, thousands, etc.
   b. tenths, hundredths, thousandths, etc.
   c. fractions

3. To add and subtract decimals you,
   a. Line up by the last number
   b. Line up by the first number
   c. Line up by the decimal

4. To find the average of a group of numbers you,
   a. Put the numbers in numerical order and find the middle number
   b. Count how many separate numbers you are working with, add up all the numbers to find the sum, divide the sum by how many numbers there are.
   c. Find the difference between the highest and lowest numbers.

How well do you agree or disagree with the questions below? Using the following scale, circle the number that best represents your answer:

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&quot;Strongly agree&quot;</td>
<td>&quot;Agree&quot;</td>
<td>&quot;Disagree&quot;</td>
<td>&quot;Strongly disagree&quot;</td>
</tr>
</tbody>
</table>

5. I understand how my job effects other employees and departments.
   1   2   3   4

6. I feel comfortable adding, subtracting, multiplying and dividing decimals.
   1   2   3   4

7. I feel comfortable figuring out percentages.
   1   2   3   4

8. I know how to figure out mean, median, mode, and range.
   1   2   3   4

9. I read charts and graphs to find out information in my life.
   1   2   3   4

10. I use quality control processes every day.
    1   2   3   4

11. I know when to use mean, median and mode.
    1   2   3   4

12. I use a calculator when I need to figure out a math problem.
    1   2   3   4
Your instructor will complete these questions

Instructor ____________________________

Class Schedule ________________________

Module ______________________________

A. Course Number ______________________ Site Location ______________________

B. Who completed this form? (MARK ONE BOX)

☐ The learner
☐ The learner, with assistance from instructor or project staff
☐ An instructor or project staff member with information provided by the learner
☐ Other (Please specify) ____________________________

C. Date form completed: __/__/____

1. Name: ______________________________

2. Address: ____________________________

3. Phone Number: ( ) __________________

4. Social Security Number: ___________ - _______ - _______

5. In the future, do you plan to take any of the following courses?

(Mark one for each line)

Plan to Take       Do Not Plan to Take

☐ A basic skills course in reading, writing, or math.
☐ A course in using English (such as ESL).
☐ A computer course.
☐ A GED course or the GED exam.
☐ Courses to get an occupational certificate.
☐ A job training course.
☐ Courses leading to a 2-year or 4-year college degree.
☐ A home-study course.
Learner Assessment Form V
Math for Statistical Process Control

Since this course began, have you:

(Mark one for each line)

Learned what you wanted to learn in this course? □ YES □ NO
Changed your educational or career goals? □ YES □ NO
Had more responsibility added to your job? □ YES □ NO
Moved to a shift you prefer? □ YES □ NO
Switched from part-time to full-time? □ YES □ NO
Received a pay raise? □ YES □ NO
Been promoted? □ YES □ NO
Received an award, bonus, or other special recognition on your job? □ YES □ NO
Received your GED? □ YES □ NO
Applied for a new job? □ YES □ NO
Started a new job at another company? □ YES □ NO
Been laid off? □ YES □ NO
Left your job for any other reason? (Please Specify) □ YES □ NO

7. Please rate your ability to perform each of the following activities.

(Please mark one response for every activity)

Read English: □ Poor □ Fair □ Good □ Excellent
Understand English: □ Poor □ Fair □ Good □ Excellent
Speak English: □ Poor □ Fair □ Good □ Excellent
Write in English: □ Poor □ Fair □ Good □ Excellent
Work as part of a team: □ Poor □ Fair □ Good □ Excellent
Use math: □ Poor □ Fair □ Good □ Excellent
Solve problems/use reasoning: □ Poor □ Fair □ Good □ Excellent

Thank you. You have completed this form. Please return it to your instructor.
Instructor: ________________________________
Class Schedule: __________________________
Module: __________________________________

Your instructor will complete these questions

A. Course Number: _________________________
   Site Location: ___________________________

B. Who completed this form?
   (MARK ONE BOX)
   ☐ The learner
   ☐ The learner, with assistance from
     instructor or project staff
   ☐ An instructor or project staff mem-
     ber with information provided by
     the learner
   ☐ Other (Please specify) ____________________

C. Date form completed: __/__/____

Name: ________________________________

2. Address: _______________________________

3. Phone Number: ( ) _________________

4. Social Security Number: ___________

5. Age: __________

6. Were you born in the United States?
   ☐ Yes ☐ No

7. Sex: ☐ Male ☐ Female

8. Race: (Mark One Box)
   ☐ White
   ☐ Black (African American)
   ☐ Asian or Pacific Islander
   ☐ American Indian or Alaskan Native
   ☐ Hispanic
   ☐ Other (Please specify):

9. Is English the language that is spoken most
   often in your home?
   ☐ Yes ☐ No

10. How many years of school have you
    completed? ___________
    Of these, how many in the U.S.? _______
    In any other country? ___________

11. Are you a union member?
   ☐ Yes- What is the name of your union?
       ________________________________
   ☐ No

12. Please rate your ability to perform each of
    the following activities.

    (Please mark one response for every activity)

    | Activity               | Poor | Fair | Good | Excellent |
    |------------------------|------|------|------|-----------|
    | Read English           | ☐    | ☐    | ☐    | ☐         |
    | Understand English     | ☐    | ☐    | ☐    | ☐         |
    | Speak English          | ☐    | ☐    | ☐    | ☐         |
    | Write in English       | ☐    | ☐    | ☐    | ☐         |
    | Work as part of a team | ☐    | ☐    | ☐    | ☐         |
    | Use math               | ☐    | ☐    | ☐    | ☐         |
    | Solve problems/use rea-
    soning                | ☐    | ☐    | ☐    | ☐         |

13. Do you have a job?
   ☐ Yes, employed
   ☐ Yes, on temporary layoff Go to next
   ☐ No, retired
   ☐ No, not employed STOP

Thank you. You have completed this form.
Please return it to your instructor.
Please answer questions 14-18 for the job that allows you to take this course.

14. Name of company or employer: ________________________________

15. Job Title: ________________________________

16. On average, how many hours per week do you work on this job?
   ______ - _______ Hours per week

17. How much do you earn at this job?
   (Write amount and mark one box)
   $_______  □ Per hour  □ Per year

18. Do you get any of the following benefits at this job?
   (Mark one for each line)

   Yes   No
   Paid vacation  □  □
   Paid sick leave □  □
   Paid holidays  □  □
   Health insurance □  □

19. How long have you worked at this job?
   ______ - _______ and ______ - _______
      years      months

20. At your job, do you need to do any of the following?
   (Mark one for each line)

   Yes  No
   Read instructions  □  □
   Receive spoken instructions in English  □  □
   Speak English  □  □
   Work as part of a team  □  □
   Write in English  □  □
   Use math  □  □
   Solve problems/use reasoning  □  □

21. Do you work at more than one job?
   □ Yes  □ No

Thank you. You have completed this form. Please return it to your instructor.
Getting to Know You

In this exercise you'll get to know your classmates better!

Use the questions below to interview a partner. Then your partner will interview you! At the end of class, you will use the answers on this filled-out worksheet to introduce your partner to the class. Then your partner will introduce you!

First name __________________________ Last name __________________________

Nickname ("friends call me...") ____________________________________________

Three coworkers names ____________________________________________________

_________________________________  _________________________________

Mother's name ___________________________________________________________

Father's name __________________________________________________________

Husband's or wife's name ________________________________________________

Children's names

_________________________________  _________________________________

_________________________________  _________________________________

Favorite foods __________________________________________________________

Favorite singer __________________________________________________________

How did you hear of this company? _______________________________________

_____________________________________________________________________

How long have you worked at this company? ______________________________

_____________________________________________________________________

Name of supervisor _____________________________________________________

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Handout 1
My Job Is...

Answer the questions below so that you can discuss your job with the group.

1. What is your job title?

2. What department do you work in?

3. What is the name of each part you make or assemble?

4. Where does the part you work on come from? (Which department or coworker?)

5. After you finish your work, where do you send the part you work on?

6. What happens if the part you get is not made correctly? What if you cannot work on it or you have to fix it first? What do you say to the person who sends you the part? Do you send the bad part back?

7. Do you tell your boss when you get a bad part? What do you say?

8. Do you ever have bad parts sent back to you because they weren't made right? About how many parts are returned to you in one week?
The Company Team

1. What is the name of your company?

2. What is the name of the President of your company?

3. What is the name of the visitor today?

4. What products does your company make?

5. What are these products used for?

6. Have you ever used one of these products yourself?
Reading and Writing Numbers

In this lesson you will learn (1) to read and write numbers, (2) to add, subtract, multiply, and divide whole numbers, and (3) to take the square root of a number.

1. In our number system, we write numbers so that each place tells you “How many ones?” “How many tens?” And so on.

For example, the number 34 means that you have 3 tens ("30") and 4 ones ("4"). Thus $34 = 30 + 4$. We read this number as "Thirty-four." Thirty means "3 tens" and four means "4 ones."

Note that the first place is "ones" and the second place is "tens." In other words, each place represents a specific number value.

2. The system allows you to express larger numbers by adding more places. After "tens" comes "hundreds."

$$234 = 200 + 30 + 4$$

Now you have "Two hundred thirty-four." The Two hundred means "2 hundreds"; the rest is the same as in the example above.

3. And after "hundreds" comes "thousands."

$$5,234 = 5000 + 200 + 30 + 4$$

Now you have "Five thousand two hundred thirty-four." The Five thousand means "5 thousands," and the rest is the same as in the example above.
Your Turn!

Complete the following exercises:

1. Break down the number 67 into tens and ones: 67 = ____ + ____

2. Read the following number aloud: 467

3. Break down 467 into hundreds, tens, and ones: 467 = ____ + ____ + ____

4. Jim weighs 195 pounds (say, "one hundred ninety-five pounds"). He could write his weight like this: 100 + 90 + 5

   How much do you weigh? Write your weight in groups: ____ + ____ + ____

5. Now write your weight in the usual way (for example, 195): ____

6. How do you say this number? Write it in words:

   ____________________________
Addition of Whole Numbers

Complete the following exercises.

1. Use numbers to express \( 0 + 00 = 000 \).

2. Use circles to write the meaning of \( 8 + 5 \).

3. What does \( 12 + 5 \) mean? Sometimes we write this as:
   \[
   \begin{array}{c}
   12 \\
   +5 \\
   \end{array}
   \]

4. Add: \( 400 + 52 + 19 \)

5. Add: \( 1,239 + 542 + 95 + 1 \)

6. Now try adding the following:
   \[
   \begin{array}{c}
   2 + 3 = \\
   15 + 17 = \\
   551 + 22 = \\
   702 + 1259 + 55 + 1 =
   \end{array}
   \]

Remember: Write the numbers you are adding one below the other, and then add the numbers in each column starting from the right.
Subtraction of Whole Numbers

Complete the following exercises.

1. Use numbers to express 000 - 00 = 0

2. Use circles to write the meaning of 8 - 5.

3. What does "12 - 5" mean? Sometimes we write this as:
   \[
   \begin{array}{c}
   12 \\
   -5 \\
   \end{array}
   \]

4. Subtract: 400 - 52

5. Subtract: 1,239 - 542

6. Now try these:
   \[
   \begin{array}{c}
   12 - 3 = \\
   35 - 17 = \\
   551 - 22 = \\
   702 - 259 = \\
   \end{array}
   \]

Remember: Write the numbers you are subtracting one below the other, and then subtract the numbers in each column starting from the right.
Addition and Subtraction Word Problems

As you read the following "word problems," search for the basic arithmetic information. Don't be fooled by the extra information! Follow the example:

Example:

Juan Juarez makes $300 per week and his wife Irma makes $150 per week. Together, how much money do Juan and Irma make each week?

Juan makes $300.00
Irma makes +$150.00

$450.00

Answer: The Juarez family makes $450.00 each week.

1. I drive a Toyota Corolla. My mother drives a Honda Accord, and my father prefers to drive an Oldsmobile. Our next-door neighbors have a pickup and a Honda Civic. Our upstairs neighbors have two cars.

How many cars will you see parked in front of our apartment complex when we are all home?

2. Ask the person sitting on your right how many people are sitting to his/her right. Ask the person sitting on your left how many people are sitting to his/her left. Now find the total number of people sitting in your row.

3. You have $1,500 in your checking account. Today is payday, and you receive $1,000 in your paycheck. After work, you spend $105 for groceries. After shopping, you decide to deposit the rest of your paycheck into your checking account. How much money do you have in the account after you make your deposit?
Multiplication of Whole Numbers

Multiplication

1. Use numbers to express

   000000
   000000
   000000

2. Use circles to write the meaning of 8 x 5.

3. What does 12 x 5 mean? Sometimes we write this as

   \[ \begin{array}{c}
   12 \\
   \times 5
   \end{array} \]

4. Multiply 400 x 52:

   \[ \begin{array}{c}
   400 \\
   \times 52
   \end{array} \]

5. Now try the same problem with a calculator. Ask for help if necessary!

6. Multiply using a calculator: 1,239 x 542 x 95 x 2
Division Problems

Complete the following exercises.

1. Use circles to express $8 \div 2$

2. Use circles to write the meaning of $8 \div 5$

3. Divide: $400 \div 52 = $

4. Divide: $1,239 \div 542 = $
Division Word Problems

As you read the following word problems, search for the basic arithmetic information. Don't be fooled by the extra information! Follow the example:

Example:

In the Juarez family, Juan makes $300 per week and his wife Irma makes $150 per week. What is the difference between Juans pay and Irmas pay?

Answer: $300 - $150 = $150. The difference in pay is $150.

But we can also say that Juan earns twice as much as Irma—or that he earns 2 times what Irma earns. Note the arithmetic here:

$$\frac{300}{150} = 2$$

Thus Juan earns 2 times as much as Irma earns.

Problems

1. Today is payday and you receive $1,200 in your paycheck. If you spend half of it for groceries and rent, how much of your pay do you have left?
Square Roots

1. What is the square root of $\sqrt{25}$

2. $\sqrt{25} + \sqrt{36} = \hfill$

3. What is the square root of $\sqrt{75}$

4. Wallpaper border needs to be ordered for the Johnson's kitchen. The room is 20' x 15' x 20' x 15'. How much wallpaper border do you need to order?

5. The Juarez family wants to fence in a yard that is exactly square. The area of the yard is 225 square feet. How much fencing is the Juarez family going to need?
Decimal Numbers

1. What does the number .67 mean?

\[ .67 = \underline{\_} + \underline{\_} \]

2. How do you read/write the number .67?

3. What does the number 4.67 mean?

\[ 4.67 = \underline{\_} + \underline{\_} + \underline{\_} \]

4. How do you read/write the number 4.67?

Find your own examples of decimal numbers, and repeat the exercises above.
Decimal Numbers: Adding and Subtracting

1. What does 1.2 + .5 mean?
   
   $\begin{array}{c}
   1.2 \\
   + .5 \\
   \end{array}$

2. Add: 4.00 + 5.2 + .19.
   
   $\begin{array}{c}
   4.00 \\
   + 5.2 \\
   + .19 \\
   \end{array}$

3. Add: 12.39 + 54.2 + .95 + 10

4. What does 1.2 - .5 mean? How do you write this?

5. Subtract: 4.00 - 5.2

6. Subtract: 12.39 - 5.42
Decimal Numbers: 
Addition and Subtraction Word Problems

Complete the following exercises. Follow the example.

Example:

Juan Juarez makes $225.50 per week and his wife Irma makes $150.75 per week. How much money do Irma and Juan earn each week?

Juan makes = $225.50
Irma makes = $150.75

$376.25

Answer: Irma and Juan make $376.25 each week.

1. You have $1,500.50 in your checking account. Today is payday and you receive $1,245.50 in your paycheck. On your way home, you spend $105.37 for groceries. Then you decide to deposit the rest of your paycheck into your checking account.

How much money do you have in your account after your deposit?
Decimal Numbers: Multiplying

Complete the following exercises.

1. 1.2 x 6 means 1.2 + 1.2 + 1.2 + 1.2 + 1.2 + 1.2. The sum is 7.2 (add the numbers to see for yourself).

   Instead of adding all these numbers, you can multiply two numbers, as follows:

   \[
   \begin{array}{c}
   1.2 \\
   \times 6 \\
   \hline
   7.2
   \end{array}
   \]

   As before, the answer is 7.2.

2. Multiply: 4.25 x 52

   \[
   \begin{array}{c}
   4.25 \\
   \times 52 \\
   \hline
   \end{array}
   \]

3. Now repeat #2 above but this time use a calculator. If you don't know how to use a calculator, ask someone in your group who does, or ask your instructor. You will learn how to use a calculator in the next worksheet.

   Multiply using your calculator: 4.25 x 52

4. Multiply: 12.39 x 5.42
Using the Calculator

Use your calculator to solve the following problems. Write the answers after the equals sign.

1. 3 \times 4 =
2. 30 \times 40 =
3. 300 \times 400 =
4. 3,000 \times 4,000 =
5. 30,000 \times 40,000 =

Can you read the answers that are in scientific notation? If not, ask your instructor for help.

Now use your calculator to compute the following divisions. Write your answers after the equals sign.

1. \frac{3}{4} =
2. \frac{3}{40} =
3. \frac{3}{400} =
4. \frac{3}{4,000} =
5. \frac{3}{40,000} =
6. \frac{3}{400,000} =

Can you read the answers that are in scientific notation? If not, ask your instructor for help.
Decimal Numbers: Dividing

1. Use circles to express $10 + 2.5$

2. Use circles to write the meaning of $8 + 5$.

3. Divide: $400 + 52 = $

4. Divide: $1,239 + 542 = $

5. Juan Juarez makes $325.75 per week and his wife Irma makes $155.80 per week. They divide their combined pay into 3 equal parts: one part for rent, one part for food, and one part for all other expenses.

How much do Irma and Juan spend on rent?
Percents

1. Pick a plastic square flat and count the number of small squares in it. (Or simply draw a large square on your paper and divide each side into ten parts. Now you have a 10x10 square.)

2. Cover 25 of the small squares with the small dice. (If you are working with pencil and paper, shade in 25 of the small squares.)

3. How many squares are shaded? ___ How many squares total? ___

4. We can write the above in several different ways:

   25 squares per 100 squares
   25 per 100
   25/100
   25%
   .25

All these statements mean the same thing: namely, 25 squares out of 100 squares. This is the same as one-fourth of the large square or 1 out of four or $\frac{1}{4}$ or $1 + 4$.

Use your calculator to perform this division: First press 1, then the division sign (+), then 4, and finally the equals sign (=). Answer: $25 = 25\%$.

5. Now take the 25 small plastic squares off the flat and put just 10 of them back on the flat. How do we write this new arrangement?

   per _____ or ______/______ or ______% or .10

6. Now repeat exercises 1 to 4 by covering the flat (or flats) with the following number of small squares or dice: 5, 7, 50, 90, 99, 100, 125, 200.

7. Can you repeat exercises 1 to 5 by using a circle instead of a flat? Which percents are easy to measure? Which are hard?
Percents (Continued)

Use your calculator to answer the following division problems:

1. \( \frac{20}{100} = \)
2. \( \frac{2}{10} = \)
3. \( \frac{200}{1,000} = \)
4. \( \frac{2,000}{10,000} = \)
5. \( \frac{20,000}{100,000} = \)

What pattern do you notice in the above answers?

6. Ken pays $200 per month for food. His pay each month is $1,000. What percent of Ken's pay does he spend for food?

\[
\frac{200}{1000} \text{ or } \frac{200}{1000} \text{ or } \frac{200}{1000} \%
\]

7. If you cover one half of the plastic flats with small dice (squares), then you are covering ____% of the flat.

8. If you pay 7% state sales tax, that means that for every dollar you spend, you have to pay the state ____.
To solve word problems involving percents, follow the steps below this sample problem:

**Sample Problem**

At the grocery store, Mary purchases a carton of milk for $1.59 and a pound of potatoes for $1.99. The sales tax is 7.75%. What is the total that Mary pays for her purchases?

**Step-by-Step Solution**

**Step 1: Understand and Interpret the Problem**

This problem has three parts:

a. Add Mary’s individual purchases to get a subtotal (in dollars).

b. Compute the tax—*in dollars*—that she must pay on her purchases.

c. Add the tax, *in dollars*, to the dollar amount of her purchases (the total will be her total expense).

Note that Parts a and c are simple addition. Part b is a percent computation.

**Step 2: Add the Individual Purchases**

Add Mary’s individual purchases—*in this case, $1.59 + $1.99 = $3.58.* This is the subtotal, the number on which you must calculate the sales tax.

**Step 3: Compute the Tax in Dollars**

a. *Convert the Percent to a Decimal.* To figure out the tax in dollars, you must first convert the sales tax, which is 7.75%, to a decimal number. The 7.75% tax can be expressed as $7.75/100$ or $0.0775$.

b. *Use the Decimal to Compute the Dollar Amount.* Multiply $0.0775$, the converted percent, by the subtotal: $3.58 \times 0.0775 = 0.277$.

**Step 4: Add the Dollar Tax to the Dollar Subtotal**

Mary’s total grocery expense is $3.58 + 0.277 = 3.857$, rounded to $3.59$. 

---

**Lesson 3: Decimals and Percents**

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Handout 19c
Dan's credit card account balances are as follows:

<table>
<thead>
<tr>
<th>Account</th>
<th>Interest Percent</th>
<th>Current Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Citibank Visa</td>
<td>18.94%</td>
<td>$400.01</td>
</tr>
<tr>
<td>Discover</td>
<td>14.98%</td>
<td>$398.90</td>
</tr>
<tr>
<td>Citibank MasterCard</td>
<td>19.98%</td>
<td>$401.34</td>
</tr>
</tbody>
</table>

**Question:** If you were Dan, which account would you pay off first?

**Question:** How much interest will Dan pay on each balance?

To calculate Dan's interest on these balances, convert each interest percent to a decimal, and multiply each balance by that decimal amount:

- Visa: \( \frac{18.94}{100} \times 400.01 = \)
- Discover: \( \frac{14.98}{100} \times 398.90 = \)
- MasterCard: \( \frac{19.98}{100} \times 401.34 = \)
Percents
(Continued)

Work with a partner to solve the following problem. Ask your instructor for help if necessary.

In his will, Mr. Smith left his daughter $500,000, his wife $600,000, and a local charity $200,000.

What percent of his total did Mr. Smith leave to his daughter? To his wife? To the charity?
Sample Problem 1
You are driving, and your speedometer reads 45 mph (that is, 45 miles per hour). How much distance will you cover in one hour?

Follow the steps given below to explain how to understand, to interpret, and then find the answer.

Step 1: Understand and Interpret the Problem
Basically this problem asks you to figure out miles traveled at a given mph rate.

Step 2: Convert the Symbols
Basically, mph (miles per hour) = miles/hour = m/h.

Multiplying m/h by h gives an answer in miles—that is, miles.

Step 3: Complete the Computation
Multiply 45 m/h by 1 h:

\[
45 \text{ m x } 1 \text{ h} = 45 \text{ miles}
\]

Note that the answer is in miles only.

Sample Problem 2
If you are driving 45 mph, how much distance will you cover in 10 minutes?

1. Convert 10 minutes to hours: 10 minutes = 10/60 hours or 1/6 hours.

2. Multiply 45 m/h by 1/6 h:

\[
45 \text{ m x } \frac{1}{6} \text{ h} = 7.5 \text{ miles}
\]

Note that the answer is in miles only.
Sample Problem 2
Sandra bought 10 pounds of potatoes at $1.99 per pound, 5 pounds of apples at $1.89 per pound, and 7 pounds of oranges at $1.69 per pound. How much money did Sandra pay?

Step 1: Understand and Interpret the Problem
Basically this problem asks you to figure out total cost (dollars) for three different items for sale at different rates (all expressed in dollars per pound).

Step 2: Convert the Symbols
Basically, dollars per pound = $/lb. Multiplying $/lb by lb gives an answer in $—that is, dollars only.

Step 3: Complete the Computation
a. Calculate the individual cost of each of the three items:

For the cost of 10 pounds of potatoes at $1.99 per pound, multiply the rate price ($/lb) by 10 lbs:

$1.99/lb x 10 lbs = $19.90

For the cost of 5 pounds of apples at $1.89 per pound, multiply the rate price ($/lb) by 5 lbs:

$1.89/lb x 5 lbs = $9.45

For the cost of 7 pounds of oranges at $1.69 per pound, multiply the rate price ($/lb) by 7 pounds:

$1.69/lb x 7 lbs = $11.83

b. Total the cost of the three items:

$19.90
9.45
11.83
$41.18

Answer: Sandra pays $41.18.
Your Turn!

Using what you have learned so far, compute the following problems. Be sure to proceed one step at a time!

1. The Pacific Toy Company has a production line of 90 workers. The “normal” rate of production for each worker on the line is 25 toys per day. Workers receive a bonus of $2.00 per toy for every toy they make over their daily quota.

   At the end of a workweek, how many toys will PTC produce if the workers make no extra toys?

   One week Maria made 3 toys over her quota, and Tom made 5 toys over the quota. How much of a bonus did Maria receive? How much did Tom receive?

2. Citibank Visa's interest rate is 18.87%, and its MasterCard interest rate is 18.95%. John's Visa balance is $101.96 and his MasterCard balance is $98.27.

   Which balance should John pay off first?
Rainfall for the week of 3/9

Sunday: 0.0
Monday: 0.3
Tuesday: 0.3
Wednesday: 1.2
Thursday: 1.5
Friday: 0.0
Saturday: 0.3
Costs for XYZ, Inc.

- 45% Production costs
- 25% Marketing
- 15% Miscellaneous
- 10% Research
- 5% Administration
Reading Graphs and Tables

Complete the exercises below.

1. Where will you find graphs and tables?

2. Below there are two pictures of your boss—a happy picture, and an unhappy picture. Looking at the line graphs below, predict how your boss will react to each graph as you read items a through d. Use the pictures for your "predictions."

   ![Graph A](image1) ![Graph B](image2)

   a. How will your boss react if Graph A shows the trend in profit for your company? How will your boss react to Graph B?

   b. How will your boss react if Graph A shows the number of new customers for your company? How will your boss react to Graph B?

   c. How will your boss react if Graph A shows the number of products returned by customers for your company? How will your boss react to Graph B?

   d. How will your boss react if Graph A shows sales units for your company? How will your boss react to Graph B?
Reading and Interpreting Tables

This week in Robert's department, Robert made 16 pieces of work, Juan made 20, Cathy made 16, and Kim made 12. Kim is a new worker, so Robert is working with him to provide additional training.

1. Fill in the table to show how many pieces these workers made:

<table>
<thead>
<tr>
<th>Name of Worker</th>
<th>Number of Pieces Made This Week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robert</td>
<td></td>
</tr>
<tr>
<td>Juan</td>
<td></td>
</tr>
<tr>
<td>Cathy</td>
<td></td>
</tr>
<tr>
<td>Kim</td>
<td></td>
</tr>
</tbody>
</table>

2. Which worker made the highest number?

3. Which worker made the lowest number?

4. Why did Kim make only 12 pieces this week?

5. If all the workers put their items together, how many did they make?

6. If Cathy gives Kim four items to help him out, then how many would each of the workers have?
Reading and Interpreting Bar Graphs

Compare the bar graph below with the table in Handout 25.

The graph below shows the same data as the table in the previous handout—but in bar graph form. From the bar graph, can you tell which worker made the most pieces? The least?

1. Fill in the table below using this information: The Juarez family budget this month is as follows: Rent $650, Food $1,250, Auto expenses $120, and Entertainment $85.

<table>
<thead>
<tr>
<th>Type of Expenses</th>
<th>Amount ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Draw a bar graph using the information in the table above.
Math for Statistical Process Control

Lesson 4: Descriptive Statistics

Reading and Interpreting Line Graphs

For one day, the temperatures in Los Angeles were recorded in the following table:

<table>
<thead>
<tr>
<th>Time of Day</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 AM</td>
<td>55</td>
</tr>
<tr>
<td>9 AM</td>
<td>68</td>
</tr>
<tr>
<td>12 NOON</td>
<td>85</td>
</tr>
<tr>
<td>3 PM</td>
<td>81</td>
</tr>
<tr>
<td>6 PM</td>
<td>75</td>
</tr>
<tr>
<td>9 PM</td>
<td>62</td>
</tr>
</tbody>
</table>

1. What was the highest temperature of the day?

2. What was the lowest temperature?

3. What do you guess the temperature was at 10 AM?

4. What do you guess the temperature was at 10 PM?

The line graph below represents the same data as in the table above. Now answer questions 1 through 4 above using the graph.
Reading and Interpreting Line Graphs

For one day, the temperatures in New York were recorded as follows: 6AM, 50; 9AM, 62; 12 noon, 75; 3PM, 70; 6PM, 75; and 9PM, 62. Enter this information in the following table:

<table>
<thead>
<tr>
<th>Time of Day</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. What was the highest temperature of the day?
2. What was the lowest temperature?
3. What do you guess the temperature was at 10 AM?
4. What do you guess the temperature was at 10 PM?

The line graph below shows the same data as in the table above. Now answer questions 1 through 4 above using the graph.
Comparing Line Graphs

The graph below positions the two temperature line graphs side by side, so you can compare temperatures in both cities at the same time. The line at the very bottom of the graph shows the difference in temperature.

1. What were the estimated temperatures at 9 PM (a) in Los Angeles and (b) in New York?

2. What was the difference in the estimated temperatures in the two cities at 9 PM? Does your answer agree with the “difference: in temperature” line at the bottom of the graph?

3. Guess the temperature in each city at 10 PM. Then extend both lines to those points. Can you also extend the “difference” line to 10 PM?
Reading and Interpreting Circle Graphs

Use the following "measuring device" to estimate how to interpret the pie charts in the questions. The small slice shown is 10% of the entire circle (sometimes we call circle graphs pie charts). So it takes 10 of the small ones make up the entire circle.

1. If you spend 40% on your salary on rent, how many of the small slices above represent your rent expense?

2. If 80% of your company's expenses go to employee wages, how many small slices does wage expense represent?

3. Consider Maria's budget breakdown: Rent $500, Food $300, Car $100, and Entertainment $100. Her total salary is $1,000. How many slices of the circle represent Rent? How many represent Food? Car? Entertainment? Your pie chart should look something like this:
Building Frequency Tables

Empty your pocket change onto your desk and count it. When your instructor tells you, record the amount on the sheet below:

1. Fill in the table as your classmates tell you the amounts:

<table>
<thead>
<tr>
<th>Amount of Pocket Money ($)</th>
<th>Tally (III/I)</th>
<th>Frequency (Number)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$ 0.00 - $4.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$ 5.00 - $9.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$10.00 - $14.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$15.00 - $19.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$20.00 - $24.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$25.00 - $29.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$30.00 or more</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Which category has the most money?

3. Which category has the lowest number?
Building Bar Charts

Use the data in Handout 30 to complete the bar chart below. As each person reports how much change she or he has, shade in the appropriate box. The first filled-in box represents the instructor, who claims to be broke! Your finished bar graph should like the graph at the beginning of the lesson.

<table>
<thead>
<tr>
<th>People</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0.00-$4.99</th>
<th>$5.00-$9.99</th>
<th>$10.00-$14.99</th>
<th>$15.00-$24.99</th>
<th>$25.00-$29.99</th>
<th>$30 or more</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>0.00-$4.99</th>
<th>$5.00-$9.99</th>
<th>$10.00-$14.99</th>
<th>$15.00-$24.99</th>
<th>$25.00-$29.99</th>
<th>$30 or more</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
Exercises on the Balancing Point

Work with a partner to complete the following activities. Your instructor will give you a yardstick or meter stick and some plastic rods and dice for this exercise.

1. Balance the yardstick or meter stick using a pen or pencil (or your index finger). Have the other partner identify where the yardstick balances. Look at the yardstick and read off the precise position. Write this number here:

   The yardstick balance position is at ______ inches

   The meter stick balance position is at ______ centimeters.

2. While one partner continues balancing the stick, the other partner now places one plastic cube at the 1-inch mark of the yardstick AND one plastic cube at the 35-inch mark. If you are using a meter stick, place one cube at the 1-centimeter mark and the second cube at the 99-centimeter mark. Did the balancing point change?

3. Now do the following math:

   a. If you have a yardstick: \((1 + 35) / 2\)

   b. If you have a meter stick: \((1 + 99) / 2\)
Exercises on the Balancing Point
(continued)

Continue working in pairs as you complete the following activities.

4. On the yardstick, place one cube at the 1-inch mark and two cubes at the 35-inch mark (on a meter stick, one cube at the 1-centimeter mark and two at the 99-centimeter mark). Is the balancing point the same as before? Explain the change to your partner.

5. To balance the stick once more, where must you place the pencil (or your finger)?

6. Complete the following math:
   a. If you have a yardstick: \((1 + 35 + 35)/3\)
   b. If you have a meter stick: \((1 + 99 + 99)/3\)

7. Now switch places with your partner. Experiment placing various numbers of plastic cubes along the stick and observe how the balance changes. Write down the numbers where the sticks balance. Note that the place where the stick balances is called the average.

8. Now assume that in 7 above your findings are as follows:

<table>
<thead>
<tr>
<th>Number of cubes</th>
<th>1</th>
<th>4</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location on the stick</td>
<td>5</td>
<td>10</td>
<td>15</td>
<td>30</td>
</tr>
</tbody>
</table>

   What is the average? Where does the stick balance?
Steps in Finding the Average or Mean

To find the average or the mean, follow these steps:

1. Count how many separate numbers you are working with.
2. Add up all the numbers to find the sum.
3. Divide the sum by how many numbers.

Example: Assume you have a list of 20 numbers and they total 180. To find the average or mean of 20 numbers, apply the step above:

1. Q: How many numbers? A: 20
2. Q: What is their sum? A: 180
3. Q: What is their average or mean? A: 180/20 = 9
Exercises in Finding the Average or Mean

Look at the screen and put the same number of pennies on your own desk as the teacher does. Then answer the following questions.

1. How many pennies does Ken have?

2. How many pennies does Alfred have?

3. How many pennies do Ken and Alfred have together?

4. If Alfred gives Ken one penny, then how many will each have?

5. What is \((2 + 4) / 2\)? (In other words, what is the average or the mean of 2 and 4?)
Exercises in Finding the Average or Mean (continued)

6. The answer you got in (5) is called the AVERAGE or the MEAN of the numbers. If we put Ken and Alfred's money together (2+4) = 6, then they have 6 pennies together. If we divide by 2 (one is Ken the other is Alfred) then we get what's called the AVERAGE, or MEAN. What is the AVERAGE or MEAN number of pennies Ken and Alfred have together?

7. Suppose Ken has 7 pennies (place 7 pennies in a row on your own desk) and Alfred has 9 pennies (place 9 pennies in a second row on your own desk). What is the average or mean number of pennies Ken and Alfred now have?

8. What is the average or mean number of pennies the following three people have?

   Ken has 9 pennies
   Alfredo has 11 pennies
   Tran has 7 pennies
Exercises in Finding the Average or Mean
(continued)

9. Describe the steps you would take to find the average or the mean of a set of 35 numbers.
   a. 
   b. 

10. Find the average hourly salary of ten workers who earn $6.70, $7.50, $8.25, $6.00, $10.05, $7.35, $7.00, $6.80, $8.60, and $9.50.
Additional Exercises in Finding the Average or Mean

Calculate the average or the mean in the following problems.

1. Place all of your pocket change in front of you. Add up all the change you have and tell the instructor your total. Find the average or mean amount of pocket change for the class. Use the space below for your calculation.

2. Find the average height of your class, including the instructor. Work in pairs to measure everyone's height. After the instructor has written the heights on the board, find the average or mean height for the entire class.
Additional Exercises in Finding the Average or Mean (continued)

3. Find the other employees in your class who do the same job as you do. Together, record the number of pieces each of you worked on yesterday. Find the average number for your group.

4. Choose a partner. Each of you will now make up a story problem that requires you to find the mean or average. Then work together to solve the problems. Your problems should resemble these examples:

   a. What is the average amount of money you and your partner spend on food for your families each month?

   b. What is the average amount of money you and your partner spend on rent for your families each month?

   c. What is the average number of hours you and your partner spend driving to work each day?

Create similar problems using data from three or four people in your class, or using data from the entire class.

If you don't have enough space here, do your calculations on a separate piece of paper.
Finding the Median

1. What is the average of the number of rods your teacher has put on the overhead?

2. Look at the numbers 2, 10, 1, 1, 1, 1, 10, 1, 2, 1, 1 again. How well does the average represent this entire set of numbers? Explain your answer.

3. Sometimes the median, not the mean or average, is a better statistic to use to represent a group of numbers as a whole. To find the median of the numbers listed in the numbers 2, 10, 1, 1, 1, 1, 10, 1, 2, 1, 1, do this:
   a. First arrange the numbers from left to right, like this:
      
      1, 1, 1, 1, 1, 1, 1, 2, 2, 10, 10
   
   b. Then find the middle number. Since eleven numbers are displayed, the median is the sixth number, 1.
      
      1, 1, 1, 1, 1, 1, 2, 2, 10, 10
Finding the Median
(continued)

4. Which number better represents the number of years an employee has worked for this company, the average (3) or the median (1)?

5. The 11 people below earn hourly wages as listed:

Fred  Tony  Juan  Peg  Don  Tran  Dave  Pedro  Bob  Kim  Rosa
$7     $20    $5     $5     $5     $5     $20    $5     $6     $5

Find the AVERAGE pay for these 11 workers.

6. To find the median hourly pay for the 11 people above, (a) put the salaries in order, (b) find the middle person, and (c) read that number:

Juan  Rosa  Peg  Don  Tran  Pedro  Kim  Bob  Fred  Tony  Dave
$5     $5     $5     $5     $5     $5     $6     $7     $20    $20

What is the median pay?
Steps in Calculating the Median

To find the median, follow these steps:

1. Rewrite the data from smallest to largest.

2. If there is an *odd number of data*, the middle number is the median. (For example, given 19 separate pieces of data, the median is 9; given 27 pieces, the median is 14; etc.)

3. If there is an *even number of data*, the median position will be between the two middle numbers. The average of these two numbers is the median. (For example, given 14 pieces of data, the median falls between 7 and 8; therefore, the median is 7.5.)
Calculating the Median

Study these examples before you work the problems:

Example A

Question: What is the median of the numbers 11, 12, and 17?

a. First re-write the numbers from smallest to largest like this: 11, 12, 17.
b. Because there is an odd number of data (3 pieces), find the middle number, which is 12.

Answer: The median is 12.

Example B

Find the median of 12, 17, 11, and 20:

a. Rewrite the numbers from smaller to larger: 11, 12, 17, 20.
b. Now find the average of the two middle numbers: \((12+17)/2 = 14.5\)

Answer: The median is 14.5.

Now find the median in the following problems!

1. Find the median of the following numbers: 32, 45, 12, 34, 56, 34, 21, 23, 54, 100, 215.

2. Your instructor will ask everyone in the class to place his or her pocket change on the desk. As employees tell their totals, the instructor will write each amount on the board. When the instructor has written the last amount on the board, find the median amount of pocket change for the class. Use the space below for your calculation.
Calculating the Median
(continued)

3. Find the median height of your class, including the instructor. Work in pairs to measure everyone's height. After the instructor has written the heights on the board, find the median height for the entire class.

4. Find the other employees in your class who do the same job as you do. Together, record the number of pieces each of you worked on yesterday. Find the median number for your group.

5. Choose a partner. Each of you will now make up a story problem that requires you to find the median. Then work together to solve the problems. Your problems should resemble these examples:
   a. What is the median amount of money you and your partner spend on food for your families each month?
   b. What is the median amount of money you and your partner spend on rent for your families each month?
   c. What is the median number of hours you and your partner spend driving to work each day?

Create similar problems using data from three or four people in your class, or using data from the entire class.

If you don't have enough space here, do your calculations on a separate piece of paper.
Finding the Mode

In the following set of numbers, which number occurs most often? (The answer is the mode.)

1. Find the mode in the numbers: 2, 10, 1, 1, 1, 1, 10, 1, 2, 1, 1

2. Find the mode of the hourly salary for the people in the table below.

<table>
<thead>
<tr>
<th></th>
<th>Juan</th>
<th>Rosa</th>
<th>Peg</th>
<th>Don</th>
<th>Tran</th>
<th>Pedro</th>
<th>Kim</th>
<th>Bob</th>
<th>Fred</th>
<th>Tony</th>
<th>Dave</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salary</td>
<td>$5</td>
<td>$5</td>
<td>$5</td>
<td>$5</td>
<td>$5</td>
<td>$5</td>
<td>$6</td>
<td>$7</td>
<td>$20</td>
<td>$20</td>
<td></td>
</tr>
</tbody>
</table>

3. Find the mode of pocket change for the entire class.

4. Find the mode of the height of the class, including the teacher.
Finding the Range

Complete the problems below.

1. Take two equal-size plastic rods or two equal coins and place them on a yardstick, one at the 1-inch mark, the other at the 35-inch mark. The range is the difference between the highest and the lowest score. In this case, there are only two scores: 35 and 1. What is the difference—the range—between 35 and 1?

2. Now move the plastic rods or coins to the 16-inch mark and the 20-inch mark. Where does the yardstick balance? What is the difference—that is, the range—between 20 and 16?

3. At what other positions can you balance the Cuisenaire rods or coins at the 18-inch mark? What is the range in each case?

4. Find the range of these scores: 2, 10, 1, 1, 1, 1, 10, 1, 2, 1, 1.
Finding the Range
(continued)

5. Find the range of the hourly salary for the people listed below.

<table>
<thead>
<tr>
<th>Name</th>
<th>Salary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Juan</td>
<td>$5</td>
</tr>
<tr>
<td>Rosa</td>
<td>$5</td>
</tr>
<tr>
<td>Peg</td>
<td>$5</td>
</tr>
<tr>
<td>Don</td>
<td>$5</td>
</tr>
<tr>
<td>Tran</td>
<td>$5</td>
</tr>
<tr>
<td>Pedro</td>
<td>$5</td>
</tr>
<tr>
<td>Kim</td>
<td>$6</td>
</tr>
<tr>
<td>Bob</td>
<td>$7</td>
</tr>
<tr>
<td>Fred</td>
<td>$20</td>
</tr>
<tr>
<td>Tony</td>
<td>$20</td>
</tr>
<tr>
<td>Dave</td>
<td>$20</td>
</tr>
</tbody>
</table>

6. Your instructor will ask everyone in the class to place his or her pocket change on the desk. As employees tell their totals, the instructor will write each amount on the board. When the instructor has written the last amount on the board, find the range of pocket change for the class.

7. Find the range of the height of your class, including the instructor. Work in pairs to measure everyone's height. After the instructor has written the heights on the board, find the range for the entire class.
Quality Control in the World Around Us

Follow your instructor's directions for this exercise.

Have you seen old-fashioned radios? Listeners tuned them very carefully, turning the tuning knob first a little to the left, then little to the right, then left again and right again, each time adjusting the knob slightly, moving in smaller and smaller increments until the tuning was "just right."

Whenever listeners changed stations, they had to repeat this process to make sure those old radios did not "drift" from the broadcast signals.

Sound-mixing studios still use this method today to make tapes and CDs. Sound engineers use very sensitive gauges that tell them when the sound is "just right"—that is, when the gauge is in the middle. There are many other examples of quality control in everyday life.

You are using quality control when you adjust the focus on your camera; the time on your watch; the volume, brightness, or contrast control of your TV set; the speed of your car; the brightness of a lamp; the amount of sugar in your coffee; and the amount of salt in your soup.
Quality Control in the World Around Us

Questions

Consider quality control in your everyday life; then answer the following questions.

1. Name two quality control processes that you use in everyday life.

2. Why do tape and CD manufacturers use sensitive sound equipment to keep the sound "in control"?

3. Why is it important to have a camera in focus before taking a picture?

4. Name two automatic process controls that you use in everyday life.
A Sample Control Chart

Control Chart

UCL

| | | | | | | |

LCL

| | | | | | | |

Sample Number

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
## A Blank Control Chart Sheet

<table>
<thead>
<tr>
<th>Sample #</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time,</td>
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<tr>
<td>12:40</td>
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<tr>
<td>Toss #1</td>
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<td></td>
</tr>
<tr>
<td>Toss #2</td>
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<td></td>
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<td></td>
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<tr>
<td>Toss #3</td>
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</tr>
<tr>
<td>Toss #4</td>
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<tr>
<td>Toss #5</td>
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<td>Sum</td>
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<tr>
<td>Average, x</td>
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</tr>
</tbody>
</table>

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Getting to Know You

In this exercise you'll get to know your classmates better!

Use the questions below to interview a partner. Then your partner will interview you! At the end of class, you will use the answers on this filled-out worksheet to introduce your partner to the class. Then your partner will introduce you!

First name ___________________________ Last name ___________________________

Nickname ("friends call me...") ____________________________________________

Three coworkers names ____________________________________________________
                                                                                   __________________________________________

Mother's name ___________________________

Father's name ___________________________

Husband's or wife's name ___________________________

Children's names __________________________________________________________
                                                                                   __________________________________________

Favorite foods ______________________________________________________________

Favorite singer _____________________________________________________________

How did you hear of this company? _____________________________________________
                                                                                   __________________________________________

How long have you worked at this company? _____________________________________
                                                                                   __________________________________________

Name of supervisor ________________________________________________________
My Job Is...

Answer the questions below so that you can discuss your job with the group.

1. What is your job title?

2. What department do you work in?

3. What is the name of each part you make or assemble?

4. Where does the part you work on come from? (Which department or coworker?)

5. After you finish your work, where do you send the part you work on?

6. What happens if the part you get is not made correctly? What if you cannot work on it or you have to fix it first? What do you say to the person who sends you the part? Do you send the bad part back?

7. Do you tell your boss when you get a bad part? What do you say?

8. Do you ever have bad parts sent back to you because they weren't made right? About how many parts are returned to you in one week?
The Company Team

1. What is the name of your company?

2. What is the name of the President of your company?

3. What is the name of the visitor today?

4. What products does your company make?

5. What are these products used for?

6. Have you ever used one of these products yourself?
Reading and Writing Numbers

In this lesson you will learn (1) to read and write numbers, (2) to add, subtract, multiply, and divide whole numbers, and (3) to take the square root of a number.

1. In our number system, we write numbers so that each place tells you "How many ones?" "How many tens?" And so on.

For example, the number 34 means that you have 3 tens ("30") and 4 ones ("4"). Thus 34 = 30 + 4. We read this number as "Thirty-four." Thirty means "3 tens" and four means "4 ones."

Note that the first place is "ones" and the second place is "tens." In other words, each place represents a specific number value.

2. The system allows you to express larger numbers by adding more places. After "tens" comes "hundreds."

234 = 200 + 30 + 4

Now you have "Two hundred thirty-four." The Two hundred means "2 hundreds"; the rest is the same as in the example above.

3. And after "hundreds" comes "thousands."

5,234 = 5000 + 200 + 30 + 4

Now you have "Five thousand two hundred thirty-four." The Five thousand means "5 thousands," and the rest is the same as in the example above.
Your Turn!

Complete the following exercises:

1. Break down the number 67 into tens and ones: \(67 = \_ + \_

2. Read the following number aloud: 467

3. Break down 467 into hundreds, tens, and ones: \(467 = \_ + \_ + \_

4. Jim weighs 195 pounds (say, "one hundred ninety-five pounds"). He could write his weight like this: \(100 + 90 + 5\)

   How much do you weigh? Write your weight in groups: \(\_ + \_ + \_

5. Now write your weight in the usual way (for example, 195): ___

6. How do you say this number? Write it in words: _________________________________
Addition of Whole Numbers

Complete the following exercises.

1. Use numbers to express $0 + 00 = 000$.

2. Use circles to write the meaning of $8 + 5$.

3. What does $12 + 5$ mean? Sometimes we write this as:
   \[
   \begin{array}{c}
   12 \\
   + 5 \\
   \end{array}
   \]

4. Add: $400 + 52 + 19$

5. Add: $1239 + 542 + 95 + 1$

6. Now try adding the following:
   \[
   \begin{array}{c}
   2 + 3 = \\
   15 + 17 = \\
   551 + 22 = \\
   702 + 1259 + 55 + 1 = \\
   \end{array}
   \]

Remember: Write the numbers you are adding one below the other, and then add the numbers in each column starting from the right.
Subtraction of Whole Numbers

Complete the following exercises.

1. Use numbers to express 000 - 00 = 0

2. Use circles to write the meaning of 8 - 5.

3. What does "12 - 5" mean? Sometimes we write this as:
   \[
   \begin{array}{c}
   12 \\
   -5 \\
   \end{array}
   \]

4. Subtract: 400 - 52

5. Subtract: 1,239 - 542

6. Now try these:
   \[
   \begin{array}{c}
   12 - 3 = \\
   35 - 17 = \\
   551 - 22 = \\
   702 - 259 = \\
   \end{array}
   \]

Remember: Write the numbers you are subtracting one below the other, and then subtract the numbers in each column starting from the right.
Addition and Subtraction Word Problems

As you read the following "word problems," search for the basic arithmetic information. Don't be fooled by the extra information! Follow the example:

Example:

Juan Juarez makes $300 per week and his wife Irma makes $150 per week. Together, how much money do Juan and Irma make each week?

Juan makes $300.00
Irma makes +150.00

$450.00

Answer: The Juarez family makes $450.00 each week.

1. I drive a Toyota Corolla. My mother drives a Honda Accord, and my father prefers to drive an Oldsmobile. Our next-door neighbors have a pickup and a Honda Civic. Our upstairs neighbors have two cars.

How many cars will you see parked in front of our apartment complex when we are all home?

2. Ask the person sitting on your right how many people are sitting to his/her right. Ask the person sitting on your left how many people are sitting to his/her left. Now find the total number of people sitting in your row.

3. You have $1,500 in your checking account. Today is payday, and you receive $1,000 in your paycheck. After work, you spend $105 for groceries. After shopping, you decide to deposit the rest of your paycheck into your checking account. How much money do you have in the account after you make your deposit?
Multiplication of Whole Numbers

Multiplication

1. Use numbers to express
   
   \[
   \begin{array}{c}
   000000000000 \\
   \end{array}
   \]

2. Use circles to write the meaning of \(8 \times 5\).

3. What does \(12 \times 5\) mean? Sometimes we write this as

   \[
   \begin{array}{c}
   12 \\
   \times 5
   \end{array}
   \]

4. Multiply \(400 \times 52\):

   \[
   \begin{array}{c}
   400 \\
   \times 52
   \end{array}
   \]

5. Now try the same problem with a calculator. Ask for help if necessary!

6. Multiply using a calculator: \(1,239 \times 542 \times 95 \times 2\)
Division Problems

Complete the following exercises.

1. Use circles to express \( 8 \div 2 \)

2. Use circles to write the meaning of \( 8 \div 5 \)

3. Divide: \( 400 \div 52 = \)

4. Divide: \( 1,239 \div 542 = \)
Division Word Problems

As you read the following word problems, search for the basic arithmetic information. Don’t be fooled by the extra information! Follow the example:

Example:

In the Juarez family, Juan makes $300 per week and his wife Irma makes $150 per week. What is the difference between Juans pay and Irmas pay?

Answer: $300 - $150 = $150. The difference in pay is $150.

But we can also say that Juan earns twice as much as Irma—or that he earns 2 times what Irma earns. Note the arithmetic here:

\[
\frac{300}{150} = 2
\]

Thus Juan earns 2 times as much as Irma earns.

Problems

1. Today is payday and you receive $1,200 in your paycheck. If you spend half of it for groceries and rent, how much of your pay do you have left?
Square Roots

1. What is the square root of $\sqrt{25}$

2. $\sqrt{25} + \sqrt{36} =$

3. What is the square root of $\sqrt{75}$

4. Wallpaper border needs to be ordered for the Johnson's kitchen. The room is 20' x 15' x 20' x 15'. How much wallpaper border do you need to order?

5. The Juarez family wants to fence in a yard that is exactly square. The area of the yard is 225 square feet. How much fencing is the Juarez family going to need?
Decimal Numbers

1. What does the number .67 mean?

   .67 = ____ + ____

2. How do you read/write the number .67?

3. What does the number 4.67 mean?

   4.67 = ____ + ____ + ____

4. How do you read/write the number 4.67?

Find your own examples of decimal numbers, and repeat the exercises above.
Decimal Numbers: Adding and Subtracting

1. What does $1.2 + .5$ mean?

   \[
   \begin{array}{c}
   1.2 \\
   + .5 \\
   \end{array}
   \]

2. Add: $4.00 + 5.2 + .19$.

   \[
   \begin{array}{c}
   4.00 \\
   + 5.2 \\
   + .19 \\
   \end{array}
   \]

3. Add: $12.39 + 54.2 + .95 + 10$

4. What does $1.2 - .5$ mean? How do you write this?

5. Subtract: $4.00 - 5.2$

6. Subtract: $12.39 - 5.42$
Decimal Numbers:
Addition and Subtraction Word Problems

Complete the following exercises. Follow the example.

Example:

Juan Juarez makes $225.50 per week and his wife Irma makes $150.75 per week. How much money do Irma and Juan earn each week?

Juan makes = $225.50
Irma makes = $150.75

Answer: Irma and Juan make $376.25 each week.

1. You have $1,500.50 in your checking account. Today is payday and you receive $1,245.50 in your paycheck. On your way home, you spend $105.37 for groceries. Then you decide to deposit the rest of your paycheck into your checking account.

How much money do you have in your account after your deposit?
Decimal Numbers: Multiplying

Complete the following exercises.

1. $1.2 \times 6$ means $1.2 + 1.2 + 1.2 + 1.2 + 1.2 + 1.2$. The sum is 7.2 (add the numbers to see for yourself).

   Instead of adding all these numbers, you can multiply two numbers, as follows:

   $\begin{align*}
   & \phantom{.}1.2 \\
   \times & \phantom{.}6 \\
   \hline
   & \phantom{.}7.2
   \end{align*}$

   As before, the answer is 7.2.

2. Multiply: $4.25 \times 52$

   $\begin{align*}
   & \phantom{.}4.25 \\
   \times & \phantom{.}52 \\
   \hline
   & \phantom{.}218 \phantom{.}000 \\
   & \phantom{.}212 \phantom{.}500 \\
   \hline
   & \phantom{.}221 \phantom{.}800
   \end{align*}$

3. Now repeat #2 above but this time use a calculator. If you don’t know how to use a calculator, ask someone in your group who does, or ask your instructor. You will learn how to use a calculator in the next worksheet.

   Multiply using your calculator: $4.25 \times 52$

4. Multiply: $12.39 \times 5.42$

   $\begin{align*}
   & \phantom{.}12.39 \\
   \times & \phantom{.}5.42 \\
   \hline
   & \phantom{.}52 \phantom{.}162 \\
   & \phantom{.}62 \phantom{.}510 \\
   & \phantom{.}61 \phantom{.}941 \\
   \hline
   & \phantom{.}66 \phantom{.}926
   \end{align*}$
Using the Calculator

Use your calculator to solve the following problems. Write the answers after the equals sign.

1. \(3 \times 4 = \)
2. \(30 \times 40 = \)
3. \(300 \times 400 = \)
4. \(3,000 \times 4,000 = \)
5. \(30,000 \times 40,000 = \)

Can you read the answers that are in scientific notation? If not, ask your instructor for help.

Now use your calculator to compute the following divisions. Write your answers after the equals sign.

1. \(3/4 = \)
2. \(3/40 = \)
3. \(3/400 = \)
4. \(3/4,000 = \)
5. \(3/40,000 = \)
6. \(3/400,000 = \)

Can you read the answers that are in scientific notation? If not, ask your instructor for help.
Decimal Numbers: Dividing

1. Use circles to express $10 \div 2.5$

2. Use circles to write the meaning of $8 \div 5$.

3. Divide: $400 \div 52 = $

4. Divide: $1,239 \div 542 = $

5. Juan Juarez makes $325.75 per week and his wife Irma makes $155.80 per week. They divide their combined pay into 3 equal parts: one part for rent, one part for food, and one part for all other expenses.

   How much do Irma and Juan spend on rent?
Percents

1. Pick a plastic square flat and count the number of small squares in it. (Or simply draw a large square on your paper and divide each side into ten parts. Now you have a 10x10 square.)

2. Cover 25 of the small squares with the small dice. (If you are working with pencil and paper, shade in 25 of the small squares.)

3. How many squares are shaded? ___ How many squares total? ___

4. We can write the above in several different ways:

   - 25 squares per 100 squares
   - 25 per 100
   - 25/100
   - 25%
   - .25

   All these statements mean the same thing: namely, 25 squares out of 100 squares. This is the same as one-fourth of the large square or 1 out of four or 1/4 or 1 + 4.

   Use your calculator to perform this division: First press 1, then the division sign (+), then 4, and finally the equals sign (=). Answer: .25 = 25%.

5. Now take the 25 small plastic squares off the flat and put just 10 of them back on the flat. How do we write this new arrangement?

   per _____ or _____/____ or _____ % or .10

6. Now repeat exercises 1 to 4 by covering the flat (or flats) with the following number of small squares or dice: 5, 7, 50, 90, 99, 100, 125, 200.

7. Can you repeat exercises 1 to 5 by using a circle instead of a flat? Which percents are easy to measure? Which are hard?
Percents
(Continued)

Use your calculator to answer the following division problems:

1. \( \frac{20}{100} = \)
2. \( \frac{2}{10} = \)
3. \( \frac{200}{1,000} = \)
4. \( \frac{2,000}{10,000} = \)
5. \( \frac{20,000}{100,000} = \)

What pattern do you notice in the above answers?

6. Ken pays $200 per month for food. His pay each month is $1,000. What percent of Ken’s pay does he spend for food?

\[
\frac{200}{1000} \text{ or } \frac{200}{1000} \text{ or } \%
\]

7. If you cover one half of the plastic flats with small dice (squares), then you are covering \( \)\% of the flat.

8. If you pay 7\% state sales tax, that means that for every dollar you spend, you have to pay the state __.
Percents
(Continued)

To solve word problems involving percents, follow the steps below this sample problem:

Sample Problem

At the grocery store, Mary purchases a carton of milk for $1.59 and a pound of potatoes for $1.99. The sales tax is 7.75%. What is the total that Mary pays for her purchases?

Step-by-Step Solution

Step 1: Understand and Interpret the Problem
This problem has three parts:

a. Add Mary's individual purchases to get a subtotal (in dollars).
b. Compute the tax—in dollars—that she must pay on her purchases.
c. Add the tax, in dollars, to the dollar amount of her purchases (the total will be her total expense).

Note that Parts a and c are simple addition. Part b is a percent computation.

Step 2: Add the Individual Purchases
Add Mary's individual purchases—in this case, $1.59 + $1.99 = $3.58. This is the subtotal, the number on which you must calculate the sales tax.

Step 3: Compute the Tax in Dollars

a. Convert the Percent to a Decimal. To figure out the tax in dollars, you must first convert the sales tax, which is 7.75%, to a decimal number. The 7.75% tax can be expressed as 7.75/100 or .0775.

b. Use the Decimal to Compute the Dollar Amount. Multiply .0775, the converted percent, by the subtotal: $3.58 x .0775 = $0.277.

Step 4: Add the Dollar Tax to the Dollar Subtotal
Mary's total grocery expense is $3.58 + $0.277 = $3.857, rounded to $3.59.
Percents
(Continued)

Dan's credit card account balances are as follows:

<table>
<thead>
<tr>
<th>Account</th>
<th>Interest Percent</th>
<th>Current Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Citibank Visa</td>
<td>18.94%</td>
<td>$400.01</td>
</tr>
<tr>
<td>Discover</td>
<td>14.98%</td>
<td>$398.90</td>
</tr>
<tr>
<td>Citibank MasterCard</td>
<td>19.98%</td>
<td>$401.34</td>
</tr>
</tbody>
</table>

Question: If you were Dan, which account would you pay off first?

Question: How much interest will Dan pay on each balance?

To calculate Dan's interest on these balances, convert each interest percent to a decimal, and multiply each balance by that decimal amount:

Visa: $400.01 \times \frac{18.94}{100} = 
Discover: $398.90 \times \frac{14.98}{100} = 
MasterCard: $401.34 \times \frac{19.98}{100} =
Percents
(Continued)

Work with a partner to solve the following problem. Ask your instructor for help if necessary.

In his will, Mr. Smith left his daughter $500,000, his wife $600,000, and a local charity $200,000.

What percent of his total did Mr. Smith leave to his daughter? To his wife? To the charity?
Rates

Sample Problem 1
You are driving, and your speedometer reads 45 mph (that is, 45 miles per hour). How much distance will you cover in one hour?

Follow the steps given below to explain how to understand, to interpret, and then find the answer.

Step 1: Understand and Interpret the Problem
Basically this problem asks you to figure out miles traveled at a given mph rate.

Step 2: Convert the Symbols
Basically, mph (miles per hour) = miles/hour = m/h.

Multiplying m/h by h gives an answer in m—that is, miles.

Step 3: Complete the Computation
Multiply 45 m/h by 1 h:

\[45 \text{ m} \times 1 \text{ h} = 45 \text{ miles}\]

Note that the answer is in miles only.

Sample Problem 2
If you are driving 45 mph, how much distance will you cover in 10 minutes?

1. Convert 10 minutes to hours: 10 minutes = 10/60 hours or 1/6 hours.

2. Multiply 45 m/h by 1/6 h:

\[45 \text{ m} \times \frac{1}{6} \text{ h} = 7.5 \text{ miles}\]

Note that the answer is in miles only.
Sample Problem 2
Sandra bought 10 pounds of potatoes at $1.99 per pound, 5 pounds of apples at $1.89 per pound, and 7 pounds of oranges at $1.69 per pound. How much money did Sandra pay?

Step 1: Understand and Interpret the Problem
Basically this problem asks you to figure out total cost (dollars) for three different items for sale at different rates (all expressed in dollars per pound).

Step 2: Convert the Symbols
Basically, dollars per pound = $/lb. Multiplying $/lb by lb gives an answer in $—that is, dollars only.

Step 3: Complete the Computation
a. Calculate the individual cost of each of the three items:

For the cost of 10 pounds of potatoes at $1.99 per pound, multiply the rate price ($/lb) by 10 lbs:
$1.99/lb x 10 lbs = $19.90

For the cost of 5 pounds of apples at $1.89 per pound, multiply the rate price ($/lb) by 5 lbs:
$1.89/lb x 5 lbs = $9.45

For the cost of 7 pounds of oranges at $1.69 per pound, multiply the rate price ($/lb) by 7 pounds:
$1.69/lb x 7 lbs = $11.83

b. Total the cost of the three items:
$19.90
9.45
11.83
$41.18

Answer: Sandra pays $41.18.
Your Turn!

Using what you have learned so far, compute the following problems. Be sure to proceed one step at a time!

1. The Pacific Toy Company has a production line of 90 workers. The “normal” rate of production for each worker on the line is 25 toys per day. Workers receive a bonus of $2.00 per toy for every toy they make over their daily quota.

At the end of a workweek, how many toys will PTC produce if the workers make no extra toys?

One week Maria made 3 toys over her quota, and Tom made 5 toys over the quota. How much of a bonus did Maria receive? How much did Tom receive?

2. Citibank Visa’s interest rate is 18.87%, and its MasterCard interest rate is 18.95%. John’s Visa balance is $101.96 and his MasterCard balance is $98.27.

Which balance should John pay off first?
Temperature on March 9

- 50°F at 6:00am
- 60°F at 9:00am
- 70°F at 12:00pm
- 80°F at 3:00pm

TIME:
- 6:00am
- 9:00am
- 12:00pm
- 3:00pm
- 6:00pm
- 9:00pm
- 12:00am
Costs for XYZ, Inc.

- Administration: 10%
- Production costs: 15%
- Marketing: 5%
- Miscellaneous: 25%
- Research: 45%
Reading Graphs and Tables

Complete the exercises below.

1. Where will you find graphs and tables?

2. Below there are two pictures of your boss—a happy picture, and an unhappy picture. Looking at the line graphs below, predict how your boss will react to each graph as you read items a through d. Use the pictures for your “predictions.”

   a. How will your boss react if Graph A shows the trend in profit for your company? How will your boss react to Graph B?

   b. How will your boss react if Graph A shows the number of new customers for your company? How will your boss react to Graph B?

   c. How will your boss react if Graph A shows the number of products returned by customers for your company? How will your boss react to Graph B?

   d. How will your boss react if Graph A shows sales units for your company? How will your boss react to Graph B?
This week in Robert's department, Robert made 16 pieces of work, Juan made 20, Cathy made 16, and Kim made 12. Kim is a new worker, so Robert is working with him to provide additional training.

1. Fill in the table to show how many pieces these workers made:

<table>
<thead>
<tr>
<th>Name of Worker</th>
<th>Number of Pieces Made This Week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robert</td>
<td></td>
</tr>
<tr>
<td>Juan</td>
<td></td>
</tr>
<tr>
<td>Cathy</td>
<td></td>
</tr>
<tr>
<td>Kim</td>
<td></td>
</tr>
</tbody>
</table>

2. Which worker made the highest number?

3. Which worker made the lowest number?

4. Why did Kim make only 12 pieces this week?

5. If all the workers put their items together, how many did they make?

6. If Cathy gives Kim four items to help him out, then how many would each of the workers have?
Reading and Interpreting Bar Graphs

Compare the bar graph below with the table in Handout 25.

The graph below shows the same data as the table in the previous handout—but in bar graph form. From the bar graph, can you tell which worker made the most pieces? The least?

1. Fill in the table below using this information: The Juarez family budget this month is as follows: Rent $650, Food $1,250, Auto expenses $120, and Entertainment $85.

<table>
<thead>
<tr>
<th>Type of Expenses</th>
<th>Amount ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<tr>
<td></td>
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<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Draw a bar graph using the information in the table above.
Reading and Interpreting Line Graphs

For one day, the temperatures in Los Angeles were recorded in the following table:

<table>
<thead>
<tr>
<th>Time of Day</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 AM</td>
<td>55</td>
</tr>
<tr>
<td>9 AM</td>
<td>68</td>
</tr>
<tr>
<td>12 NOON</td>
<td>85</td>
</tr>
<tr>
<td>3 PM</td>
<td>81</td>
</tr>
<tr>
<td>6 PM</td>
<td>75</td>
</tr>
<tr>
<td>9 PM</td>
<td>62</td>
</tr>
</tbody>
</table>

1. What was the highest temperature of the day?
2. What was the lowest temperature?
3. What do you guess the temperature was at 10 AM?
4. What do you guess the temperature was at 10 PM?

The line graph below represents the same data as in the table above. Now answer questions 1 through 4 above using the graph.
Reading and Interpreting Line Graphs

For one day, the temperatures in New York were recorded as follows: 6AM, 50; 9AM, 62; 12 noon, 75; 3PM, 70; 6PM, 75; and 9PM, 62. Enter this information in the following table:

<table>
<thead>
<tr>
<th>Time of Day</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. What was the highest temperature of the day?
2. What was the lowest temperature?
3. What do you guess the temperature was at 10 AM?
4. What do you guess the temperature was at 10PM?

The line graph below shows the same data as in the table above. Now answer questions 1 through 4 above using the graph.
Comparing Line Graphs

The graph below positions the two temperature line graphs side by side, so you can compare temperatures in both cities at the same time. The line at the very bottom of the graph shows the difference in temperature.

1. What were the estimated temperatures at 9 PM (a) in Los Angeles and (b) in New York?

2. What was the difference in the estimated temperatures in the two cities at 9 PM? Does your answer agree with the “difference in temperature” line at the bottom of the graph?

3. Guess the temperature in each city at 10 PM. Then extend both lines to those points. Can you also extend the “difference” line to 10 PM?
Reading and Interpreting Circle Graphs

Use the following “measuring device” to estimate how to interpret the pie charts in the questions. The small slice shown is 10% of the entire circle (sometimes we call circle graphs pie charts). So it takes 10 of the small ones make up the entire circle.

1. If you spend 40% on your salary on rent, how many of the small slices above represent your rent expense?

2. If 80% of your company’s expenses go to employee wages, how many small slices does wage expense represent?

3. Consider Maria’s budget breakdown: Rent $500, Food $300, Car $100, and Entertainment $100. Her total salary is $1,000. How many slices of the circle represent Rent? How many represent Food? Car? Entertainment? Your pie chart should look something like this:
Building Frequency Tables

Empty your pocket change onto your desk and count it. When your instructor tells you, record the amount on the sheet below:

1. Fill in the table as your classmates tell you the amounts:

<table>
<thead>
<tr>
<th>Amount of Pocket Money ($)</th>
<th>Tally (I/I)</th>
<th>Frequency (Number)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$ 0.00 - $4.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$ 5.00 - $9.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$10.00 - $14.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$15.00 - $19.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$20.00 - $24.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$25.00 - $29.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$30.00 or more</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Which category has the most money?

3. Which category has the lowest number?
Building Bar Charts

Use the data in Handout 30 to complete the bar chart below. As each person reports how much change she or he has, shade in the appropriate box. The first filled-in box represents the instructor, who claims to be broke! Your finished bar graph should like the graph at the beginning of the lesson.

<table>
<thead>
<tr>
<th>People</th>
<th>0.00-$4.99</th>
<th>$5.00-$9.99</th>
<th>$10.00-$14.99</th>
<th>$15.00-$24.99</th>
<th>$25.00-$29.99</th>
<th>$30 or more</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
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<tr>
<td>4</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>3</td>
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<tr>
<td>2</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>//////////</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Exercises on the Balancing Point

Work with a partner to complete the following activities. Your instructor will give you a yardstick or meter stick and some plastic rods and dice for this exercise.

1. Balance the yardstick or meter stick using a pen or pencil (or your index finger). Have the other partner identify where the yardstick balances. Look at the yardstick and read off the precise position. Write this number here:

   The yardstick balance position is at _____ inches

   The meter stick balance position is at _____ centimeters.

2. While one partner continues balancing the stick, the other partner now places one plastic cube at the 1-inch mark of the yardstick AND one plastic cube at the 35-inch mark. If you are using a meter stick, place one cube at the 1-centimeter mark and the second cube at the 99-centimeter mark. Did the balancing point change?

3. Now do the following math:
   a. If you have a yardstick: \( \frac{1 + 35}{2} \)
   b. If you have a meter stick: \( \frac{1 + 99}{2} \)
Exercises on the Balancing Point
(continued)

Continue working in pairs as you complete the following activities.

4. On the yardstick, place one cube at the 1-inch mark and two cubes at the 35-inch mark (on a meter stick, one cube at the 1-centimeter mark and two at the 99-centimeter mark). Is the balancing point the same as before? Explain the change to your partner.

5. To balance the stick once more, where must you place the pencil (or your finger)?

6. Complete the following math:
   a. If you have a yardstick: \((1 + 35 + 35)/3\)
   b. If you have a meter stick: \((1 + 99 + 99)/3\)

7. Now switch places with your partner. Experiment placing various numbers of plastic cubes along the stick and observe how the balance changes. Write down the numbers where the sticks balance. Note that the place where the stick balances is called the average.

8. Now assume that in 7 above your findings are as follows:

<table>
<thead>
<tr>
<th>Number of cubes</th>
<th>1</th>
<th>4</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location on the stick</td>
<td>5</td>
<td>10</td>
<td>15</td>
<td>30</td>
</tr>
</tbody>
</table>

What is the average? Where does the stick balance?
Steps in Finding the Average or Mean

To find the average or the mean, follow these steps:

1. Count how many separate numbers you are working with.
2. Add up all the numbers to find the sum.
3. Divide the sum by how many numbers.

Example: Assume you have a list of 20 numbers and they total 180. To find the average or mean of 20 numbers, apply the step above:

1. Q: How many numbers?  A: 20
2. Q: What is their sum?  A: 180
3. Q: What is their average or mean?  A: 180/20 = 9
Exercises in Finding the Average or Mean

Look at the screen and put the same number of pennies on your own desk as the teacher does. Then answer the following questions.

1. How many pennies does Ken have?

2. How many pennies does Alfred have?

3. How many pennies do Ken and Alfred have together?

4. If Alfred gives Ken one penny, then how many will each have?

5. What is \((2 + 4) / 2\)? (In other words, what is the average or the mean of 2 and 4?)
6. The answer you got in (5) is called the AVERAGE or the MEAN of the numbers. If we put Ken and Alfred's money together \((2+4)=6\), then they have 6 pennies together. If we divide by 2 (one is Ken the other is Alfred) then we get what's called the AVERAGE, or MEAN. What is the AVERAGE or MEAN number of pennies Ken and Alfred have together?

7. Suppose Ken has 7 pennies (place 7 pennies in a row on your own desk) and Alfred has 9 pennies (place 9 pennies in a second row on your own desk). What is the average or mean number of pennies Ken and Alfred now have?

8. What is the average or mean number of pennies the following three people have?

Ken has 9 pennies
Alfredo has 11 pennies
Tran has 7 pennies
Exercises in Finding the Average or Mean
(continued)

9. Describe the steps you would take to find the average or the mean of a set of 35
   numbers.
   a.
   b.

10. Find the average hourly salary of ten workers who earn $6.70, $7.50, $8.25, $6.00, $10.05,
    $7.35, $7.00, $6.80, $8.60, and $9.50.
Additional Exercises in Finding the Average or Mean

Calculate the average or the mean in the following problems.

1. Place all of your pocket change in front of you. Add up all the change you have and tell the instructor your total. Find the average or mean amount of pocket change for the class. Use the space below for your calculation.

2. Find the average height of your class, including the instructor. Work in pairs to measure everyone's height. After the instructor has written the heights on the board, find the average or mean height for the entire class.
Additional Exercises in Finding the Average or Mean (continued)

3. Find the other employees in your class who do the same job as you do. Together, record the number of pieces each of you worked on yesterday. Find the average number for your group.

4. Choose a partner. Each of you will now make up a story problem that requires you to find the mean or average. Then work together to solve the problems. Your problems should resemble these examples:

   a. What is the average amount of money you and your partner spend on food for your families each month?

   b. What is the average amount of money you and your partner spend on rent for your families each month?

   c. What is the average number of hours you and your partner spend driving to work each day?

Create similar problems using data from three or four people in your class, or using data from the entire class.

If you don't have enough space here, do your calculations on a separate piece of paper.
Finding the Median

1. What is the average of the number of rods your teacher has put on the overhead?

2. Look at the numbers 2, 10, 1, 1, 1, 1, 10, 1, 2, 1, 1 again. How well does the average 3 represent this entire set of numbers? Explain your answer.

3. Sometimes the median, not the mean or average, is a better statistic to use to represent a group of numbers as a whole. To find the median of the numbers listed in the numbers 2, 10, 1, 1, 1, 1, 10, 1, 2, 1, 1, do this:
   a. First arrange the numbers from left to right, like this:

      1, 1, 1, 1, 1, 2, 2, 10, 10

   b. Then find the middle number. Since eleven numbers are displayed, the median is the sixth number, 1.

      1, 1, 1, 1, 1, 1, 2, 2, 10, 10
Finding the Median
(continued)

4. Which number better represents the number of years an employee has worked for this company, the average (3) or the median (1)?

5. The 11 people below earn hourly wages as listed:

Fred  Tony  Juan  Peg  Don  Tran  Dave  Pedro  Bob  Kim  Rosa
$7    $20   $5    $5    $5    $5    $20   $5    $6    $5    $5

Find the AVERAGE pay for these 11 workers.

6. To find the median hourly pay for the 11 people above, (a) put the salaries in order, (b) find the middle person, and (c) read that number:

Juan  Rosa  Peg  Don  Tran  Pedro  Kim  Bob  Fred  Tony  Dave
$5    $5    $5    $5    $5    $5    $6    $7    $20   $20

What is the median pay?
Steps in Calculating the Median

To find the median, follow these steps:

1. Rewrite the data from smallest to largest.

2. If there is an odd number of data, the middle number is the median. (For example, given 19 separate pieces of data, the median is 9; given 27 pieces, the median is 14; etc.)

3. If there is an even number of data, the median position will be between the two middle numbers. The average of these two numbers is the median. (For example, given 14 pieces of data, the median falls between 7 and 8; therefore, the median is 7.5.)
Calculating the Median

Study these examples before you work the problems:

Example A

Question: What is the median of the numbers 11, 12, and 17?

a. First re-write the numbers from smallest to largest like this: 11, 12, 17.
b. Because there is an odd number of data (3 pieces), find the middle number, which is 12.

Answer: The median is 12.

Example B

Find the median of 12, 17, 11, and 20:

a. Rewrite the numbers from smaller to larger: 11, 12, 17, 20.
b. Now find the average of the two middle numbers: \( \frac{12+17}{2} = 14.5 \)

Answer: The median is 14.5.

Now find the median in the following problems!

1. Find the median of the following numbers: 32, 45, 12, 34, 56, 34, 21, 23, 54, 100, 215.

2. Your instructor will ask everyone in the class to place his or her pocket change on the desk. As employees tell their totals, the instructor will write each amount on the board. When the instructor has written the last amount on the board, find the median amount of pocket change for the class. Use the space below for your calculation.
Calculating the Median
(continued)

3. Find the median height of your class, including the instructor. Work in pairs to measure everyone's height. After the instructor has written the heights on the board, find the median height for the entire class.

4. Find the other employees in your class who do the same job as you do. Together, record the number of pieces each of you worked on yesterday. Find the median number for your group.

5. Choose a partner. Each of you will now make up a story problem that requires you to find the median. Then work together to solve the problems. Your problems should resemble these examples:

   a. What is the median amount of money you and your partner spend on food for your families each month?

   b. What is the median amount of money you and your partner spend on rent for your families each month?

   c. What is the median number of hours you and your partner spend driving to work each day?

Create similar problems using data from three or four people in your class, or using data from the entire class.

If you don't have enough space here, do your calculations on a separate piece of paper.
Finding the Mode

In the following set of numbers, which number occurs most often? (The answer is the mode.)

1. Find the mode in the numbers: 2, 10, 1, 1, 1, 10, 1, 2, 1, 1

2. Find the mode of the hourly salary for the people in the table below.

<table>
<thead>
<tr>
<th>Name</th>
<th>Juan</th>
<th>Rosa</th>
<th>Peg</th>
<th>Don</th>
<th>Tran</th>
<th>Pedro</th>
<th>Kim</th>
<th>Bob</th>
<th>Fred</th>
<th>Tony</th>
<th>Dave</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salary</td>
<td>$5</td>
<td>$5</td>
<td>$5</td>
<td>$5</td>
<td>$5</td>
<td>$5</td>
<td>$6</td>
<td>$7</td>
<td>$20</td>
<td>$20</td>
<td>$20</td>
</tr>
</tbody>
</table>

3. Find the mode of pocket change for the entire class.

4. Find the mode of the height of the class, including the teacher.
Finding the Range

Complete the problems below.

1. Take two equal-size plastic rods or two equal coins and place them on a yardstick, one at the 1-inch mark, the other at the 35-inch mark. The range is the difference between the highest and the lowest score. In this case, there are only two scores: 35 and 1. What is the difference—the range—between 35 and 1?

2. Now move the plastic rods or coins to the 16-inch mark and the 20-inch mark. Where does the yardstick balance? What is the difference—that is, the range—between 20 and 16?

3. At what other positions can you balance the Cuisenaire rods or coins at the 18-inch mark? What is the range in each case?

4. Find the range of these scores: 2, 10, 1, 1, 1, 10, 1, 2, 1, 1.
Finding the Range
(continued)

5. Find the range of the hourly salary for the people listed below.

<table>
<thead>
<tr>
<th>Juan</th>
<th>Rosa</th>
<th>Peg</th>
<th>Don</th>
<th>Tran</th>
<th>Pedro</th>
<th>Kim</th>
<th>Bob</th>
<th>Fred</th>
<th>Tony</th>
<th>Dave</th>
</tr>
</thead>
<tbody>
<tr>
<td>$5</td>
<td>$5</td>
<td>$5</td>
<td>$5</td>
<td>$5</td>
<td>$5</td>
<td>$6</td>
<td>$7</td>
<td>$20</td>
<td>$20</td>
<td></td>
</tr>
</tbody>
</table>

6. Your instructor will ask everyone in the class to place his or her pocket change on the desk. As employees tell their totals, the instructor will write each amount on the board. When the instructor has written the last amount on the board, find the range of pocket change for the class.

7. Find the range of the height of your class, including the instructor. Work in pairs to measure everyone's height. After the instructor has written the heights on the board, find the range for the entire class.
Quality Control in the World Around Us

Follow your instructor’s directions for this exercise.

Have you seen old-fashioned radios? Listeners tuned them very carefully, turning the tuning knob first a little to the left, then a little to the right, then left again and right again, each time adjusting the knob slightly, moving in smaller and smaller increments until the tuning was “just right.”

Whenever listeners changed stations, they had to repeat this process to make sure those old radios did not “drift” from the broadcast signals.

Sound-mixing studios still use this method today to make tapes and CDs. Sound engineers use very sensitive gauges that tell them when the sound is “just right”—that is, when the gauge is in the middle. There are many other examples of quality control in everyday life.

You are using quality control when you adjust the focus on your camera; the time on your watch; the volume, brightness, or contrast control of your TV set; the speed of your car; the brightness of a lamp; the amount of sugar in your coffee; and the amount of salt in your soup.
Quality Control in the World Around Us
Questions

Consider quality control in your everyday life; then answer the following questions.

1. Name two quality control processes that you use in everyday life.

2. Why do tape and CD manufacturers use sensitive sound equipment to keep the sound "in control"?

3. Why is it important to have a camera in focus before taking a picture?

4. Name two automatic process controls that you use in everyday life.
A Sample Control Chart

Control Chart

UCL

LCL

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Sample Number
## A Sample Control Chart Summary Sheet

<table>
<thead>
<tr>
<th>Sample #</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time,</strong></td>
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<tr>
<td><strong>Toss #1</strong></td>
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<tr>
<td><strong>Toss #2</strong></td>
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<td><strong>Toss #3</strong></td>
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<tr>
<td><strong>Toss #4</strong></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td><strong>Toss #5</strong></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Sum</strong></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Average, ( \bar{x} )</strong></td>
<td>6.4</td>
<td>5.0</td>
<td>5.6</td>
<td>6.8</td>
<td>5.8</td>
<td>8.0</td>
<td>5.5</td>
<td>5.3</td>
<td>8.0</td>
<td>6.4</td>
<td>7.8</td>
<td>7.2</td>
<td>8.6</td>
<td>6.8</td>
<td>7.2</td>
<td>8.6</td>
</tr>
<tr>
<td><strong>Range, ( R )</strong></td>
<td>6.0</td>
<td>10.0</td>
<td>7.0</td>
<td>8.0</td>
<td>6.0</td>
<td>6.0</td>
<td>2.0</td>
<td>4.0</td>
<td>5.0</td>
<td>4.0</td>
<td>6.0</td>
<td>7.0</td>
<td>9.0</td>
<td>5.0</td>
<td>6.0</td>
<td>2.0</td>
</tr>
</tbody>
</table>

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Control Chart

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Math for Statistical Process Control

Supervisor—Making Numbers Count
Math for Statistical Process Control

Making Numbers Count

Supervisor Lesson 1

Winning At Work

JobLink
Lesson Description

Lesson 1:
Supervisors receive an introduction to the concepts taught in Math for Statistical Process Control. Supervisors are then given a summary of the lessons, and both questions to ask and discussion topics to use as the module is being taught.

Lesson 2:
Supervisors are given a summary of the progress of the class. The rest of the hour focuses on strategies for improving and continuing the skills learned in Math for Statistical Process Control.
**Objectives**

By completing this lesson, supervisors will be able to:

1. **Understand** basic concepts taught in module.
2. **Encourage** supervisors to help support learning between classes.

**Materials Needed**

**Hardware**

1. Overhead projector
2. Whiteboard/Flip chart
3. Whiteboard Flip chart pens
4. Ball of String
5. Blindfold

**Transparencies**

"Objectives" (Supervisor Transparency 1)

"Quality Control in the World Around Us" (Supervisor Transparency 2)

**Handouts**

"Representative handouts from the module"

**Classroom Set-up**

**Total Time: 60 minutes**

**First Hour**

- Opening- Large Group 10 min.
- First Activity- Large Group 15 min.
- Second Activity- Large Group 15 min.
- Third Activity- Large Group 10 min.
- Ending- Large Group 5 min.
Objectives

1. Understand the basic concepts of SPC.

2. Determine the relationship between decimal and fractional numbers.

3. Analyze bar graphs and line graphs.

4. Interpret and record measured data.

5. Produce bar graphs and line graphs.

6. Understand basic statistical terminology.
Activities

Opening: 15 Minutes

1. Welcome everyone and introduce yourself.
2. Ask everyone for their names and what department or area they are from.
3. Explain that the purpose of the next hour is to familiarize them with the material in the class that their employees will be taking over the next few weeks.
4. Ask the supervisors, "What do you want your people to get out of the training?" Write the information you receive on a flipchart or whiteboard.
5. Explain that the module covers a lot of the information they are looking for.
6. Project the six objectives of the module and explain each:
   - Understand the basic concepts of SPC
   - Determine the relationship between decimal and fractional numbers
   - Interpret and record measured data
   - Produce bar graphs and line graphs
   - Understand basic statistical terminology
   - Analyze bar graphs and line graphs
Activities

First Activity: 15 Minutes

1. **Explain** that everyday we are confronted with examples of math and statistics.

2. **Ask** "Can you give me some every day life examples of when we use addition? Subtraction? Multiplication? Division?"


5. **Say**, "We are confronted with opportunities to use math on a daily basis. Many employees have a lot of difficulties figuring out how much of a tip to leave a waitress at a restaurant, or how much their credit card company is charging them in interest on their credit card balance. Yet, we think nothing of asking them to read a control chart taped to a machine or even interpret productivity statistics."

6. **Explain** "This class gives an introduction to basic math principles used in Statistical Process Control, ranging from addition and subtraction to percentages and decimals. In addition, we introduce them to some terminology of SPC such as mean, median, range, and quality control."
Quality Control In the World Around Us

Have you seen old-fashioned radios? Listeners tuned them very carefully, turning the tuning knob first a little to the left, then a little to the right, then left again and right again, each time adjusting the knob slightly, moving in smaller and smaller increments until the tuning was "just right."

Whenever listeners changed stations, they had to repeat this process to make sure those old radios did not "drift" from the broadcast signals.

Sound-mixing studios still use this method today to make tapes and CDs. Sound engineers use very sensitive gauges that tell them when the sound is "just right"—that is, when the gauge is in the middle. There are many other examples of quality control in everyday life.

You are using quality control when you adjust the focus on your camera; the time on your watch; the volume, brightness, or contrast control of your TV set; the speed of your car; the brightness of a lamp; the amount of sugar in your coffee; and the amount of salt in your soup.
Activities

Second Activity: 15 Minutes

1. **Project** "Quality Control in the World Around Us". *Deliberately* leave the transparency out of focus. Wait until a supervisor points out the transparency is out of focus; then play with the adjustment knob, deliberately keeping the image out of focus by going slightly past the focus point in each direction several times. Finally, focus on the image properly. Now say to the group, "Adjusting the knob on this projector is an example of *quality control".*

2. **Read** through transparency. **Explain** that this is a real life example that make the concepts of quality control easy for the employee to understand.

3. **Tell** the supervisors you would like to do a brief demonstration. **Ask** for four volunteers.

4. Have everyone stand up. Have the four volunteers work in pairs. Instruct each pair to hold a long piece of string so as to form a path a little narrower than a normal sidewalk. Make the path as long as the room will allow (say 12 to 20 feet long).

5. **Ask** another volunteer to walk the path; then blindfold the volunteer. **Tell** him or her to walk the length of the path without touching the strings. Instruct the class to yell "Stop! You're out of control" whenever the blindfolded employee touches the string.
\section*{Activities}

\subsection*{Second Activity: (continued)}

6. Next, ask another volunteer to guide the person to the middle of the path again where the blindfolded volunteer tries again to make it to the other side. When the blindfolded volunteer makes it to the other side, the class cheers and applauds.

7. \textbf{Explain} “This is a simple example of a control chart. The idea is to keep a process, such as a manufacturing process, between the acceptable tolerances of quality. The blindfolded person acts as the "product" coming down the assembly line. When the group yells "Stop!" the line is stopped until the problem is fixed, until the blindfold person is placed in the middle of the lane again.”

8. \textbf{Explain} “This is a simple exercise that makes it easy for the employees to understand what a control chart is.”
Activities

Third Activity: 10 Minutes

1. **Put** together some handouts from the class that you feel are representative of the material covered. Emphasize the handouts that cover information requested by the supervisors.

2. Go over the handouts to give the supervisors a chance to “experience” some of the materials their employees will be covering.

3. Encourage supervisors to send their employees to class with real math problems to solve or charts and graphs to read and interpret.
Activities

Ending: 5 Minutes

1. Ask for questions concerning the module.
2. Emphasize the importance of the supervisor's role in the success of the training.
3. Remind supervisors of next session.
4. Say good-bye.
Math for Statistical Process Control

Making Numbers Count

Supervisor Lesson 2
Lesson Description

Supervisors are given a summary of the progress of class. The rest of the hour focuses on strategies for improving and continuing the skills learned in Math for Statistical Process Control.
Objectives

By completing this lesson, supervisors will be able to:

2. **Reinforce** techniques for increasing the transfer of learning.

Materials Needed

**Hardware**

1. Overhead projector
2. Whiteboard/Flip chart
3. Whiteboard Flip chart pens

**Transparencies**

"Objectives" (Supervisor Transparency 1)
"Increasing Your Chance of Success" (Supervisor Transparency 3)

**Handouts**

"Increasing Your Chance of Success" (Supervisor Handout 1)

Classroom Set-up

**Total Time: 60 minutes**

**Second Hour**

Opening- Large Group 15 min.
First Activity- Small Groups 15 min.
Second Activity- Large Group 20 min.
Ending- Large Group 10 min.

Key

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Objectives

1. Understand the basic concepts of SPC.

2. Determine the relationship between decimal and fractional numbers.

3. Analyze bar graphs and line graphs.

4. Interpret and record measured data.

5. Produce bar graphs and line graphs.

6. Understand basic statistical terminology.

Supervisor Transparency 1
Activities

Opening: 15 Minutes

1. Welcome the group back and reintroduce yourself.

2. Remind supervisors of the module objectives. Project “Objectives” on the overhead.

3. Explain “The purpose of today is to give you some techniques to reinforce the skills your employees have learned over the last few weeks.”

4. Ask the supervisors to give you feedback on the module - specifically, ask for feedback about the module and any improvements they have seen.
First Activity: 15 Minutes

1. Direct the supervisors to get into groups of 3 - 4.

2. Have each group come up with as many benefits to doing this module as they can think of.

3. Have each group share their answers.

4. Discuss the concept of ROI (Return on Investment). Explain that this training program translates to actual savings or improvements for their department as demonstrated by their lists.
Increasing Your Chance of Success

1. Know the skills your employees are learning
2. Be an example
3. Set goals
4. Give them the support they need to use their new skills
5. Give positive reinforcement and recognize results

Supervisor Lesson 2
Handout 1, Transparency 3
Math for Statistical Process Control

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Math for Statistical Process Control

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Supervisor Lesson 2
Handout 1, Transparency 3
Math for Statistical Process Control
Activities

Second Activity: 20 Minutes

1. Distribute "Increasing Your Chance of Success".

2. Discuss the items on the handout:

Know the skills your employees are learning.
These supervisor sessions are designed to inform you about what your employees learned in class.

Be an example.
The employees look up to you as an example. The most common phrase we hear in class is, "But my supervisor doesn't do this, so why should I?"

Set goals.
Give the employee something to shoot for. Let them know how you expect to see them use the skills.
V Activities

V Second Activity: (continued)

Give them the support they need to use their new skill.
No one likes change. Trying to change our behavior is hard enough without having to fight other factors. Give your employees both a chance and a reason to use their new skills.

Give positive reinforcement and recognize results.
Most importantly recognize employees when you see them using the new skill. There is nothing more powerful.

3. **Ask** “Do you have anything to add to the list?”

4. **Ask** “How can you reinforce the skills learned in Math for Statistical Process Control using the above techniques?”
### Activities

**Ending: 10 Minutes**

1. **Ask** "What one thing will you do today to reinforce the skills your employees have learned in this module?"

2. **Give** the supervisors a minute to think of something, and then go around the room and have each person share one thing. **Write** their responses on the flip chart or whiteboard.

3. **Re-emphasize** the importance of each supervisor's support and recognition. **Remind** them that their support and recognition will increase the chances that their employees will use the new skills.

4. **Thank** the supervisors for their time and participation.

5. **Say** good-bye.
Increasing Your Chance of Success

- Know the skills your employees are learning.

- Be an example.

- Set goals.

- Give them the support they need to use their new skills.

- Give positive reinforcement and recognize results.
Objectives

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Quality Control in the World Around Us

Have you seen old-fashioned radios? Listeners tuned them very carefully, turning the tuning knob first a little to the left, then a little to the right, then left again and right again, each time adjusting the knob slightly, moving in smaller and smaller increments until the tuning was "just right."

Whenever listeners changed stations, they had to repeat this process to make sure those old radios did not "drift" from the broadcast signals.

Sound-mixing studios still use this method today to make tapes and CDs. Sound engineers use very sensitive gauges that tell them when the sound is "just right"—that is, when the gauge is in the middle. There are many other examples of quality control in everyday life.

You are using quality control when you adjust the focus on your camera; the time on your watch; the volume, brightness, or contrast control of your TV set; the speed of your car; the brightness of a lamp; the amount of sugar in your coffee; and the amount of salt in your soup.
Increasing the Payoffs of Training

- Know the skills your employees are learning.

- Be an example.

- Set goals.

- Give them the support they need to use their new skills.

- Give positive reinforcement and recognize results.
NOTICE

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