COURSE DESIGN STRUCTURE FOR E-SELF LEARNING & LESSON PLANNING

CASIO-MODERN TEACHING

OCTOBER 10, 2022

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Overview

With technology integration nowadays and the exposure of modern teaching pedagogies, Education is facing a drastic change from shifting to teacher centered learning to student centered learning. As teachers in the current educational schemes are known as facilitators to guide students in their learning process. Aligned with these changes, self-learning courses known as e-learning has migrated to education and played a vital role on the impact of our students learning development.

For all of these terminologies and ideas being exposed, Bloom's Taxonomy comes as an in indicator of students' cognition in lessons and courses. For this ideology, the aim is to shift students from lower-order thinking skills to only remember, understand, and apply to a higher order thinking skills to be able to analyze, evaluate and create (Figure 1).

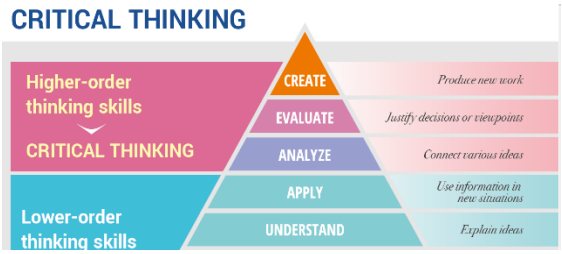


Figure 1: https://edu.casio.com/forteachers/math_education/

In this course design, we will be implementing a course structure aligned with modern teaching skills and pedagogies. This scheme will provide teachers a roadmap to create their own self-training courses. Moreover, it will be focusing on implementing new teaching strategies and ideas for more engagement of students in their self-learning process.

Furthermore, the course design will focus on differentiating resources and guidelines for students according to their levels. Accordingly, students will be able to achieve the same learning outcomes with different learning styles. Additionally, we will be focusing on assessments as a benchmark for students' progress and evaluations.

Finally, and to link self-training courses to classroom activities, we also provided samples of lesson planning that teachers could follow in their classroom, besides some extra activities for more students' engagements.

For a better representation of the course structure we will be demonstrating a course design sample targeting Trigonometric Functions.

Main Learning Objectives / Goals

In every Course, Specifying the Main Objectives or Goals is very essential, as students should know what is the purpose of this course and what they are going to learn through the process.

It also better to start your course objectives with stating that by the end of the course, students will be able to: ……

For our chosen sample course (Trigonometric Functions), the main objectives / goals that students will be able to achieve are:

Sample

1) Evaluate Trigonometric Functions.
2) Differentiate Between the 6 Trigonometric Ratios.
3) Analyze the Measures of Angles and Sides.
4) Discover Different Angles Measures.
5) Link Trigonometric Functions to Real Life Situations.
6) Determine Trigonometric Ratios Geometrically.

Breakdown of the Course into Lessons

For students to be able to fulfil the main objectives of any course, it is easier for them to start by completing smaller tasks in order to build up their knowledge and to meet the main course objectives. So it is recommended to break down the course into lessons in which a student can achieve the learning outcome of each of them. Once students complete the whole lessons, automatically they will be targeting the main goals.

In our sample course chosen, we would breakdown it down to 6 lessons in the following manner:

Sample

Lesson1: Trigonometric Functions and Acute Angles.
Lesson2: Angles and the Unit Circle.
Lesson3: Trigonometric Functions and Real Numbers.
Lesson4: Graphing Sine and Cosine Functions.
Lesson5: Graphing Other Trigonometric Functions.
Lesson6: Translating Trigonometric Functions.

Lesson 1

Before directly tackling the first lesson, it is very important for teachers to plan a lesson including the following points:

i. Lesson Essential Question.
ii. Lesson Vocabulary.
iii. Lesson Learning Outcomes.
iv. Lesson Pre-Assessment.
v. Lesson Differentiation.
vi. Lesson Explanations and More Resources.
vii. Lesson Post / Formative Assessments.
viii. Lesson Overview.

Throughout our course design structure we will be discussing each idea in details and providing samples for our chosen topic for each mentioned point. As mentioned earlier, Lesson 1 would be about Trigonometric Functions and Acute Angles. For this Lesson we would be applying the above mentioned points:

i. Essential Question:

Sample

How can ratios of lengths of sides within right triangles help determine other lengths and angle measures in the triangles?

ii. Lesson Vocabulary:

Sample

- Cofunction
- Cofunction Identities
- Cosecant
- Cosine
- Cotangent
- Reciprocal Trigonometric Functions
- Secant
- Sine
- Tangent

iii. For the Learning Outcomes of this Lesson students will be able to:

Sample

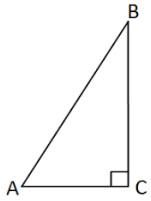
- Use special triangles to determine trigonometric ratios geometrically.
- Use trigonometric functions and the Pythagorean Theorem to find missing side lengths.
- Identify and explain trigonometric identities.

iv. Pre-Assessment:

Pre-assessment is very important for teachers as an essential tool to gather key information about what students know and are able to do prior to instructions, as well as what student interests and learning styles are. Note that a pre-assessment is not necessarily a group of questions, it could be also an activity.

Sample

Answer the following questions for the following figure:

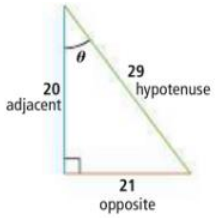


1) Which side of the triangle is the hypotenuse?
2) Which side of the triangle is opposite to <A?
3) Which side of the triangle is adjacent to <A?
4) We can use SOH-CAH-TOA for which type of triangles?
5) What is the ratio for tangent?
6) What is the ratio for cosine?
7) What is the ratio for sine?
8) …
9) …

v. Differentiation:

Differentiation is a technique in modern teaching to deliver the same learning outcome for all students of deferent levels. Differentiated teaching occurs when a teacher plans a lesson that adjusts either the content being discussed, the process used to learn or the product expected from students to ensure that learners at different starting points can receive the instruction they need to grow and succeed. In education we have mainly 3 types of students categorized as low achievers, middle achievers, and high achievers. Accordingly, any lesson could be differentiated to fit the needs for all students. Taking into consideration the pre-assessment done, the course could navigate students automatically in this particular lesson to their level, or teachers can assign each students to a particular Group.
Our lesson could be differentiated in the following manner:

Sample

Group 1 (Low Achievers) Note: Do not mention to students neither their level nor what does these groups mean in the course.
Task 1: (Note: Use your **calculators**) Given these equations: $1)\ \sin 55° = \frac{15}{x}$ $2)\ \tan 40° = \frac{x}{4}$ a) Solve each equation for x. (Round your answers to the nearest tenth). b) What do you have to do when x is in the denominator? c) If x is in the numerator, how do you solve the equation? d) What do you think x represents in this situation? Why?
Task 2: SOH-CAH-TOA S: sine, O: opposite, H: hypotenuse C: cosine, A: adjacent, H:hypotense T: tangent, O: opposite, A: adjacent    Using these labels as ratios to find the sine, cosine, and tangent of the following figure. Write your answers as simplified fractions then convert to decimals and round your answers to the nearest tenth using your **calculators**.
Task 3: …
Task n: …

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Sample

Group 2 (Middle Achievers) Note: Do not mention to students neither their level nor what does these groups mean in the course.

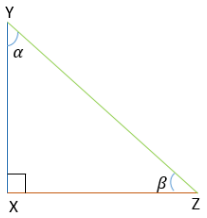
Task 1:

Use the following figure and SOH-CAH-TOA ratios to fill the following table:

S: sine, O: opposite, H: hypotenuse

C: cosine, A: adjacent, H:hypotense

T: tangent, O: opposite, A: adjacent



Note: Use your **calculators** to write your answers in fractions in simplified form.

$\sin\alpha = \frac{16}{34}$	$\cos\alpha = \frac{30}{34}$	$\sin\beta = \frac{25}{65}$	$\cos\beta = \frac{72}{78}$
$\cos\beta = ?$	$\sin\beta = ?$	$\cos\alpha = ?$	$\sin\alpha = ?$

a) Fill the table. What can you deduce from the results?
b) Are the two angles complementary? Why?
c) What relation between the two angles can be drawn?
[Note that what you found is called cofunction identities)

Task 2:

Fill the following table:

Note: Use your **calculators** for your calculations.

$\sin\theta = \frac{8}{17}$	$\cos\theta = \frac{15}{17}$	$\tan\theta = \frac{8}{15}$
$\csc\theta = \frac{17}{8}$	$\sec\theta = \frac{1}{\cos\theta} = ?$	$\cot\theta = ?$

a) What can you deduce?
b) Write the six trigonometric formulas?

Task 3:

Complete the following table by using your **calculators**.

Hypotenuse	Hypotenuse Square	Long Side	Long Side Square	Short Side	Short Side Square	Long Side Square+ Short Side Square
13	$13^2 = ?$	**12**	$12^2 = ?$	**5**	$5^2 = ?$	$12^2 + 5^2 = ?$
10	?	**8**	?	**6**	?	?
$\sqrt{\mathbf{113}}$	?	**8**	?	**7**	?	?

a) What conclusion can you draw?
[Note that what you found is called Pythagorean theorem]

Task n: …

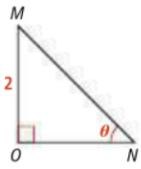
Sample

Group 3 (High Achievers) Note: Do not mention to students neither their level nor what does these groups mean in the course.

Task 1:

1) Do your research to state the six trigonometric ratios?
2) What do they mean?

Task 2:

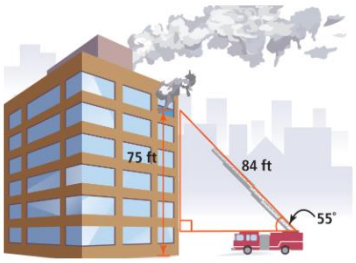


△ Triangle MNO is a $45° - 45° - 90°$ triangle with side length OM=2. What are the six trigonometric ratios for angle N with measureθ ?

Note: Use your **calculator** for your calculations and keep fractions in simplified form.

Task 3:

A fire truck has an 84ft ladder extended against a building forming a $55°$ angle with the top of the truck. The truck is 8ft tall. The firefighters are trying to reach a window that is 75ft above the ground. Will they be able to reach the window using the ladder set at this angle?

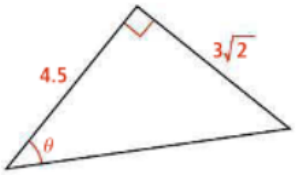


Note: Make sure your **calculator** is set to Degrees in your calculations.

Task 4:

(Note: Use your **calculators**)

Use the right triangle with the given rational and irrational side lengths.



Q: Write the six trigonometric functions for the right triangle. Round to the nearest hundredth.

Q: Why is it helpful to evaluate the trigonometric functions using decimals to the nearest hundredth?

Q: Why is it helpful to evaluate the trigonometric functions using decimals to the nearest hundredth?

Task 5: …

Task n: …

With all these samples, please make sure that you always include real-life applications and simulations to all students no matter what their level is. Moreover, and as specified in all groups, calculator usage is a must to trigger independent learning for students, as it is also considered a supportive tool in each and every learning environment. Furthermore, though the number of tasks may differ between these levels, the main objective should be maintained for all students to complete all learning objectives.

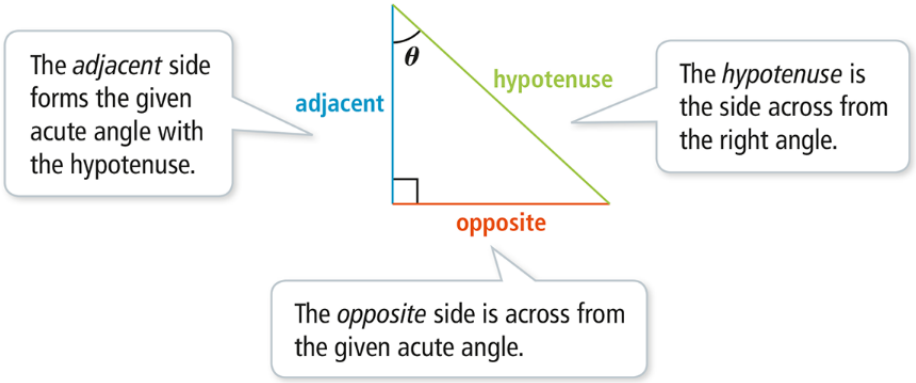
Explanation and More Resources:

The lesson is explained at this stage after students had done did their independent learning practice. Teachers could now provide through their online lesson a detailed step by step explanation of the lesson, and support with more resources. Keep in mind that student should always be provided with extra resources and material to read on their own so they can regularly practice independent learning to develop their critical thinking, analytical and evaluative skills.

Sample

Concept of Trigonometric Ratios:

Any right triangle has three sides referred as Hypothesis (the longest leg facing the 90°) and the other two legs. (Known as the long and short legs).
The Greek letter/symbol θ known and read as (theta), is often used to represent acute angles in right triangles. Knowing that the angle θ is a shortcut for: An angle with measure θ.



There are six basic trigonometric functions of the angle θ:

Sine
$$\sin\theta = \frac{opposite}{hypotenus}$$

Cosine
$$\cos\theta = \frac{adjacent}{hypotenus}$$

Tangent
$$\tan\theta = \frac{opposite}{adjacent}$$

The reciprocal trigonometric functions of the angle θ are formed by exchanging the terms in each ratio.

Cosecant
$$\csc\theta = \frac{hypotenus}{opposite}$$

Secant
$$\sec\theta = \frac{hypotenus}{adjacent}$$

Cotangent
$$\cot\theta = \frac{adjacent}{opposite}$$

More Resources Sample: https://www.youtube.com/watch?v=vFPwFAOM6tI
Resources not only could be videos, but also simulations, documents, etc.

Explain Trigonometric Identities:

A. Which Trigonometric Ratios are reciprocals of each other?

An identity is an equation that is true for all values of the variable for which all expressions in the equation are defined. You have seen that some trigonometric functions include ratios that are reciprocals.

One example:

$$sin\ \theta = \frac{opposite}{hypotenuse} \qquad \csc\theta = \frac{hypotenuse}{opposite}$$

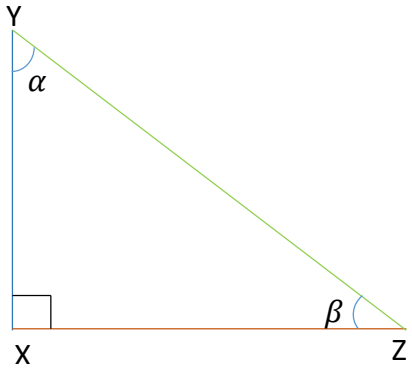
Show that the following reciprocal identity is true for all values of θ that measure an acute angle: $sin\ \theta = \frac{1}{\csc\theta}$

Confirm that the equation is true algebraically by using substitution:

$$sin\ \theta = \frac{1}{\csc\theta} = \frac{1}{(\frac{hypotenuse}{opposite})} = \frac{opposite}{hypotenus}$$

Sample

B. How are the trigonometric ratios of the two non-right angles in a right triangle related to each other?



α and β are complementary angles.
$\alpha + \beta = 90°, so$
$\alpha = 90° - \beta$
$\beta = 90° - \alpha$
(The Greek Letters α(alpha) and β (beta) are often used to represent angles in trigonometry.

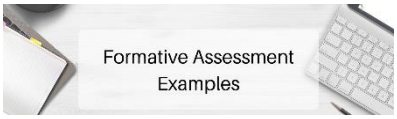
Compare sine and cosine forα and β:

$$\sin\alpha = \frac{ZX}{YZ} \quad \sin\beta = \frac{XY}{YZ}$$

$$\cos\alpha = \frac{XY}{YZ} \quad \cos\beta = \frac{ZX}{YZ}$$

If $\beta = 90° - \alpha$, then $\sin\alpha = \cos\beta$ and $\cos\alpha = \sin\beta$.
The trigonometric function for the complement of an angle is called a cofunction, so these are the cofunction identities for sine and cosine.

vi. Post/Formative Assessments:

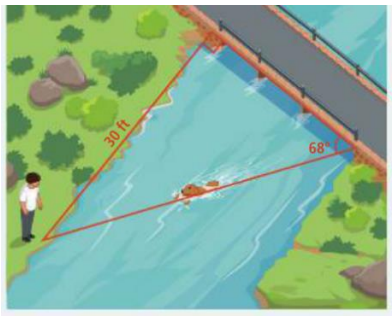


In this section, the lesson ends and it's time to assess students work. Keep in mind that no matter how the instructions are differentiated as discussed in the differentiation section above, all students should achieve the same learning outcomes. It is only different in the approach. Furthermore, this means that all students should be able at this level to answer the post or formative assessment questions. Below is a sample:

Sample

1) Mike's dog jumped into a stream at a $68°$ angle from the corner of a bridge. Mike crossed the bridge and walked downstream to meet the dog.

Part A: How long is the bridge, in feet?
Part B: How many feet did the dog swim?



Note: Use your **calculators.**

2) Match each trigonometric ratio in the left column with its reciprocal expression in the right column.

a) $\sin\theta$	$A.\ \frac{1}{\cos\theta}$
b) $\sec\theta$	$B.\ \frac{1}{\sin\theta}$
c) $\tan\theta$	$C.\ \frac{1}{\cot\theta}$
d) $\cos\theta$	$D.\ \frac{1}{\sec\theta}$
e) $\csc\theta$	$E.\ \frac{1}{\tan\theta}$
f) $\cot\theta$	$F.\ \frac{1}{\csc\theta}$

vii. Lesson Overview:

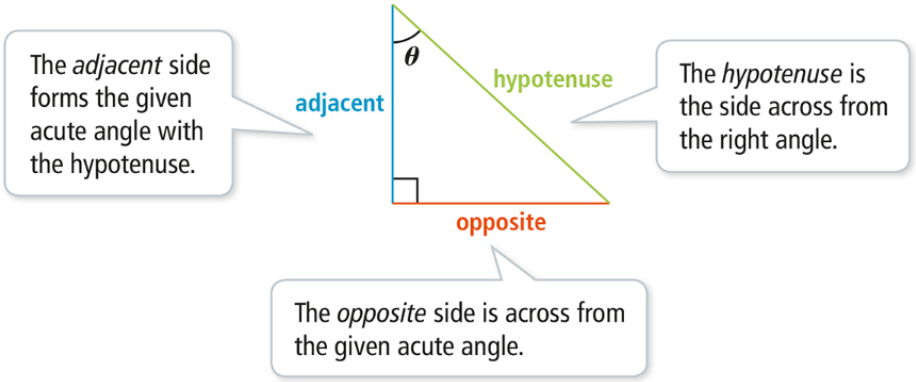
overview

The lesson now concludes with an overview for students to refresh their knowledge and highlight the main points. Below is our sample:

Sample

Words: The ratios of the sides of any right triangle are always the same for a given angle θ. These ratios define the six trigonometric functions.

Definitions:



Sine $\sin\theta = \frac{\text{opposite}}{\text{hypotenuse}}$	Cosine $\cos\theta = \frac{\text{adjacent}}{\text{hypotenuse}}$	Tangent $\tan\theta = \frac{\text{opposite}}{\text{adjacent}}$
Cosecant $\csc\theta = \frac{\text{hypotenuse}}{\text{opposite}}$	Secant $\sec\theta = \frac{\text{hypotenuse}}{\text{adjacent}}$	Cotangent $\cot\theta = \frac{\text{adjacent}}{\text{opposite}}$

Teachers can summarize all key points in this section and provide a clear overview for all ideas in the lesson as well as it is beneficial to remind students on the learning outcomes and course objectives.

Lesson 2, 3….n

For the remaining lessons, the teacher should follow the same structure and points discussed above.

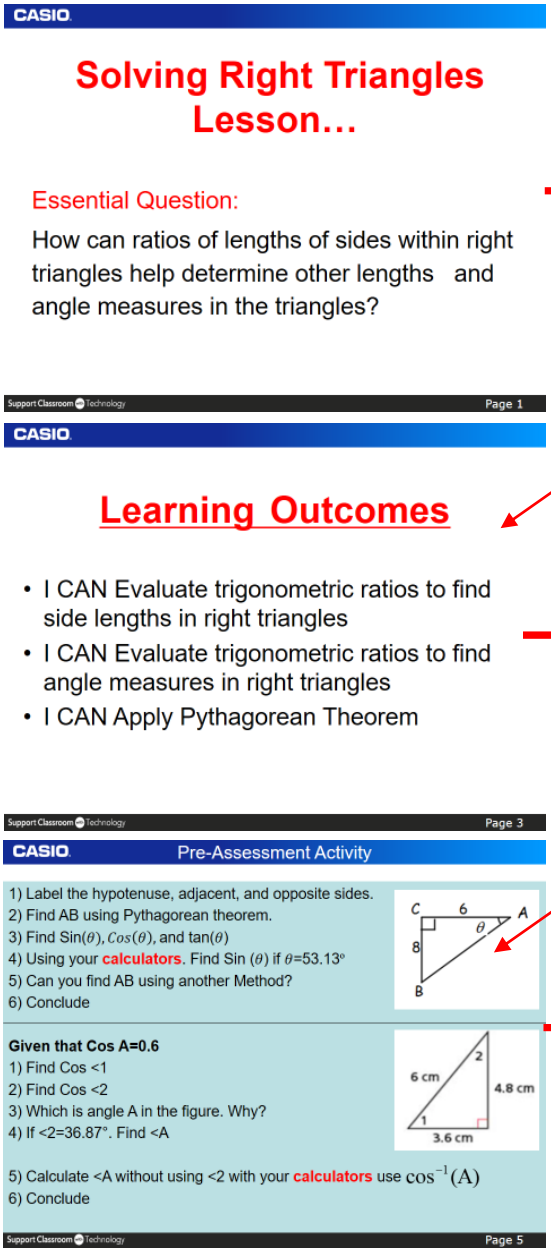
Evaluate Course Effectiveness

In this section, we discuss the importance of course effectiveness as teachers needs to assess the impact of their self-training/learning course. There are various ways to do that, it could be either by analyzing students' performance in the whole course, or even surveying students to ask about difficulties and challenges they faced during the course flow in order to do the required modifications according to their needs. Moreover, external exams could be also a benchmark for the course effectiveness. With all these scenarios, teachers should be able to evaluate the influence of their course on the learning progress of their students.

Additionally, teachers can also reflect the course training strategies in classrooms, as they can follow the same criteria to raise the bar and standards for students critical thinking, at the same time they would train their students on these new methodologies, and encourage them always for independent learning and self-paced studying. Not to forget that the aim is always to practice new teaching methodologies and pedagogies weather in online courses or in classrooms.

Sample Lesson Plan for Classroom Teaching Aligned with the Course Design

In this part, we will be projecting our course design to classrooms, as teachers and part of the modern teaching pedagogies can easily reflect and implement this course criteria in classrooms to be aligned with it. However, it may differ in the type of activities as interactions occur between teachers and students, which creates more room for communication. Below is a sample presentation on solving right triangles assuming that students at this point only know the 6 trigonometric ratios from a previous lesson!



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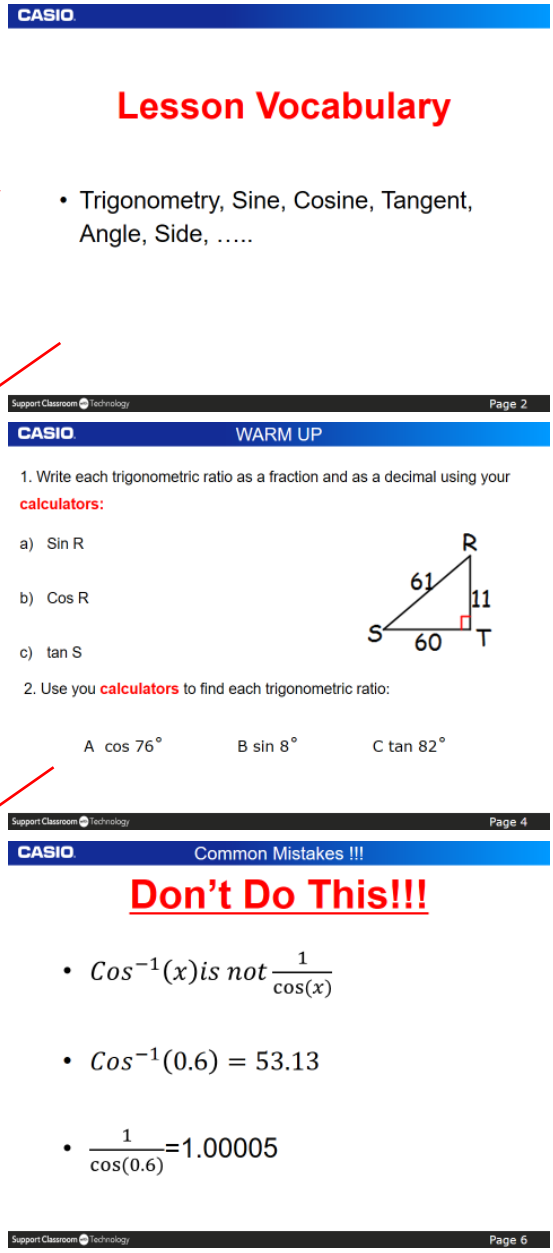
Solving Right Triangles Lesson…

Essential Question:

How can ratios of lengths of sides within right triangles help determine other lengths and angle measures in the triangles?



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Lesson Vocabulary

- Trigonometry, Sine, Cosine, Tangent, Angle, Side, …..

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Learning Outcomes

- I CAN Evaluate trigonometric ratios to find side lengths in right triangles
- I CAN Evaluate trigonometric ratios to find angle measures in right triangles
- I CAN Apply Pythagorean Theorem

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CASIO WARM UP

1. Write each trigonometric ratio as a fraction and as a decimal using your **calculators:**

a) Sin R

b) Cos R

c) tan S

2. Use you **calculators** to find each trigonometric ratio:

A cos 76° B sin 8° C tan 82°

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CASIO Pre-Assessment Activity

1) Label the hypotenuse, adjacent, and opposite sides.
2) Find AB using Pythagorean theorem.
3) Find Sin(θ), $Cos(\theta)$, and tan(θ)
4) Using your **calculators**. Find Sin (θ) if θ=53.13°
5) Can you find AB using another Method?
6) Conclude

Given that Cos A=0.6
1) Find Cos <1
2) Find Cos <2
3) Which is angle A in the figure. Why?
4) If <2=36.87°. Find <A

5) Calculate <A without using <2 with your **calculators** use $\cos^{-1}(A)$
6) Conclude

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CASIO Common Mistakes !!!

Don't Do This!!!

- $Cos^{-1}(x) is\ not \frac{1}{\cos(x)}$
- $Cos^{-1}(0.6) = 53.13$
- $\frac{1}{\cos(0.6)}$=1.00005

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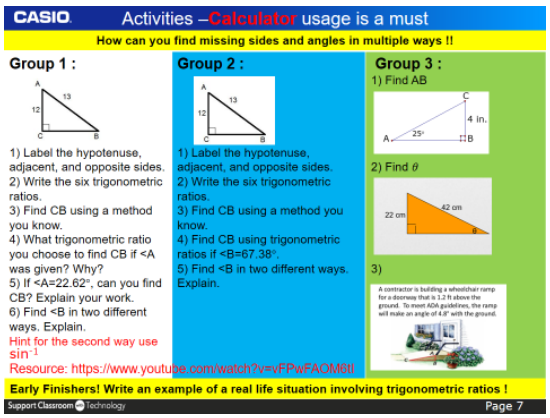
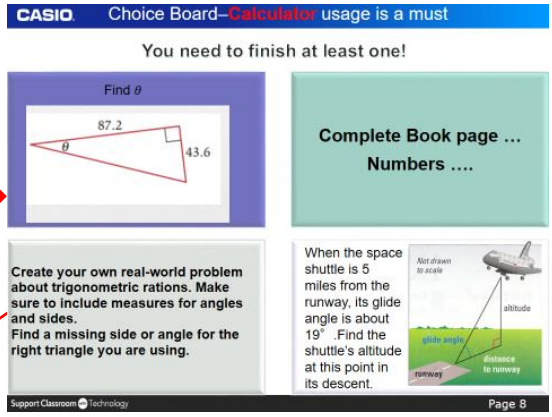
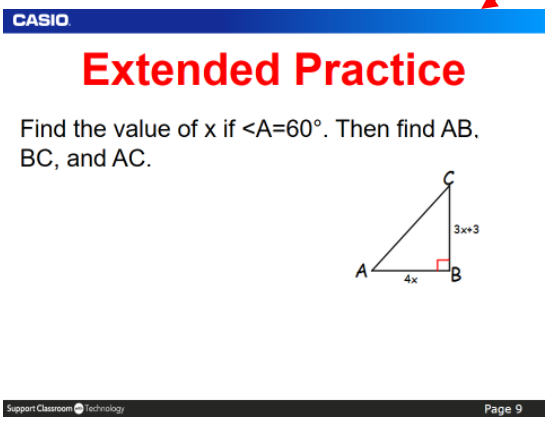
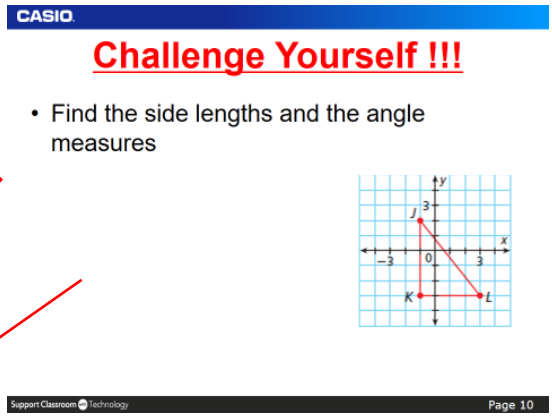
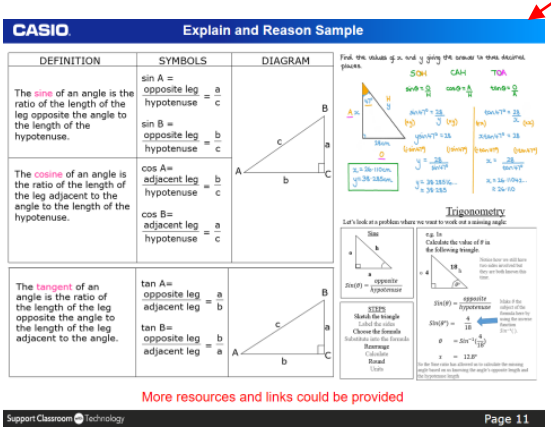
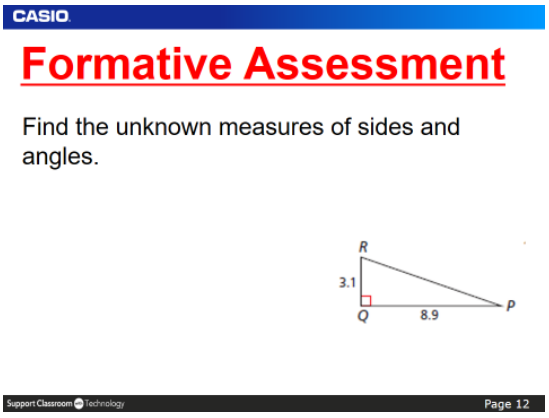












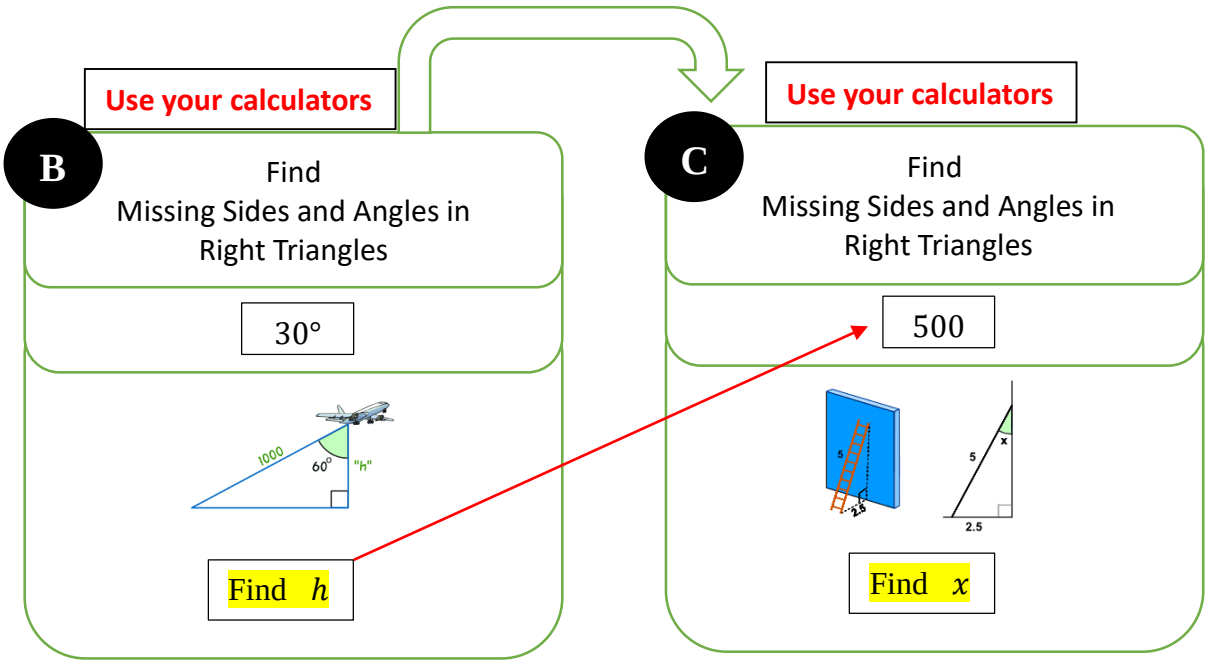
In this sample lesson plan, we followed the same criteria of the course plan and structure, however, in classrooms teachers can provide more differentiation as a new idea is introduced known as a choice-board where students can chose their own task to complete. Additionally, teachers can manually assign students to groups not only based on the pre-assessment, but also based on the prior knowledge of each student level. Furthermore, some warm up activities could be addressed and additional extended practices and challenges are also parts of students' critical thinking.

Enriching Learning with Activities

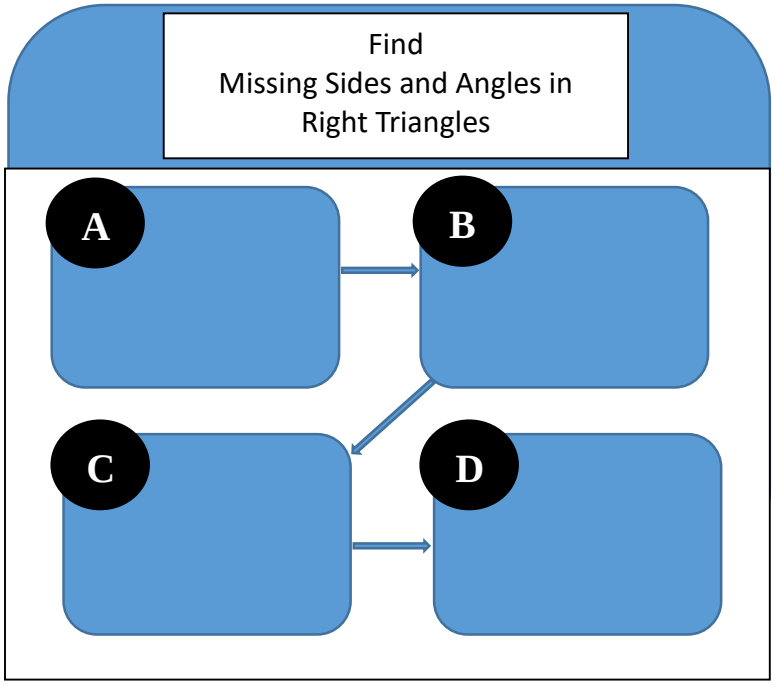
In this section, we will be providing some outdoor activities that also could be utilized in teaching. We already saw some activities conducted inside classrooms in the previous section, however, it is always useful to integrate additional fun activities for the wellbeing of students. By heading outside and learning in nature, kids improve their emotional, intellectual, and behavioral development. Outdoor learning helps foster the development of creativity, problem-solving, independence, and confidence.

One of the samples we provide is named Scavenger Hunt. Students work in groups to solve mathematics problems posted on station cards. They start at any station card and solve the problem posted on the bottom of it. Noting that these stations could be anywhere outside the classroom (mainly green fields). Once they solve the problem, they find another station card posted around the field with that solution located on the top of it. This new station card also includes another problem to solve (on the bottom half of the card) then find the station card with that answer on it. If students solve all of the problems correctly, they'll move from station to station, then end back up at the station they started at.

Each student group can start at a different station and will move through the same loop of stations simultaneously. Note that students can use their **calculators** as a supportive technological tool in any activity in which technology, activities, and group work are all integrated in one scheme. Below is an example:



Some teachers have students record all of their work on a recording sheet that might look something like this.



This is another example of a different kind of scavenger hunt that also could be implemented outdoors where students link ideas to real life and need to search for geometric items.

Mathematics

Mathematical Scavenger Hunt

How many of the following can you find?

Shapes
A Square
A Cuboid
A Sphere
Triangles
Equilateral (3-sides equal)
.....

As a conclusion, the aim for all of these strategies and criteria is to deliver an outstanding course involving activities, differentiation, technology, and modern teaching methodologies. Teachers are always free to adjust and modify the content and activities based on their classes. Meanwhile students should always be encouraged for independent learning and self-training mentality as nowadays critical thinking and thinking outside the box is the key for a student success. Finally, calculators are the essential tools in such a learning scheme in which with technology, independent learning, critical thinking, and modern teaching pedagogies, "Education and teaching is at a different level now" with CASIO.