WAMC Lab Template

Math Concept(s): Converting measurements, estimation, similar triangles, linear algebra (solving for an unknown value), inverse trigonometry.

Source / Text:

Developed by: Chris Aiken E-Mail: caiken@eagles.edu Date: 6/21/22

Attach the following documents:

- Lab Instructions
- Student Handout(s)
- Rubric and/or Assessment Tool

Short Description (Be sure to include where in your instruction this lab takes place):

Students will go outside and use a variety of tools and techniques to calculate the height of a tree by using basic algebra (proportions and solving for an unknown variable), geometry (similar triangles), problem solving skills to collaboratively work with a partner, use tools and technology to calculate and express their findings.

Lab Plan

Lab Title: How tall is the tree?

Students will use a yardstick and a measuring tape to calculate the height of a tree. This will require students to be able to calculate their own pace distance (feet per 10 paces) in order to estimate the average distance of one pace in feet. Students will measure the length of their arm in order to acquire the required information to complete this task. When students know their pace distance and the length of their arm, they will then find a tree to measure (preferably a tall tree). Students will stand at the base of a tree and pace away from the tree (recording this number of paces). They will then multiply this number x the # of feet per pace (already established). This will give the students the base distance from the tree (horizontal distance). Students will then hold a yardstick in one hand (at the very bottom), extend their arm parallel to the ground, close one eye and look at the top of the tree. Students will need to record the number of inches on the yardstick that correlates to the top of the tree (record this number). Students will then divide this number by 12 to convert this number from inches to feet (recording this number). With this information, the students will be able to use similar triangles (the right triangle created by the yardstick and student and the right triangle created by the student and the tree) to calculate the height of the tree. Once the height of the tree is calculated (and recorded), they will reflect on this process by answering a set of questions posted in their google classroom.

Prerequisite skills:

- Students need to be able to read a yardstick.
- Students need to be able to read a tape measure.
- Students need to be able to solve a basic linear equation (solve for x).

- Students need to be able to solve a proportion (algebraically).
- Students need to be able to understand the properties of a similar triangles.
- Students need to be able to set up a proportion when similar triangles are established.
- Students need to be able to convert between feet and inches.

Lab objective:

- To engage students
- To create a scenario where students will use basic tools to establish information not already established.
- To create collaboration between 2 students.
- To create a scenario where students need to record data.
- To create a scenario where students use collected data in order to calculate a real life problem mathematically (both using algebra and geometry).
- To create a scenario where students can discuss the differences between a perfect answer and an estimated value and when each can or should play a role in real life.
- To connect a mathematical problem to real life (specifically to the practice of forestry).

Standards: *(Note SPECIFIC relationship to Science, Technology, and/or Engineering)*

K-12 Science Standards

- HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

Technology

- 1.c. Students use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.

Engineering

- HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

Standards for Mathematical Practice:

- CCSS.MATH.CONTENT.8.G.A.4
  Understand that a two-dimensional figure is similar to another if the second can be obtained from the first by a sequence of rotations, reflections, translations, and dilations; given two similar two-dimensional figures, describe a sequence that exhibits the similarity between them.
- CCSS.MATH.CONTENT.HSA.CED.A.1
  Create equations and inequalities in one variable and use them to solve problems.
- CCSS.MATH.CONTENT.8.G.A.4
  Understand that a two-dimensional figure is similar to another if the second can be obtained from the first by a sequence of rotations, reflections, translations, and dilations; given two similar two-dimensional figures, describe a sequence that exhibits the similarity between them.

Leadership/21st Century Skills:

21st Century Interdisciplinary themes (Check those that apply to the above activity.)

☐ Global Awareness ☐ Financial/Economic/Business/Entrepreneurial Literacy ☐ Civic Literacy
☐ Health/Safety Literacy ☒ Environmental Literacy

21st Century Skills (Check those that students will demonstrate in the above activity.)

LEARNING AND INNOVATION

Creativity and Innovation
☒ Think Creatively
☒ Work Creatively with Others
☒ Implement Innovations

Critical Thinking and Problem Solving
☐ Reason Effectively
☐ Use Systems Thinking
☒ Make Judgments and Decisions
☒ Solve Problems

Communication and Collaboration
☒ Communicate Clearly
☒ Collaborate with Others

INFORMATION, MEDIA & TECHNOLOGY SKILLS

Information Literacy
☐ Access and Evaluate Information
☒ Use and manage Information

Media Literacy
☐ Analyze Media
☐ Create Media Products

Information, Communications and Technology (ICT Literacy)
☒ Apply Technology Effectively

LIFE & CAREER SKILLS

Flexibility and Adaptability
☐ Adapt to Change
☒ Be Flexible

Initiative and Self-Direction
☐ Manage Goals and Time
☐ Work Independently
☐ Be Self-Directed Learners

Social and Cross-Cultural
☒ Interact Effectively with Others
☐ Work Effectively in Diverse Teams

Productivity and Accountability
☐ Manage Projects
☒ Produce Results

Leadership and Responsibility
☐ Guide and Lead Others
☒ Be Responsible to Others

Teacher Preparation: (What materials and set-up are required for this lab?)

Materials

- Yardstick
- Measuring tape (50 feet)
- Calculator
- How tall is the tree worksheet

Set-Up Required:

- Students will be given the "How tall is the tree" worksheet
- Students will outside (north end of the high school)
- Students will group up and start to fill out the worksheet that will systematically take them through the lab.
- All tools/implements will be brought down to the north end of the school by myself.

Lab Organization Strategies:

Leadership (Connect to 21st Century Skills selected):

21st Century Interdisciplinary themes (Check those that apply to the above activity.)

☐ Global Awareness ☒ Financial/Economic/Business/Entrepreneurial Literacy ☐ Civic Literacy
☐ Health/Safety Literacy ☒ Environmental Literacy

21st Century Skills (Check those that students will demonstrate in the above activity.)

LEARNING AND INNOVATION

Creativity and Innovation
☒ Think Creatively
☒ Work Creatively with Others
☐ Implement Innovations

Critical Thinking and Problem Solving
☒ Reason Effectively
☐ Use Systems Thinking
☒ Make Judgments and Decisions
☒ Solve Problems

Communication and Collaboration
☒ Communicate Clearly
☒ Collaborate with Others

INFORMATION, MEDIA & TECHNOLOGY SKILLS

Information Literacy
☐ Access and Evaluate Information
☒ Use and manage Information

Media Literacy
☐ Analyze Media
☐ Create Media Products

Information, Communications and Technology (ICT Literacy)
☒ Apply Technology Effectively

LIFE & CAREER SKILLS

Flexibility and Adaptability
☐ Adapt to Change
☒ Be Flexible

Initiative and Self-Direction
☒ Manage Goals and Time
☐ Work Independently
☐ Be Self-Directed Learners

Social and Cross-Cultural
☐ Interact Effectively with Others
☒ Work Effectively in Diverse Teams

Productivity and Accountability
☐ Manage Projects
☐ Produce Results

Leadership and Responsibility
☐ Guide and Lead Others
☒ Be Responsible to Others

Cooperative Learning:

- Students will work in groups of 2 (working within their self-determined roles)

Expectations:

- Students will select their roles (Pacer or measurer)
- Students will work cooperatively during the process
- Students will problem solve together and respect each other

Timeline:

- 1 class period

Post Lab Follow-Up/Conclusions:

Discuss real world application of learning from lab

- This conversation will happen the day after the lab and the student reflection sheets will be used to drive this conversation.

Career Applications

- Forestry

Optional or Extension Activities

- None

Name _____ Per_____ Date_____

How tall is the tree?

1) Please verify which role you have chosen within your group:

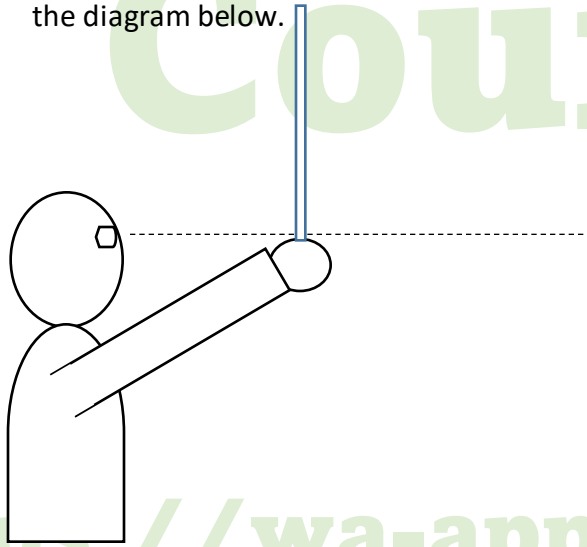
Pacer _____

Measurer _____

*Both students are responsible for the calculations.

Role of the Pacer and measurer

2) Pacer - Stand with your feet together and mark your starting point (from the back of your foot).
3) Pacer - Take 10 paces (natural paces, not exaggerated) and mark where you end up (marking the front of your foot (last step).
4) Measurer - Measure the distance of your pacers 10 paces in feet = _____ ft.
5) Measurer - Take the total feet and divide by 10 to get the feet per pace (round to the nearest foot) _____ft/pace.
6) Pacer - With your back to the tree, pace 20-30 paces away from the tree (you decide how many).
7) Measure - Take this number of paces and multiply it by the # of ft/pace to estimate the base distance from the tree total paces x ft/pace = _____ ft. (this is your base distance)
8) Measurer – hold the yardstick in one hand and hold your arm out with the top of your hand directly in front of your eye (pick the eye that is open, one should be closed). See the diagram below.



Note:

- The line of sight is parallel with the ground and passes over the top of the hand. The yardstick should be held at the 1 inch mark.
- Your arm should not be parallel to the ground.

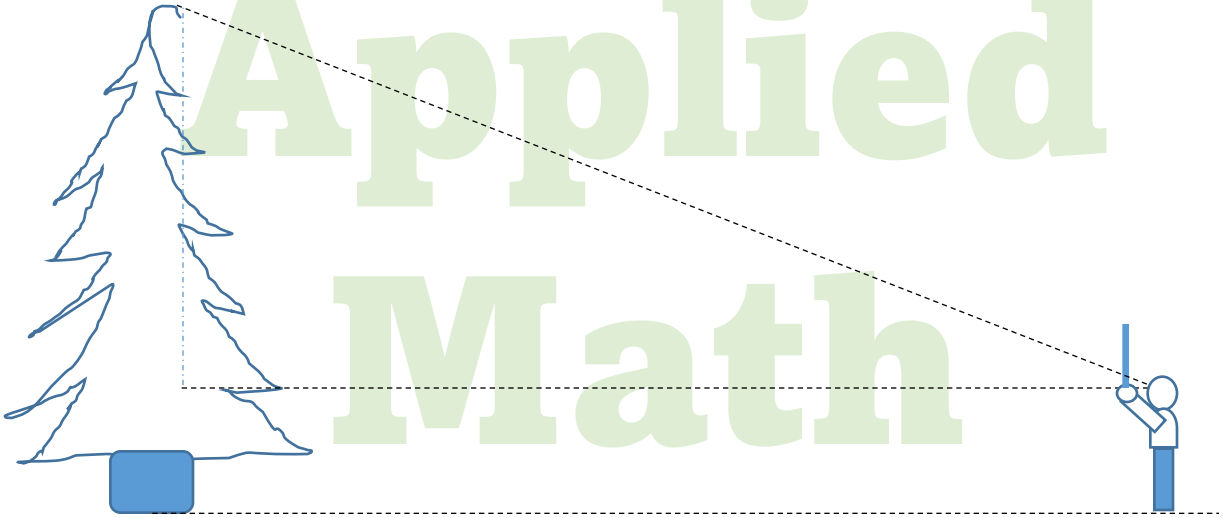
9) Pacer – measure the horizontal distance from the eye to the base of the yardstick (answer in inches – round to the nearest inch) _____ inches

10) Measurer – take the horizontal distance in inches and divide by 12 to convert to feet (Round to the nearest tenth of a foot). _____ ft

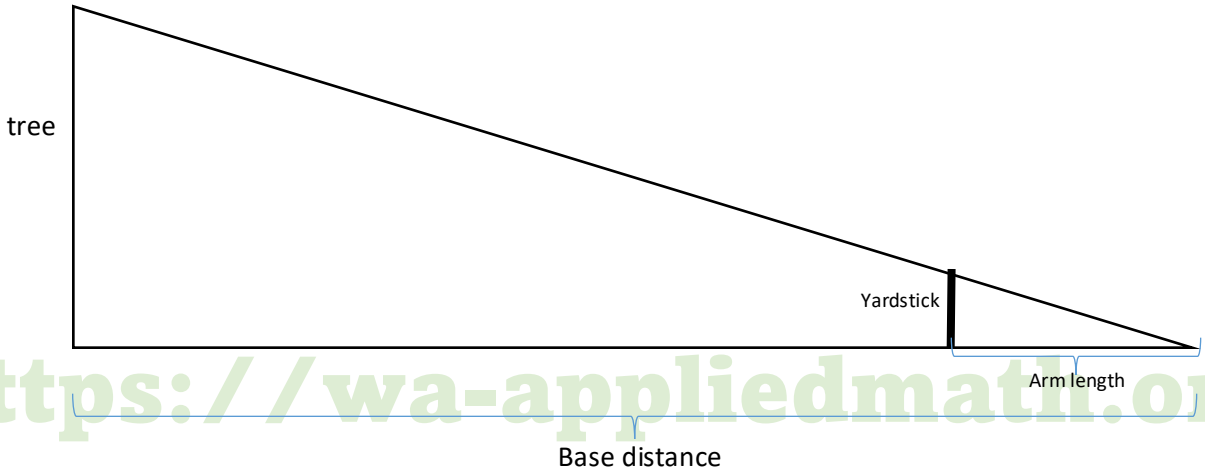
11) Measure – Stand at your last pace mark and face the tree. Hold out your arm with the yardstick (as you did in step 8), close one eye and look at the top of the tree (without moving your head). Record the inches on the yardstick that correlates to the top of the tree. _____ inches

12) Take this measurement and divide by 12 to convert to feet (round to the tenth of a foot). _____ ft.

13) This experience will look something like the diagram below.



14) Label the diagram below that represents your values (acquired in steps 1-12).



How tall is the tree (Round to the nearest foot)?_____

Reflection

The implementation for this procedure within forestry has been around for centuries where a forester could measure the height of a tree very easily with minimal tools while standing within a forest canopy. Answer the following questions about this process:

1) What did you learn about this lab that you didn't know prior to doing it?
_____
_____
_____

2) Was this lab able to help you strengthen your math skills (i.e. Similar triangles, conversion of measurements, using tools, proportions, fractions, algebra, etc.)?
_____
_____
_____

3) Was there a real life problem that you noticed about what we did in relationship to our findings and how those findings could have been used for pricing lumber?
_____
_____
_____

4) Was there a tool that you could have used that is available technologically today that was not available 20 years ago that would assist you with this process? Would the mathematics change if you used that tool?
_____
_____
_____

Possible reflections/points of contention

1. <u>What did you learn about this lab that you didn't know prior to doing it?</u>

- Answers will vary and student specific

2. <u>Was this lab able to help you strengthen your math skills (i.e. Similar triangles, conversion of measurements, using tools, proportions, fractions, algebra, etc.)?</u>

- Knowledge and proficiency with similar triangles
- Conversion from inches to feet
- Making sure all measurements were in the same unit of measure
- Solving a proportion algebraically

3. <u>Was there a real life problem that you noticed about what we did in relationship to our findings and how those findings could have been used for pricing lumber?</u>

- The distance from the measurer's eye to the ground was not included in the height of the tree.
- What if the ground is not level? What would you do then?
- What if you were in a dense wooded forest and you couldn't see the top of the tree or get and adequate distance from the tree because the canopy is too dense? Then what?
- To calculate the value of the tree don't you need more information? What info is needed? How would you get that?
- The entire tree doesn't have value nor would be used in the board feet calculation. Why measure the height of the entire tree?
- Would you do this for a deciduous tree that doesn't have one main trunk? Several large braches would alter the value of that tree. Would you do this for a tree like that?

4. <u>Was there a tool that you could have used that is available technologically today that was not available 20 years ago that would assist you with this process? Would the mathematics change if you used that tool?</u>

- A dendrometer could have been used to calculate the angle of the larger triangle.
    a. This would require right triangle trigonometry.
- A range finder could have been used to calculate the base distance more accurately.
    a. Math would be the same but it would be more accurate (less estimation).

WAMC Lesson Plan

Name(s): Christopher B. Aiken
Email Address: caiken@gmail.com
Lesson Title: Similar Triangles
Date:6/21/22
Text: None STEM Correlation: Real life application to mathematics Lesson Length: 55 min.

Big Idea (Cluster): Similar triangles and Proportionality

Mathematics K–12 Learning Standards:
K-12 Science Standards

- HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

Technology

- 1.c. Students use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.

Engineering

- HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

Standards for Mathematical Practice:

- CCSS.MATH.CONTENT.8.G.A.4
  Understand that a two-dimensional figure is similar to another if the second can be obtained from the first by a sequence of rotations, reflections, translations, and dilations; given two similar two-dimensional figures, describe a sequence that exhibits the similarity between them.
- CCSS.MATH.CONTENT.HSA.CED.A.1
  Create equations and inequalities in one variable and use them to solve problems.
- CCSS.MATH.CONTENT.8.G.A.4
  Understand that a two-dimensional figure is similar to another if the second can be obtained from the first by a sequence of rotations, reflections, translations, and dilations; given two similar two-dimensional figures, describe a sequence that exhibits the similarity between them.

Mathematical Practice(s):

1. Make sense of problems and persevere in solving them
2. Reason abstractly and quantitatively
3. Model with mathematics
4. Use appropriate tools strategically
5. Attend to precision

Content Objectives: Students will be able to:	Language Objectives (ELL):
• Identify the proportionate side lengths of similar triangles. • Identify the proportionate angles of similar triangles. • Solve for missing sides related to	Students will be able to verbally and productively collaborate, discuss and debate with each other about their mathematical findings.

similar triangles. • Create proportions as they apply to similar triangles. • Solve algebraically for the missing side of a set of similar triangles.	
Vocabulary: Similar triangles, similarity, proportionality.	Connections to Prior Learning • Proportions • Solve for x (multistep algebraic equations) • Right triangles • Congruence
Questions to Develop Mathematical Thinking: • What does it mean for 2 triangles to be similar? • How could similar triangles be used in real life to solve real life problems?	Common Misconceptions: • Similar triangles have to be both right triangles. • Similar triangles are the same as congruent triangles. • Similar triangles must be the same size and shape.

Assessment (Formative and Summative):

Formative Assessment
- Bell work on *which triangles look similar?*
- Class discussion on the definition of similar?
- Worksheet A (Identifying proportionate side lengths and angles and solving for the missing side of a set of similar triangles.
- Student to student talk – Reflection on the worksheet and their answers.
- Class discussion on the worksheet answers.
- Class discussion on how similar triangles can be used in real life (student driven and teacher directed)
- Exit ticket on the daily reflection

Summative Assessment
Quiz on similar triangles that would include:
- Identifying proportionate side lengths of similar triangles
- Identifying proportionate angles of similar triangles
- Solve for missing side lengths of similar triangles.

Materials:
- Classroom overhead projector (Bell Work)
- Worksheet A
- Exit tickets

Instruction Plan:

Introduction: The class will start with a bell work on students identifying similar shapes (triangles).
Explore: We will explore the meaning behind the definition of similar triangles and how it is defined geometrically.
When I observe students: • My initial observation will be how students define what similar is at it pertains to shapes (triangles). • That observation will extend to making sure that all students understand how *similar triangles* are defined geometrically. • After teaching and scaffolding the learning associated with solving similar triangles and their missing components, I will observe students working independently on a worksheet specific to this skill set. • I will then observe the student to student talking session as they compare their answers and ideas. • I will then participate in the classroom discussion closing out this concept and observe students take the role as leader within this discussion and clarification/misconceptions associated with any errors that occurred.
Questions to Develop Mathematical Thinking as you observe: • How did you decide that those two sides were proportionate? • Why did you write your proportion that way? Was there another way of writing it? Would that have changed your answer?
Answers: • Those two sides were corresponding sides. • I wrote AB is to DE as BC is to EF • Yes, you could have written AB is to BC as DE is to EF • No, the answer would have been the same.
Summarize:

Career Application(s):

- Construction
- Forestry
- Any trade that uses similar triangles (i.e. Welding)

Leadership/21st Century Skills:

21st Century Interdisciplinary themes (Check those that apply to the above activity.)

☐ Global Awareness ☒ Financial/Economic/Business/Entrepreneurial Literacy ☐ Civic Literacy
☐ Health/Safety Literacy ☒ Environmental Literacy

21st Century Skills (Check those that students will demonstrate in the above activity.)

LEARNING AND INNOVATION
Creativity and Innovation
☒ Think Creatively
☒ Work Creatively with Others
☐ Implement Innovations
Critical Thinking and Problem Solving
☒ Reason Effectively
☐ Use Systems Thinking
☒ Make Judgments and Decisions
☒ Solve Problems
Communication and Collaboration
☒ Communicate Clearly
☒ Collaborate with Others

INFORMATION, MEDIA & TECHNOLOGY SKILLS
Information Literacy
☐ Access and Evaluate Information
☒ Use and manage Information
Media Literacy
☐ Analyze Media
☐ Create Media Products
Information, Communications and Technology (ICT Literacy)
☒ Apply Technology Effectively

LIFE & CAREER SKILLS
Flexibility and Adaptability
☐ Adapt to Change
☒ Be Flexible
Initiative and Self-Direction
☒ Manage Goals and Time
☐ Work Independently
☐ Be Self-Directed Learners
Social and Cross-Cultural
☐ Interact Effectively with Others
☒ Work Effectively in Diverse Teams

Productivity and Accountability
☐ Manage Projects
☐ Produce Results
Leadership and Responsibility
☐ Guide and Lead Others
☒ Be Responsible to Others

Lesson Plan Sequence:

1) Students will spend 5 minutes on the Bell Work "Which triangles look similar"
    a) This exercise is designed to show misconception about what the word similar means and how it is different geometrically. Students will be allowed to discuss as a group.
2) Students will then be given the appropriate geometric definition as it pertains to similar triangles (5 minutes).
    a) **Similar triangles** are triangles that have the same shape, but their sizes may vary. All equilateral triangles, squares of any side lengths are examples of similar objects. In other words, if two triangles are similar, then their corresponding angles are congruent and corresponding sides are in equal proportion. We denote the similarity of triangles here by **'~'** symbol.
3) The lesson will transition to how similar triangles can be used to find missing side lengths (algebraically).
    a) Several problems will be used to scaffold how a student can set up a proportion and solve for the missing side length. These problems will be teacher led and questions/concerns will be answered as they arise (15 minutes).
4) After the problems are taught and students have the appropriate notes on how to solve similar triangles, they will be given a short worksheet (Worksheet A) to work independently.
    a) The teacher will formatively assess students individually at this time not to answer the questions for them, but simply guide them to understand the definitions and concepts that are necessary for the establishment of a correct process and answer (20 minutes).
5) Students will pair up (in their predetermined pair) and discuss their findings/answers on Worksheet A. They will be given 5 minutes to discuss their answers and possibly debate differences.
6) The class will come together for a reflection and students will be allowed an opportunity to discuss their successes, failures, differences, who was right, who was wrong, and why…(5 minutes).
7) Class will end with an exit ticket on their reflection for their success today. They must answer the following question:
    a) "What part of this process was easy for you? What part of this process was difficult for you? If you did not find any part of this process that was difficult, "How could similar triangle be used as a real life application? Be specific in your answers. Turn in this exit ticket at the door as you leave the room.
8) The Lab for "How tall is the tree?" will be administered the following day (one complete class period).