TEXAS MATH SOLUTION

Algebra I

Student Textbook

Skills Program Edition

SY 2022-2023

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Our Manifesto

WE BELIEVE that quality math education is important for all students, to help them develop into creative problem solvers, critical thinkers, life-long learners, and more capable adults.

WE BELIEVE that math education is about more than memorizing equations or performing on tests—it's about delivering the deep conceptual learning that supports ongoing growth and future development.

WE BELIEVE all students learn math best when teachers believe in them, expect them to participate, and encourage them to own their learning.

WE BELIEVE teachers are fundamental to student success and need powerful, flexible resources and support to build dynamic cultures of collaborative learning.

WE BELIEVE our learning solutions and services can help accomplish this, and that by working together with educators and communities we serve, we guide the way to better math learning.

LONG + LIVE + MATH

ACKNOWLEDGMENTS

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“Mathematics is so much more than memorizing rules. It is learning to reason, to make connections, and to make sense of the world. We believe in Learning by Doing™—you need to actively engage with the content if you are to benefit from it. The lessons were designed to take you from your intuitive understanding of the world and build on your prior experiences to then learn new concepts. My hope is that these instructional materials help you build a deep understanding of math.”

Sandy Bartle Finocchi, Chief Mathematics Officer

“You have been learning math for a very long time—both in school and in your interactions in the world. You know a lot of math! In this course, there's nothing brand new. It all builds on what you already know. So, as you approach each activity, use all of your knowledge to solve problems, to ask questions, to fix mistakes, and to think creatively.”

Amy Jones Lewis, Senior Director of Instructional Design

“At Carnegie Learning, we have created an organization whose mission and culture is defined by your success. Our passion is creating products that make sense of the world of mathematics and ignite a passion in you. Our hope is that you will enjoy our resources as much as we enjoyed creating them.”

Barry Malkin, CEO

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LESSON STRUCTURE

Each lesson has the same structure. Key features are noted.

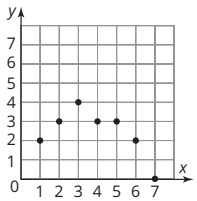
1

A Picture Is Worth a Thousand Words

Understanding Quantities and Their Relationships

Warm Up

Emma bought a new video game. The graph shown describes the number of hours Emma spent playing the game over a period of 7 days.



1. Label the axes.
2. What does the highest point on the graph represent with respect to the scenario? The lowest point?

Learning Goals (1)

- Understand quantities and their relationships with each other.
- Identify the independent and dependent quantities for a scenario.
- Match a graph with an appropriate scenario.
- Use a reasonable scale for a graph modeling a scenario.
- Identify key characteristics of graphs.
- Describe similarities and differences between pairs of graphs and scenarios.

Key Terms

- dependent quantity
- independent quantity

(2) You have analyzed graphs of relationships and identified important features such as intercepts and slopes. How can the key characteristics of a graph tell a story?

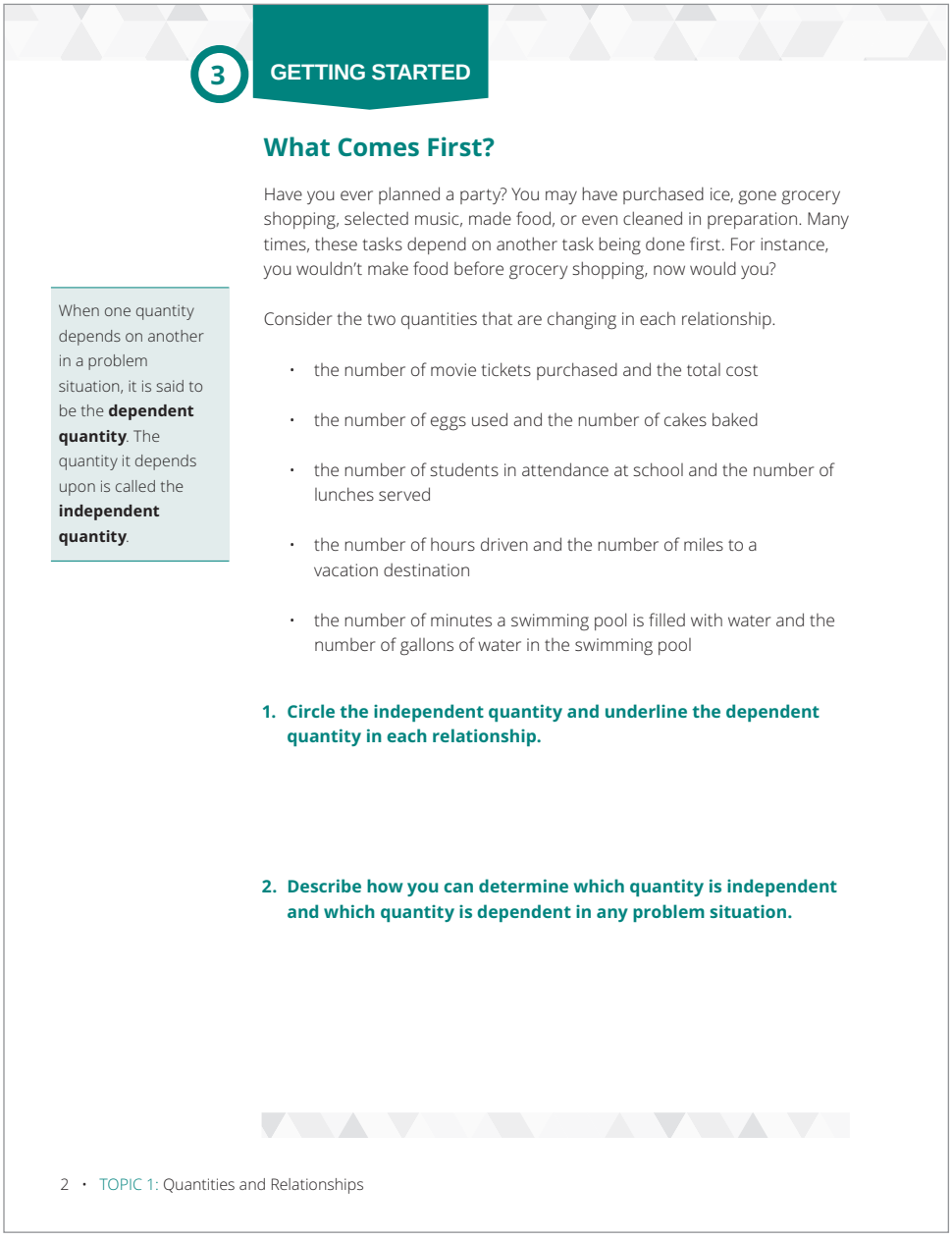
1. Learning Goals
Learning goals are stated for each lesson to help you take ownership of the learning objectives.

2. Connection
Each lesson begins with a statement connecting what you have learned with a question to ponder.

Return to this question at the end of this lesson to gauge your understanding.

3. Getting Started

Each lesson begins with Getting Started. When working on Getting Started, use what you know about the world, what you have learned previously, or your intuition. The goal is just to get you thinking and ready for what's to come.



3 GETTING STARTED

What Comes First?

Have you ever planned a party? You may have purchased ice, gone grocery shopping, selected music, made food, or even cleaned in preparation. Many times, these tasks depend on another task being done first. For instance, you wouldn't make food before grocery shopping, now would you?

When one quantity depends on another in a problem situation, it is said to be the **dependent quantity**. The quantity it depends upon is called the **independent quantity**.

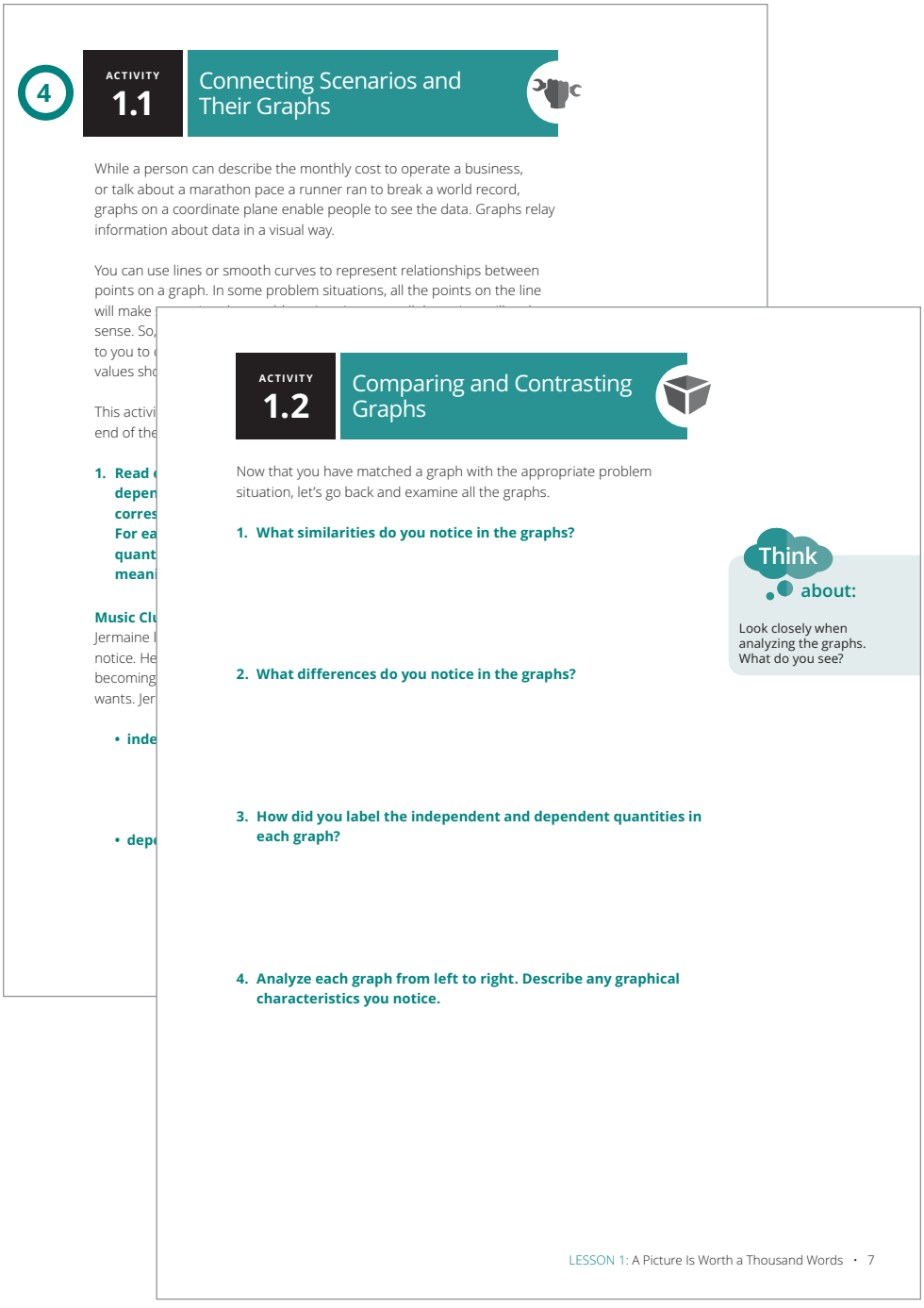
Consider the two quantities that are changing in each relationship.

- the number of movie tickets purchased and the total cost
- the number of eggs used and the number of cakes baked
- the number of students in attendance at school and the number of lunches served
- the number of hours driven and the number of miles to a vacation destination
- the number of minutes a swimming pool is filled with water and the number of gallons of water in the swimming pool

1. **Circle the independent quantity and underline the dependent quantity in each relationship.**

2. **Describe how you can determine which quantity is independent and which quantity is dependent in any problem situation.**

2 • TOPIC 1: Quantities and Relationships



4

ACTIVITY 1.1

Connecting Scenarios and Their Graphs

While a person can describe the monthly cost to operate a business, or talk about a marathon pace a runner ran to break a world record, graphs on a coordinate plane enable people to see the data. Graphs relay information about data in a visual way.

You can use lines or smooth curves to represent relationships between points on a graph. In some problem situations, all the points on the line will make
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ACTIVITY 1.2

Comparing and Contrasting Graphs

Now that you have matched a graph with the appropriate problem situation, let's go back and examine all the graphs.

1. **What similarities do you notice in the graphs?**

Think about:

Look closely when analyzing the graphs. What do you see?

2. **What differences do you notice in the graphs?**

3. **How did you label the independent and dependent quantities in each graph?**

4. **Analyze each graph from left to right. Describe any graphical characteristics you notice.**

LESSON 1: A Picture Is Worth a Thousand Words • 7

4. Activities

You are going to build a deep understanding of mathematics through a variety of activities in an environment where collaboration and conversations are important and expected.

You will learn how to solve new problems, but you will also learn why those strategies work and how they are connected to other strategies you already know.

Remember:

- It's not just about answer-getting. The process is important.
- Making mistakes are a critical part of learning, so take risks.
- There is often more than one way to solve a problem.

Activities may include real-world problems, sorting activities, worked examples, or analyzing sample student work.

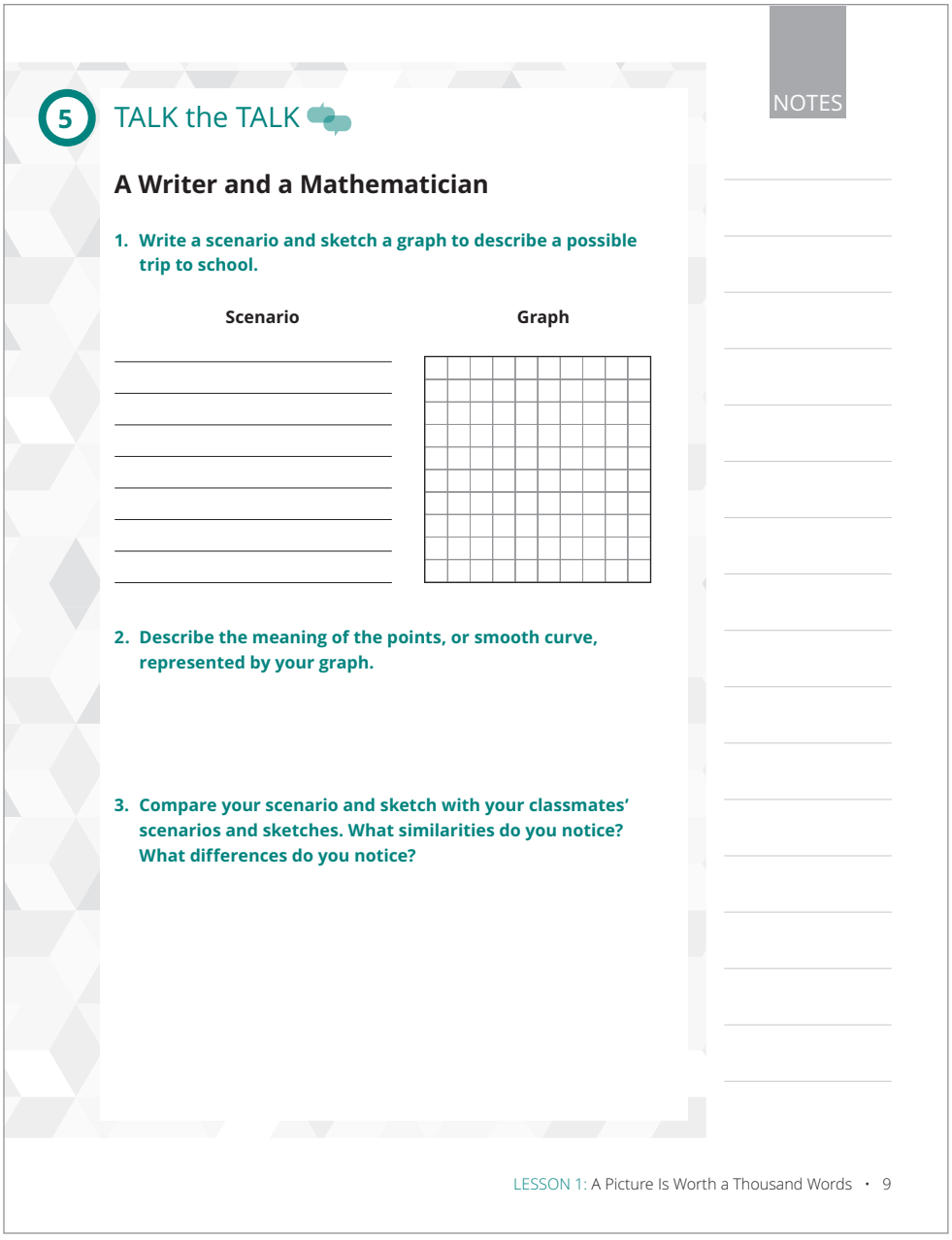
Be prepared to share your solutions and methods with your classmates.

5. Talk the Talk

Talk the Talk gives you an opportunity to reflect on the main ideas of the lesson.

- Be honest with yourself.
- Ask questions to clarify anything you don't understand.
- Show what you know!

Don't forget to revisit the question posed on the lesson opening page to gauge your understanding.



5 TALK the TALK

NOTES

A Writer and a Mathematician

1. **Write a scenario and sketch a graph to describe a possible trip to school.**

Scenario

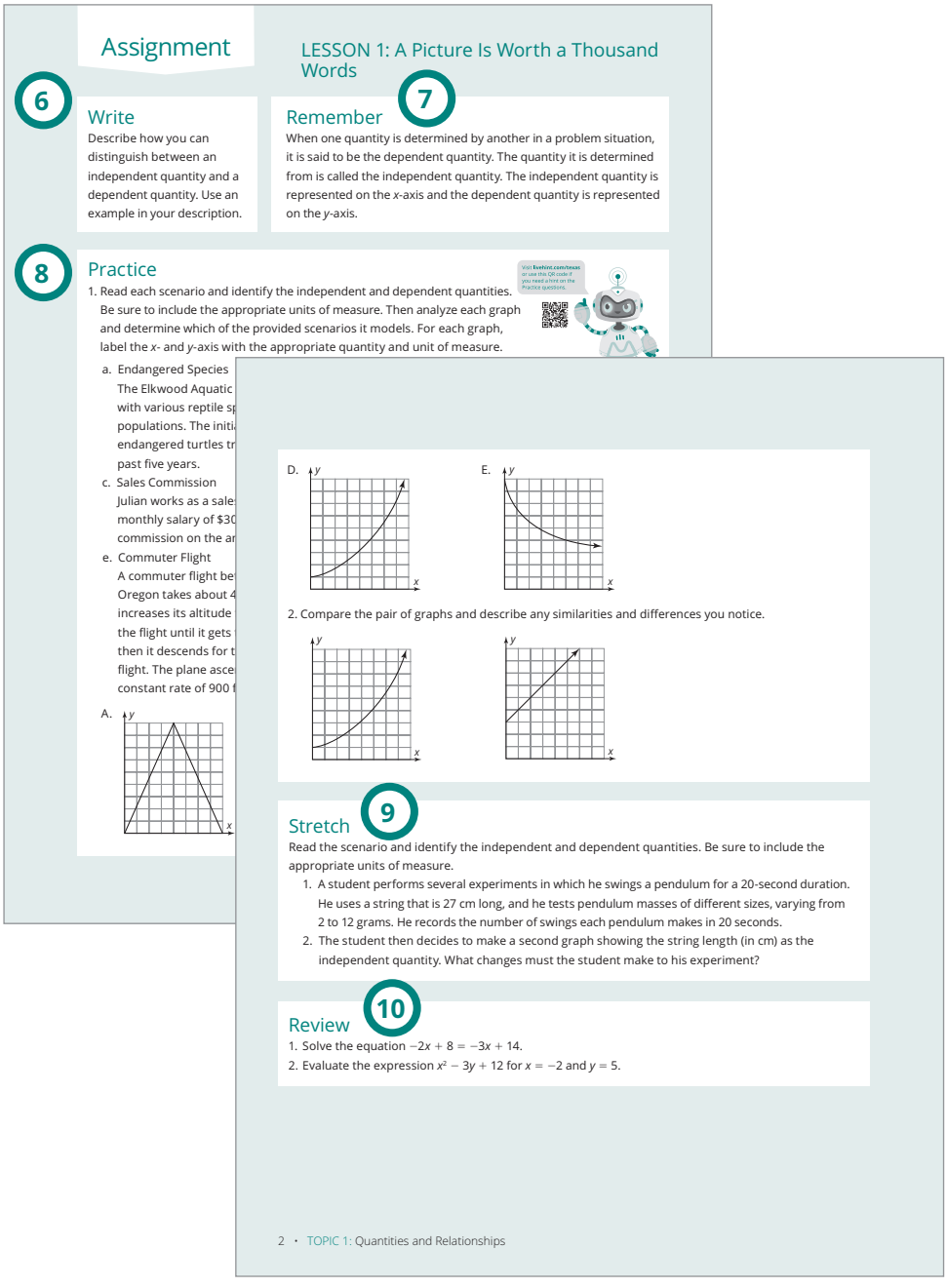
Graph

2. **Describe the meaning of the points, or smooth curve, represented by your graph.**

3. **Compare your scenario and sketch with your classmates' scenarios and sketches. What similarities do you notice? What differences do you notice?**

LESSON 1: A Picture Is Worth a Thousand Words • 9

ASSIGNMENT



Assignment

LESSON 1: A Picture Is Worth a Thousand Words

6

Write

Describe how you can distinguish between an independent quantity and a dependent quantity. Use an example in your description.

7

Remember

When one quantity is determined by another in a problem situation, it is said to be the dependent quantity. The quantity it is determined from is called the independent quantity. The independent quantity is represented on the *x*-axis and the dependent quantity is represented on the *y*-axis.

8

Practice

1. Read each scenario and identify the independent and dependent quantities. Be sure to include the appropriate units of measure. Then analyze each graph and determine which of the provided scenarios it models. For each graph, label the *x*- and *y*-axis with the appropriate quantity and unit of measure.

a. Endangered Species
The Elkwood Aquatic
with various reptile sp
populations. The initi
endangered turtles tr
past five years.

c. Sales Commission
Julian works as a sale
monthly salary of $30
commission on the ar

e. Commuter Flight
A commuter flight be
Oregon takes about 4
increases its altitude
the flight until it gets
then it descends for t
flight. The plane asce
constant rate of 900 f

A.

D.

E.

2. Compare the pair of graphs and describe any similarities and differences you notice.

9

Stretch

Read the scenario and identify the independent and dependent quantities. Be sure to include the appropriate units of measure.

1. A student performs several experiments in which he swings a pendulum for a 20-second duration. He uses a string that is 27 cm long, and he tests pendulum masses of different sizes, varying from 2 to 12 grams. He records the number of swings each pendulum makes in 20 seconds.
2. The student then decides to make a second graph showing the string length (in cm) as the independent quantity. What changes must the student make to his experiment?

10

Review

1. Solve the equation $-2x + 8 = -3x + 14$.
2. Evaluate the expression $x^2 - 3y + 12$ for $x = -2$ and $y = 5$.

2 • TOPIC 1: Quantities and Relationships

6. Write
Reflect on your work and clarify your thinking.

7. Remember
Take note of the key concepts from the lesson.

8. Practice
Use the concepts learned in the lesson to solve problems.

9. Stretch
Ready for a challenge?

10. Review
Remember what you've learned by practicing concepts from previous lessons and topics.

PROBLEM TYPES YOU WILL SEE

Worked Example

You can represent a_n using function notation.

$$a_n = 2 + 4(n - 1)$$
$$f(n) = 2 + 4(n - 1)$$

Next, rewrite the expression $2 + 4(n - 1)$.

$f(n) = 2 + 4n - 4$	Distributive Property
$= 4n + 2 - 4$	Commutative Property
$= 4n - 2$	Combine Like Terms

So, $a_n = 2 + 4(n - 1)$ written in function notation is $f(n) = 4n - 2$.

Worked Example

When you see a Worked Example:

- Take your time to read through it.
- Question your own understanding.
- Think about the connections between steps.

Ask Yourself:

- What is the main idea?
- How would this work if I changed the numbers?
- Have I used these strategies before?

Maya and Sherry each convert the given formula to degrees Fahrenheit.

Maya

$$C = \frac{5}{9}(F - 32)$$
$$C = \frac{5}{9}F - \frac{160}{9}$$
$$9(C) = 9\left(\frac{5}{9}F - \frac{160}{9}\right)$$
$$9C = 5F - 160$$
$$9C + 160 = 5F$$
$$\frac{9C}{5} + \frac{160}{5} = \frac{5F}{5}$$
$$\frac{9}{5}C + 32 = F$$

Sherry

$$C = \frac{5}{9}(F - 32)$$
$$C = \frac{5}{9}F - 32$$
$$9(C) = 9\left(\frac{5}{9}F - 32\right)$$
$$9C = 5F - 288$$
$$9C + 288 = 5F$$
$$\frac{9C}{5} + \frac{288}{5} = \frac{5F}{5}$$
$$\frac{9}{5}C + 57.6 = F$$

Thumbs Up

When you see a Thumbs Up icon:

- Take your time to read through the correct solution.
- Think about the connections between steps.

Ask Yourself:

- Why is this method correct?
- Have I used this method before?

Thumbs Down

When you see a Thumbs Down icon:

- Take your time to read through the incorrect solution.
- Think about what error was made.

Ask Yourself:

- Where is the error?
- Why is it an error?
- How can I correct it?

4. Carlos and Mikala do not like working with fractions. Each rewrites the equation so that it does not have fractions. Their work is shown.

Carlos

$$F = \frac{9}{5}C + 32$$
$$(5)F = 5\left(\frac{9}{5}C + 32\right)$$
$$5F = 9C + 160$$
$$5F - 9C = 160$$

Mikala

$$C = \frac{5}{9}(F - 32)$$
$$(9)C = (9)\left(\frac{5}{9}(F - 32)\right)$$
$$9C = 5(F - 32)$$
$$9C = 5F - 160$$
$$9C - 5F = -160$$

Carlos and Mikala got two different equations. Who is correct? Explain your reasoning.

Who's Correct?

When you see a Who's Correct icon:

- Take your time to read through the situation.
- Question the strategy or reason given.
- Determine if correct or not correct.

Ask Yourself:

- Does the reasoning make sense?
- If the reasoning makes sense, what is the justification?
- If the reasoning does not make sense, what error was made?

MATHEMATICAL PROCESS STANDARDS

Texas Mathematical Process Standards

Effective communication and collaboration are essential skills of a successful learner. With practice, you can develop the habits of mind of a productive mathematical thinker. The "I can" expectations listed below align with the TEKS Mathematical Process Standards and encourage students to develop their mathematical learning and understanding.

▶ Apply mathematics to problems arising in everyday life, society, and the workplace.

I can:

- use the mathematics that I learn to solve real world problems.
- interpret mathematical results in the contexts of a variety of problem situations.

▶ Use a problem-solving model that incorporates analyzing given information, formulating a plan or strategy, determining a solution, justifying a solution, and evaluating the problem-solving process and reasonableness of the solution.

I can:

- explain what a problem "means" in my own words.
- create a plan and change it if necessary.
- ask useful questions in an attempt to understand the problem.
- explain my reasoning and defend my solution.
- reflect on whether my results make sense.

► Select tools, including real objects, manipulatives, paper and pencil, and technology as appropriate; and techniques including mental math, estimation, and number sense as appropriate, to solve problems.

I can:

- use a variety of different tools that I have to solve problems.
- recognize when a tool that I have to solve problems might be helpful and when it has limitations.
- look for efficient methods to solve problems.
- estimate before I begin calculations to inform my reasoning.

► Communicate mathematical ideas, reasoning, and their implications using multiple representations, including symbols, diagrams, graphs, and language as appropriate.

I can:

- communicate and defend my own mathematical understanding using examples, models, or diagrams.
- use appropriate mathematical vocabulary in communicating mathematical ideas.
- make generalizations based on results.
- apply mathematical ideas to solve problems.
- interpret my results in terms of various problem situations.

► Create and use representations to organize, record, and communicate mathematical ideas.

I can:

- consider the units of measure involved in a problem.
- label diagrams and figures appropriately to clarify the meaning of different representations.
- create an understandable representation of a problem situation.

▶ Analyze mathematical relationships to connect and communicate mathematical ideas.

I can:

- identify important relationships in a problem situation.
- use what I know to solve new problems.
- analyze and organize information.
- look closely to identify patterns or structure.
- look for general methods and more efficient ways to solve problems.

▶ Display, explain, and justify mathematical ideas and arguments using precise mathematical language in written or oral communication.

I can:

- work carefully and check my work.
- distinguish correct reasoning from reasoning that is flawed.
- use appropriate mathematical vocabulary when I talk with my classmates, my teacher, and others.
- specify the appropriate units of measure when I explain my reasoning.
- calculate accurately and communicate precisely to others.

ACADEMIC GLOSSARY

There are important terms you will encounter throughout this book. It is important that you have an understanding of these words as you get started on your journey through the mathematical concepts. Knowing what is meant by these terms and using these terms will help you think, reason, and communicate your ideas.

Visit the Students & Caregivers Portal on the Texas Support Center at **www.CarnegieLearning.com/texas-help** to access the Mathematics Glossary for this course anytime, anywhere.

ANALYZE

Definition

To study or look closely for patterns. Analyzing can involve examining or breaking a concept down into smaller parts to gain a better understanding of it.

Ask Yourself

- Do I see any patterns?
- Have I seen something like this before?
- What happens if the shape, representation, or numbers change?

Related Phrases

- Examine
- Evaluate
- Determine
- Observe
- Consider
- Investigate
- What do you notice?
- What do you think?
- Sort and match

EXPLAIN YOUR REASONING

Definition

To give details or describe how to determine an answer or solution. Explaining your reasoning helps justify conclusions.

Ask Yourself

- How should I organize my thoughts?
- Is my explanation logical?
- Does my reasoning make sense?
- How can I justify my answer to others?

Related Phrases

- Show your work
- Explain your calculation
- Justify
- Why or why not?

REPRESENT

Related Phrases

- Show
- Sketch
- Draw
- Create
- Plot
- Graph
- Write an equation
- Complete the table

Definition

To display information in various ways. Representing mathematics can be done using words, tables, graphs, or symbols.

Ask Yourself

- How should I organize my thoughts?
- How do I use this model to show a concept or idea?
- What does this representation tell me?
- Is my representation accurate?

ESTIMATE

Related Phrases

- Predict
- Approximate
- Expect
- About how much?

Definition

To make an educated guess based on the analysis of given data. Estimating first helps inform reasoning.

Ask Yourself

- Does my reasoning make sense?
- Is my solution close to my estimation?

DESCRIBE

Related Phrases

- Demonstrate
- Label
- Display
- Compare
- Determine
- Define
- What are the advantages?
- What are the disadvantages?
- What is similar?
- What is different?

Definition

To represent or give an account of in words. Describing communicates mathematical ideas to others.

Ask Yourself

- How should I organize my thoughts?
- Is my explanation logical?
- Did I consider the context of the situation?
- Does my reasoning make sense?

Thought Bubbles

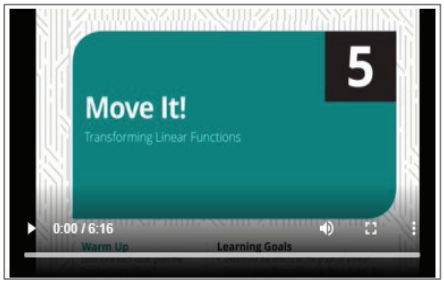
Look for these icons as you journey through the textbook. Sometimes they will remind you about things you already learned. Sometimes they will ask you questions to help you think about different strategies. Sometimes they will share fun facts. They are here to help and guide your learning.

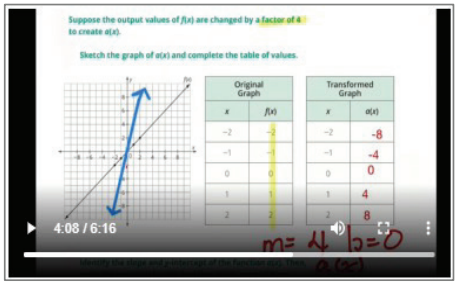
Side notes are included to provide helpful insights as you work.

Resources for Students and Caregivers

Student Lesson Overview Videos

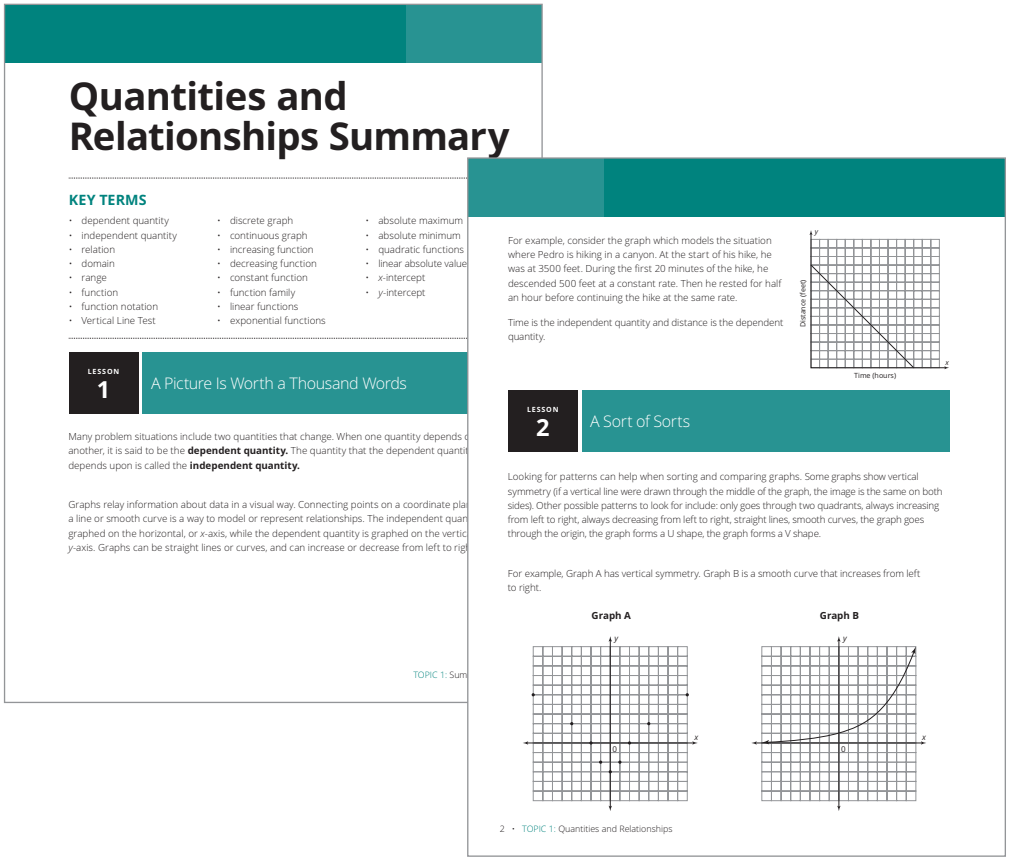
Each lesson has a corresponding lesson overview video(s) for you to use and reference as you are learning. The videos provide an overview of key concepts, strategies, and/or worked examples from the lessons.





Topic Summary

A Topic Summary is provided at the end of each topic. The Topic Summary lists all key terms of the topic and provides a summary of each lesson. Each lesson summary defines key terms and reviews key concepts, strategies, and/or worked examples.



Quantities and Relationships Summary

KEY TERMS

- dependent quantity
- independent quantity
- relation
- domain
- range
- function
- function notation
- Vertical Line Test
- discrete graph
- continuous graph
- increasing function
- decreasing function
- constant function
- function family
- linear functions
- exponential functions
- absolute maximum
- absolute minimum
- quadratic functions
- linear absolute value
- *x*-intercept
- *y*-intercept

LESSON 1 A Picture Is Worth a Thousand Words

Many problem situations include two quantities that change. When one quantity depends on another, it is said to be the **dependent quantity.** The quantity that the dependent quantity depends upon is called the **independent quantity.**

Graphs relay information about data in a visual way. Connecting points on a coordinate plane with a line or smooth curve is a way to model or represent relationships. The independent quantity is graphed on the horizontal, or *x*-axis, while the dependent quantity is graphed on the vertical, or *y*-axis. Graphs can be straight lines or curves, and can increase or decrease from left to right.

For example, consider the graph which models the situation where Pedro is hiking in a canyon. At the start of his hike, he was at 3500 feet. During the first 20 minutes of the hike, he descended 500 feet at a constant rate. Then he rested for half an hour before continuing the hike at the same rate.

Time is the independent quantity and distance is the dependent quantity.

Distance (feet)
Time (hours)

LESSON 2 A Sort of Sorts

Looking for patterns can help when sorting and comparing graphs. Some graphs show vertical symmetry (if a vertical line were drawn through the middle of the graph, the image is the same on both sides). Other possible patterns to look for include: only goes through two quadrants, always increasing from left to right, always decreasing from left to right, straight lines, smooth curves, the graph goes through the origin, the graph forms a U shape, the graph forms a V shape.

For example, Graph A has vertical symmetry. Graph B is a smooth curve that increases from left to right.

Graph A

Graph B

2 • TOPIC 1: Quantities and Relationships

Mathematics Glossary

A course-specific mathematics glossary is available to utilize and reference while you are learning. Use the glossary to locate definitions and examples of math key terms.

Glossary

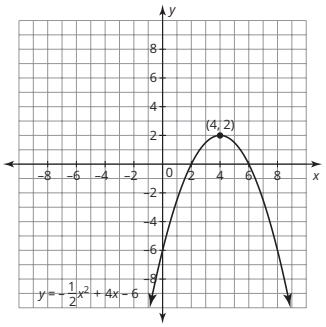
A

absolute maximum

A function has an absolute maximum if there is a point that has a *y*-coordinate that is greater than the *y*-coordinates of every other point on the graph.

Example

The ordered pair (4, 2) is the absolute maximum of the graph of the function $f(x) = -\frac{1}{2}x^2 + 4x - 6$.

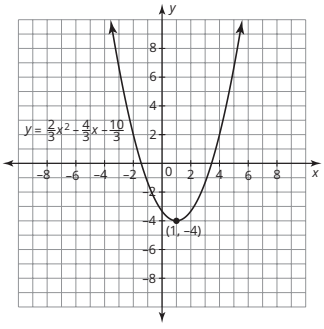


absolute minimum

A function has an absolute minimum if there is a point that has a *y*-coordinate that is less than the *y*-coordinates of every other point on the graph.

Example

The ordered pair (1, −4) is the absolute minimum of the graph of the function $y = \frac{2}{3}x^2 - \frac{4}{3}x - \frac{10}{3}$.



argument of a function

The argument of a function is the variable on which the function operates.

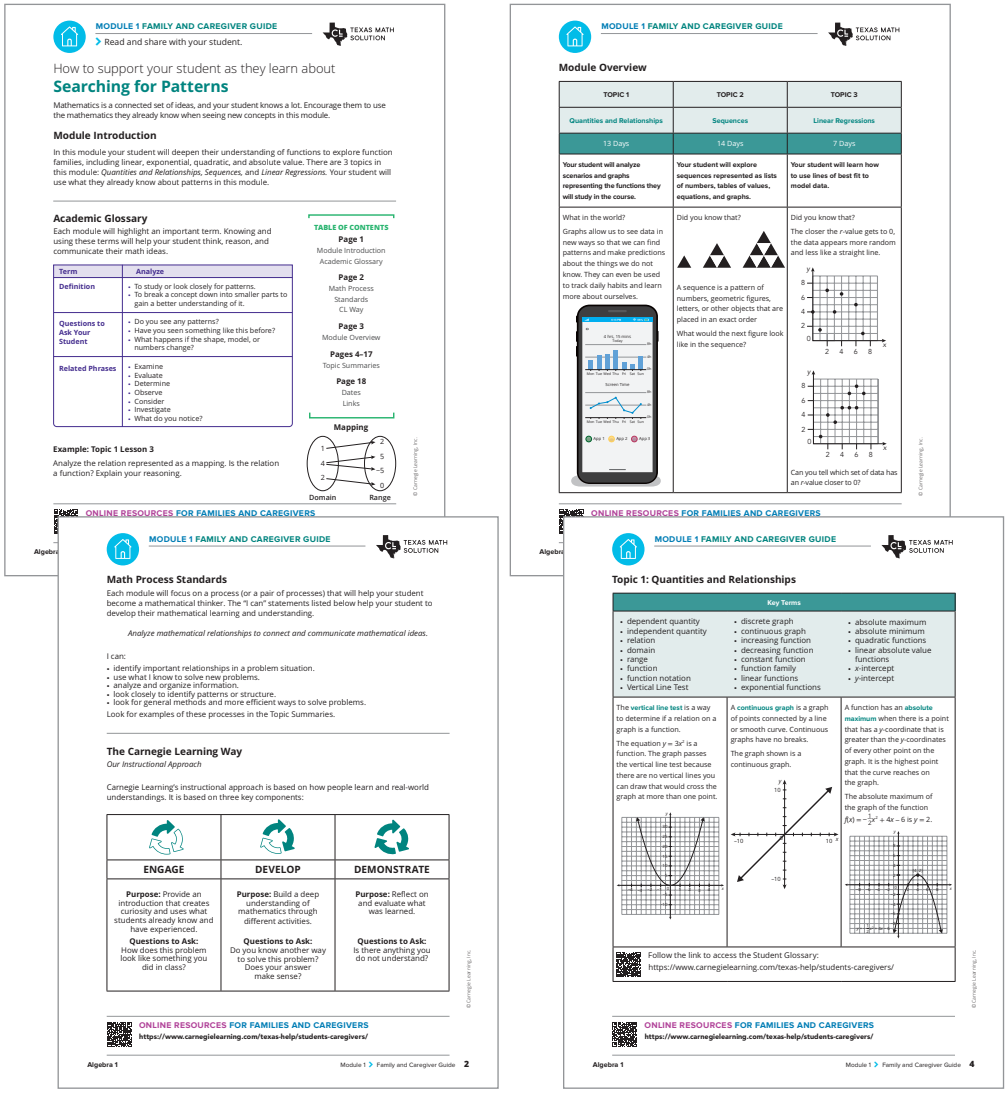
Example

In the function $f(x + 5) = 32$, the argument is $x + 5$.

Module Family and Caregiver Guides

Each module guide will provide a different highlight of the academic glossary, description and examples of TEKS Mathematical Process Standards, and an overview of a different component of our instructional approach known as The Carnegie Learning Way. Also included is a module overview of content, specific key terms, visual representations, and strategies you are learning in each topic of the module.

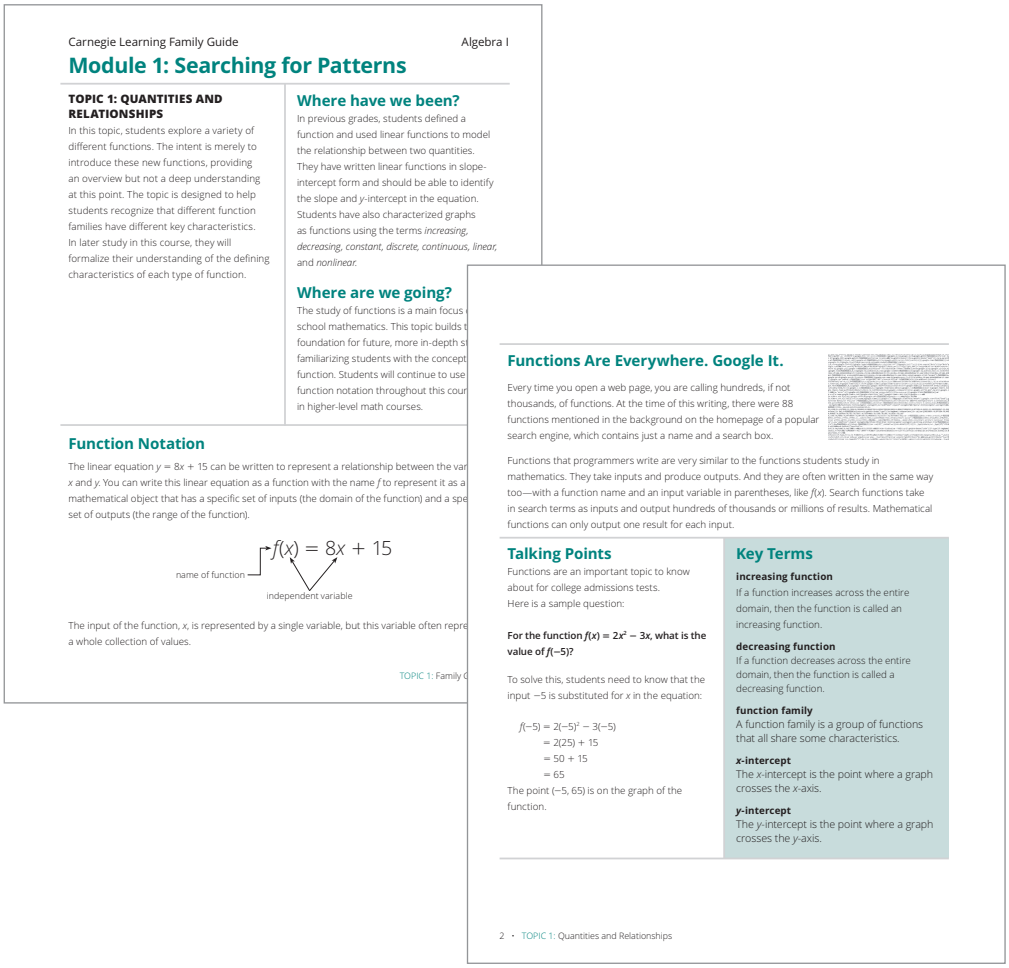
The purpose of the Family and Caregiver Guides is to bridge student learning in the classroom to student learning at home. Our goal is to empower you and your family to understand the concepts and skills learned in the classroom so that you can review, discuss, and solidify the understanding of these key concepts together. Videos will also be available on the Students & Caregivers Portal on the Texas Support Center to provide added support.



Topic Family Guides

Each topic contains a Family Guide that provides an overview of the math of the topic and answers the questions, “Where have we been?” and “Where are we going?” Additional components of the Family Guide are, as follows: new notation or strategy taught in the topic, definitions of a few key terms, connection of math to the real world, related standardized test question sample, or talking points for caregivers to support your learning.

We recognize that learning outside of the classroom is crucial to student success at school. While we don’t expect families and caregivers to be math teachers, the Family Guides are designed to assist families and caregivers as they talk to you about what you are learning. Our hope is that both you and your family will read and benefit from these guides.



Carnegie Learning Family Guide Algebra I

Module 1: Searching for Patterns

TOPIC 1: QUANTITIES AND RELATIONSHIPS

In this topic, students explore a variety of different functions. The intent is merely to introduce these new functions, providing an overview but not a deep understanding at this point. The topic is designed to help students recognize that different function families have different key characteristics. In later study in this course, they will formalize their understanding of the defining characteristics of each type of function.

Where have we been?

In previous grades, students defined a function and used linear functions to model the relationship between two quantities. They have written linear functions in slope-intercept form and should be able to identify the slope and *y*-intercept in the equation. Students have also characterized graphs as functions using the terms *increasing, decreasing, constant, discrete, continuous, linear,* and *nonlinear.*

Where are we going?

The study of functions is a main focus
school mathematics. This topic builds t
foundation for future, more in-depth s
familiarizing students with the concept
function. Students will continue to use
function notation throughout this cour
in higher-level math courses.

Function Notation

The linear equation $y = 8x + 15$ can be written to represent a relationship between the var
x and y. You can write this linear equation as a function with the name f to represent it as a
mathematical object that has a specific set of inputs (the domain of the function) and a spe
set of outputs (the range of the function).

$f(x) = 8x + 15$

name of function

independent variable

The input of the function, x, is represented by a single variable, but this variable often repre
a whole collection of values.

TOPIC 1: Family

Functions Are Everywhere. Google It.

Every time you open a web page, you are calling hundreds, if not thousands, of functions. At the time of this writing, there were 88 functions mentioned in the background on the homepage of a popular search engine, which contains just a name and a search box.

Functions that programmers write are very similar to the functions students study in mathematics. They take inputs and produce outputs. And they are often written in the same way too—with a function name and an input variable in parentheses, like $f(x)$. Search functions take in search terms as inputs and output hundreds of thousands or millions of results. Mathematical functions can only output one result for each input.

Talking Points

Functions are an important topic to know about for college admissions tests. Here is a sample question:

For the function $f(x) = 2x^2 - 3x$, what is the value of $f(-5)$?

To solve this, students need to know that the input -5 is substituted for x in the equation:

$$\begin{aligned} f(-5) &= 2(-5)^2 - 3(-5) \\ &= 2(25) + 15 \\ &= 50 + 15 \\ &= 65 \end{aligned}$$

The point $(-5, 65)$ is on the graph of the function.

Key Terms

increasing function
If a function increases across the entire domain, then the function is called an increasing function.

decreasing function
If a function decreases across the entire domain, then the function is called a decreasing function.

function family
A function family is a group of functions that all share some characteristics.

***x*-intercept**
The *x*-intercept is the point where a graph crosses the *x*-axis.

***y*-intercept**
The *y*-intercept is the point where a graph crosses the *y*-axis.

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Students and Caregivers Portal

Research has proven time and again that family engagement greatly improves a student's likelihood of success in school.

The Students & Caregivers Portal on the Texas Support Center provides:

- Getting to Know Carnegie Learning video content to provide an introduction to the instructional materials and research.
- Articles and quick tip videos offering strategies for how families and caregivers can support student learning.
- Access to instructional resources to support students and caregivers.

  To access new content and resources, visit the Students and Caregivers Portal on the Texas Support Center at https://www.CarnegieLearning.com/texas-help/students-caregivers/