LESSON SCENARIO 02:
COSINE RULE

Topic: Cosine rule

Level: Age 15 - 18

Foreknowledge: Concept of sine and cosine, area of a quadrangle

Correlation: Physics (operation with vectors); Astronomy (parallax method)

Time: 45 minutes

LEARNING OUTCOMES

- **Use trigonometry**
- **Find out Cosine Rule**
- **Be able to compare different statements of the same concept**

TEACHING METHODS

- **VR technology**
- **individual work and pair work**

KEY WORDS

- **acute/ obtuse angle**
- **triangles**
- **quadrangles**
- **equivalence of polygons**

RESOURCES

- **VR headsets**
- **blackboard**
- **cardstock, pencil, coloured pens, two cardboard reference triangles**
- **triangle rulers, geometric instruments, scissors**
- **laptop/ computer, pocket calculator, projector**

ACTIVITIES

INTRODUCTION: RULES OF CONDUCT WHEN USING VR IN THE CLASSROOM (5 min)

The teacher starts discussion with the students asking them about the use of VR and their expectations in using VR in classroom.

After the discussion the teacher defines the work methods and rules of conduct for students regarding safety precautions for using VR headsets in the classroom and learning in virtual environment:

- **listen to the teacher carefully**

- **remove physical obstacles before using VR**

- **always work in pair - never alone**

- **keep the device clean.**

Activity 1 (5 min) INTRODUCTION TO THE LESSON

Form of work: frontal

Required accessories: blackboard or prepared PowerPoint

The teacher asks the students to list some definitions and formulas: definition of cosine of an angle; formula for determining the area of a square; formula for determining the area of a parallelogram. They will use these formulas during the activity. Then he/she divides the class in four groups and gives to each group a violet cardboard triangle: two of them are acute angled triangles, the other two are obtuse angled triangles (see figure):
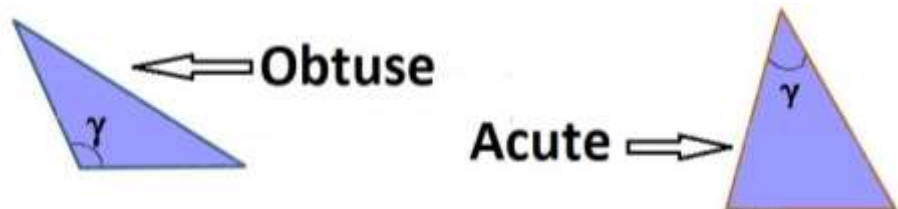
The teacher asks to name one angle of the triangle (γ as in figure above) and to name the three sides of the triangle a, b and c (where c is the side opposite to γ).
**Then he/she says to the students that they are going to get the Cosine rule by comparing figures.**

Activity 2 (10-15 min) HANDS-ON PART OF THE LESSON

Form of work: frontal

Required accessories: blackboard or prepared PowerPoint, cardstock, pencil, coloured pens, two cardboard reference triangles, triangle rulers, geometric instruments, scissors

The teacher asks each group to draw one of the following figure, using as a starting point the triangle they have just received. The students can use cardstock, rulers and scissors. They can also color their figure, using the colors below.
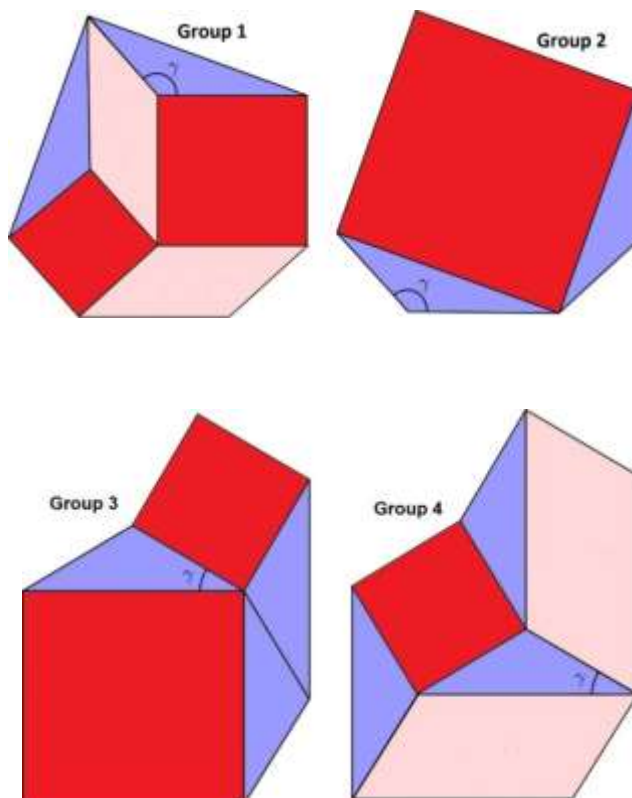
An example of how to conduct the drawing:

Group 1: draw the violet triangle on the cardboard. Draw a red square below the lower side of the triangle (adjacent to γ). Draw a pink parallelogram starting from the left side of the square. Etc.

**Group 2: draw a red square of side c, the longest side of the triangle (opposite to γ). Draw a violet triangle on one side of the square. Etc.**

Group 3: draw the violet triangle on the cardboard. Draw two red squares starting from the two sides of the triangle adjacent to γ (a and c). Etc.

Group 4: Draw a red square with side c. Draw the violet triangle on three of the four sides of the red square. Etc.

Activity 3 (15-20 min) CALCULATION PART

Each group have to calculate the area of its figure, by adding the areas of various parts (squares and parallelograms). They should come to this calculation (see figures)
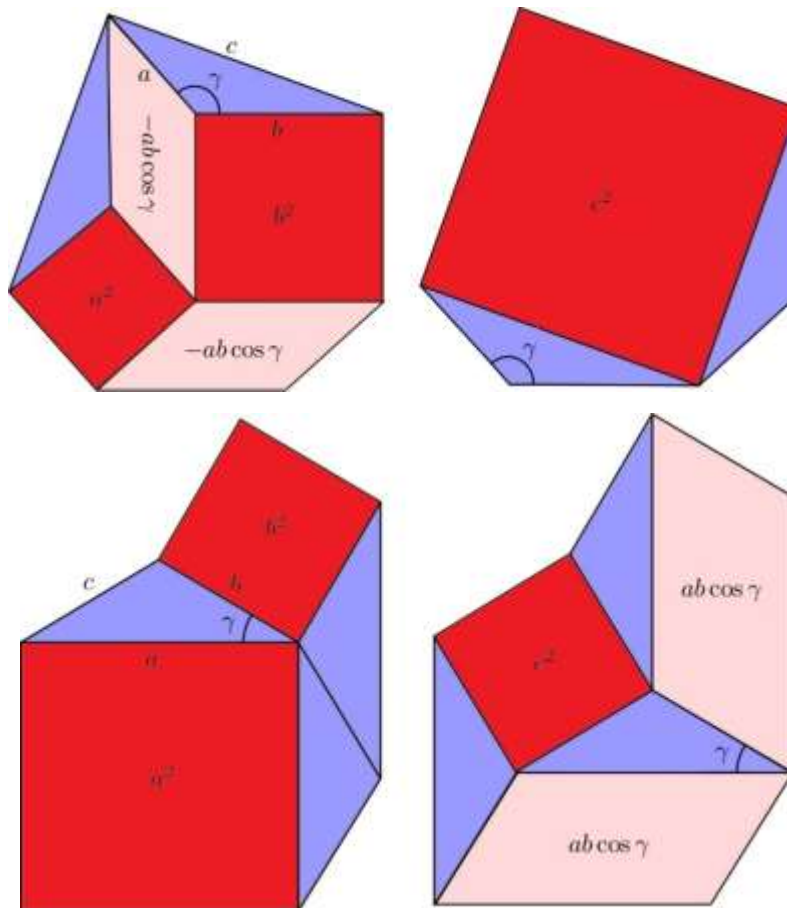
From the equivalence of the figures (two by two) and some algebraic arrangements, the students will arrive to the Cosine rule formula:

$$c^2 = a^2 + b^2 - 2ab \cdot cos\gamma$$

An example of algebraic arrangements for groups 3 and 4:
The area of figure 3 (on the left above) is $a^2 + b^2 + A_T + A_T + A_T$ where A_T is the area of the violet triangle.
The area of figure 2 (on the right above) is $c^2 + A_T + A_T + A_T + abcos\gamma + abcos\gamma$.
Equaling the two areas we get: $a^2 + b^2 + 3A_T = c^2 + 3A_T + 2abcos\gamma$.
By subtracting $(3A_T + 2abcos\gamma)$ from both sides of the equality we get the final formula.
Similar procedure for groups 1 and 2.
The teacher helps the students to write down the statement of the Cosine rule: "The square of the length of any side of a triangle equals the sum of the squares of the length of the other sides minus twice their product multiplied by the cosine of their included angle."

Activity 4 (10 min) COSINE RULE IN VR APPLICATION

The teacher assigns the task to the students.

Student:
-   **finds and selects the COSINE RULE exercise on the exercise shelf**
-   **solves tasks in VR application**

Form of work: work in pairs

Required accessories: VR headset

CORUSE OF ACTIVITY:

The teacher divides the students into pairs.
Student A carefully puts on his VR headset and opens the COSINE RULE exercise in a virtual library in a VR application.
To do the required task, student A will go to point C, near the window. From this point he sees the distance to peak A, b = AC = 2041 meters, the distance to peak B, a = BC = 2394 meters and the angle formed by the two sides, <ACB = 42°. The task is to calculate the distance c = AB between the two peaks.
Student A gives student B the headset so that he/she could also see the task and, assisted by students A, he/she will write down the task and they will solve the problem using Cosine Rule.

$$c^2 = a^2 + b^2 - 2ab \cdot cosC$$
$$c^2 = 2041^2 + 2394^2 - 2 \cdot 2041 \cdot 2394 \cdot cos42°$$
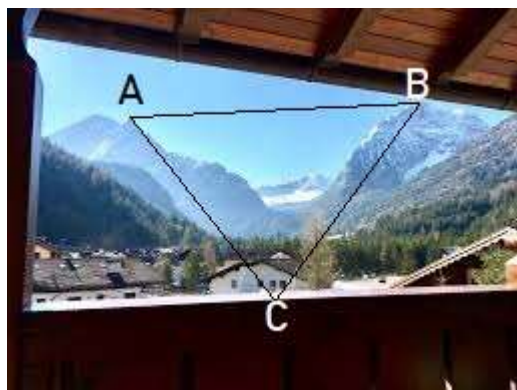$$c^2 = 4165681 + 5731236 - 9772308 \cdot 0.7431$$
$$c^2 = 9896917 - 7261802.0748$$
$$c^2 = 2635114.9252$$

$$c = 1623.3037m$$

So, the distance between the two peaks is 1623 meters.
Student B will type the answer and they will take turns in enjoying the view as a reward for their performance.

1. I like the way of work in this lesson	1	2	3	4	5
2. This lesson was interesting	1	2	3	4	5
3. It is clear what I was supposed to learn in this lesson	1	2	3	4	5
4. The subject matter was clearly explained	1	2	3	4	5
5. I have learned the subject matter	1	2	3	4	5
6. I think I actively participated in this lesson	1	2	3	4	5
7. I was more active in this lesson than usually	1	2	3	4	5
8. By being active I contributed to the quality of the lesson	1	2	3	4	5
9. I was motivated for work in this lesson	1	2	3	4	5
10. I prefer using VR in lessons	1	2	3	4	5

111. Name two things you liked in this lesson:

12. Name two things you didn`t like in this lesson:

INCLUSIVENESS GUIDELINES

Every student is different and their needs for the material might vary. Below you will find several tips that could make mathematics lesson more inclusive for students who struggle with learning disorders.

- When giving assignments to classroom try to break them into small pieces of information. Avoid the double tasks in the instructions. Remember that in case of operations/exercises with multiple steps, it is critical to help learners decompose the steps.
- You can use checklists for your students to make sure they have done all the steps
- Make sure the font, line spacing, and alignment of your document is accessible for students with learning disorders. It is recommended to use a plain, evenly spaced sans serif font such as Arial and Comic Sans. Others: Verdana, Tahoma, Century Gothic and Trebuchet. Spacing should be 1.5 and try to avoid justification in the text.
- At the end of each activity, take some time to ask the students what they have learnt to acknowledge every step in their learning process
- Make sure that the material the students manipulate is easy enough to grasp
- While using different media (paper, computer and visual aids) choose different background than white which can be too bright for students with learning disorders. The best choice would be cream or soft pastel but try to test different colours to learn more about student's preference.
- To stimulate short and long-term memory prepare for all the students in the classroom an outline describing what they are going to learn on this lesson and finish it with a resume of what has been taught. In this way they will strengthen the ability to remember information.

EXAMPLE:

1. Start every lesson with a short "CHECK-IN"
   - Today, we will study the topic (name of the topic)
   - I will tell you about: (name 3 keywords connected with the topic)
   - Then I will present exercises: (name the exercises form the student book)
   - Then we will do exercises (explain the way student will be working: ex. together with teacher / in pairs /individually)
   - Once the exercises will be done [To continue]

2. Then finish lesson with a short "CHECK-OUT"
   - During the lesson we learn about (topic of the lesson)

- **The most important things were: (name 3 keywords connected with the topic)**
- **We were able to do… (tell about the work student done during the lesson)**
- **We will explore the topic next time when we will learn about (name the following topic)**

It is a small adjustment that will take 5 min from the lesson but can make a great difference in the way that the material will be remembered. Try to create this as a routine habit.