Course	FMP 10		
Lesson Title	Finding the missing height using Trigonometric Ratios		
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Stage 1

Outcomes and Indicators

FP10.4 Develop and apply the primary trigonometric ratios (sine, cosine, tangent) to solve problems that involve right triangles.

a. Develop, generalize, explain, and apply relationships between the ratios of side lengths and angle sizes in similar right triangles.
b. Demonstrate how to identify the hypotenuse of a right triangle and the adjacent and opposite sides to an acute angle in that right triangle.
c. Solve problems, with or without the use of technology, involving one or more right triangles by applying primary trigonometric ratios and/or the Pythagorean Theorem.
d. Create and solve problems that involve indirect and direct linear measurements by using the primary trigonometric ratios, the Pythagorean Theorem, and measurement instruments such as a clinometer or metre stick.

Key Understandings (I can / I understand statements)

I CAN…

- Use the trigonometric ratios (sine, cosine, tangent) to solve problems regarding right triangles
- Measure lengths in different linear measurements.
- Identify similar triangles using the ratio of side lengths and angle measurement of two triangles.
- apply the Pythagorean Theorem in problems involving triangles.
- Measure lengths using different measuring tools (meter stick, protractor, clinometer, etc.)
- Determine the right measurement to use in problems involving measurements.

Essential/Big/Key Questions/Ideas

- **Pythagorean Theorem**
- **Trigonometric ratios**
- **Why is measuring important/essential?**
- **How are the Pythagorean Theorem and Trigonometric ratios related?**
- **What makes two triangles “similar?”**

Prerequisite and Corequisite Learnings

SS8.1 Demonstrate understanding of the Pythagorean Theorem concretely or pictorially and symbolically and by solving problems.

a. Generalize the results of an investigation of the expression a b c 2 2 2 + = (where a, b, and c are the lengths of the sides of a right triangle, c being the longest):
    i. concretely (by cutting up areas represented by a2 and b2 and fitting the two areas onto c2)
    ii. pictorially (by using technology)
    iii. symbolically (by confirming that a b c 2 2 2 + = for a right triangle).
b. Explore right and non-right triangles, using technology, and generalize the relationship between the type of triangle and the Pythagorean Theorem (i.e., if the sides of a triangle

satisfy the Pythagorean equation, then the triangle is a right triangle which is known as the Converse of the Pythagorean Theorem).

c. Explore right triangles, using technology, using the Pythagorean Theorem to identify Pythagorean triples (e.g., 3, 4, 5 or 5, 12, 13), hypothesize about the nature of triangles with side lengths that are multiples of the Pythagorean triples, and verify the hypothesis.
d. Create and solve problems involving the Pythagorean Theorem, Pythagorean triples, or the Converse of the Pythagorean Theorem.

SS9.3. Demonstrate understanding of similarity of 2-D shapes.

a. Observe and describe 2-D shapes, relevant to self, family, or community, that are similar.
b. Explain the difference between similarity and congruence of polygons.
c. Verify whether or not two polygons are similar.
d. Explain how ratios and proportionality are related to similarity of polygons.
e. Draw a polygon similar to a given polygon and explain the strategies used.
f. Solve situational questions involving the similarity of polygons.

FP10.3 Demonstrate understanding of SI and imperial units of measurement including:

- linear measurement
- ~~surface area of spheres, and right cones, cylinders, prisms, and pyramids~~
- ~~volume of spheres, and right cones, cylinders, prisms, and pyramids~~
- ~~relationships between and within measurement systems~~

a. Provide personal referents for linear measurements, including millimetre, centimetre, metre, kilometre, inch, foot, yard, and mile and explain the choices.

*Trigonometric ratios (this lesson comes after the trigonometric ratio lesson)

a. Right triangles
b. Sine, cosine, tangent
c. Solve problems involving right triangles

Angles…(180 degrees is the sum of the interior angles of any triangle)

Measuring using tools (except clinometer** will introduce)

Stage 2 - Evidence to be gathered and tools	
Formative Assessment	
Paper Findings/Research - After the activity, students will hand in their written findings/calculations to be assessed by the teacher. Observations of students during discussion Observations during activity	
Summative Evaluation	
Stage 3 - Learning Plan	
Set (Hook/Engagement)	
Teacher	**Student**
Before the class starts, prepare the materials needed for the lesson (see below for the list). Place the materials in the middle of the table, so students will see these right away and start	

thinking of what they will be doing in the class today. 1. Create a random sitting plan where students will pick a popsicle stick with a number on it. a. As each student enters the classroom, ask them to pick one popsicle stick and sit on the table that matches the number on their popsicle stick. 2. “In the middle table, you will see three types of objects: a meter stick, a tape measure, a protractor, and a clinometer. Have one person from your table group come up and grab one of each and bring it to your group. You will also need to bring out your calculators, pencils, a blank piece of paper, and a ruler just in case. Then, write down any questions you may have about all the materials on your table.” a. Walk around the class to hear and see some discussions arising within each group. Make sure to be aware of stop-thinking questions and proximity questions along the way. 3. As students discuss and ask questions, draw a right triangle on the board. Do not say anything, but make sure the students see you drawing the right triangle. Again, walk around the classroom to observe the discussions within the table groups. Remember to avoid stop-thinking questions and proximity questions.	1. As students enter the classroom, they will pick a popsicle stick with a random number written on it. This number will dictate their table group number for the duration of the class. a. Students are to sit and wait until everyone in the class has found their groups. 2. One student from each table group will grab the materials from the middle table and bring them to their table. Students may start playing with the tape measure or the meter stick. Other students may start measuring anything they see on their table such as the chairs, the table itself, and so on. Some students may wonder about the clinometer since it might be a new tool for them and/or this is the first time they have seen one. Students may list down questions such as a. What are we doing? b. I wonder how this clinometer works. c. Are we measuring something? d. Are we doing some crafts e. Are we making shapes? f. Is this something about trigonometric ratios? g. Pythagorean theorem? *Students will have prior knowledge of the trigonometric ratios in this case. 3. As students observed the teacher drawing a right triangle on the board, more questions/discussions may arise: a. Are we measuring triangles? b. What is the side length of that triangle? c. Why is the teacher drawing a triangle? d. What is going on? e. Pythagorean Theorem!!! f. Trigonometric Ratios???

Development	
Teacher	**Student**
1. Bring the class together and ask what questions/discussions arise within their groups. a. “I have seen students measuring things, why is the first thing you did when you got the rulers to measure? I also heard something about side lengths, which are related to measuring. What about the side lengths? b. “I also heard some conversations about the Pythagorean theorem, and that is great because you might use it!” c. “Lastly, I heard some conversations about trigonometric ratios, and that will play a huge part in today’s lesson/activity.”	1. Students are discussing their findings/wonderings. Students may start to narrow down their discussion to just measuring triangles, the Pythagorean Theorem, trigonometric ratios, and so on. Make sure to acknowledge each student’s answers.
2. “We are going to have an outside activity today. Bring all the measuring tools, calculators, pencils, and paper. Show me what you can do with triangles and measuring materials provided for you. Show all of your findings on the paper. You will be working with your table groups so do not forget to write all the members’ names on the paper. a. “Before we go outside, I would like to show you how to use the clinometer. A clinometer is a tool used to measure the angle of inclination. In other words, the clinometer measures the angle from your eye level (which is 0 degrees) to the top of an object” b. Demonstrate with the whole class how to use the clinometer. Make sure the students understand how to use it. “Try measuring the angle from your eye level to the ceiling, what is the angle?” c. “There is this website that I can refer to on how to use the clinometer in case you need some refreshments while you	2. Students are listening to the instruction and demonstration of the clinometer. Students may start to wonder why they need to measure the angles when the Pythagorean Theorem accounts for the side lengths. Students may also wonder about the objects they want to measure outside the school after the clinometer demonstration.

are outside" (see below for the link)	
3. The teacher will observe the students outside, making sure they are staying within the school premises. a. If some students are getting the hang of their findings by measuring two side lengths, ask them "What if you can only figure out one side length? What would you do? What if the height of the object is out of your reach? What else could you do or use to find its height?" b. "I see that you are getting comfortable with this method of calculation, could you find ways to solve this differently?"	3. Students will go outside and walk around the school area. Students may use the light post, the flag pole, or even the school building to create right triangles. a. Students may also go smaller and use the yield sign, crossing sign, etc. b. Students will be documenting everything on their papers.
4. After meaningful minutes of activity, call everybody and return to the classroom. While walking back, ask each group to discuss their "best" findings to share with the whole class. As students get in their table groups and discuss, walk around the class and observe the discussions happening.	4. Students are returning to their classroom. In the classroom, students will sit on their table groups and discuss their findings. In the discussion, students will highlight their key findings, what they found out about measuring angles and finding the missing height, and so on.
5. Call each table group and have them discuss their findings. Students can talk about a. The things they measured b. How they measured it c. What they found interesting d. What difficulty do they face during the activity e. What did they do to overcome that difficulty f. ETC… *make sure to acknowledge their findings and reflect on them briefly before moving to the next table group.	5. Students will discuss their findings/research with the whole class.
Closure	
Teacher	**Student**
1. Collect the student's paper findings/research **2. Question for the students: "Some things you might want to think about**	

is what would these calculations look like on a graph? Experiment with right triangles and trigonometric ratios. Do you see any pattern? What can you say about Pythagorean Theorem and Trigonometric ratios? Are there any similarities that you see? Any difference? **Answer one of these or all of them, and show me your findings for the next class.**	

Needed Materials List

1. **Meter stick**
2. **Tape measure**
3. **Clinometer**
4. **Protractor**
5. **Pencil**
6. **Paper**
7. **Calculator**

Attachments

References

https://www.instructables.com/Using-a-clinometer-to-measure-height/