

McGraw-Hill Education

MathLinks 9

PATHWAYS TO SUCCESS

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A Tour of Your Textbook

Chapter Opener

Each chapter begins with a two-page spread that introduces you to the **Big Idea** and explores how the math covered in the chapter is used in real life. The **Inquire and Explore** feature provides inquiry questions related to the Big Idea for you to think about as you learn the content in the chapter.

Chapter 2

Scale Factors and Similarity

Have you ever wondered how the scale fits a map work? What about how tall a cliff or a mountain is, or how far it is to the other side of a river or a valley? In this chapter, you will explore the SI measurement system and scale factors. You will also use the properties of similar triangles to find heights of very tall objects.

Workers in fields, such as architecture, road construction, and surveying often use the SI measurement system, scale factors, and diagrams. For example, a draftsman prepares technical drawings and plans that are used to build everything from industrial machines to skyscrapers. The drawings show the details of the structure and specify the dimensions, the materials to be used, and the procedures to be followed.

Big Idea
Photograph, model, and drawing are often enlargements or reductions of the original. The scale factor is the multiplier that relates the relationship between them. You can use proportional reasoning to understand how the changes in size are related.

Inquire and Explore

- How can you describe, measure, and compare special relationships?
- How are similar shapes related?
- What characteristics make shapes similar?

Get Ready

These two pages provide an overview of the prerequisite skills you will need to be successful in the chapter. Teaching boxes review content before you apply what you know.

Get Ready

Operations With Integers

To add integers, you can use a number line.

$(-2) + (-4) = -6$

$(-1) + (-3) = -1 + (-4) = -5$

How is subtracting a negative the same as adding the opposite?

The product of two integers with the same sign is positive.

The product of two integers with different signs is negative.

$4 \times (-3) = -12$ $-24 \div 6 = -4$
 $-6 \times (-2) = 12$ $(-15) \div (-3) = 5$

You can apply the order of operations to integers.

$-2(-3 + 7)^2 = -2(4)^2 = -2(16) = -32$

Teaching Boxes:
 Addition: In the order written.
 Multiplication: In the order written.
 Subtraction: In the order written.

- Add or subtract:
 - a) $8 + (-9)$
 - b) $-12 + 5$
 - c) $-5 + 7$
 - d) $12 + (-6)$
- Use the order of operations to evaluate:
 - a) $7 \times (-8) + (-10)$
 - b) $(-3)(-4) + 8 + (-3)$
 - c) $-25 + 5 + 5$
 - d) $36 \div (7 - 10)$
 - e) $(-4)^2 + 9$
 - f) $5 + 12^2$

Add and Subtract Rational Numbers

$\frac{1}{2} + \frac{3}{4} = \frac{2}{4} + \frac{3}{4} = \frac{5}{4}$

Learn the you practice (Common denominator)

When subtracting you can add the opposite.

$\frac{1}{2} - \frac{3}{4} = \frac{2}{4} - \frac{3}{4} = -\frac{1}{4}$

- Add or subtract:
 - a) $\frac{1}{2} + \frac{3}{4}$
 - b) $\frac{1}{3} - \frac{2}{5}$
 - c) $-\frac{3}{4} + \frac{1}{2}$
 - d) $-\frac{1}{2} \times (-\frac{3}{4})$
 - e) $\frac{1}{3} - (-\frac{2}{5})$
 - f) $-\frac{1}{4} - (-\frac{3}{5})$
 - g) $\frac{2}{3} + (-\frac{1}{4})$
 - h) $-\frac{1}{2} \times \frac{1}{4}$

Multiply and Divide Rational Numbers

$\frac{3}{16} \times (-\frac{2}{3}) = -\frac{3}{16} \times (\frac{2}{3})$

You can multiply by the reciprocal.

$\frac{24}{144} = \frac{1}{6}$

Use the rule: $\frac{a}{b} \times \frac{c}{d} = \frac{ac}{bd}$

Use the rule: $\frac{a}{b} \div \frac{c}{d} = \frac{a}{b} \times \frac{d}{c}$

How do you know that $-\frac{3}{8}$ and $-\frac{2}{3}$ are opposites of each other?

5. Evaluate:

- a) $\frac{8}{15} \times (-\frac{5}{12})$
- b) $-\frac{2}{3} \times \frac{14}{3}$
- c) $\frac{5}{3} \div (-\frac{8}{25})$
- d) $-\frac{10}{9} \div (-\frac{2}{3})$

Area of a Rectangle and a Triangle

To determine the area of a rectangle, multiply the length by the width, $A = l \times w$.

The area of a triangle is half the area of a rectangle. To determine the area of a triangle, calculate the product of the base and height and divide by 2, $A = \frac{1}{2}bh$.

This triangle has a base of 14 units and a height of 8 units, so the area is $\frac{1}{2}(14)(8) = 56 \text{ units}^2$.

6. Determine the area of each shape.

Teaching Boxes:
 We can find the area because we are referring to square units.

Exponent Rules

Product Rule: To multiply powers with a common base, add the exponents.

$2^3 \times 2^4 = 2^{3+4} = 2^7$

Quotient Rule: To divide powers with a common base, subtract the exponents.

$\frac{4^5}{4^2} = 4^{5-2} = 4^3$

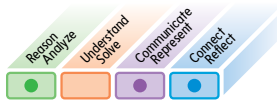
7. Rewrite as a single power:

- a) $2^3 \times 2^7$
- b) $4^5 \times 4^6$
- c) $(-3)(-3)^3$
- d) $\frac{10^8}{10^3}$
- e) $\frac{5^7}{5^2}$
- f) $\frac{(-2)^3}{(-2)^5}$

Three-Part Lesson Plan




The Know-Do-Understand icon emphasizes the BC curriculum model and divides the lesson into three parts.



Curricular competency icons are used in the **Explore and Analyze** and **Connect and Reflect** sections to show you which competencies you will need to use to solve a problem or answer a question. The icons are placed beside questions that are particularly good examples of those competencies.

2.2 Enlargements and Reductions

Focus On ...
In this lesson, you'll learn to:
• compare the dimensions of a diagram to the actual distance by which it was measured or reduced
• scale the actual measurement to create a given scale



Explore and Analyze


Scale
The relationship between a distance on a diagram, model or map and the actual distance is called the **scale**.
For example, a scale of 1 cm = 1 m means that 1 cm on the diagram represents 1 m in actual life.

Scale reduction
The reduction used to reduce the size of an object.

Scale factor
• the number used as a multiplier to reduce
• the number to enlarge a measurement
• 1 multiplied each side of the original figure by 1

1. A **scale reduction** is often used to illustrate large things that are not practical to draw to actual size because they are too big. Research the dimensions of a standard stop sign in Canada.
a) Measure the width of the stop sign on the photo.
b) How many times as wide is an actual stop sign as the stop sign in the photo?
This is called the **scale factor**.

2. Express the scale of the photo as a diagram measurement: actual measurement ratio.
a) Express the ratio in lowest terms. Do not include the units in the ratio.



Explore and Analyze

These activities provide you with opportunities to investigate the content and build your own understanding of a new concept. On CONNECTschool, you will find links to websites, videos, worksheets, and other tools to provide support as you complete these activities. Many of the Explore and Analyze activities also promote inquiry-type problem solving and thinking.

Develop Understanding

This section includes **Examples** and worked **Solutions** that show you how to use your prior knowledge and what you have learned in the Explore and Analyze activity to develop further understanding of the content.

- **Thought bubbles** prompt you to think about what you know and how you know it.
- Sometimes different methods of solving the same problem are shown. One way may make more sense to you than another.
- Calculator key-press sequences are shown where appropriate.
- The **Show You Know** section after each Example allows you to check that you understand the skill covered in the Example before moving on to the next.
- CONNECTschool provides videos, interactive activities, and links to websites for more information.

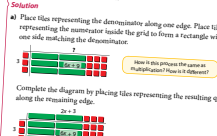
Develop Understanding

Example 1: Divide a Polynomial by a Monomial Using Algebra Tiles

Determine the quotient: a) $\frac{6x^2 + 9}{3}$ b) $\frac{2x^2 - 4x}{-2x}$

Solution

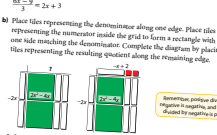
a) Place tiles representing the denominator along one edge. Place tiles representing the numerator inside the grid to form a first rectangle with one side matching the denominator.



After it is placed, the area is $6x^2 + 9$.
Complete the diagram by placing tiles representing the resulting quotient along the remaining edge.

$\frac{6x^2 + 9}{3} = 2x^2 + 3$

b) Place tiles representing the denominator along one edge. Place tiles representing the numerator inside the grid to form a rectangle with one side matching the denominator. Complete the diagram by placing tiles representing the resulting quotient along the remaining edge.



Remember: positive divided by negative is negative.
 $\frac{2x^2 - 4x}{-2x} = -x + 2$

Show You Know

Model each quotient using algebra tiles or a diagram.
a) $\frac{12x^2 - 6}{3}$ b) $\frac{8x^2 + 6x}{-2x}$

4.5 Dividing Polynomials by Monomials 143

Connect and Reflect

This section includes the **Key Ideas** and the **Practise, Apply, and Extend** questions. You will show what you have learned by practising, connecting, and reflecting on the concepts. Curricular competency icons indicate which competencies are addressed by selected key questions throughout the exercise set. **Competency Check** questions allow you to demonstrate your level of understanding of the concepts using multiple competencies.

Connect and Reflect

Key Ideas

- Equivalent fractions represent the same rational number.
 - $\frac{1}{2}, \frac{2}{4}, \frac{3}{6}$ and $\frac{4}{8}$ are equivalent.
- One strategy for comparing and ordering rational numbers is to use a number line.
 - On a horizontal number line, a larger rational number is to the right of a smaller rational number.
 - Opposite rational numbers are the same distance in opposite directions from zero.
 - Opposites: $-\frac{1}{2}$ and $\frac{1}{2}$, 0.5 and $-\frac{1}{2}$
- To compare fractions with the same denominator, compare the numerators.
 - $\frac{3}{10} > \frac{2}{10}$ because $3 > 2$.
- One strategy for identifying a rational number between two given rational numbers is to use a number line.
 - A rational number in fraction form between -0.3 and -0.1 is $-\frac{1}{5}$.
- If the side length of a square models a number, the area of the square models the square of the number.
 - If the area of a square models a number, the side length of the square models the square root of the number.

Extend

12. Royce is renovating his family's cabin. To help plan, he makes a quick sketch of the layout. The diagram is not to scale.

a) The exterior walls and the wall between the bedrooms are made of log and are 20 cm thick. Determine the missing dimensions of Bedroom 2.

b) Draw a scale diagram using the scale 1 square = 20 cm. The bedroom doors are 80 cm wide and 15 cm from the corner of the room. The 110 cm wide wall starts 50 cm from the corner.

13. The legs of a table have a diameter of 40 cm. The legs are attached 10 cm from the edges of the tabletop, as shown in the diagram. The tabletop is 9 cm thick. The table is 150 cm long, 90 cm wide, and 75 cm high.

Other Features

Tasks

The Tasks at the beginning of the book require you to use skills from more than one section or chapter. To promote an inquiry approach, you may need to do some research and explore some new concepts to complete the Task. You will apply what you learn to real life and create a presentation. CONNECTSchool provides links to websites, worksheets, and helpful information to help you complete each Task. It also includes Project versions of each Task for students who prefer a more open inquiry-based approach to learning.

Task

City Planning

Architects, designers, engineers, and lobbyists all use scale models to replicate objects. There are even professionals whose job it is to make scale models. Scale models can replicate large items like ships by reducing the scale of the model. Or, they can replicate small items like DNA or computer chips by increasing the scale of the model.

What You Will Do

Have you ever seen a scale model up close? What is an enlargement or a reduction? Why do you think it was created? What features did you notice? The detail in model cars, planes, figurines, and buildings can be amazing! In this task, you will work with your class to create a mathematically correct scale model of a city block. It can be a block in your neighborhood or a fictitious one that you create together. You will need to show the original dimensions of the items you are replicating and how your model is scaled. Materials you might use include modelling clay, bits of styrofoam, a 3-D printer, or anything else that you can safely work with.

- As a class, discuss the types of buildings you will create for your block and other features such as roads, trees, park equipment, cars, and people. Choose a building or feature to model and research its dimensions and significance to the city or block.
- Make a table that shows the calculations and your use of proportional reasoning to find the dimensions of your scale model.
- Draw scale diagrams of each view of the object.
- Construct your scale model.

What You Need to Know

Part 1: Research the Dimensions

- How to use Pythagoras' theorem (Section 2.1)

Part 2: Create a Scale Diagram of Your View

- How to create scale diagrams (Section 2.3)
- How to draw the front, and side view of 3-D objects (Grade 8, further Area)

Part 3: Build a Model of Your Scale

- How to use scale factors and proportional reasoning to build a scale model (Section 2.3)

What You Need to Show

Your final presentation must contain

- top, front, and side views of your item
- a scale model of your object including scale factor calculations
- an explanation of the mathematical process for and usefulness of creating 3-D scale models
- a self-assessment rubric

City Planning • 189

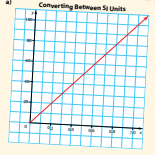
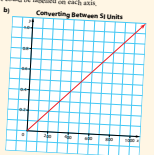

Rich Problems

These questions, at the end of each chapter, require you to connect and apply various concepts in a challenging and engaging environment. You may wish to work individually or in small groups to complete them.

Chapter Review

At the end of each chapter there is a Chapter Review. You can use the learning goals summary to self-assess your understanding of the chapter content. Also, review the **Inquire and Explore** questions to make sure you understand the Big Ideas from the chapter. The review is organized by section number so you can look back if you need help with a question. The **Connect the Concepts** section includes questions that use content from more than one section in the chapter.

Rich Problems

- For the graphs below, state two possible SI units that could be labelled on each axis.
 - Converting Between SI Units**

 - Converting Between SI Units**

- The international paper size standard is defined as follows:
 - The A0 or starting size has an area of 1 m².
 - The length to width ratio is $\sqrt{2}$.
 - Each subsequent size A(n) is defined as A(n-1) cut in half parallel to its shorter side.
 - The standard length and width of each size is rounded to the nearest millimetre.
 If A0 has dimensions 1189 mm by 841 mm, what are the dimensions for A1, A4, and A6 sheets of paper?
- The geometric mean between two numbers, a and b , is the value x such that $\frac{a}{x} = \frac{x}{b}$. You are given $\triangle ABC$ such that $\triangle ADB \sim \triangle BDC$ and $\angle ADB = 90^\circ$.
 - Why can BD be defined as the geometric mean of sides AD and DC ?
 - Write a proportion and solve for x .

MHR • Chapter 2: Scale Factors and Similarity

Chapter 8 Review

Learning Goals

Inquire and Explore: What factors do you need to consider when determining whether to survey an entire population or a sample of a population? How can you compare data to determine whether there are valid and reliable data?

After this section, I can

- investigate how influencing factors affect data collection
 - write data and identify patterns related to bias, timing, wording, privacy, cultural sensitivity, and other influencing factors
 - write survey questions that are understandable to data collected
- make connections between populations and different types of samples
 - write survey questions to target for a specific situation
 - identify sampling bias in surveys and census data
- refine open-ended questions and responses and design
 - analyze data for bias and representativeness
 - identify a correlation that does not agree with a graph or table and explain why
- design a survey plan
 - complete a research project according to the plan, draw conclusions, and communicate the findings

8.1 Factors Affecting Data Collection, pages 274–279

- For each survey question, identify any influencing factors. Rewrite the question so the resulting data are valid and reliable.
 - Do you prefer to drink watered-down orange juice from a carton or fresh-squeezed and nutritious, hand-squeezed orange juice?
 - Is the loud, heavy beat of rap music damaging to the human body?
 - Due to overcrowding, should another school be built?
- Identify the influencing factor in each survey question. Rewrite the question free of bias.
 - Sam asks riders of all-terrain vehicles: *Do you think some riding trails should be closed to save some endangered animals?* YES NO
 - A scientist asks people at an airport: *Do you think going to all the airports will travel a long distance?* YES NO
- Is each question biased or unbiased? Explain your reasoning.
 - Does the school board have the right to enforce a dress code?
 - Do you think the mayor is doing a good job despite his questionable character?
 - Do you prefer daytime or evening television programming?
 - Do you think the government should be allowed to cut down trees whenever they want for new highways?

8.2 Collecting Data, pages 280–286

- Every seventh person that comes out of the library is asked whether they prefer to read a book or watch movies. Is this question biased or unbiased, and why?
- Cherie needs to find out what classes people like the most. When she arrives at her French club meeting, she asks the people there. What kind of sample is that? Justify your answer.

8.3 Identifying and Critiquing Misrepresented Data, pages 292–296

- Cherie and her friends like three different rock bands: The Stones, The Beatles, and The Rolling Stones. Cherie surveys her classmates about their favourite one of these bands. She records the data.

Band	Votes
The Stones	8
The Beatles	6
The Rolling Stones	2

 - Draw a graph to make it appear that The Stones are much more popular than the other two bands.
 - Explain how your graph distorts the data.
- Cat owners were surveyed about their results in training their cats to stop bad habits. The graph shows the results.

Training Method	Percentage of Owners
Clicking on a leash	40%
Clicking on a collar	30%
Clicking on a harness	20%
Clicking on a vest	10%

 - If there are 346 cat owners, how many taught their cats not to climb on furniture?
 - Do these cat owners represent a sample or a population?
 - Are your results generalizable?

Connect the Concepts

- Natural events such as droughts, floods, and tornadoes are increasingly affecting how we live. Choose a topic that interests you. Research how statistics are used and how they affect predictions about the topic. For example, would the study of floods involve a sample set of data, or a population?
- A local retailer sells 57000 of garden supplies each month from April to June. In July and August, sales fall to 34000 each month. Describe how the retailer could present misleading data in an ad and why the retailer might want to do this.

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Answers

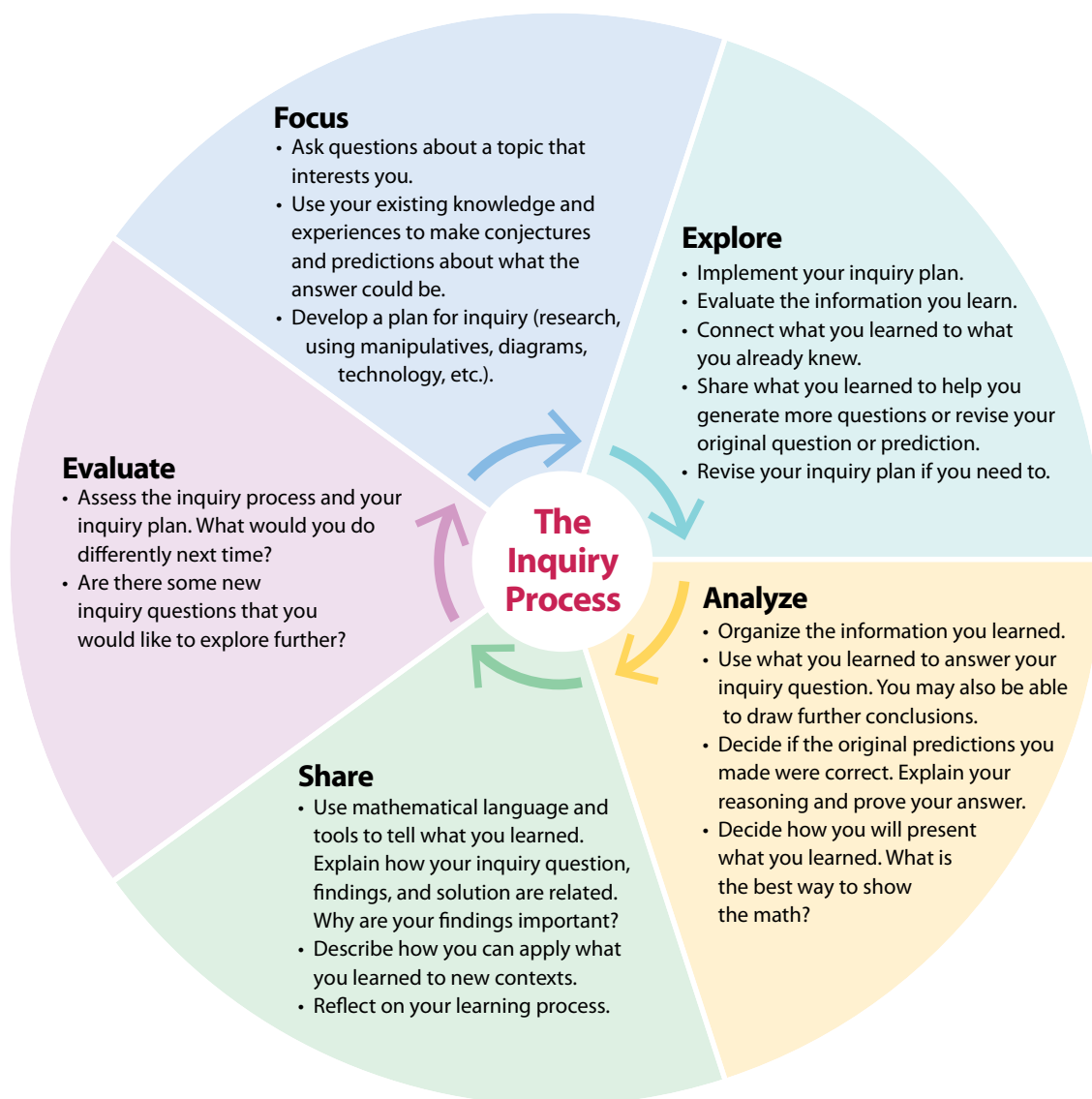
Answers are provided for all Practise, Apply, and Extend questions, except the Competency Check questions. Your teacher may use these to assess your understanding and progress. There are also answers for the Rich Problems and Chapter Review questions.

Inquiry-Based Learning

Why Should You Do Inquiry?

Inquiry-based learning

- lets you to take control of your learning and build your own understanding
- allows you to develop meaningful questions that have multiple answers
- is an active exploration of a topic
- improves your logical reasoning, research, analysis, and communication skills
- offers opportunities to collaborate
- allows you to make connections between Big Ideas, concepts, and competencies



Good Inquiry Questions and Responses

Inquiry works best when the question you start with meets the following criteria:

- The topic of the question is relevant and interesting to you.
- The question is open-ended. This means it cannot be answered with a simple yes or no.
- You will learn something new by responding to the question. If you already know the answer to an inquiry question, there is little point in investigating it.

A Sample Inquiry

Stage of Inquiry	Example
<p>Focus Your teacher tells you to imagine that you are in charge of renovating a two-storey office building where 200 people work. It already has several stairwells and one elevator, but the owners want to get more people to the second floor more easily. You are given a floor plan that shows the amount of space available to solve the problem. You need to choose a method of moving people between floors and draw it on the scale diagram.</p>	<p>After some thought, I decided to research</p> <ul style="list-style-type: none"> • the amount of space needed for an elevator and an escalator • the dimensions of each • the number of people each one can transport in the same amount of time • the speed at which they can move people • the difference in cost
<p>Explore Your teacher now asks you to start implementing your inquiry plan.</p>	<p>Using the Internet, I found the dimensions of a typical escalator and elevator and realized that either one would fit in the space allowed, although the escalator took up more room. There was not enough room on the diagram to include two elevators because of the layout of the available space. I discovered that an escalator can move more people more quickly. However, an escalator is more expensive to install.</p>
<p>Analyze Next, you use the information you learned to draw conclusions to answer your inquiry question. You decide how you will share your conclusions with your class.</p>	<p>To present my findings, I drew my scale diagram of the escalator on the floor plan, showing my scale factor calculations. I made a table to compare the information for the escalator and elevator. I also created two graphs to show the difference in the time it would take for people to get to the second floor and the difference in cost. I concluded that the escalator is a better choice because it is so much faster.</p>
<p>Share Present your findings to the class. Explain why you wanted to figure out the answer to the inquiry question and why it is an important question. Talk about where you might be able to use the skills or information you have learned in the future.</p>	<p>I wanted to compare escalators and elevators because I was curious about why you might choose one over the other. I learned that escalators move more people more quickly, but they are more expensive and take up more horizontal space than elevators; in some situations they might not be a practical choice. Learning how to compare different options in order to make a decision is a skill I might use when making big decisions in the future, like choosing what to do after high school, or what car to buy.</p>
<p>Evaluate How well did your inquiry process work? Could you have done it differently to be more efficient? Did the process make you think of any other questions that you would like answered?</p>	<p>I wondered whether it would have been better to fit two elevators in the space by moving some walls. I also wondered how much office space would be lost by installing the escalator, which takes up more floor space. How important would that be? During my research, I noticed that the maintenance contracts for escalators are often much more expensive than for elevators. I did not take that into consideration for this project, but I wonder if that would change some people's choice.</p>