

Build a Strong Bridge and House!

Introduction	In this project, learners will explore properties of triangles (angles, sides, types, outer angle, median, height, right angle triangle etc) and solve a real-life problem structure of strong bridge or strong house. Learners will work in groups to design, measure, calculate and build. This process deepens mathematical knowledge and builds observation, problem-solving, teamwork and presentation skills.
Main Question	"Can we use the properties of triangles to make such a bridge or house which is balanced, strong and proven by maths?"
Lesson (Number and Name)	Lesson 6 – A Tale of Three Intersecting Lines
Expected Time	5 days in class, 40 minutes each day At home 4 days, 10-20 minutes each day
Materials Required	Sketch pen, chart paper, scale, protractor, colour paper, sticker, thermocol / cardboard, straw, measuring tape, scissors, glue, graph paper / slanted paper, inspiring pictures of triangle designs, projector/picture flashcard (if possible)
Learning Outcomes	By the end of this project, learners will be able to: Knowledge-based Outcomes: 1. Classify triangles based on sides (equilateral, isosceles, scalene) and angles (acute, right, obtuse). 2. Calculate the third angle of a triangle when two angles are given, using the angle sum property. 3. Apply the exterior angle property of a triangle to find unknown angles. 4. Identify and draw the median and altitude of a triangle. 5. Apply the triangle inequality rule to check whether a triangle can be formed with given side lengths. 6. Understand the concept of congruency of triangles. 21st Century Skill Outcomes: 1. Collaborate in groups to design, build, and present a model. 2. Evaluate design choices and argue for the most suitable triangle type. 3. Communicate findings clearly through a model and verbal presentation. 4. Create an original structure using mathematical reasoning.
Suggestions for Teachers (Under national level learning standards to achieve the given curriculum goals and related skills)	1. All teachers should see the content and plan for each day before the class starts. 2. Inform learners one day in advance about the materials not available in school for that day so that they can bring them the next day. 3. Before starting, divide all learners into groups so that they can do group work, experiment or any other activity in the group only. Make sure groups are always mixed and inclusive (with learners of all genders and all levels). 4. Create a creative and collaborative environment for learning in the classroom. 5. After the project ends, make the groups discuss the questions given in the textbook and ask them to write their answers individually.

Day 1

Learners will identify types of triangles by their sides and angles and connect triangle properties to real-world structures seen in Nagaland.

Teaching Material	Sketch pen, scale, grid sheet or A4 paper, straw/ thin wooden sticks, thread/ fevicol, scale
Time	Activities and Details
5 minutes	<u>Inspiring Hook Activity:</u> "Search for Strength: Triangle versus Quadrilateral." The teacher will narrate the following story: Imagine that in your village two friends Aki and Mimi are making their own houses. Aki made his house roof in a quadrilateral/rectangular shape, and Mimi made it a triangle. Suddenly a storm comes, strong wind blows... Now think, whose roof will be stronger? And whose house will shake or fall? And why?

Flashcard activity: The teacher can show four picture cards



1. A house whose roof is quadrilateral
2. A house whose roof is a triangle – standing strong.
3. An iron bridge with a triangle truss structure.
4. Construction site where workers are making triangle structures.

Ask the learners -

- Have you ever seen triangles in any bridge, roof, or window grill?
- What do you think about why engineers and builders often use triangles?
- If you make a tent or swing yourself, will you make a triangle in it or a quadrilateral?

The teacher will explain:

“Today, we will understand how a triangle is the strongest geometric shape and how it will help in our building and design work in class!” (For this you can also see the video given here.)

15 minutes

Group Activity: ‘Our Triangle Design:

Fun start – Pick chit, get a mission!

The teacher says, “Let’s begin the class with a small game”.

- The teacher keeps a basket with 4 folded chits (small papers).
- 2 chits say “Build Bridge (Bridge Builder)”
- 2 chits say “Build House (House Designer)”

What learners do:

- One member from each group picks one chit randomly from the basket.
- The chit they pick becomes their group’s **mission**.
- Every group makes one triangle design to complete their mission.

What it means:

- If they pick *Bridge Builder* → they will do an activity related to building a bridge.
- If they pick *House Designer* → they will do an activity related to building a house.



Before design – think a little, discuss a little!

The teacher says, “Buildings or bridges become strong only when their base and structure are balanced. What shapes have you seen in old iron bridges? Or what shapes are seen in house roofs?”

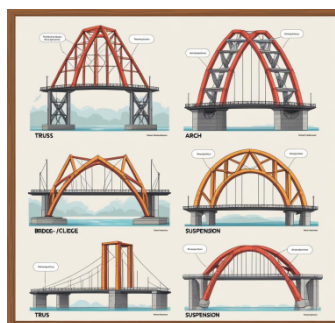
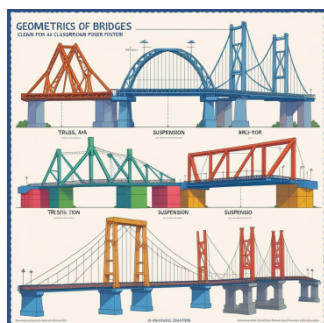
Discussion points -

- In which places have you seen the use of triangles?
- Why do you think triangles are often used in bridges or roofs?
- If two triangles are joined, what shape is made?
- Are all triangles the same?

After discussion, expected work -

- One clean, labelled sketch with at least 3 triangles.
- Do naming of triangles (like: Triangle A, B, C).
- Write direction of angles and estimated measures (example: 90° , 60° , etc).

Show roof, support beam, building structure, etc., in the sketch.



Questions for group discussion:

- Which triangles are in our design and why?
- Can we join two triangles to make a strong frame?
- If one angle is 90° , what will be the guess for other angles?
- Why is our design strong?

Teacher Observation During Group Visit: While moving around the groups, the teacher should observe whether learners are:

- able to identify types of triangles?
- making a strategy by thinking before design?
- thinking creatively and practically?

10 minutes

Teacher says:

Come today, we make our understanding of triangles strong. We will also explore different types of triangles.

The triangle is the most basic closed shape. As we know, it is made of the following:

- Three corner points, which we call the vertices of the triangle, and
- Three line segments or sides, which join the pairs of these vertices.

Classification of a Triangle based on Sides	
Type	Details
Equilateral Triangle	All three sides are equal.
Isosceles Triangle	Two sides are equal.
Scalene Triangle	All three sides are different.

	<table><tr><th colspan="2">Classification of a Triangle based on Angles</th></tr><tr><th>Type</th><th>Details</th></tr><tr><td>Acute Angle Triangle</td><td>All its angles are less than 90°.</td></tr><tr><td>Right Angle Triangle</td><td>It has one angle of 90°.</td></tr><tr><td>Obtuse Angle Triangle</td><td>It has one angle more than 90°.</td></tr></table>	Classification of a Triangle based on Angles		Type	Details	Acute Angle Triangle	All its angles are less than 90° .	Right Angle Triangle	It has one angle of 90° .	Obtuse Angle Triangle	It has one angle more than 90° .		
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10 minutes	<u>Worksheet/ Notebook Work:</u> Triangle identification and classification worksheet Instructions: 1. Look carefully at the triangles given below. 2. Classify each triangle on two bases: - Based on sides: equilateral, isosceles, scalene - Based on angles: right angle, acute angle, obtuse angle 3. Fill in the answers in the table given below. <table><tr><th>Triangle</th><th>Type based on sides</th><th>Type based on angles</th></tr><tr><td>A (60°, 60°, 60°)</td><td></td><td></td></tr><tr><td>B (30°, 60°, 90°)</td><td></td><td></td></tr><tr><td>C (45°, 45°, 90°)</td><td></td><td></td></tr></table> Think and answer: Which triangle will be most suitable in the design of the bridge or house you made and why?	Triangle	Type based on sides	Type based on angles	A (60° , 60° , 60°)			B (30° , 60° , 90°)			C (45° , 45° , 90°)		
Triangle	Type based on sides	Type based on angles											
A (60° , 60° , 60°)													
B (30° , 60° , 90°)													
C (45° , 45° , 90°)													
Homework	Find such places in your house or neighbourhood where triangles are seen (corner of window, barricade, ladder net, etc) • Take a photo or sketch 2 places • Tell their types and write them in your own / notebook												

Day 2

Learners will construct triangles and explore the triangle inequality rule.

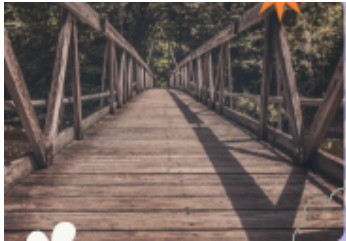
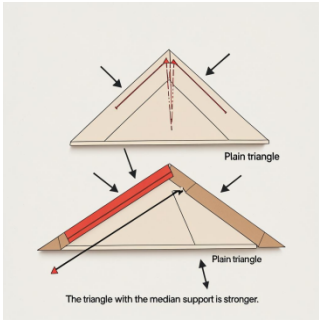
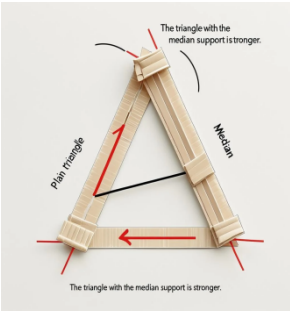
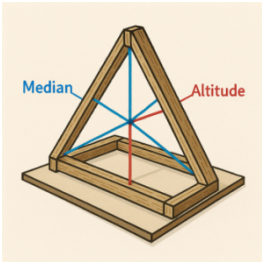
Teaching Material	Protractor (to measure angles), sketch paper, naming labels for triangles, colour pens, ice cream sticks, straw, cardboard, thread, glue, scissors, scale, protractor (for measurement), tape, thermocol or chart paper base
Time	Activity and Details
15 minutes	Teacher says: Today, we will learn to construct triangles. First, we will make an equilateral triangle. Making an equilateral triangle with the help of a circle is very easy. The steps outlined below: Step 1: Make a line segment - Draw a straight line and mark two points A and B on it. - This line segment will be the side of the triangle. Step 2: Set the compass to the length of AB - Put a compass needle on A. - Stretch the other needle till B (set the length AB on the compass). Step 3: Draw an arc with A as the centre - Put a compass needle on A and draw an arc upwards. Step 4: Now draw an arc with B as the centre - Now, without changing the compass (in the same length), put on B and make one more arc so that both arcs cut each other. Step 5: Label the intersection point as C. - Label the point where both arcs meet as C.

	Step 6: Join line segments AC and BC - Join A to C and B to C. Result: Triangle ABC is an equilateral triangle because: $AB = BC = CA$, all three sides are of equal length. The teacher will ask Learners, - - Did everyone make an equilateral triangle? - Did you face any difficulty in making an equilateral triangle? - If you had to make a scalene triangle instead of an equilateral triangle, then what could you do? The teacher will ask the learners to read 7.2, Constructing a Triangle When its Sides are Given, in Lesson 3 - A Tale of Three Intersecting Lines, and from there, learners will learn to make a scalene triangle.								
10 minutes	<u>Understanding the Triangle Inequality rule:</u> Teacher explain – - Can a triangle be made with any given side lengths? - Are there such lengths for which making a triangle is impossible? Let us find out, <table border="1"> <thead> <tr> <th>Triangle sides</th><th>Can a triangle be made? (Yes / No)</th></tr> </thead> <tbody> <tr> <td>4cm, 5 cm, 7cm</td><td></td></tr> <tr> <td>4cm, 6cm, 11cm</td><td></td></tr> <tr> <td>5cm, 7cm, 14cm</td><td></td></tr> </tbody> </table> The teacher asks - - A Triangle cannot be formed with the last two sets of sides? - Why? - What do these two sets of sides have in common? Conclusion from the class discussion – To make a triangle, its three sides must follow a special condition. This condition is called the triangle inequality rule. If ABC is a triangle, then - $AB + BC > AC$ $BC + CA > AB$ $CA + AB > BC$ If all three conditions are true → triangle can be made. If even one condition is not satisfied, a triangle cannot be made.	Triangle sides	Can a triangle be made? (Yes / No)	4cm, 5 cm, 7cm		4cm, 6cm, 11cm		5cm, 7cm, 14cm	
Triangle sides	Can a triangle be made? (Yes / No)								
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15 minutes	<u>‘From Sketch to Model!’ - Group Activity (next step)</u> Purpose: Learners will now start making a 3D model on the basis of their first day sketch and second day triangle construction and triangle inequality rule, which will be their bridge or house. Teacher gives instructions to the learners- Look at your sketch keeping the questions given below in mind and make a plan. - Which parts of your model will be joined first? - Verify triangle inequality rule in your triangle structure. - Which parts will you make strong with triangle structure? Start construction: - Learners will work on their model in group. - First construct triangle parts (beam, roof, etc) - Then join/assemble the remaining structure. - Ensure that angles and lengths stay balanced.								

	 Use of mathematical ideas ○ Use right-angle triangles in support beams. ○ Check the strength where two triangles are joined. Teacher discuss on guiding questions : ● Which part is most difficult to make? Why? ● With which triangles are you making your model strong? ● Did you have to make any changes while making a model from a sketch? ● Can you tell in which part of your model the angle is most important? Expected result after group work ● One starting 3D structure, in which it is clearly seen how the model is standing with triangles. ● Every group puts tags on their model — with Triangle A, B, C, etc.
Homework	Solve the triangle inequality questions given in the textbook.

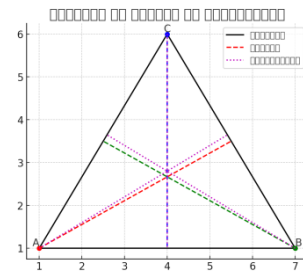
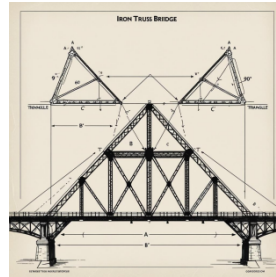
Day 3

Learners will identify the median and altitude in a triangle while designing and constructing models like bridges or houses..

Teaching Material	
Time	Activity and Details
10 minutes	<u>The teacher will explain the case given below to students:</u> Inspiring Story: "Shaking Bridge or Balanced Design?" "Imagine – in a village, two engineer friends are there – Neelu and Raju. Both have to make a footbridge on the river. Neelu made the bridge structure without straight ends and angles by joining three straight wooden planks. Raju added something special in his design, from every angle he drew a line till the middle of the front side, that is the median, and from each angle he drew a vertical line down, that is the altitude.  As soon as the bridge was ready, light rain came, and Neelu's bridge slowly started bending. Raju's bridge stayed steady and strong. Why? Now you tell, what was that which was bringing strength in Raju's design?   

”Learners will do the following activity in a group -
 “Bend and Check”

- Make 2 types of triangles from paper strips. One where there is no median.
- And in the other triangle, make a median from one angle and give support with cardboard or straw.
- Now try to bend both, learners will themselves feel the difference.



The teacher will explain:

“Inside every triangle there is a balance line, which makes it steady, which we call median. And one height which transfers the load down in the right way, which we call altitude. This is the difference between a simple design and an engineer’s design.”

15 minutes

Group Activity: “Mid-Point Scan – Line of Strength”

Purpose:

Learners identify median and altitude in their made design, make them, and understand how these make their house/bridge strong.

Teacher (role):

“Yesterday, you had to design your house or bridge. Today we will add lines of strength in it, that is, the median and altitude, so that our model becomes more durable and balanced.

Steps of work :

Step 1: Take out the old sketch

Every group keeps their triangle design of the second day in front.

Step 2: Make Median

1. Join both ends of one side of your triangle.
2. Measure and mark the middle point of that side (mid-point).
3. Draw a line from the front corner to this middle point, this is the median!
4. Mark this line with red colour/thread.

Step 3: Make Altitude

Again from the same angle draw one straight line down, which cuts the front side at 90°. This line is called altitude, show it with green colour or chalk dust.

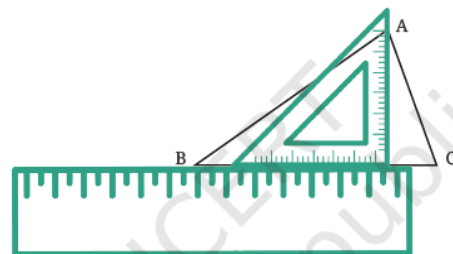
Tip: If the protractor is not there, a book can be kept from the corner to make a straight line.

Step 4: Compare Median and Altitude

Every group write on a small chart:

Feature	Median	Altitude
Where does it start from?	From angle	From angle
Where does it go?	Till middle point of front side	Cutting front side at 90°

	How does it look?	Balance line	Vertical strength line
	Why is it needed?	Makes balance of bridge/house	Sends strength downwards
Every group will share their work with the whole class.			
15 minutes	Teacher will discuss: • Median: “That line which goes from any vertex angle to the middle point of the front or opposite side” • Altitude : “That vertical line which is drawn from any vertex angle on the opposite side” Blackboard Picture: • Show both median and altitude in one triangle. • Do a demo measuring the length of the median and making a 90° mark on altitude. Pair Practice: “Secret of Median and Height” Instructions: 1. Divide learners in pairs. 2. Give each pair one worksheet in which this triangle is given: Triangle ABC : AB = 6 cm, BC = 8 cm, CA = 7 cm 3. Partner A: Make median – from A till middle of BC. 4. Partner B: Make an altitude, a perpendicular line from A on BC. 5. Then both compare their lines – which one is longer? Which one is straight? Question – Discuss in pair: • What difference did you see between median and altitude? • How are your made lines dividing the triangle? If this triangle is part of your bridge/house design, which line will be used where? Making Altitude of Triangle learners now we will learn to make altitude. In the steps given below, we understand how the construction of altitude (Altitude) in triangle is done with the help of set square and scale - 1. Keep the scale (ruler) straight along the base line. Now keep set square on the scale in such way that edge of its right angle (90°) edges is touching the scale. 2. Slide the set square with ruler in such way that the vertical edge of set square touches point A. 3. Using the vertical edge of set square draw perpendicular from point A on line BC.		
Homework	• Make a sketch of the door, roof, window etc of your house. • Make one triangle in it and show the median and altitude in it. • Stick 1 photo or sketch in your diary.		



Day 4

Learners will understand the basic idea of congruence through a hands-on matching activity, finish models and prepare for presentation.

Teaching Material	Scrap paper, scissors, pencil, scale
Time	Activities and Details
5 minutes	Recap: Patterns in Design (Whole Class) Teacher says: "Look at a bamboo fence or the frame of a morung. What do you notice about the triangles? Are they all different or do some look exactly the same?"

	Take 2 to 3 responses. Teacher says: <i>"When builders repeat the same shape again and again, it makes a structure more stable and predictable. Today we are going to learn a maths word for this idea."</i>
20 minutes	<u>Congruence is "Same Shape, Same Size" (Whole Class then Pairs)</u> Teacher says: <i>"Take a scrap of paper. Draw any triangle you like. Now fold the paper exactly in half and cut along the outline. Open it up. What do you have?"</i> [Whole class does this, 3 minutes.] Teacher says: <i>"You have two triangles. Place one on top of the other. Do they match perfectly? Can you rotate or flip one to make it sit exactly over the other?"</i> Allow pairs to try, 2 minutes. Teacher says: <i>"When two shapes are exactly the same in size and shape, and one can be placed exactly over the other, we call them congruent. Congruent does not mean they are in the same position. You can rotate them, flip them: if they still match perfectly, they are congruent."</i> Write on board: Congruent = Same Shape + Same Size. Teacher asks: <i>"Can a big triangle and a small triangle be congruent? Why not?"</i> Take responses from the learners. Teacher says: <i>"No. Size must be exactly equal. Same shape alone is not enough."</i> Ask: <i>"Have you seen congruent triangles anywhere in real life? In a saree border? In a bamboo mat? In a window grill?"</i> Take 2 to 3 responses. Teacher says: <i>"In your bridge or house design, if you repeated a triangle shape, those two triangles are congruent. That repetition is what makes real structures hold together."</i> Note: Do not introduce SSS, SAS, ASA, or RHS here. The goal today is the concept only. Then ask pairs: <i>"Look at the triangles in your model sketch from Day 3. Can you find two triangles that look like they might be congruent? Point to them."</i>
10 minutes	<u>Spot the Congruent Pair (Group Work)</u> Teacher says: <i>"Now look at your own design. Every good bridge or house has at least one pair of congruent triangles in it. Your job is to find that pair."</i> Steps: Step 1: Groups place their Day 3 design sketch on the desk and look carefully at all the triangles. Step 2: They identify two triangles that look the same in shape and size. They mark them with a circle or a star on the sketch. Step 3: They use a scale to check: do the sides of the two triangles look roughly equal? They do not need to measure every side precisely. A visual check with one measurement is enough. Step 4: The groups write one sentence in the notebook in this format: "Triangle ____ and Triangle ____ in our design look congruent because they appear to be the same shape and same size." Step 5: If the group cannot find a congruent pair in their design, they choose to add one by drawing a second triangle identical to one they already have, placed on the other side of the structure. Each group shares their finding in one sentence with the whole class. Teacher says: <i>"Good. After this project, you will learn the exact rules mathematicians use to prove congruence. For now, you have found it with your eyes and your design."</i>

Homework	Make simple drawings on corners of walls of your house and apply Pythagoras theorem. Example: TV corner, door frame , table side – evaluate them. Photo/sketch + write whether $c^2 = a^2 + b^2$ is true or not.
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Day 5

Learners will present and explain their model confidently before the class, describing its design and mathematical understanding.

Teaching Material	Sketch pen, tape, label sticker, scale
Time:	Activities and Details
5 minutes	  Teacher says: “Learners , now the day has come when you will present your made designs in front of the class, big learners and teachers. The triangles, angles and theorems you learnt, today they will speak, through your model and your story! But before that, let us prepare our model.” Teacher instructions (for all groups): Check on model: ○ Are all triangles labelled? (equilateral, right angle etc) ○ Are parts like Pythagoras' theorem, median, and altitude clearly seen in the model? Look at the poster: ○ Is the name, information of triangles, main principles and measurements clearly written on your poster? ○ Is its title attractive? Like “Our Bridge: From Triangle to Strength”. Repeat presentation talk: ○ Do all members remember their role? ○ Who will narrate the story, who will explain calculation, who will show the poster?
30 minutes	<u>Every group will get 5 minutes for presentation:</u> Outline of presentation: 1.Short introduction (30 seconds) 2.Model display (2 minutes) ○ Which triangles were used (equilateral, isosceles, right angle) ○ Measurement and theorem (median, height, Pythagoras theorem) 3. Poster presentation (1 minute) 4, Question-answer (1 minute) Teacher direction: Teach learners to give true, relevant and creative feedback. Appreciation and Closing ● Appreciate all groups with clapping. ● Give small certificates, stickers or titles like: ○ “Strongest Design” ○ “Triangle Expert” ○ “Most Creative Presentation” Teacher will ask learners :

	- “What triangle did you use the most in your design?” - “If you have to make it again, what will you change?” - “How did you feel while making design with maths?”
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ASSESSMENT CRITERIA

A majority of my learners were able to:

- ☐ Classify a given triangle correctly by its sides (equilateral, isosceles, scalene) and by its angles (acute, right, obtuse).
- ☐ Calculate the third angle of a triangle when two angles are given, using the angle sum property.
- ☐ Calculate the exterior angle of a triangle using the exterior angle property.
- ☐ Draw and correctly label the median and altitude of a given triangle.
- ☐ Check whether three given side lengths can form a triangle using the triangle inequality rule.
- ☐ Identify two triangles in their design that look congruent and explain in one sentence why they appear to be the same shape and same size.
- ☐ Present their model to an audience and explain at least one triangle property used in the design.

MODIFICATIONS FOR SIMPLIFICATION

- If time is short (3 days instead of 5):** Combine Days 1 and 2 into one session focused on triangle types and angle sum property only. Skip exterior angle property in depth during the project and leave it as a textbook follow-up. Keep Day 3 for median, altitude, and model construction. Use Day 4 or 5 for peer feedback and presentation. All core learning outcomes on classification, angle sum property, median, and altitude are retained.
- If materials are very limited:** Replace the straw or stick 3D model with a flat paper model. Learners draw the bridge or house on chart paper, cut out the triangles, and assemble a 2D collage on the back of an old calendar sheet or newspaper. All labelling, calculations, and the congruent pair identification are written directly on the collage. The presentation becomes an explanation of the collage with oral description. All learning outcomes are fully retained.
- If learner levels are very mixed:** For learners who need more support, provide a pre-drawn triangle template with two angles already filled in. Ask them to find the third angle using the angle sum property, label the triangle type, and identify one pair of matching triangles in the group's design by looking at them visually. For learners who are ready for more, ask them to look up the four congruence criteria (SSS, SAS, ASA, RHS) in the textbook after Day 4 and come prepared to name which rule their spotted congruent pair would follow. This creates a natural bridge to the post-project textbook lesson without slowing down the rest of the class.

CHAPTER-PROJECT MAPPING

Corresponding NCERT Chapter: Grade 7 Maths, Chapter 6: A Tale of Three Intersecting Lines (The Triangle and its Properties)

Chapter Topic	Sub-Topic	Covered in Project?
6.1 Introduction	Meaning and parts of a triangle	Yes
6.2 Classification of Triangles	Based on sides: equilateral, isosceles, scalene	Yes (Day 1)
6.2 Classification of Triangles	Based on angles: acute, right, obtuse	Yes (Day 1)
6.3 Medians of a Triangle	Definition and drawing of median	Yes (Day 3)

6.4 Altitudes of a Triangle	Definition and drawing of altitude	Yes (Day 3)
6.5 Exterior Angle of a Triangle	Exterior angle property	Yes (Day 2)
6.6 Angle Sum Property	Sum of interior angles = 180 degrees	Yes (Day 2)
6.7 Triangle Inequality	Sum of any two sides greater than the third side	Yes (Day 2, verification activity)
6.8 Congruence of Triangles	Concept of congruence: same shape and same size	Yes, concept only (Day 4)
6.8 Congruence of Triangles	Criteria: SSS, SAS, ASA, RHS	Not covered in project. To be taught as a post-project textbook lesson using Chapter 6 exercises.