MATH *for* CARPENTRY *and* CONSTRUCTION

RICHARD B. MILES

Second Edition

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Preface

Math for Carpentry and Construction was developed to bridge the abstract principles taught in academic math to the real-world problems a carpenter must solve in the construction trades. With today's emphasis on standardized testing in education, this book was developed as a tool to help you become proficient in accurately performing trade-related mathematical problems.

This second edition of ***Math for Carpentry and Construction*** contains two new resources. The first is the addition of Section 6, *Material Estimating Activities*. Every carpenter needs to know how to estimate a job to give a quote to a customer, or to order materials for an upcoming job. This final section consists of 10 activities that will teach students the formulas and steps used to estimate materials. These activities provide a great opportunity to draw upon the math skills they have learned in the text. The second is a new resource entitled Appendix A, *Construction Diagrams and Terms*. This additional Appendix will assist the student when working through this text and will be an exceptional resource during their career.

After 16 years of working in residential, modular, and commercial construction, I entered secondary education with the goal of teaching high school students the trade of carpentry and construction. I was shocked at how many students could not measure or apply basic mathematical concepts to construction trade problems. I quickly realized that before I could properly teach my trade, I first needed to raise the competency level in mathematic concepts, and then apply them to construction principles. With over 25 years of experience in the classroom laying a solid foundation of applied math concepts, I have assembled those principles in ***Math for Carpentry and Construction*** to help instructors lay that same solid math foundation in their classrooms.

Based on my observation and experience, academic mathematic instruction has been driven by a culture of standardized testing. Because of this, students are not always learning the concepts necessary to be successful in a trade career, only the skills necessary to pass a standardized test. Often while teaching a concept the students have already covered in math class, I can see that moment when things begin to make sense because I have shown them how to apply it in a trade application. ***Math for Carpentry and Construction*** has been developed first and foremost with the purpose of teaching you the skills necessary and to make those connections so you will be proficient in the construction trades. This ensures that the student will be prepared for national and trade certification exams and a successful career in the construction trades.

All the problems in ***Math for Carpentry and Construction*** can be performed with the use of a calculator. Because it is my belief that every student should know how to work the problem without a calculator, every concept has been explained step-by-step so you can learn the concepts and process to complete any problem you will face in the field by hand. A calculator will give you the right answer, but you will not develop an understanding of how the answer was achieved. This will not help you the day you need to perform the math and do not have an electronic device.

Math for Carpentry and Construction is the best tool on the market today to learn math concepts used in the construction industry. It covers mathematic principles in a logical, applied manner, so that you can become mathematically proficient in your career.

Richard B. Miles

About the Author

Richard B. Miles is an instructor at Columbia-Montour Area Vocational-Technical School where he teaches residential construction. Mr. Miles earned his bachelor's degree in workforce education and development from Pennsylvania State University and his Trade Competency and Vocational II certifications in carpentry. He taught carpentry and career education at a residential treatment center and has served as a subject-matter expert designing and editing trade exams for the National Occupational Competency Testing Institute (NOCTI). Mr. Miles' work experience includes over 25 years in secondary education teaching carpentry and construction and career education. Mr. Miles also has over 15 years of work experience as a carpenter in commercial, residential, and modular construction. Mr. Miles is a freelance writer, specializing in educational writing. He is a contributing writer of *Agricultural Mechanics and Technology Systems*.

Reviewers

The author and publisher wish to thank the following industry and teaching professionals for their valuable input into the development of ***Math for Carpentry and Construction***.

Andrew Bell
Kotzebue Middle High School
Kotzebue, AK

Mark Enger
Renaissance High School
Meridian, ID

Jennifer Nichols
Hudson Valley Community College
Troy, NY

Bev Sroka
Milwaukee Area Technical College
Oak Creek, WI

James Wiater
Middlesex County Vocational School
East Brunswick, NJ

New to This Edition

The following changes have been made to the second edition of ***Math for Carpentry and Construction*** to strengthen the student's math skills so they can apply these skills in their trade.

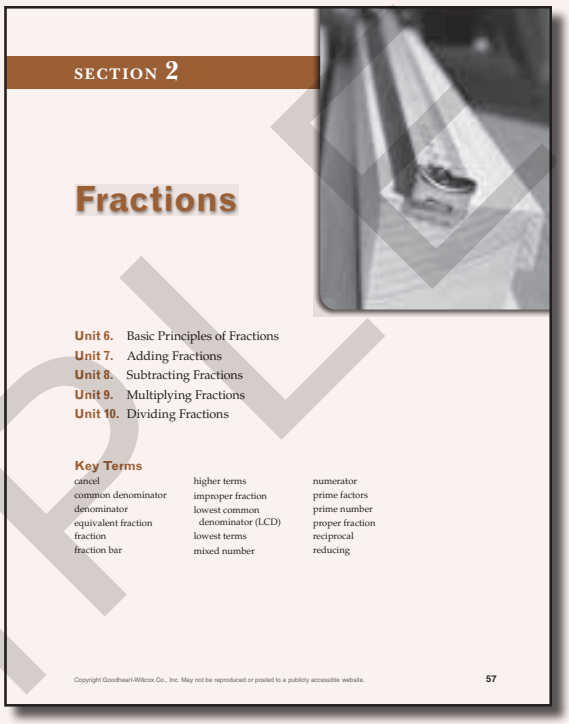
- Section 6, *Material Estimating Activities*, will enhance the student's ability to calculate accurate materials quantities in order to supply competitive job estimates as well as order materials for the next phase of a project. Formulas and examples are provided for estimating materials needed for floor, wall, ceiling, roof, and stair frames. Activities are also provided for estimating concrete, roof finish, siding, insulation, and interior trim.
- Appendix A, *Construction Diagrams and Terms* consists of labeled diagrams illustrating foundation and floor frames, wall and roof frames, roof terminology, stair frames, and interior and exterior finish. A glossary of trade terms and components shown in these diagrams is also provided. This resource will be valuable for students to refer to while answering review questions in this text as well as on the job.
- *Understanding Measurement Tools Videos and Activities* consisting of 12 videos with worksheets and quizzes will help students learn and practice fundamental measurement skills they will use in class and on the job.

Features of the Textbook

The instructional design of this textbook includes student-focused learning tools to help you succeed. This visual guide highlights these features.

Section Opening Materials

Each section opener contains a table of contents of the units appearing in each section, along with a list of **Key Terms** to be learned in the section.


SECTION 2

Fractions

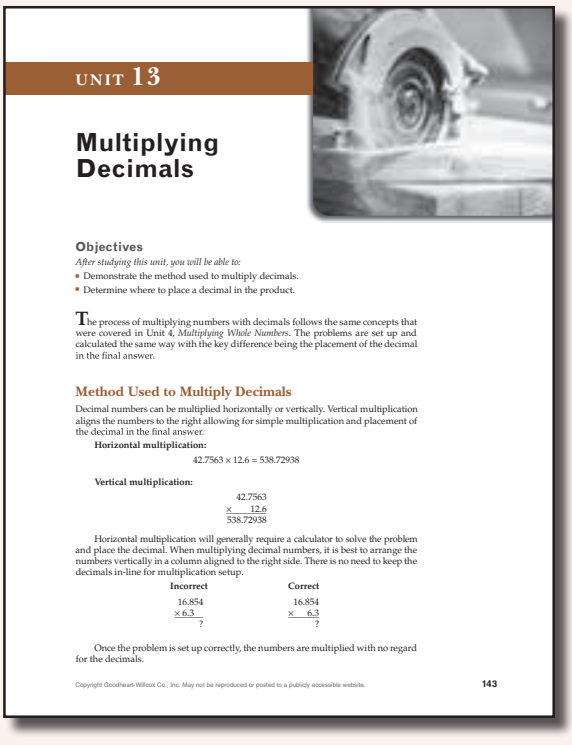
Unit 6. Basic Principles of Fractions
Unit 7. Adding Fractions
Unit 8. Subtracting Fractions
Unit 9. Multiplying Fractions
Unit 10. Dividing Fractions

Key Terms

canceled
common denominator
denominator
equivalent fraction
fraction
fraction bar
higher terms
improper fraction
lowest common denominator (LCD)
lowest terms
mixed number
numerator
prime factors
prime number
proper fraction
reciprocal
reducing

Unit Opening Material

Each unit opener lists **Objectives** that clearly identify the knowledge and skills to be gained when the unit is completed.


UNIT 13

Multiplying Decimals

Objectives

After studying this unit, you will be able to:

- Demonstrate the method used to multiply decimals.
- Determine where to place a decimal in the product.

The process of multiplying numbers with decimals follows the same concepts that were covered in Unit 4, *Multiplying Whole Numbers*. The problems are set up and calculated the same way with the key difference being the placement of the decimal in the final answer.

Method Used to Multiply Decimals

Decimal numbers can be multiplied horizontally or vertically. Vertical multiplication aligns the numbers to the right allowing for simple multiplication and placement of the decimal in the final answer.

Horizontal multiplication:

$$42.7563 \times 12.6 = 538.72938$$

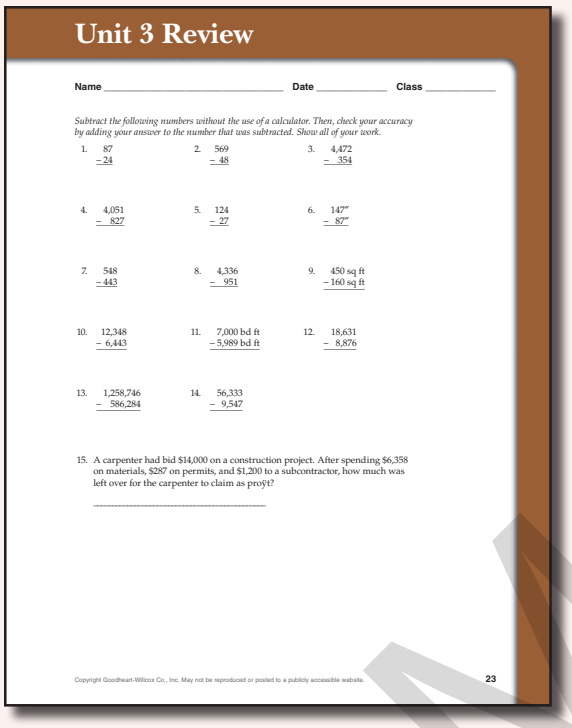
Vertical multiplication:

$$\begin{array}{r} 42.7563 \\ \times \quad 12.6 \\ \hline 538.72938 \end{array}$$

Horizontal multiplication will generally require a calculator to solve the problem and place the decimal. When multiplying decimal numbers, it is best to arrange the numbers vertically in a column aligned to the right side. There is no need to keep the decimals in-line for multiplication setup.

Incorrect	Correct
$\begin{array}{r} 16.854 \\ \times 6.3 \\ \hline ? \end{array}$	$\begin{array}{r} 16.854 \\ \times \quad 6.3 \\ \hline ? \end{array}$

Once the problem is set up correctly, the numbers are multiplied with no regard for the decimals.



Unit 3 Review

Name _____ Date _____ Class _____

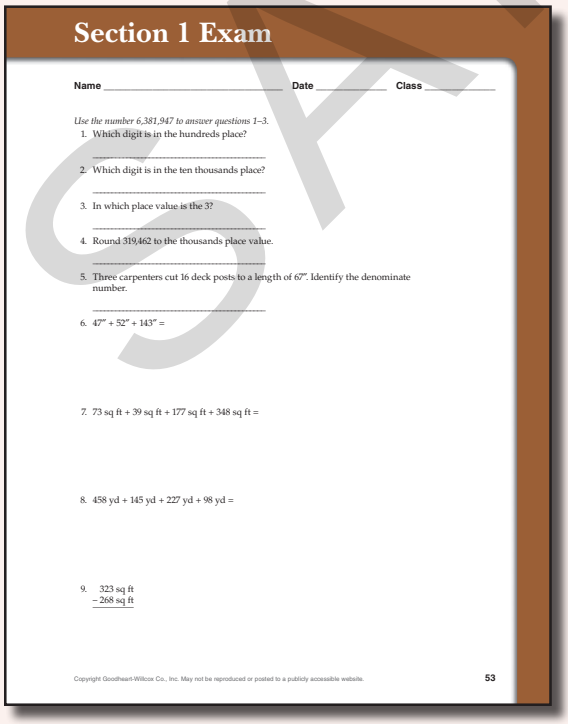
Subtract the following numbers without the use of a calculator. Then, check your accuracy by adding your answer to the number that was subtracted. Show all of your work.

1. 87 − 24
2. 569 − 48
3. 4,472 − 354
4. 4,051 − 827
5. 124 − 27
6. 147″ − 87″
7. 548 − 443
8. 4,336 − 951
9. 450 sq ft − 160 sq ft
10. 12,348 − 6,443
11. 7,000 bd ft − 5,989 bd ft
12. 18,631 − 8,876
13. 1,258,746 − 586,284
14. 56,333 − 9,547
15. A carpenter had bid $14,000 on a construction project. After spending $6,358 on materials, $287 on permits, and $1,200 to a subcontractor, how much was left over for the carpenter to claim as profit?

_____

Unit Reviews

End of unit material provides an opportunity for you to demonstrate knowledge and comprehension of unit material.



Section 1 Exam

Name _____ Date _____ Class _____

Use the number 6,381,947 to answer questions 1–3.

1. Which digit is in the hundreds place?

   _____

2. Which digit is in the ten thousands place?

   _____

3. In which place value is the 3?

   _____

4. Round 319,462 to the thousands place value.

   _____

5. Three carpenters cut 16 deck posts to a length of 67″. Identify the denominate number.

   _____

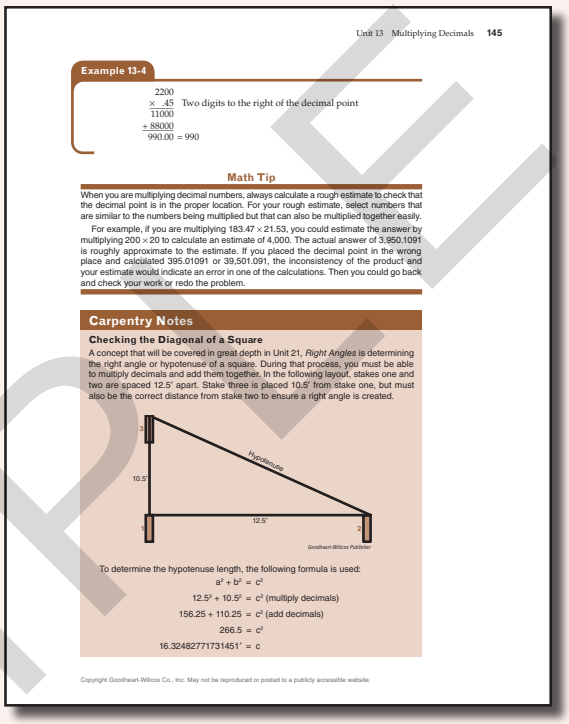
6. 47″ + 52″ + 143″ =
7. 73 sq ft + 39 sq ft + 177 sq ft + 348 sq ft =
8. 458 yd + 145 yd + 227 yd + 98 yd =
9. 323 sq ft − 268 sq ft

Section Exams

End of section exams test retention of knowledge gained throughout units of each section.

Additional Features

Additional features are used throughout the body of each unit to further learning and knowledge. **Math Tips** underscore important points and provide additional easy-to-understand examples. **Examples** demonstrate the concept that has just been presented, showing all the work needed to solve a mathematical problem. **Carpentry Notes** help you explore industry situations and the math needed to solve problems on the job.



Unit 13 Multiplying Decimals 145

Example 13-4

2200
× .45 Two digits to the right of the decimal point
11000
+ 88000
990.00 = 990

Math Tip

When you are multiplying decimal numbers, always calculate a rough estimate to check that the decimal point is in the proper location. For your rough estimate, select numbers that are similar to the numbers being multiplied but that can also be multiplied together easily.

For example, if you are multiplying 183.47 × 21.53, you could estimate the answer by multiplying 200 × 20 to calculate an estimate of 4,000. The actual answer of 3,950.1091 is roughly approximate to the estimate. If you placed the decimal point in the wrong place and calculated 395.01091 or 39,501.091, the inconsistency of the product and your estimate would indicate an error in one of the calculations. Then you could go back and check your work or redo the problem.

Carpentry Notes

Checking the Diagonal of a Square

A concept that will be covered in great depth in Unit 21, *Right Angles* is determining the right angle or hypotenuse of a square. During that process, you must be able to multiply decimals and add them together. In the following layout, stakes one and two are spaced 12.5′ apart. Stake three is placed 10.5′ from stake one, but must also be the correct distance from stake two to ensure a right angle is created.

To determine the hypotenuse length, the following formula is used:

$a^2 + b^2 = c^2$

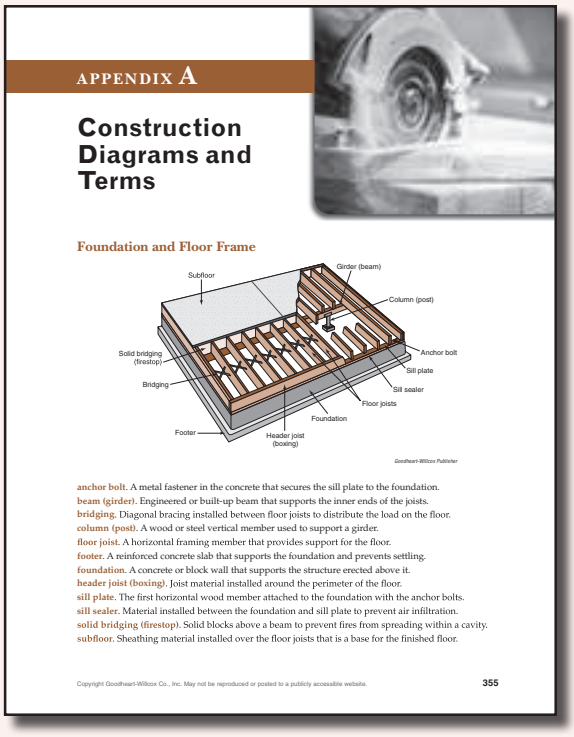
$12.5^2 + 10.5^2 = c^2$ (multiply decimals)

$156.25 + 110.25 = c^2$ (add decimals)

$266.5 = c^2$

$16.32482771731451' = c$

An **Appendix** that provides diagrams as well as a glossary of trade terms and components has been added to this new edition. Construction terms are highlighted within the units, with a marginal note to refer to Appendix A as a reference.



APPENDIX A

Construction Diagrams and Terms

Foundation and Floor Frame

anchor bolt. A metal fastener in the concrete that secures the sill plate to the foundation.
beam (girder). Engineered or built-up beam that supports the inner ends of the joists.
bridging. Diagonal bracing installed between floor joists to distribute the load on the floor.
column (post). A wood or steel vertical member used to support a girder.
floor joist. A horizontal framing member that provides support for the floor.
footer. A reinforced concrete slab that supports the foundation and prevents settling.
foundation. A concrete or block wall that supports the structure erected above it.
header joist (boxing). Joist material installed around the perimeter of the floor.
sill plate. The first horizontal wood member attached to the foundation with the anchor bolts.
sill sealer. Material installed between the foundation and sill plate to prevent air infiltration.
solid bridging (firestop). Solid blocks above a beam to prevent fires from spreading within a cavity.
subfloor. Sheathing material installed over the floor joists that is a base for the finished floor.

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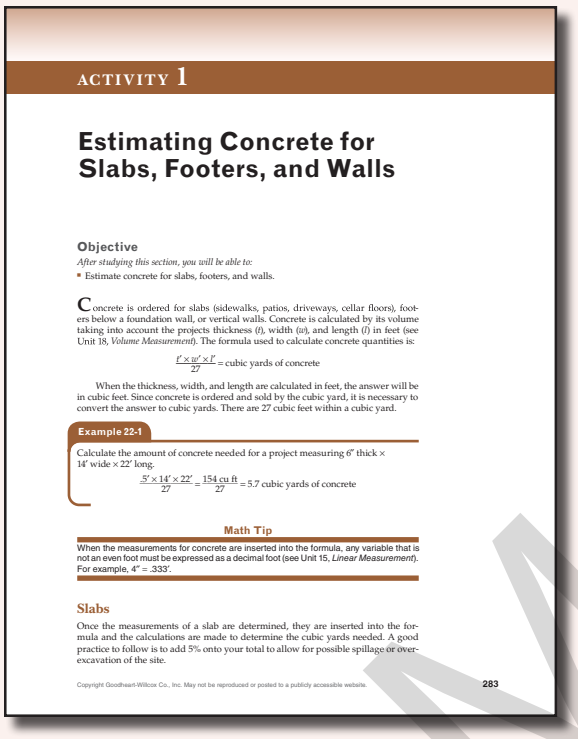


ACTIVITY 1

Estimating Concrete for Slabs, Footers, and Walls

Objective

After studying this section, you will be able to:

- Estimate concrete for slabs, footers, and walls.

Concrete is ordered for slabs (sidewalks, patios, driveways, cellar floors), footers below a foundation wall, or vertical walls. Concrete is calculated by its volume taking into account the projects thickness (*t*), width (*w*), and length (*l*) in feet (see Unit 18, *Volume Measurement*). The formula used to calculate concrete quantities is:

$$\frac{t' \times w' \times l'}{27} = \text{cubic yards of concrete}$$

When the thickness, width, and length are calculated in feet, the answer will be in cubic feet. Since concrete is ordered and sold by the cubic yard, it is necessary to convert the answer to cubic yards. There are 27 cubic feet within a cubic yard.

Example 22-1

Calculate the amount of concrete needed for a project measuring 6" thick × 14' wide × 22' long.

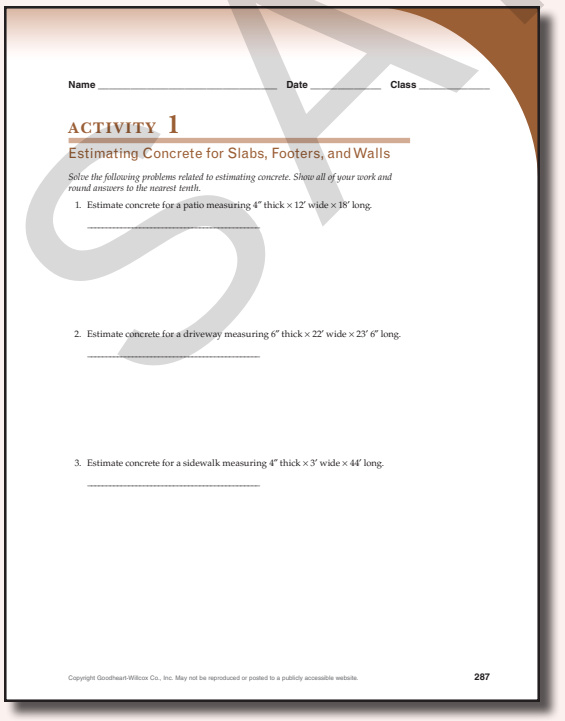
$$\frac{.5' \times 14' \times 22'}{27} = \frac{154 \text{ cu ft}}{27} = 5.7 \text{ cubic yards of concrete}$$

Math Tip

When the measurements for concrete are inserted into the formula, any variable that is not an even foot must be expressed as a decimal foot (see Unit 15, *Linear Measurement*). For example, 4" = .333'.

Slabs

Once the measurements of a slab are determined, they are inserted into the formula and the calculations are made to determine the cubic yards needed. A good practice to follow is to add 5% onto your total to allow for possible spillage or over-excavation of the site.



Name _____ Date _____ Class _____

ACTIVITY 1

Estimating Concrete for Slabs, Footers, and Walls

Solve the following problems related to estimating concrete. Show all of your work and round answers to the nearest tenth.

1. Estimate concrete for a patio measuring 4" thick × 12' wide × 18' long.

   _____

2. Estimate concrete for a driveway measuring 6" thick × 22' wide × 23' 6" long.

   _____

3. Estimate concrete for a sidewalk measuring 4" thick × 3' wide × 44' long.

   _____

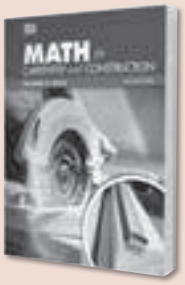
Expanding Your Learning

Activities have been added to apply math skills in preparing estimates for material quantities needed for a project.

TOOLS FOR STUDENT AND INSTRUCTOR SUCCESS

Student Tools

Student Text



Math for Carpentry and Construction is a write-in textbook that provides a wealth of examples and exercises for an in-depth learning experience. This edition includes a new section with estimating activities as well as an industry-related glossary in the Appendix.

G-W Digital Companion

For digital users, e-flash cards and vocabulary exercises allow interaction with content to create opportunities to increase achievement.

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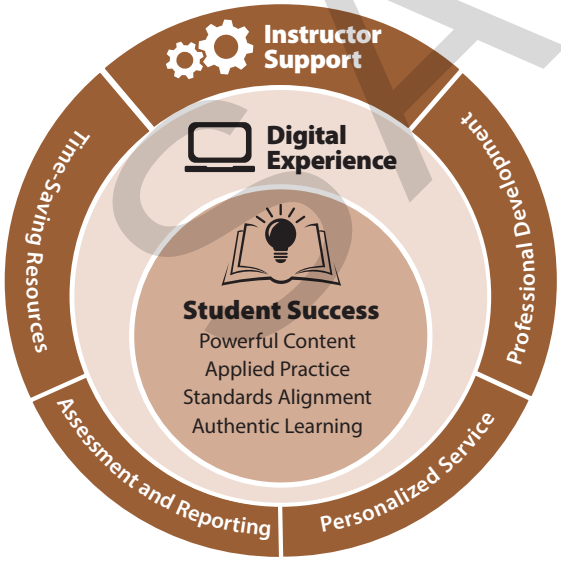

Instructor Tools

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- The **Instructor Resources** provide instructors with time-saving preparation tools such as answer keys, editable lesson plans, and other teaching aids.
- **Instructor's Presentations for PowerPoint®** are fully customizable, richly illustrated slides that help you teach and visually reinforce the key concepts from each unit.
- Administer and manage assessments to meet your classroom needs using **Assessment Software with Question Banks**, which include hundreds of matching, completion, multiple choice, and short answer questions to assess student knowledge of the content in each unit.

See **www.g-w.com/math-for-carpentry-construction-2024** for a list of all available resources.

Professional Development

- Expert content specialists
- Research-based pedagogy and instructional practices
- Options for virtual and in-person Professional Development

Brief Contents

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Material Estimating Activities

Feature Contents

Carpentry Notes