Teacher: Panagiotis PAPADOPOULOS
Subject: Mathematics

Title: Exploring the Pythagorean Theorem through Computational Thinking	**Time: 45 minutes**
Subject*: Mathematics*	
Aims: Students will understand and apply the Pythagorean Theorem through the lens of computational thinking, focusing on the four principles: decomposition, pattern recognition, abstraction, and algorithm design.	
Key CS elements: Decomposition; Pattern recognition; Abstraction; Algorithm design.	
Age group: 13-14 years old	
Learning situations: classroom, IT lab	**Activity type:** analysis

Resources:

1. Whiteboard and markers
2. Computers or tablets with internet access
3. Pythagorean Theorem worksheet
4. Scratch or another block-based programming platform (optional)

Learning development:

Problem definition:

Introduction (15 minutes):

- Begin by reviewing the basics of the Pythagorean Theorem: $a^2 + b^2 = c^2$, where "a" and "b" are the legs of a right-angled triangle, and "c" is the hypotenuse.
- Discuss real-world applications of the Pythagorean Theorem, such as calculating distances or designing structures.For instance, finding the distance between two points on a map or determining the length of a ladder needed to reach a certain height.
- Introduce the four principles of computational thinking: decomposition, pattern recognition, abstraction, and algorithm design.

1. Decomposition:

- In the beginning they should understand what a right triangle is
- A right triangle has a hypotenuse opposite the right angle
- It has two sides adjacent to the hypotenuse whose sum of their angles is also 90 degrees
- Question: Is there any relation between the two adjacent sides and the hypotenuse?
- The main task is to find the length of the hypotenuse (c) of a right-angled triangle using the Pythagorean Theorem ($a^2+b^2=c^2$)

2. Pattern Recognition:

- Discuss common patterns that emerge from the different approaches.
- Emphasize the connection between the patterns and the Pythagorean Theorem.
- Ask students to identify specific instances where pattern recognition is useful in problem-solving.
- Pattern: Students may observe that the Pythagorean Theorem involves squaring the lengths of the two shorter sides (legs) and adding them together to get the square of the hypotenuse. In this phase they should square the two adjacent sides add them together and compare it with the square of the hypothenuse. What do they notice?

In the next face let them square the lengths of ordinary triangles and compare the sum of the two squares of the two adjacent side with the square of the largest side. Is the sum equal?

What do they conclude?

- Recognition: Recognizing this pattern is crucial because it helps students identify a consistent mathematical operation applied to the sides of any right-angled triangle. It establishes a pattern that extends beyond specific examples and contributes to the general formula $a^2 + b^2 = c^2$.
- Pattern: Students may notice that there are certain sets of whole numbers, known as Pythagorean triplets, which satisfy the Pythagorean Theorem without the need for complex calculations. For example, (3, 4, 5) or (5, 12, 13).
- Recognition: Identifying these triplets as a pattern helps students see that not all combinations of side lengths are valid, but specific sets follow a consistent rule. This recognition aids in understanding that the relationship between side lengths is not arbitrary and provides a shortcut for verifying whether a given set of numbers forms a right-angled triangle without going through the computation of $a^2 + b^2 = c^2$.

3. Abstractions:

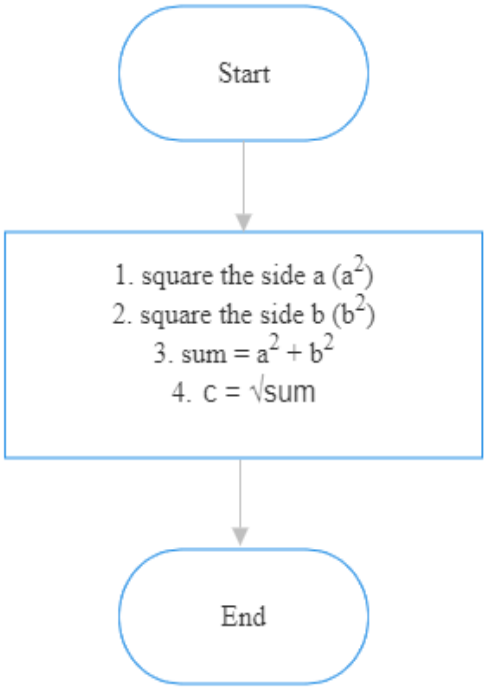
- Introduce the concept of abstraction by discussing how the Pythagorean Theorem is an abstraction of the relationship between the sides of a right-angled triangle.
  - Representing the Pythagorean Theorem using symbols and variables rather than specific numbers. For instance, instead of dealing with specific side lengths, use the variables *a*, *b*, and *c* to denote the sides of a right-angled triangle.
  - By abstracting the theorem into symbolic form ($a^2+b^2=c^2$), students can see the general relationship between the sides without being limited to specific numerical values. This abstraction allows for a more universal understanding, applicable to a wide range of triangles.

- Discuss the advantages of abstraction in problem-solving and its role in making complex ideas more manageable. I.e. reading the map of a town (focus only on the essential parts i.e. streets)

4. Algorithm design

Encourage students to create an algorithm, flowchart or diagram that visually represents the steps involved in finding the hypotenuse. Each step should be clearly defined and connected to the next.

Step1: Squaring the length of one side (a^2).
Step2: Squaring the length of the other side (b^2).
Step3: Adding the two squared values.
Step4: Taking the square root of the sum to find the length of the hypotenuse (c).



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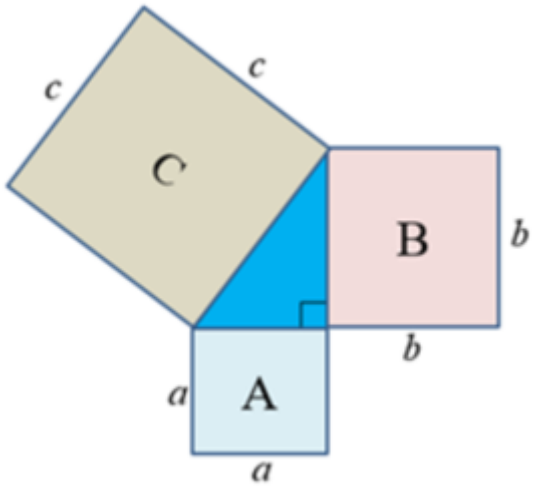

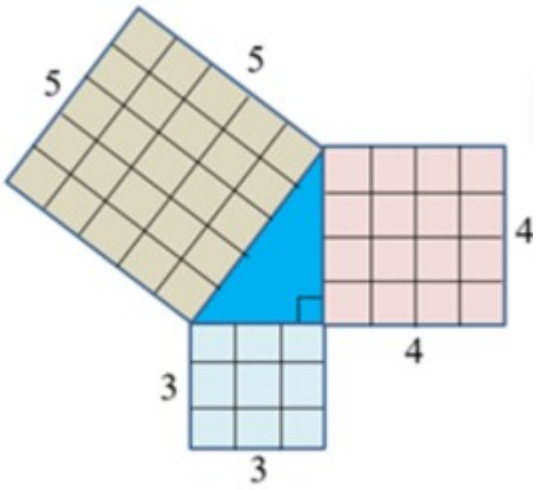

Area A + Area B = Area C
$a^2 + b^2 = c^2$

$3^2 + 4^2 = 5^2$
$9 + 16 = 25$

Assessment Test:

Part 1: Multiple Choice

1. What is the Pythagorean theorem?
   a) $a^2+b^2=c^2$
   b) $a^2-b^2=c^2$
   c) $a+b=c$
   d) $a^2+b=c^2$

2. In a right-angled triangle, the hypotenuse is:
   a) The longest side
   b) The shortest side
   c) The side opposite the smallest angle
   d) One of the two shorter sides

3. If a triangle has sides 3, 4, and 5, is it a right-angled triangle?
   a) Yes
   b) No
   c) Not enough information
   d) Only if the angle is 90 degrees

Part 2: Short Answer

4. Calculate the length of the hypotenuse in a right-angled triangle where the other two sides are 6 cm and 8 cm.
5. If the hypotenuse of a right-angled triangle is 13 cm and one of the shorter sides is 5 cm, find the length of the other side.

Part 3: True or False (2 points each)

6. The Pythagorean theorem only works for right-angled triangles.
    - True / False
7. In any triangle, $a^2+b^2=c^2$.
    - True / False
8. You can use the Pythagorean theorem to find the area of any shape.
    - True / False

Part 4: Application

9. You are building a ramp for a skateboard. The base of the ramp is 9 meters long, and the height is 12 meters. What is the length of the slanted (inclined) side of the ramp? (Hint: Use the Pythagorean theorem.)

Expected results: By the end of the lesson, students should be able to decompose a right-angled triangle problem, recognize patterns in side lengths, abstract the Pythagorean theorem to various contexts, and follow an algorithmic process to apply it effectively. They will have improved problem-solving skills and a deeper understanding of geometric relationships.

Note: