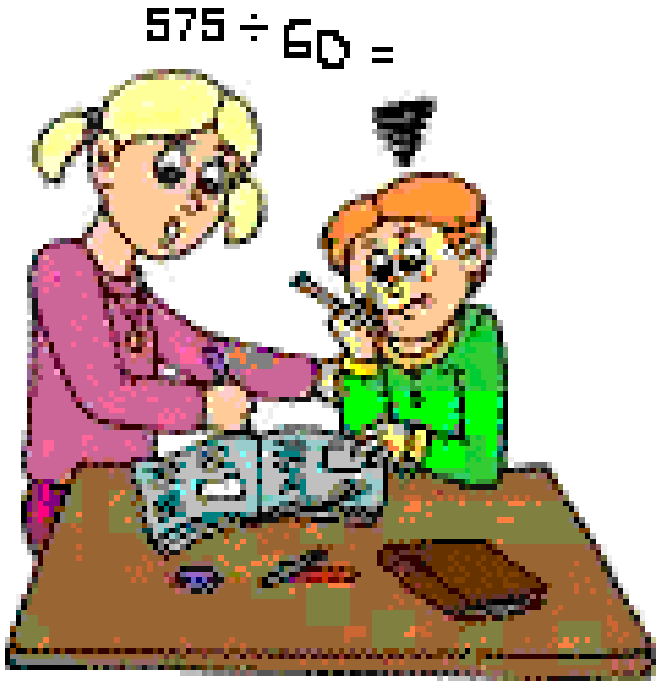
ESTIMATION MANIA



American Textile History Museum
Traveling Textiles Program

TEACHER'S GUIDE

(Museum Educator's Visit Edition)

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Introduction

The American Textile History Museum in Lowell, Massachusetts, recreates the "museum experience" in school classrooms through the Traveling Textiles program. Our educational programs and Museum exhibitions aim to provide enjoyable opportunities for both personal growth and discovery through exposure to America's diverse textile history and its impact on today. We provide the information and artifacts for students to make this connection. Along the way, we showcase the creativity and problem solving skills shown by earlier American textile producers, both at home and in business, and encourage students to appreciate these skills and, most importantly, to develop their own.

How to Use this Guide

This guide is intended to provide educational materials supporting the main lesson presented by a Museum teacher. Included are optional lesson plans for before and after the main lesson by the Museum teacher for those who wish to teach an entire unit on the subject, descriptions of related follow-up activities (without lesson plans), as well as connections to the Massachusetts Curriculum Frameworks. The pre-lessons are intended to give students some background for the arrival of the Museum teacher, and post-lesson activities are additional reinforcement. The post-lessons relate to and reinforce the main lesson subject matter.

Objectives

The lessons of the *Estimation Mania* program have been developed to emphasize math skills in estimation. By participating in this lesson students will have practice in:

- Computing whole numbers, fractions, and decimals using mental arithmetic
- Developing techniques for estimation and verbally explaining those techniques to others
- Checking the reasonableness of results.

Program Description

Optional pre and post lessons are provided for reinforcement of the main program presented by a museum teacher.

There are three lesson plans with worksheets in this booklet. The first, an estimating activity, gives students the opportunity to move around the classroom to view and examine objects. This 45-minute to one-hour motivational activity is listed first so that it will provoke students' interest in the rest of the lessons. The lesson contains introductory and concluding discussions, while students answer questions about the objects using estimation skills.

The shorter second lesson, called “Reviewing Skills in Math Approximation,” is included to provide students with practice using mental arithmetic to make their estimations, and reminds them of some estimating phrases and techniques. Teachers should use this lesson if additional practice in estimating beyond the teacher’s own curriculum is needed, or use it as a warm-up to the *Estimation Mania* activity. This half-hour second lesson and worksheet could also be used before the first estimating lesson or to supplement other estimating activities, depending on curriculum and student skill level.

The third lesson includes Worksheet 4, which lists some suggestions for writing exercises after the main lesson estimation game presented by the museum teacher. This is a cross-curriculum subject lesson, and may be used as follow-up in math class, or in the students’ English or social studies classes as reinforcement. Each writing exercise should take approximately ten to twenty minutes and could be done on the day of the visit or assigned at other times.

It is hoped that these lessons will provide opportunities for students to investigate objects they can pick up and touch, practice math skills, and discuss interesting objects they see with a new eye for mathematical judgment. A great follow-up activity to this kit would be an actual visit to the Museum.

Lesson Plans

Pre-Lesson Plan

Title: Estimating Activity
Program: Traveling Textiles – *Estimation Mania*
Grade Level(s): 5-7
Length of time for Lesson: 45 min. -1 Hour
Lesson Prior:

Objective:

- Students will know the difference between estimates and exact answers and the values of each
- Students will gain experience in making estimates about real items
- Students will value teamwork in arriving at reasonable problem solving solutions

Materials: Worksheet 1 (one copy per student) *Create additional estimation questions based on the items you supply (see below)
Picture of a weaver sitting at a loom
Picture of a man by a spinning jack
Add items that you can supply, such as:

- a jar of nuts and bolts
- a heavy metal machine gear or metal tool
- an empty wooden box or plastic crate
- a long length of cloth
- a skein of yarn

Steps:

1. Discuss the difference between an estimate and an exact answer:
   - estimate: made using some previous knowledge
   - exact answer: made using measuring tools like scales and rulers
2. Discuss the usefulness of estimation. Ask:
   - Why is it helpful to get an idea of the weight or height of something without knowing the exact answer?
   - If you are using a recipe to make a special dessert, why is it important to measure the ingredients exactly?
   - Suppose you know you need 2 pencils for every student in your class. You have a bag of pencils and you know that there are about 60 pencils in the bag. How can you decide that you have enough pencils for the class before counting out two pencils for each student?
3. Place the objects and pictures (each labeled) in different areas about the room, allowing space for students to walk around and handle them
4. Distribute Worksheet 1 (one copy per student). Add additional questions based on the objects you bring to the lesson.
5. Divide students into groups to study the items and discuss their estimates for completion of Worksheet 1. Allow free discussion of estimating strategies and use of simple tools in the room (i.e. a ruler)

6. Prepare for discussion after everyone has examined each object and made their estimations
    - Ask each group how they made their estimate of the measurement required for each item (each group could select a spokesperson)
    - List estimation skills on the board as they are mentioned (see list)

Estimation Strategies (with examples)

- Perception count as many nuts and bolts in a jar as can be seen, then add a few more for the ones not visible
- Approximation estimate the circumference of a bobbin to be a certain number of inches, then multiply by a reasonable number to get the length of the entire piece of yarn on the bobbin
- Comparison estimate the person next to the spinning jack to be 5 ½' tall, then subtract 1' because the jack is a little bit shorter than the person
- Previous Experience compare memory of weight of a 5-pound bag of flour and the weight of a heavy tool or gear
- Cooperation students may have worked together on their guesses and used each other's knowledge
- Rounding Off a cloth measurer may decide some cloth is a little more than a yard long and put down 1 yard as the answer
- Experimentation after experimenting with winding a 1 yard piece of yarn around a bobbin and counting how many turns it took, students could estimate the entire length of yarn on the bobbin

7. Discuss (here or earlier) reasonable vs. unreasonable answers - for example:
    - Ask: Is 80 yards a good estimate for a given length of cloth?
      Is 50 pounds a good estimate for the weight of a given tool?
    - Point out the difference between an estimation (using the skills above) and random guessing, which could lead to an unreasonable answer
8. Teacher should extend the math questions once correct estimating answers are known to the class
    - Example: If we know the cloth dimensions are 4' X 6', find the area of the cloth in square feet

Answers to Worksheet 1:

1. They have to warp 575 ends. They do 60 at a time. 575 is divided by 60 approximately 9 times. 9 X 20 min. = 180 min. which equals 3 hours. So, it would take the two people about 3 hours; About 10 days to weave the tablecloths.
2. Approximately 80 yards; Approximately 8,000 yards

Worksheet 1

Estimation Mania
Estimating Activity

You will be looking closely at a few objects and photographs. The photographs are from the collection of or were taken at the American Textile History Museum. You will be asked to make estimations based on your experience and estimating math skills.

1. **Picture of a weaver sitting at a loom**

   This picture shows a woman sitting at a hand loom. The loom must be prepared before the weaving actually begins. One of the steps of preparation is to pass the vertical threads of the loom through the heddles. To do this the weaver threads the thin yarn through eyes (openings) of the heddles. The heddles lift the yarn up and down as the weaver works the loom. There are about 575 strands of yarn, called ends, to be threaded. This set of yarn strands is called the warp. The warp is very long, perhaps 100 yards long. The warp is made very long because you don't want to have to do this job often. It is hard work!

   It would take the weaver and an assistant, who stands on the opposite side of the loom, about 20 minutes to warp 60 ends. Remember, there are 575 ends to warp on this loom. About how many hours will the two people work at this job?

   _____

   It may have taken this weaver one full day and most of a second day to weave one tablecloth. About how many days would it take to weave 5 tablecloths?

   _____

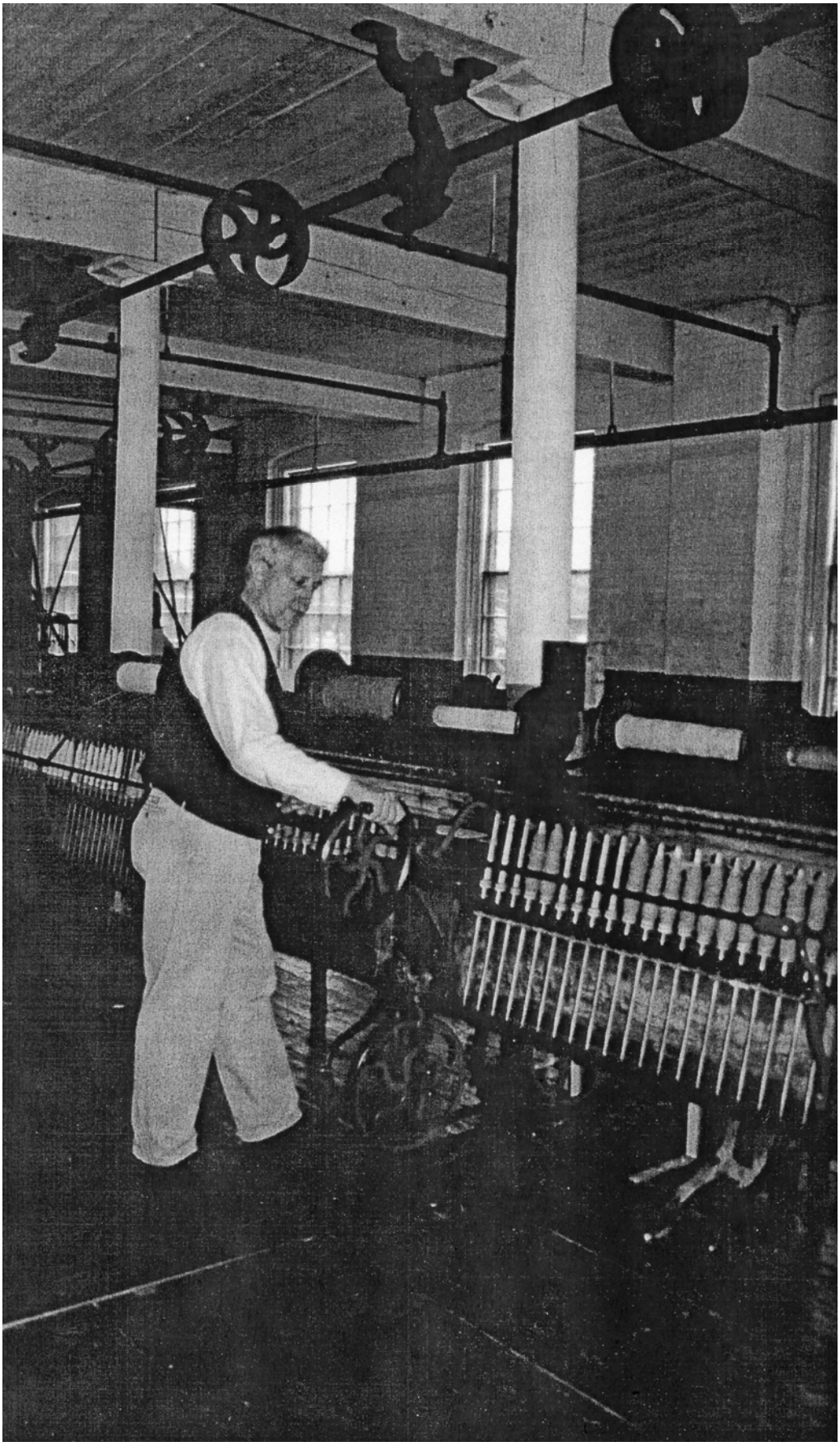
2. **Man at spinning jack**

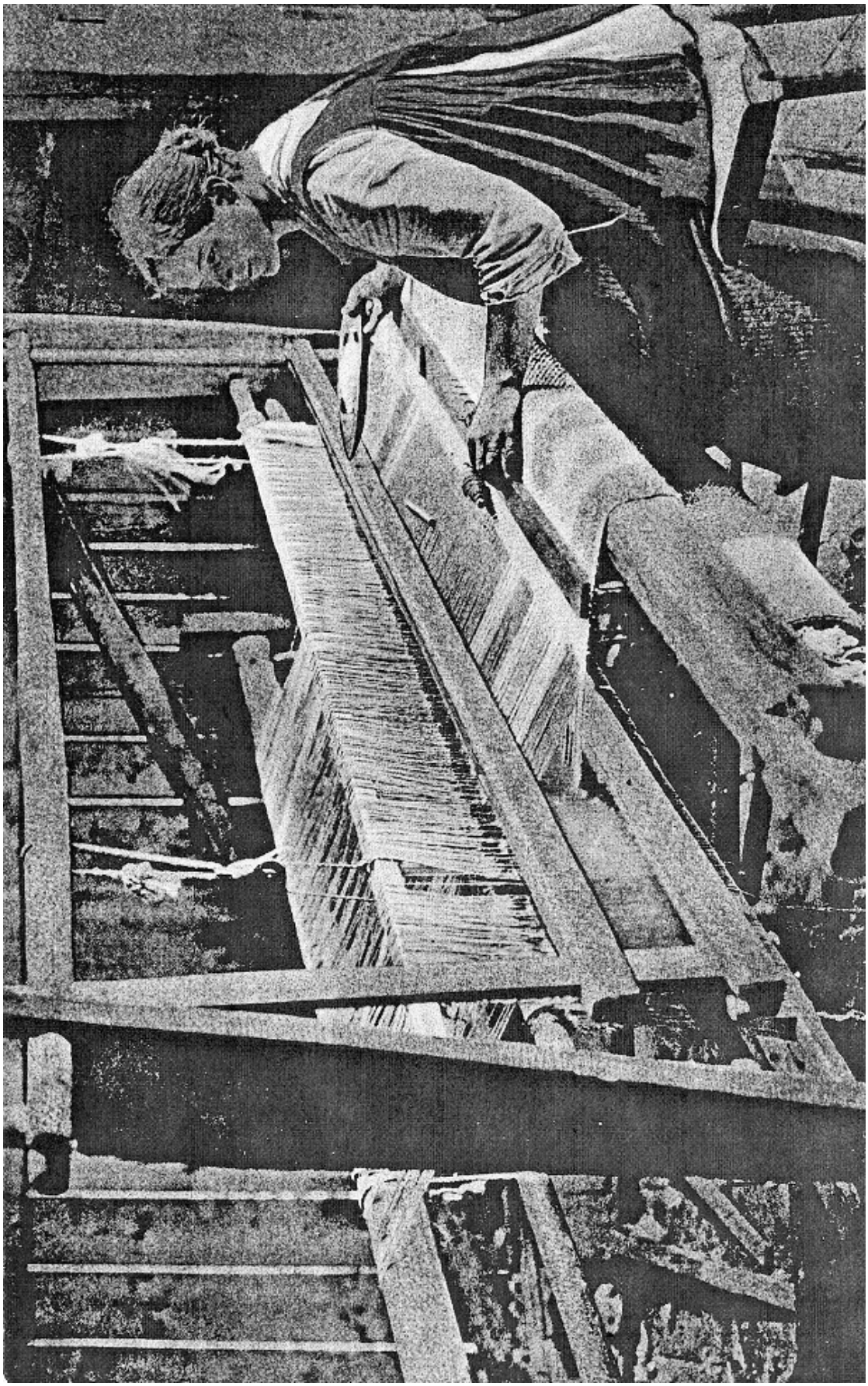
   One of the photographs is of a person next to a spinning jack. The jack holds one hundred bobbins and spins yarn on them. Bobbins can come in many shapes and sizes. If you know someone who has a sewing machine, you could ask to see that machine's bobbin. It will be much smaller than these on the jack.

   Looking at the yarn wound on the bobbins in the picture, make an estimate of how much yarn a bobbin would hold. _____

   The spinning jack holds 100 bobbins. How much yarn would they all hold?

   _____





Pre-Lesson Plan

Title: Reviewing Skills in Math Approximation
Program: Traveling Textiles – *Estimation Mania*
Grade Level(s): 5-7
Length of time for Lesson: 30 min.
Lesson Prior: Estimating Activity (optional)

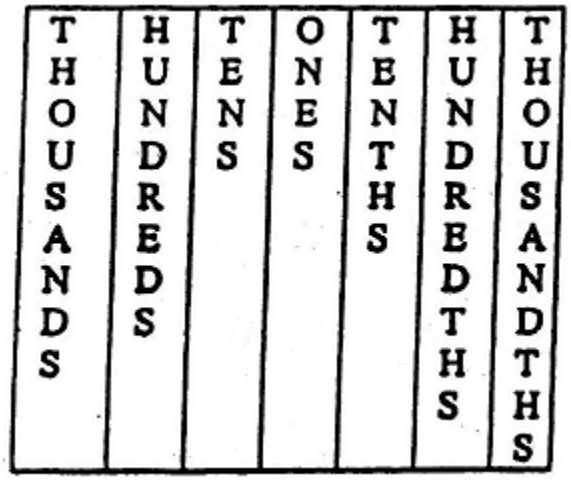
Objective:

- Students will practice using mental arithmetic to make estimations

Materials: Worksheet 2 (one for each student)
Pencils

Steps:

1. Review the 4 types of problems included on Worksheet 2
   a. Special vocabulary, including phrases such as "taking half" or "taking one third"
   b. Rounding off numbers:
      - Decide which decimal column you want to round to
      - Look at the number to the right of it
      - If that number is 5 or greater, your chosen number is increased by l
      - If that number is less than 5, your chosen number is decreased by l
      - Names of columns beginning with the thousands column and working right are:



   c. Adding or subtracting fractions
      - Find a common denominator which is the smallest number that all denominators (bottom part of the fraction) divide into evenly
      - Change all denominators to the common denominator
      - Multiply the numerators (top part of the fraction) by the same number the denominator was multiplied by to get the common denominator
      - Add the numerators
      - The common denominator should be the denominator of the answer
      - Simplify the answer to lowest terms

d. Multiplying fractions
   - Multiply the numerators – straight across the top of the fractions
   - Multiply the denominators – straight across the bottom of the fractions
   - Simplify the answer to lowest terms

2. Distribute Worksheet 2.
3. Instruct students to do the problems in their head (no calculator, etc.)
4. Review answers and techniques when students are finished with the worksheet

Worksheet 2

Estimation Mania
Reviewing Skills in Math Approximation

You do not need to use a calculator, or even a pencil and paper to solve these. Do these problems in your head, then write down what you think is the best answer.

1. Approximately how much is one third of 92? _____

2. Taking one half of a number is the same as dividing it by _____

3. If you have 4 ½ bolts of cloth for each of five people and you want to find out how many bolts you have altogether, what math operation do you perform to find the answer? _____
   Approximately how many bolts would you have? _____

4. How much is $3.23 rounded off to the nearest dollar? _____

5. To estimate 42 multiplied by 3.4, you could round off 42 to _____ and 3.4 to _____. The exact answer would be slightly less than/greater than the estimated answer (circle your choice).

6. Forty days ago was about how many weeks? _____
   What operation did you perform to figure out that answer? _____

7. If you measured something and found it was 39 inches long, how many yards would you say it is? _____
   How long is that in feet? _____
   About how many meters does that convert to? _____

8. About how many inches are in 6 feet? _____
   If you estimate a piece of yarn to be 2 yards and 3 inches, and you rounded off to the nearest number of feet, how long would you say the yarn is? _____

9. If you have 21 quarters, is the amount of money you have closer to $5 or $6? ____

10. If it takes about one minute to weave a one inch piece of cloth, about how long would it take to weave one yard of cloth? _____

Answers for Worksheet 2

1. About 30
2. 2
3. Multiplication, 22
4. $3.00
5. 40; 3; greater than
6. 5; division or multiplication
7. About 1 yard; 3 feet; about 1 meter
8. About 70 inches; about 6 feet
9. $5.00
10. About 36 minutes, or a little over ½ hour

Post-Lesson Plan

Title: *Estimation Mania* Writing Exercises
Program: Traveling Textiles – *Estimation Mania*
Grade Level(s): 5-7
Length of time for Lesson: 45 min.
Lesson Prior: *Estimation Mania* Activity

> **NOTE:** This is a cross-curriculum subject lesson and may be used as follow-up in math class, or in students' English or social studies classes as reinforcement for the Museum Tour Activity

Objective:

- Students will make connections between new information and prior knowledge of the Industrial Revolution and the textile industry

Materials: Worksheet 3 (one for each student)
Paper/pens

Steps:

1. Ask class to take out paper and pens
2. Distribute Worksheet 3 to the class
3. Ask students to write answers to one or more questions. [Option: allow students answering #3 (write a play script) to work in group(s)]
4. When finished, ask students to share their work with the class.

NOTE: Instructors could use this format to include questions on additional topics relevant to their classroom experience.

Worksheet 3

Estimation Mania
Writing Exercise

On a separate sheet of paper, write answers for the following questions:

1. Do you know anyone who uses yarn, thread, or cloth to make things? Describe who this person is and what they make.

2. The American Industrial Revolution took place in the nineteenth century. Because of many inventions during this time, machines were made which made some work easier for people. You may have learned some things about the Industrial Revolution already. Write a paragraph on what you know about the Industrial Revolution.

3. Write a one-page script for a play. The play takes place in a general store. A customer comes in with some cloth she has woven. The customer is going to barter with the shopkeeper of the general store so that she can purchase items she needs at home. Bartering means to discuss what items can be traded for other items. Write a script of the bartering between the customer and the general store shopkeeper.

4. Many of the jobs done today by machine used to be done by people. Some of these are knitting, spinning, and weaving. People continue to do them because the process of creating a handwoven or knitted object is very enjoyable. Many people who do these things do not think of them as hard work to do because they like doing these things in their leisure time. The objects, such as tablecloths or mittens, can be very beautiful. You may have been to a museum or county fair where a handcraft was demonstrated, or maybe you have seen a demonstration of a handcraft on television. Write a paragraph describing the demonstration you remember.

5. Have you every visited a modern factory? Write a paragraph describing what the factory or workshop looked like. How big was it? What kind of equipment was in it? Did it have windows? Was it air-conditioned or heated? How were the rooms lighted? Include other details that were interesting to you.

6. Have you ever seen a workshop or studio where people make things by hand? What was the workshop like? What kind of equipment was in it? How was the room lighted? Describe the workshop or studio you have visited with as much detail as you remember.

Related Follow-up Activities

Math Baseball

A shortage of American workers led the Abbot Worsted Mill owners (Westford, MA) to lure laborers here from overseas by providing worker housing and even social activities. Competitive mill sports teams were started, recruiting the best players from abroad. Abbot himself went to Keithley, England to hire their best soccer players for mill jobs so they could play on the mill team. He recruited competitive baseball players abroad, too.
This math game involves students correctly answering math problems in order to score runs to advance around a baseball diamond drawn on the blackboard. Imagine you comprise two mill worker teams competing.

Method:

- Draw a baseball diamond on the blackboard. Choose a student who will write names of players in their positions on the diamond, moving batters' names as they progress around the bases
- Choose a scorekeeper to keep score on the blackboard
- Divide the class into 2 teams
  - 8 players play each inning – 4 batters from one team; a catcher, 1st, 2nd, 3rd basemen from the other
  - The teacher is the pitcher
- How to play
  - The pitcher (teacher) asks the first batter a math problem
  - If the batter answers first, he moves to 1st base
  - If the catcher answers first, the batter is out
  - The pitcher can ask problems of runners on base
  - If the runner answers first, he steals a base
  - If the baseman answers first, the runner is out
  - Runners on base are pushed around the bases as batters answer correctly and get on base also
  - The original 8 players switch places (one group at bat, one fielding) after 3 outs
  - Substitute all players with teammates who haven't played yet after each inning (6 outs)

If the teacher feels students can handle the pitcher's job, place a student in this position and add another batter to the other team, totaling 10 players active each inning.

Mathematics Countdown

Mill workers were always pressed to work quickly to keep up with their speeding machines. Likewise, this math game involves both speed and accuracy.

Method:

1. Divide the class into two teams.
2. Set a time limit (i.e. 5 minutes).
3. The teacher presents a math problem to the entire class. Using a watch, time how long it takes before the first hand goes up with the correct solution.
4. The team of the first correct problem solver gets a point and the solver must sit out the rest of the game.
5. Keep going until you use up the pre-set time limit. Declare a winning team.
6. Repeat entire process as often as you wish.

Counting Sheep

Use this information to answer the questions and color your sheep:

The yield of raw wool from an average colonial sheep was 4 pounds. After cleaning and carding, about 2 pounds were ready to be spun.

In colonial times, yarn and thread varied in thickness so standard measurements were difficult. In the problems below, the amount of yarn produced per pound of cleaned, carded wool was 2,000 yards.

Questions:

1. Estimate the number of yards of yarn or thread in the following items. Then color in how many sheep (or fractions of a sheep) you would need in order to produce the yarn to eventually make into the item. You may use a different color for each item. It is OK to use different colors on the same sheep if the wool can be used in more than one item.

Table cloth – 60 inches by 60 inches with 30 threads per square inch
Sweater – weighing 3.5 pounds
Undershirt – made of 3 square feet of fabric having 30 threads per square inch
Cloak – made of 4 square yards of fabric with a thread count of 40 threads per square inch

HINT: Fabric is interwoven vertical AND horizontal threads or yarn. When you need to find the amount of thread in an item, figure the amount of thread needed horizontally, then double your answer.

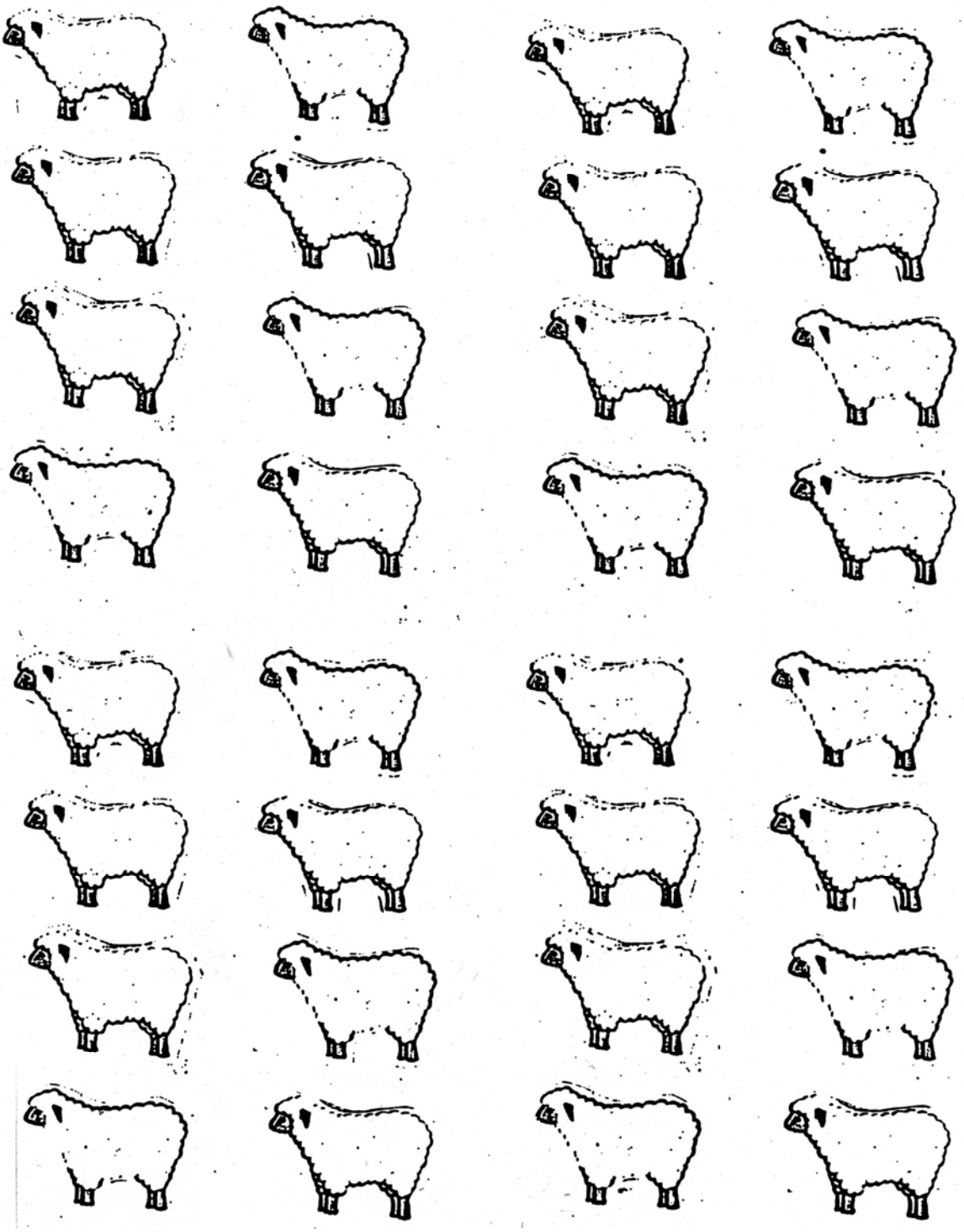
2. Could you estimate the amount of yarn or thread necessary in some items you own?

3. How is yarn sold today? By running yard? By weight?

4. Are uses for yarn determined by how thick or thin it is? List some examples.

*Adapted from Unit One: Pre-Industrial Cloth Makers, in "Discovering Science and Technology Through American History," a project of the Society for the History of Technology supported by the National Science Foundation.

Adapted by the American Textile History Museum



Answers for Counting Sheep

Given Data: From 1 sheep you get: 2 lbs. of wool fit to spin
1 lb. of wool yields 2,000 yards of thread, therefore wool from 1 sheep yields 4,000 yards of thread
4,000 yards = 12,000 feet = 144,000 inches

1. Table cloth:
   60" (width) X 30 threads = 1800" of thread per inch of cloth
   1800" X 60" (length) = 108,000" of thread needed
   144,000 divided by 108,000 = .75 or ¾ sheep
   Double the answer to account for warp and weft = 1 ½ sheep

   Sweater:
   1 sheep yields 2 lbs. of wool
   To get 3.5 lbs., we need 1 ¾ sheep

   Undershirt:
   36" (width) X 30 threads = 1080" thread per inch of cloth
   1080" X 36" (length) = 38,880" of thread
   38,880 divided by 36 = 1080 yards of thread
   Since 1 sheep yields 4,000 yards of thread = ¼ sheep
   Double the answer to account for warp and weft = ½ sheep

   Cloak
   4 square yards = 12' X 12' or 144" X 144"
   144" (width) X 40 threads = 5,760" of thread per inch of cloth
   5,760" X 144" (length) = 829,440" of thread needed
   829,440" divided by 36 = 23,040 yards of thread
   Since 1 sheep yields 4,000 yards of thread = 5 ¾ sheep
   Double the answer to account for warp and weft = 11 ½ sheep

2. (Make estimates)

3. When yarn is sold today, both weight and yardage are listed.

4. Yes. Thick yarns: rugs, blankets, bulky sweaters. Thin yarns: light weight clothing, blouses, men's suits. Different types of items can be made of thick or thin yarns; consider your clothes, curtains, etc.

Additional Information

Vocabulary

BOBBIN A spool or reel that holds thread or yarn for sewing, spinning, and weaving

CARDING Combing and straightening fibers to prepare for spinning

CLOTH Fabric or material formed by weaving, knitting, pressing, or felting of natural or synthetic fibers

FABRIC A textile structure produced by interlacing yarns or fibers

FIBER Fine, hair-like filaments which are twisted together to make yarn

FLAX A textile fiber obtained from flax; a plant with blue flowers and slender stems from which a fine, light-colored textile fiber is obtained

HEDDLES A set of parallel cords, with a loop or eye near the center, that are used to separate the warp threads and make a path for the shuttle

LOOM Any equipment that is used to weave yarns

PLAID A checked or tartan pattern consisting of stripes of varying widths and colors crossed at right angles against a solid background, forming a distinctive pattern

SPINNING Twisting fibers together to make yarn

SPINNING JACK A machine that holds bobbins and spins yarn on them

SPINNING WHEEL A device for making yarn or thread, consisting of a foot- or hand-driven wheel and a single spindle

TEXTILE Any of the following: the fibers that are spun into yarns, the yarns that are interlaced to make fabric, the fabric itself, and garments produced from fabric

WARP The strong yarns that run vertically on the loom

WEAVE To make cloth by interlacing threads of the warp and weft on the loom

WEFT The yarns that are interlaced horizontally through the warp

YARN A continuous strand of twisted threads of natural or synthetic material, as wool or nylon, used in weaving or knitting

Estimation Mania
Connections to Massachusetts Curriculum Frameworks

History and Social Science Curriculum Frameworks

Core Knowledge:
- The United States
  - 4. Expansion, Reform, and Economic Growth (1800-1861)

Geography Strand, Learning Standard 8: Places and Regions of the World
Geography Strand, Learning Standard 9: The Effects of Geography
Economics Strand, Learning Standard 13: American and Massachusetts Economic History

English Language Arts

Language Strand, Learning Standard 1: Students will use agreed upon rules for formal and informal discussions in small and large groups

Science and Technology

Guiding Principle V: Science and technology connect with other disciplines, and have a particularly integral relationship with mathematics
Strand 1: Inquiry
Strand 2: Physical Sciences: Transformation of Energy
Strand 3: Understanding and Using Technology
Strand 4: Science, Technology, and Human Affairs

Mathematics

Strand 1: Number Sense and Number Relationships
- 1.4: Estimation
- 1.7: Number Sense and Number Theory

Strand 2: Patterns, Relations, and Functions