1 Assignment and final tasks

The mathematical task is to match the graph of a function to a real arch of stone for example here in church architecture ? You will explain a method to use math functions for real situations, a bit like the pictures frequently seen in video games and which can be moving on the screen later on and not in real.

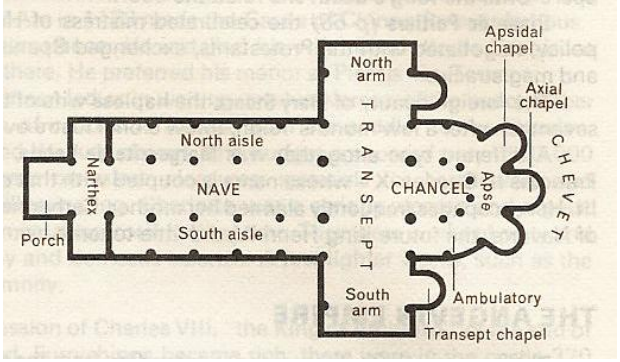
The communication task is a peer to peer students conference based on a self made poster to be given as experts in direction to visitors. All members of the team have to speak equally when presenting to the visitors.

The collaborative task is a team work in a foreign language and members are called below Alice, Bob, Charlie, David and Emmy. Feel free to share roles.

2 Plotting a human sized curve

Alice chooses one of the round arches on both sides in the chancel. It looks as a rectangle topped with a semi circle.

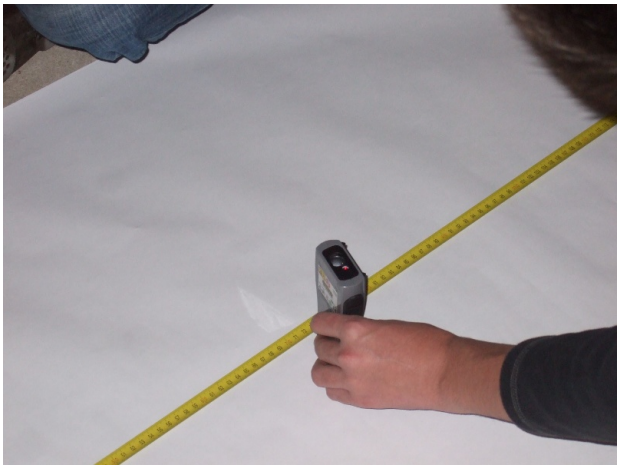
Your task is to measure many heights to plot the curve of the semicircle and calculate if it is perfectly semicircular or not. The method given in the following is to turn a real solid situation into a mathematical curve, which can be later deformed as commonly done in video games for example. Thus, situations can be drawn (photographed ?) on computer although they cannot be real.



3 Measuring on a human sized curve

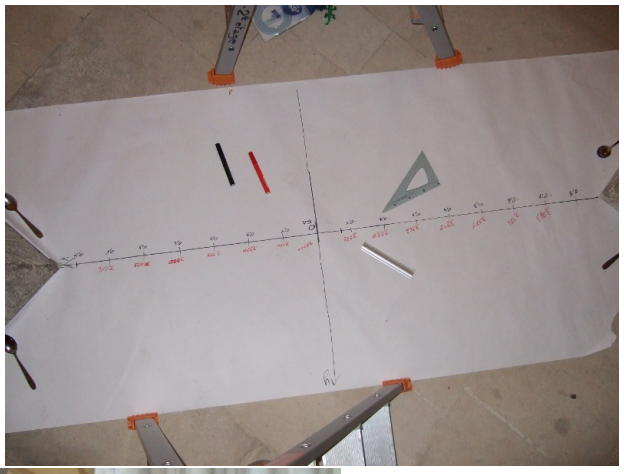
Share roles in the following instructions.

1. Lay the sheet of paper on the ground under the arch. The edge of the arch is the semi circle that has to be studied. Draw onto the paper carefully an axis where the projection of the keystone is the origin. This straight line segment is the vertical projection onto the ground of the round arch curve. Give graduations every 5 cm, orientate this axis. Secure the paper onto the ground to keep it fixed while measuring and taking notes. **FROM NOW ON THE PAPER SHOULD STAY UNREMOVED AT ALL TIMES.**
2. Measure carefully the height between the ground and the edge of the arch at all graduations. Fill the measurements into a grid given in the answer sheet.
3. Measure the height of the pile, the span and the rise of this round arch.



4 Measuring an inaccessible curve

1. Choose a much larger round arch between the nave and aisle.


2. Lay the sheet of paper on the ground under the arch. The edge of the arch is the semi circle that has to be studied. Draw onto the paper carefully an axis where the projection of the keystone is the origin. This straight line segment is the vertical projection onto the ground of the round arch curve. Give graduations every **10 cm**, orientate this axis. Secure the paper onto the ground to keep it fixed while measuring and taking notes. **FROM NOW ON THE PAPER SHOULD STAY UNREMOVED AT ALL TIMES DURING MEASUREMENTS !**
3. Measure carefully the height between the ground and the edge of the arch at all graduations. Fill the measurements into a grid given in the answer sheet.
4. Measure the height of the pile, the span and the rise of this round arch.

5 Plotting the curves based on the measurements

1. Ask the teacher for a computer and open an excel sheet. Insert in the calculation sheet all measurements taken on the human sized round arch.
2. Plot the graph of these measurements. Is it what you expected it to be ? Why or why not ?
3. Plot on a separate window the graph of measurements made on the large round arch in the nave. Comment.
4. Ask the teacher to print the graphs for the poster.

6 Approximating the graphs with the graph of a function

1. In the window used for the human sized arch, plot the graph of the function $f(x) = \sqrt{0,25^2 - x^2}$ where x is the coordinates on the axis drawn on the paper on the floor.
2. Is this theoretical graph a good approximation of the graph of the measurements ? If not, you can adjust the constant 0,25 to a better one if needed.
3. Repeat the procedure with function $f(x) = \sqrt{1,846^2 - x^2}$. Comment
4. Ask the teacher to print the graphs for the poster.

7 Bibliography

Actes de la rencontre des IREM du Grand Ouest, 2009, « De l'architecture aux mathématiques : des lycéens sur le terrain », Pierre Ageron, Odile Jenvrin, Jean-Pierre Le Goff, page 15.

8 Provided material

- a large sheet of paper to lay on the floor
- weights to secure the sheet of paper
- markers
- a laser measuring device (new batteries ?)
- a craft worker's measure tape
- a level
- a plumb line
- answer sheet with grid for measurements
- a combined protractor square set ruler
- blank sheets for further drawings to be glued onto the poster
- separate photos of places in the church and the church plan given in this assignment
- photos of the historical diagrams

Answer sheet to fill in the measurements, for calculations and personal notes

Name .....

Team .....

measurements	human sized round arch	large round arch in the nave
height of the pile		
span		
rise		

Measurements of the human sized round arch

x in metres	h in metres
-0,20	
-0,15	
-0,10	
-0,05	
0	
+0,05	
+0,10	
+0,15	
+0,20	

Measurements of the large round arch in the nave

x in metres	h in metres
-1,2	
-1,1	
-1,0	
-0,9	
-0,8	
-0,7	
-0,6	
-0,5	
-0,4	
-0,3	
-0,2	
-0,1	
0	
+0,1	
+0,2	
+0,3	
+0,4	
+0,5	
+0,6	
+0,7	
+0,8	
+0,9	
+1,0	
+1,1	
+1,2	