



Kathy Cox, State Superintendent of Schools

Title: Estimating Quantity and Cost of Framing Materials for a Wood Shell (embedding mathematics in CTAE)

Grade: 10, 11, 12

Designers: Pam Fails

Unit Development Template

Introduction

Unit Title

Estimating Quantity and Cost of Framing Materials for a Wood Shell (embedding mathematics in CTAE)

Unit Annotations

This integrated is a mathematics and construction unit on estimating materials cost of Habitat for Humanity Houses. Students are required to estimate materials and cost for the sill, beams, joist headers, floor joists, subflooring, flooring, wall plates, interior and exterior walls, and roofing. The construction class focuses on both theoretical and hands-on learning while the math classes use examples from the construction course to illustrate real-world applications of math concepts.

Grade(s)

- 10
- 11
- 12

Subject(s)

Math / Mathematics 2

(Optional) Approximate Duration of Unit

10 days on a 4X4 block schedule

Unit Author

Pam Fails (Georgia Standards)

(optional) Additional Author(s) and their Email Address(es)

Ron Harris, Construction Technology Instructor, Osborne High School, Ronald.Harris@cobbk12.org Jonas Magdangal, Math Teacher, Osborne High School, Jonas.Magdangal@cobbk12.org

Unit Focus Standards

Unit Focus Standards

MM2G1. Students will identify and use special right triangles.

- a. Determine the lengths of sides of 30°-60°-90° triangles.
- b. Determine the lengths of sides of 45°-45°-90° triangles.

Unit Focus Standards

MM2G3. Students will understand the properties of circles.

- a. Understand and use properties of chords, tangents, and secants as an application of triangle similarity.
- b. Understand and use properties of central, inscribed, and related angles.
- c. Use the properties of circles to solve problems involving the length of an arc and the area of a sector.
- d. Justify measurements and relationships in circles using geometric and algebraic properties.

Unit Focus Standards

MM2P4. Students will make connections among mathematical ideas and to other disciplines.

- a. Recognize and use connections among mathematical ideas.
- b. Understand how mathematical ideas interconnect and build on one another to produce a coherent whole.
- c. Recognize and apply mathematics in contexts outside of mathematics.

Unit Focus Standards

CTAE-FS-1 Technical Skills: Learners achieve technical content skills necessary to pursue the full range of careers for all pathways in the program concentration.

Unit Focus Standards

CTAE-FS-7 Safety, Health and Environment: Learners employ safety, health and environmental management systems in corporations and comprehend their importance to organizational performance and regulatory compliance.

Unit Focus Standards

CTAE-FS-8 Leadership and Teamwork: Learners apply leadership and teamwork skills in collaborating with others to accomplish organizational goals and objectives.

Unit Focus Standards

CTAE-FS-10 Career Development: Learners plan and manage academic-career plans and employment relations.

Unit Focus Standards

CTAE-FS-11 Entrepreneurship: Learners demonstrate understanding of concepts, processes, and behaviors associated with successful entrepreneurial performance.

Unit Focus Standards

CTAE-FS-2 Academic Foundations: Learners achieve state academic standards at or above grade level.

Unit Focus Standards

CTAE-FS-3 Communications: Learners use various communication skills in expressing and interpreting information.

Unit Focus Standards

CTAE-FS-4 Problem Solving and Critical Thinking: Learners define and solve problems, and use problem-solving and improvement methods and tools.

Unit Focus Standards

CTAE-FS-5 Information Technology Applications: Learners use multiple information technology devices to access, organize, process, transmit, and communicate information.

Unit Focus Standards

CTAE-FS-6 Systems: Learners understand a variety of organizational structures and functions.

Unit Focus Standards

CTAE-FS-9 Ethics and Legal Responsibilities: Learners commit to work ethics, behavior, and legal responsibilities in the workplace.

Unit Focus Standards

MC1G1. Students will investigate properties of geometric figures in the coordinate plane.

- a. Determine the distance between two points.
- b. Determine the distance between a point and a line.
- c. Determine the midpoint of a segment.
- d. Understand the distance formula as an application of the Pythagorean theorem.
- e. Use the coordinate plane to investigate properties of and verify conjectures related to triangles and quadrilaterals.

Unit Focus Standards

MC1P1. Students will solve problems (using appropriate technology).

- a. Build new mathematical knowledge through problem solving.
- b. Solve problems that arise in mathematics and in other contexts.
- c. Apply and adapt a variety of appropriate strategies to solve problems.
- d. Monitor and reflect on the process of mathematical problem solving.

Unit Focus Standards

MC1P4. Students will make connections among mathematical ideas and to other disciplines.

- a. Recognize and use connections among mathematical ideas.
- b. Understand how mathematical ideas interconnect and build on one another to produce a coherent whole.
- c. Recognize and apply mathematics in contexts outside of mathematics.

Unit Focus Standards

MC2A2. Students will solve simple equations.

- a. Solve quadratic equations in the form $ax^2 + bx + c = 0$, where $a = 1$, by using factorization and finding square roots where applicable.
- b. Solve equations involving radicals such as $\sqrt{x} + b = c$, using algebraic techniques.
- c. Use a variety of techniques, including technology, tables, and graphs to solve equations resulting from the investigation of $x^2 + bx + c = 0$.
- d. Solve simple rational equations that result in linear equations or quadratic equations with leading coefficient of 1.

Unit Focus Standards

MC4G1. Students will understand the properties of circles.

- a. Understand and use properties of chords, tangents, and secants as an application of triangle similarity.
- b. Understand and use properties of central, inscribed, and related angles.
- c. Use the properties of circles to solve problems involving the length of an arc and the area of a sector.
- d. Justify measurements and relationships in circles using geometric and algebraic properties.

Unit Focus Standards

MC4P1. Students will solve problems (using appropriate technology).

- a. Build new mathematical knowledge through problem solving.
- b. Solve problems that arise in mathematics and in other contexts.
- c. Apply and adapt a variety of appropriate strategies to solve problems.
- d. Monitor and reflect on the process of mathematical problem solving.

Unit Focus Standards**MC1P3. Students will communicate mathematically.**

- Organize and consolidate their mathematical thinking through communication.
- Communicate their mathematical thinking coherently and clearly to peers, teachers, and others.
- Analyze and evaluate the mathematical thinking and strategies of others.
- Use the language of mathematics to express mathematical ideas precisely.

Unit Complementary Standards**National / Local Standards / Industry / ISTE****(Recommended) National / Local Standards / Industry / ISTE****ACT-C1-1. Students will know, understand, and apply general construction and specific OSHA and EPA safety concepts and practices.**

Demonstrate an understanding of the applications of OSHA and EPA regulations concerning PPE. Demonstrate an understanding of the applications of OSHA and EPA regulations concerning environmental issues on the construction site.

ACT-C1-2. Students will use tools and equipment in a professional and safe manner. Demonstrate the use of the proper tools for a specific carpentry building procedure. Demonstrate knowledge of specific regulations as related to specific equipment.

ACT-C1-3. Students will become familiar with the selection, handling, storage, and proper use of construction materials used in site layout and floors and wall construction. Demonstrate knowledge of the proper selection of materials for site layout, floors and walls. Demonstrate knowledge of individual components used in site layout, floors and walls. Demonstrate knowledge of layout as it relates to site layout, floors and walls.

ACT-C1-4. Students will read, interpret, apply information, and estimate costs from a variety of architectural and construction working drawings. Demonstrate knowledge of reading and interpreting plans, elevations, schedules, sections, and details contained in basic construction drawings as related to site layout, floors and walls. Demonstrate the ability to estimate materials for use in site layout, floors and walls.

ACT-C1-5. Students will know and understand the materials, processes, and safety related to all cement and concrete products. Demonstrate knowledge of the safety procedures associated with construction and use of concrete products. Demonstrate knowledge of properties and composition of concrete products.

ACT-C1-6. Students will know and understand the concepts and practices of basic site layout and footings.

Demonstrate knowledge of site layout.

Demonstrate knowledge of individual components used in footings.

ACT-C1-7. Students will know and understand proper and necessary carpentry tasks that enable a team to construct floor and wall systems.

Demonstrate knowledge of the construction of floor systems.

Demonstrate knowledge of the construction of wall systems.

Literacy skills and Habits of Success

RAFT

KWL

Written summarizing

Venn Diagram

Understanding and Goals

Unit Enduring Understandings

- Understand how to prepare a materials cost estimate for the wood shell of a habitat for Humanity house.
- Understand how to use mathematical computations and read blueprints.
- Understand that math is important to the construction trades and how mathematical accuracy determines accuracy of the materials estimate.
- Understand how to calculate area and volume.

Unit Essential Questions

- Why is it important to accurately estimate materials for building sites?
- What other information can we obtain by understanding the mathematics involved in estimating framing materials?
- How is the job site affected by miscalculations of materials needed and/or their cost?

(Recommended) Pre-Requisite Knowledge & Skills / Current Unit Knowledge & Skills

Assessment & Instruction

Formative Assessments for Learning

- Subjective assessment - Subjective assessments require the teacher's judgment to determine the grade. These include short answer as well as essay tests.
- Post-test - A helpful way to find out whether your students have mastered the basic knowledge and skill levels required.
- Self-assessment - May include practice quizzes, games, simulations, checklists, rubrics and other interactive exercises, and practice written assignments
- Objective assessment - Objective assessments (usually multiple-choice, true- false, short answer) have correct answers.
- Pre-test - A helpful way to find out whether your students meet the basic knowledge and skill levels required to learn your materials.

Describe the Assessments

Describe the Assessment(s)

Subjective assessments-Projects will be informally checked for completion at the following places:

- Floor Frame Material Estimation
- Wall Frame Material Estimation
- Ceiling Frame Material Estimation
- Roof Frame Material Estimation

Pre-Test and Post-Test assessments-will be administered before beginning and after completion of the unit. (a blueprint plan must be provided)

Attachment: Materials Estimation Pre Test, Materials Estimation Post Test

Self Assessment-A template will be provided for students to use in calculation of the quantity and cost of house construction materials. **Attachment: Materials Estimation Template**

Objective assessments-Students will complete worksheets to assess understanding of Floor framing, Roof framing, estimation, and use of 16 inch versus 24 inch O.C. **Attachment: Floor framing worksheet, Roof framing worksheet, KWL Chart, Venn Diagram, and Venn Diagram Key**

Assessment(s) Attachment

(Optional) Attachment

Uploaded file: [Materials Estimate Pre Test.doc](#)

(Optional) Attachments (Typically a Rubric or Checklist)

(Optional) Attachment

Uploaded file: [Materials Estimation Post Test.doc](#)

(Optional) Attachments (Typically a Rubric or Checklist)

(Optional) Attachment

Uploaded file: [Floor Framing Worksheet.doc](#)

(Optional) Attachments (Typically a Rubric or Checklist)

(Optional) Attachment

Uploaded file: [Roof Framing Worksheet.doc](#)

(Optional) Attachments (Typically a Rubric or Checklist)

(Optional) Attachment

Uploaded file: [Materials Estimation Template.doc](#)

(Optional) Attachments (Typically a Rubric or Checklist)

(Optional) Attachment

Uploaded file: [KWL Chart.doc](#)

(Optional) Attachments (Typically a Rubric or Checklist)

(Optional) Attachment

Uploaded file: [Venn Diagram.pdf](#)

(Optional) Attachments (Typically a Rubric or Checklist)

Uploaded file: [Venn Diagram Key.pdf](#)

Instructional Planning

Instructional Planning

Construction Lessons-squaring and size of sill, beam rigidity, dimensions and leveling, joist purpose, spacing and dimensions, safety, adhesives, wall systems, stud framing and spacing, rafter layout, roofing systems

Math Lessons-Linear measurement, area calculations, Pythagorean formula

Instructional Planning Attachment

(Optional) Instructional Planning Attachment

Uploaded file: [Weekly Lesson Plans.doc](#)

Materials and Equipment / Homework Extensions

Materials and Equipment

Measuring tools

Calculators

Blueprints

Internet

VCR/TV

Power tools

Pencil

Framing Square

(Optional) Homework Extensions

Attachment – Homework Extensions

Culminating Unit Performance Task

(Optional) Culminating Unit Performance Task

Building a Model of a House

Culminating Unit Performance Task Description/Directions/Differentiated Instruction

Student will estimate framing material to be included in a proposal to build a Habitat for Humanity residential structure. After completion of the cost estimate, a model of the structure will be built to use during the proposal process.

Project Specifications

- Safety demonstrated.
- Accuracy of measurements
- Accuracy of cuts
- Selection of materials

Other Requirements:

Groups will present their Model House and a written estimate of framing materials that is needed for the Habitat for Humanity house.

(Optional) Attach Rubric or Checklist for Unit Performance Task

Uploaded file: [Model House Rubric.doc](#)

(Optional) Attachment - May be Student Directions or other attachment

Uploaded file: [Home Model student handout.doc](#)

(Optional) Attach Student Handout or other attachment

Uploaded file: [Estimating overview.doc](#)

(Optional) Attachment – May be Teacher Directions or other attachment

(Optional) Culminating Unit Performance Task

Additional Attachments

Culminating Unit Performance Task Description/Directions/Differentiated Instruction

(Optional) Attach Rubric or Checklist for Unit Performance Task

Uploaded file: [Perimeter, Area, and board feet.doc](#)

(Optional) Attachment - May be Student Directions or other attachment

Uploaded file: [Roof Framing Instructions.doc](#)

(Optional) Attach Student Handout or other attachment

(Optional) Attachment – May be Teacher Directions or other attachment

Student Work Sample Title / Description

(Optional) Student Work Sample Title / Description

See attached PowerPoint for samples of house model.

Attachment - Student Work Sample

(Optional) Attachment - Student Work Sample

Uploaded file: [Wood Shell Materials Estimating 2.ppt](#)

Teacher Commentary Title / Description

(Optional) Teacher Commentary Title / Description

Attachment - Teacher Commentary

Language of the Standards

(Optional) Language of the Standards

Unit Resources

(Optional) Web Resources

www.building-cost.net

www.cefga.org

www.get-a-quote.net/quickcal/joist/htm.

(Optional) Ancillary Materials

Textbook: *Carpentry I*, NCCER

Video: "Floor Frame", NCCER; "Wall Frame", NCCER; "Roof Frame", NCCER

(Optional) What 21st Century Technology was used in this Unit Development Template?

- Video
- Web Site(s)

(Optional) Notes and Reflections

This unit was developed in response to the reauthorization of the Carl Perkins legislation which requires CTAE teachers to embed the instruction of rigorous academics into CTAE courses. The CTAE teacher paired with a mathematics teacher who served as a consultant to help find embedded high school mathematics and to serve as support in the instruction of the embedded mathematics. The CTAE teacher served as a consultant to the mathematics teacher as he/she prepared mathematics lesson plans in which students applied mathematics to real-world, authentic CTAE projects. For more information about the eight-step unit development process, please contact Leslie Carson at leslie.carson@sreb.org. For information about the actual instruction of this project unit, please contact the additional unit authors listed above.