

Measuring the Immeasurable
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NSTEM PROJECT – Geometry
6th 6 weeks

Well Defined Outcome

The students will be able to measure an “immeasurable” object by creating a measuring device using a protractor, some string, a straw and a weight and then by using trigonometry to calculate/convert the measurements.

Secondary Objectives

(8) Congruence and the geometry of size. The student uses tools to determine measurements of geometric figures and extends measurement concepts to find perimeter, area, and volume in problem situations. The student is expected to:

(F) use conversions between measurement systems to solve problems in real-world situations.

(11) Similarity and the geometry of shape. The student applies the concepts of similarity to justify properties of figures and solve problems. The student is expected to:

(C) develop, apply, and justify triangle similarity relationships, such as right triangle ratios, trigonometric ratios, and Pythagorean triples using a variety of methods;

Materials Required

Laptops (1 per pair)
Straws (1 per pair)
String
Heavy paper protractor
Weight/nut (1 per pair)
Scissors (1 per pair)
Meter sticks/tape measures (1 for every 3 groups)
Observation/recording chart

Safety Notes

1. Use rulers and measuring devices correctly by rolling up tape measures slowly and by not using rulers as swords.
2. Be careful with scissors by not running with scissors and using them only to cut the materials provided.
3. Use the weight only as a weight for the measuring device you are creating and not as a projectile.
4. Use the straws as part of your measuring device and not as a projectile device.

Engagement -Day 1

KWL trigonometry and review of right triangle methods previously learned (Pythagorean theorem and special right triangles)

Exploration -Day 1, 2

Outside Shadow measurement Activity (comparing shadows with heights of objects)
Focusing Question

What kind of relationship is there between an object and its shadow?

Explanation: Day 2

We can solve relationships between similar figures by using proportions.

$$\frac{a}{b} = \frac{c}{d} \quad \text{where } ad = bc, \text{ using cross products (means-extremes).}$$

We can also solve the same problems by using trigonometric ratios: sine, cosine, or tangent.

We will focus on using tangent ... $\tan \theta = \frac{\text{opposite}}{\text{adjacent}}$
(Finding opposite side (height) with adjacent side and angle measure given/examples and practice problems)

Extension: Day 3, 4

Students will be in groups of 2 and will be given a laptop, protractor, straw, string and weight. They will be asked to create a measurement tool using all of the given materials which will enable them to measure an immeasurable object (like a tree or flagpole or building).

Complete measurements and continue trigonometric ratios (sine and cosine). Practice problems and application problems worksheet will be given for homework.

Evaluation: Day 5 or 6

Test over trigonometric ratios general and application problems ...

Extension Question: What other situations can you think of for which trigonometric ratios would be useful for finding missing values?

Measuring the Immeasurable Recording Chart

Object
Angle
Horizontal
Picture
Calculated Height
(Show work/calculations)

What are 3 things you need to consider while using your device to determine the heights of the building, trees, etc.?

Rubric: Measuring the Immeasurable

Using a clinometer to find the heights of immeasurable objects through the use of trigonometry

Measuring the Immeasurable

Enter rubric description

Rubric

Measuring the Immeasurable	Excellent 5 pts	Good 4 pts	Fair 3 pts	Poor 0 pts
Meets deadlines Measuring device assembled by due date	Excellent *measuring device accurately assembled and ready for use (day 1)	Good *Measuring device assembled with minor flaws and ready for use (day 1)	Fair *Measuring device assembled but incorrectly (day 1)	Poor *No measuring device assembled
Meets deadlines Chart accurately completed by due date	Excellent *chart accurately completed with angle measurements, ground measurements, and calculations recorded for 5 objects (day 1/2)	Good *chart completed with angle measurements, ground measurements, and calculations recorded (day 1/2) for 4 objects	Fair *chart completed with angle measurements, ground measurements, and calculations recorded (day 1/2) for 3 objects	Poor *chart not available
Meets deadlines Written description of processes	Excellent *written description of process for creating measuring device, using measuring device, and for finding height of objects (at least a page and very descriptive)(day 2)	Good *written description of process for creating measuring device, using measuring device, and for finding height of objects (more than 1/2 but less than 1 page) (day 2)	Fair *written description of process for creating measuring device and for finding height of objects incomplete, less than 1 page (day 2)	Poor *No written description
Calculations pictures with labeling	Excellent *picture of the triangular relationship is drawn with labeling for each object whose height is being found	Good *picture of the triangular relationship is drawn with labeling for all but one object whose height is being found	Fair *Picture of the triangular relationship is drawn without labeling for each object whose height is being found	Poor *No pictures drawn
calculations correct trigonometric function chosen	Excellent *Correct trigonometric function is chosen to calculate the height for each object/picture	Good *Correct trigonometric function is chosen to calculate the height for each object/picture	Fair *Incorrect trigonometric function is chosen to calculate the height for each object	Poor *no trigonometric function is chosen
	drawn	drawn but is used for wrong angle		

Calculations correct calculations shown	Excellent * Correct calculations are shown for all objects	Good * Correct calculations are shown for at least 70% of objects	Fair * Correct calculations are shown for at least 50% of objects	Poor * No calculations shown
Written description of processes Written description of procedure to create measuring device and written description of process for finding the heights of the objects	Excellent * written description of procedure for creating measuring device is easy to understand (is not plagiarized off a website) and complete (if I follow your directions, my device should look correct and function properly) * written description for finding the "immeasurable heights" should include correct trigonometric terminology and should lead the person following the instructions to a correct answer/result * descriptions are typed/double-spaced in an easy to read font (size 14)	Good * written description of procedure for creating measuring device is easy to understand (is not plagiarized off a website) and complete (if I follow your directions, my device should look correct and function properly) * written description for finding the "immeasurable heights" should include correct trigonometric terminology and should lead the person following the instructions to a correct answer/result * descriptions are not typed, but are written neatly with no mark-outs	Fair * see excellent * written descriptions are not typed, with mark-outs and 1 part of explanation is incorrect and would lead to an incorrect conclusion/answer	Poor * written description is not available
Teamwork work together to complete each task; jobs assigned	Excellent * Team members work together to complete each task * Team members assign "jobs" to each member such as: supply gatherer, recorder, measurer, etc.	Good * Team members work together to complete each task	Fair * 1 team member works to complete each task / 1 does not	Poor * tasks are not completed
Teamwork not sleeping, texting, or disturbing other group	Excellent * No team member is off-task (sleeping, talking, texting, disturbing other groups)	Good * 1 team member is occasionally off-task (sleeping, talking, texting, disturbing other groups)	Fair * 1 team member is consistently off-task (sleeping, talking, texting, disturbing other groups)	Poor * More than one team member is consistently off-task (sleeping, talking, texting, disturbing other groups)

