1 Geometry on the playground from the student´s view

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We cooperated with 13 and 14 years old students when creating following problems. We asked them to look for "any geometry" and make photos with interesting objects when walking in the playground. During the next phase we asked them to try creating some ideas for geometrical tasks which are based on concrete pictures. That was the way how we obtained a rich collection of photographs which presented our bases for creation of mathematical problems. There are no concrete measures related to geometrical objects in our problems, they are open problems which could be completed and solved by students.

The main goal during creation of problems was to develop students' dynamical mathematical thinking and creation of mathematical tasks. For creation concrete task students can fill measure in figure

- by estimating according to their own experiences,
- by approximating to similar real objects,
- by measuring concrete picture and adapting it in appropriate gauge,
- by searching similar object it their environment and measure it.

Following problems could be perceived more as motivation since the ideas for activities which lead us to creating mathematical tasks and we leave place for solver´s own creativity.

In the second part of the article we have chosen two problems which we have created specific assignments. When solving them, we used the software GeoGebra dynamic, as new trends in mathematics lead to the use of a variety of educational software to improve and make teaching more attractive. We suppose that we have chosen the appropriate mathematical software and show students a more interesting form of mathematics. In the development of this software we have also considered the requirements of teaching practice, and it is therefore an appropriate tool for teaching mathematics in elementary, high schools, universities. With this software, we wanted to highlight the dynamic elements that can affect the outcome or the number of solutions to the problem.

1.1 The students´ photos with mathematical ideas about them

Problem 1

There is a tree stump in the picture shaped as oblique cylinder.

- What could be the volume of tree bark which has peeled of this stump, if its thickness was 8% of its radius?
- What could be the maximum distance between ground and the ant which is walking on the tree stump?
- What could be the weight of sawdust which we could get from this whole stump, if its wood density is 690kg/m^3?

Students have proposed to calculate the area of this tree bark.

Problem 2

There is a plinth for decorative pillar shaped as regular 6-sides' prism.

- How many litters of concrete are possible to pour into the pillar?
- How many small stones were needed for decorating exterior ...., if average area covered by one stone is 7cm^2?
- In many ways can the stand be divided into two equal parts?

Problem 3

The figure shows eleven border cylindrical columns.

- How many kg of red and white painting was necessary for these columns, where 1 kg paint will cover approximately 8 m^2 area?
- How long should be the string that we would use to connect the poles if we make a loop around each of them? Tying the rope at the beginning and end we can count 1.2 m.

Students have proposed to calculate the surface area of all columns.

Problem 4

In the picture is a children's roller treadmill.

- How many wooden slats were needed for its preparation and how many rivets to attach them?

  The correctness of solutions can be verified in this picture.

- If you would like the yellow part of the cylindrical rods with a length equal to the diameter of the cylinder running repainted into green, how much area would be green?

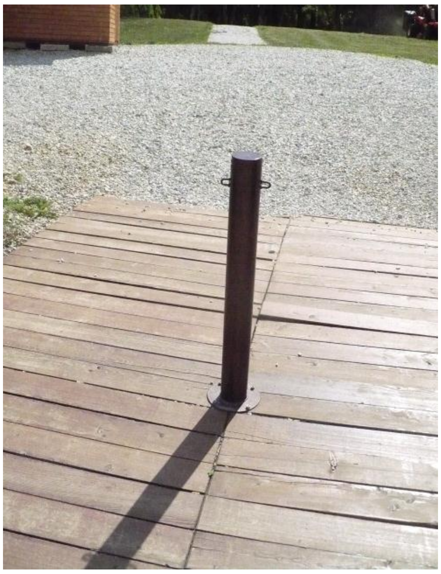
Problem 5

The picture shows the signs placed at the beginning of the playground.

- What are the different geometrical shapes in the picture?
- Redraw two units, which are central to the brand into the square grid. The length of the boxes should be the same length as the distance between two quarters of the circles. Sides of the rectangle are in ratio of 1:4 and the length of the shorter sides of the rectangle would be half the length of the box.
- What is the ratio between black and white areas?

Students have proposed to calculate the units of those brands.

Problem 6



Pillar of the picture is on a pier at the pond and serves to attach the boat.

- How high can be a column, if we know the length of its shadow?
- What would be the length of rope you would consolidate over the poles and wooden panels of the pier, with a rope to a pillar of any angle?
- Pillar, its shadow and the rope stretched out between them, could form a triangle. What are the length of tents and the size of the internal angles of the newly formed triangle?
- Pier has rectangular wooden slats covered in two rows, as in the picture. How many wooden slats would be needed to cover the pier, if one slat represents 3% of the whole pier?

Problem 7

In the picture is one of climbing frames in the playground, which is part of half-cylinder.

- What would be a developed area in the plane, if you draw the holes in the square grid?
- How many meters of rods would be needed for the construction of the climbing frame? The half-cylinder should remain consistent with its height.
- How many kilograms of yellow and red colour do we need for coating bars of climbing frame if we know the average price of a colour bar of $1m^2$.

Students wanted to find out how many kilometres of rods are obtained if all the bars of climbing frame are connected together.

Problem 8

There is a car wheel with a disc in the picture.

- How many straight lines could we use to divide the disc into two identical parts?
- How many percent of wheel represents a tyre?
- What would be the width of the tyre, if it was three times the height of the tyre?

Students have proposed to calculate radius of the wheel.

Problem 9

There is a rectangular trapezoid, created from pieces of tree trunk in the picture.

- How much soil would we need if we wanted to use the trapezoid as a decorative planter?
- Trapezoid formed this way could be used as a flowerbed. How many flowers would we need to plant if the distance between flowers was 20 cm?
- What would be the size of the internal angles of trapezoid if the bases were in the ratio 1:3?

Students have proposed to calculate the height of this trapezoid.

Problem 10

There is a rubbish bin which shape is perpendicular prism in the picture.

- What can be the maximum volume of rubbish in the bin?
- How much more wood would we need for lining bin, if we wanted to dado it without spaces?
- If we empty one-fifth of the bin the total weight will be 80 percent of the full one. What is the weight of empty bin?

Students have proposed to calculate the amount of colour needed to paint the wooden laths.

1.2 The solving problem with using software GeoGebra

We chose to sample two specific problems and their solutions demonstrate the use of software GeoGebra.

Problem 5

The picture shows the signs placed at the beginning of the playground.

Redraw two units, which are central to the brand into the square grid. The length of the boxes should be the same length as the distance between two quarters of the circles. Sides of the rectangle are in the ratio and the length of the shorter sides of the rectangle would be half the length of the box.

Grid of the sign

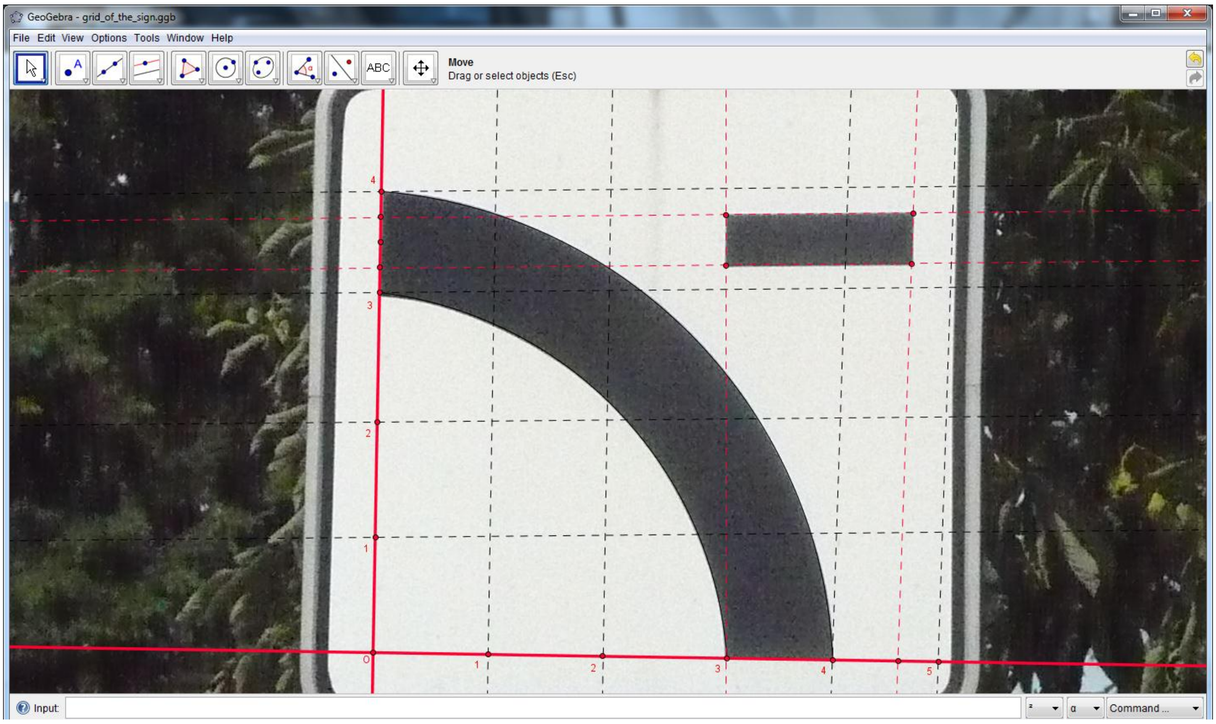


Fig.1 The photo of road sign in GeoGebra

With the GeoGebra we repainted quadrant and a rectangle by putting them into selected grid. One of the advantages of the software is the ability to play a given construction, and thereby advance to rethink the didactic process work with students. We also know the solutions of the control and work with software to view the specific practice of construction.

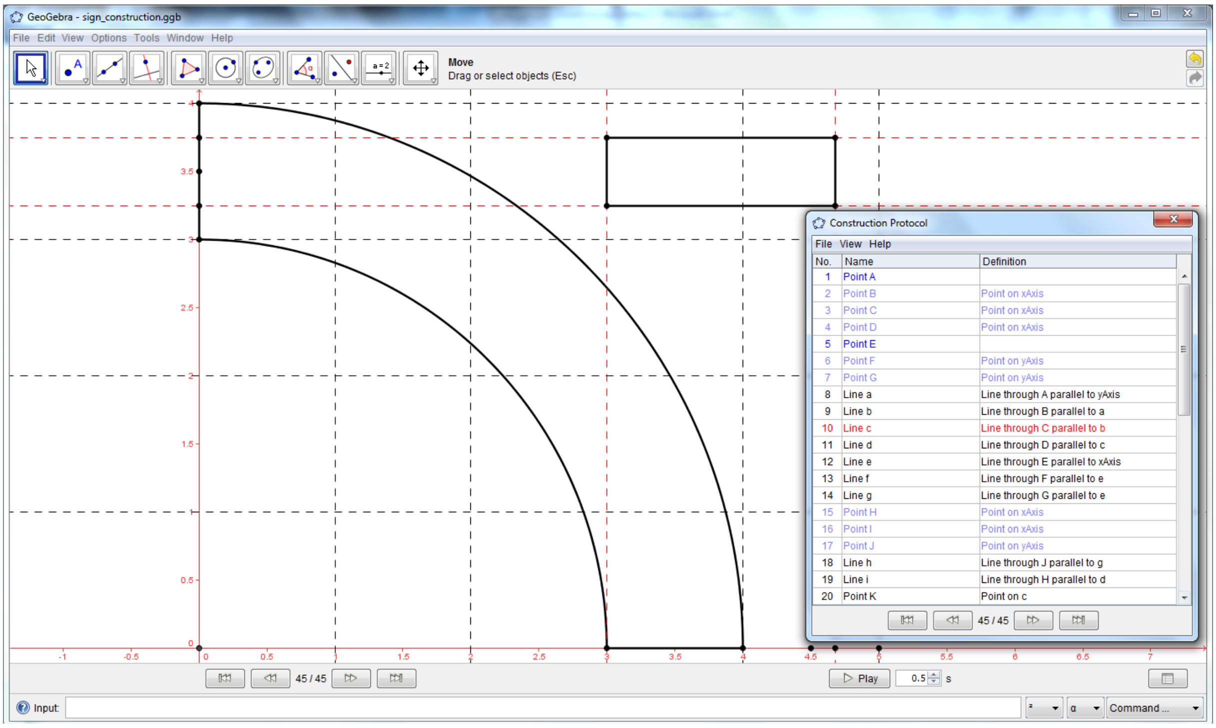


Fig.2 The road sign redrawn in a grid

The sign-construction

Problem 6

Pillar of the picture is on a pier at the pond and serves to attach the boat. Pillar, its shadow and the rope that we could stretch out between them, form a triangle.

- How does the length of the rope depend on the length of the shadow? When is in its maximum and minimum the length of the shadow?
- How does the length of the rope, depending on its attachment to the pillar?

In solution the first part of the task we use the property that the length of the shadow depends on the impact of sunlight on the pillar. In the software GeoGebra this can present a moving point *S* (with representing the sun) in a circle whose radius is the length of the distance of sun from the earth.

[The shadow]

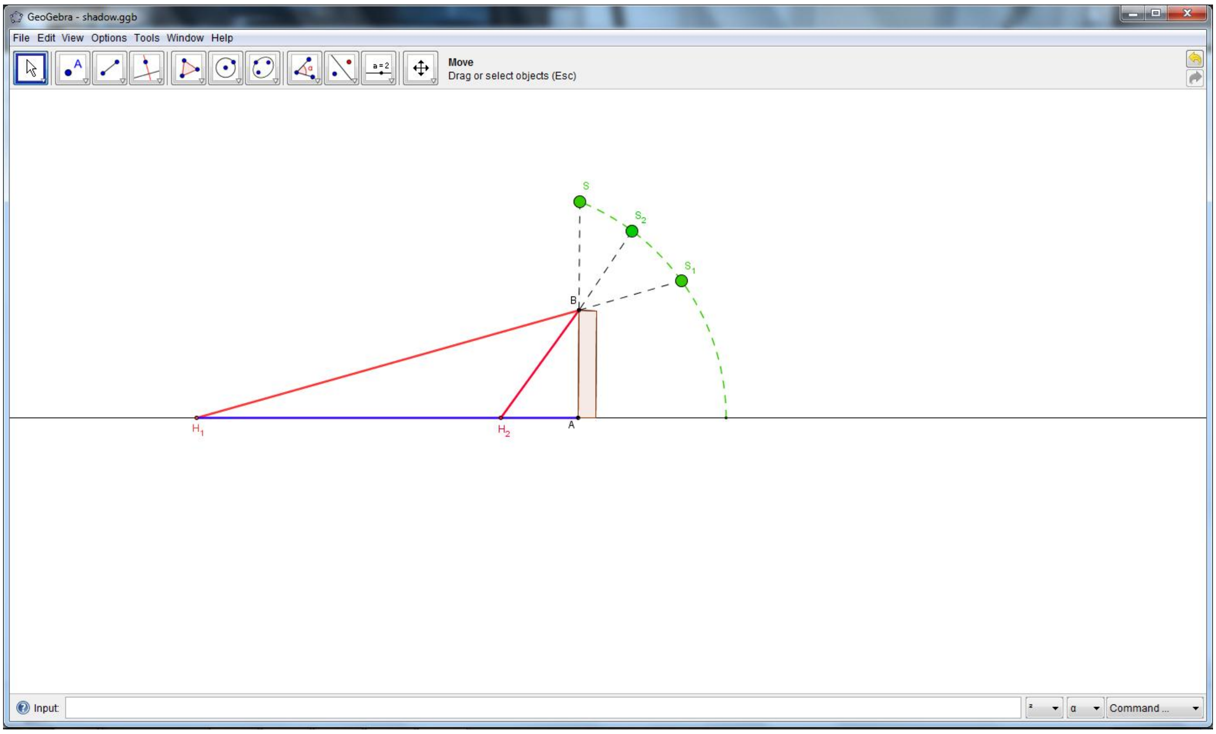


Fig.3 The dependence shadow on the position of the sun

In the second part, length of the rope depends on its location on the pillar. In GeoGebra we are changing the length of movement to point *X* on the segment *AB*, which represents the pillar. Placing the point *X* to point *B*, we get the maximum length of rope. Placing the point *X* to point *A*, a point forming a triangle and therefore rope length is equal to the length shadow.

[The rope]

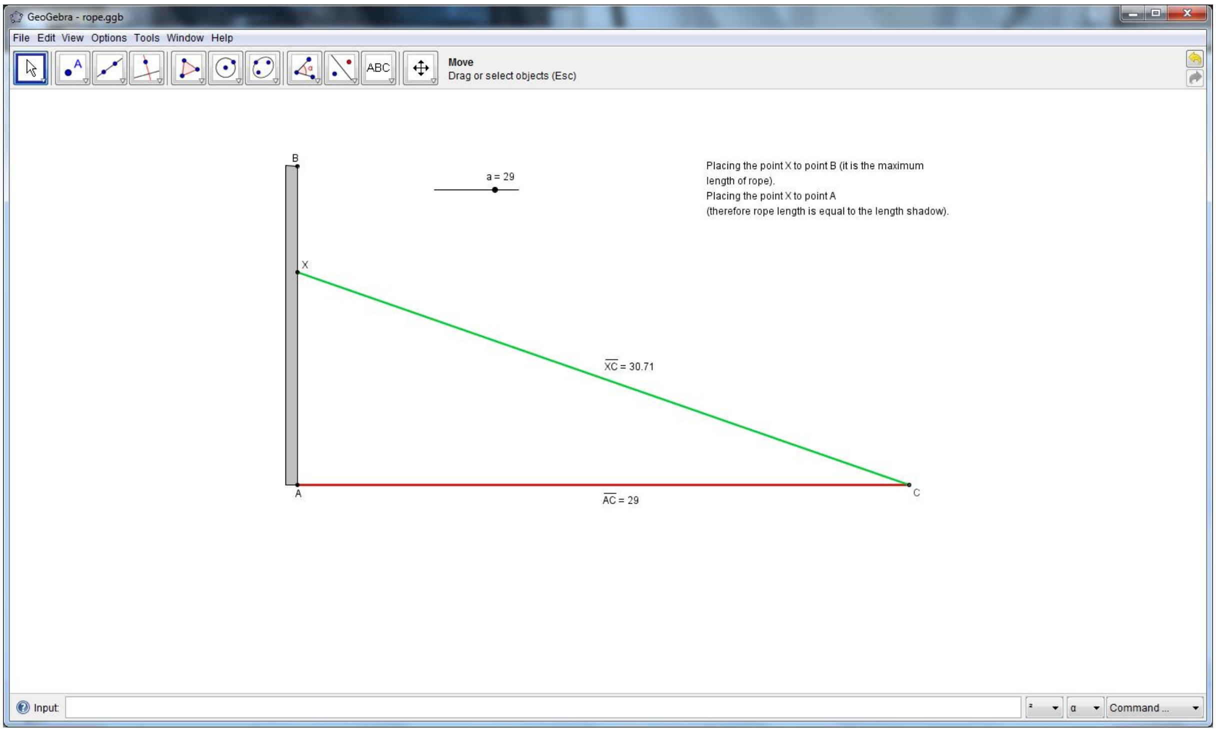
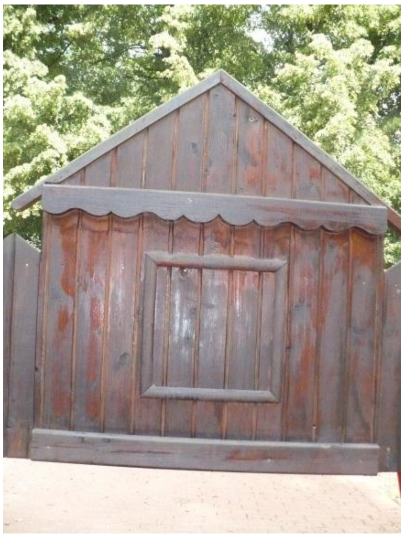


Fig.4 The dependence rope on its location on the pillar

1.3 The various other student´s photos of the playground

Photos in this section are also the students. Certainly they are suitable for making various geometric problems.







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