The Fibonacci Project

DISSEMINATING INQUIRY-BASED SCIENCE AND MATHEMATICS EDUCATION IN EUROPE

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This learning environment was created within the European project Fibonacci, a project focused on inquiry based science and mathematics education.	
Age:	15 -19 let
Subject:	Mathematics
Topic:	Volume of a cone
Target:	Determine a half of the cone volume.
Form:	Estimates, measurements, calculations, computer models. Working in pairs.
Time needed:	Two lessons, may be separated.
Tools:	Cone glass funnel (diameter 10 cm), 3 plastic transparent cups (200 ml), paper painter´s tape (wide 1cm), ruler, bottle of water, Coke, calculator, tables. Computer with Cabri 3D.
Sources:	L. Samková, Mathematics in a lab, UPVM conference 2011, České Budějovice
Author:	Mgr. Jitka Nováková, L. Samková
Twin Centrum:	TC1 České Budějovice, http://www.pf.jcu.cz/stru/katedry/m/fibo.html

Cone volume. Worksheet No. 1

Stick a paper tape vertically on a cone funnel. Mark the bottom and the top of the cone on the tape.

A. Estimate the water level, which corresponds to half of the cone volume. Mark your exstimate on the tape. Verify the estimate practically (with help of water and plastic cups).
B. Estimate the height for 1/4, 1/3, 1/2, 2/3 and 3/4 of the cone volume, mark estimates on the tape.
C. Remove the tape carefully and put it on a worksheet. Stick another paper tape on a funnel, mark the botom and the top on it.
D. Measure volumes for 1/4, 1/3, 1/2, 2/3 and 3/4 of the cone in a graduated cylinder, and create a scale on the tape.
E. Remove the second tape carefully, put it on a worksheet next to the first one, and compare them.

Check all by calculations.

Group No.: Name:

Put paper tapes here:

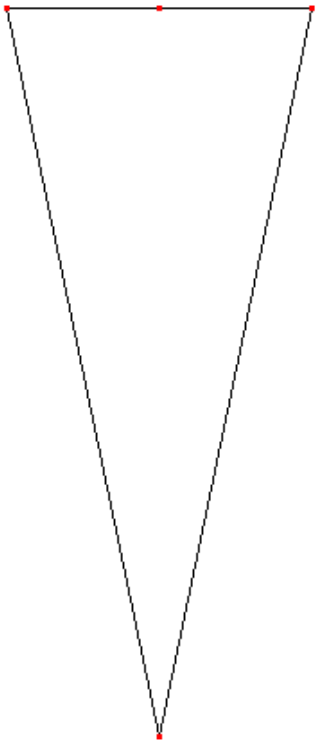
Estimates Measurement

Cone Volume. Worksheet No. 2
Determine the half cone level with help of a computer model.
Change the height and the diameter of the cone.

Group No.: Name:

Cone volume. Worksheet No. 3
Here is a side view of a cone. Determine its half-volume level.
Describe the process.

Group No: Name:



Methodological remarks

Remarks to Worksheet No. 1:

- For every pair of students we prepare a cone funnel, and two paper tapes. The hole at the top of the cone can be plugged by a piece of plasticine.
- Cone funnels are much better than cone flasks, for two reasons:
  i) Estimating half-volume level when pouring the water off a full cone is much easier with a flask. You can decline the flask at 90°, and the half-volume remains inside. For a funnel, the same declination does not help, it completely empties the cone.
  ii) The calculation for a cone funnel is much easier and more illustrative – you can better use the similarity of triangles/cones: the whole cone is similar to a cone part filled with water. This does not hold for a cone flask, in this case the part filled with water forms a truncated cone.
- We can motivate students before the A) part of the task with a call for a Coke toast. We fill the funnel with a Coke, and ask students to divide fairly the Coke with a friend: pour a half of the Coke (estimated) to a cup, and the rest of the Coke to another cup. Then compare Coke levels in cups. We may take photographs for them, illustrating the estimate accuracy.
- After estimates and volume measurements, students measure the sizes of the funnel, and verify the results by a calculation. Necessary formulas can be found in tables.

Remarks to Worksheet No. 2:

- We remind knowledge needed for working with CABRI 3D (functions Length, Volume, Calculator, Text Area).

Remarks to Worksheet No. 3:

- It is suitable to prepare several variants of the worksheet, with different shapes of cones (different height, different bottom radius).
- Students themselves choose the method: calculations or computer experiment.

In the end we acquaint the students with required results:

- The level of the water is the third root of its volume ratio. For 1/2 of the volume the level equals 0.79*height of the cone, that means approximately 4/5 of the cone height.
- The level does not depend on particular cone sizes (top angle, bottom radius).
- The same holds for pyramids.

Our experiences with the project:

- The first phase of the inquiry process – an estimate of a half-volume and its validation – is very important. The result is surprising for students, their estimates are mainly wrong. This discovery is a positive motivation for further investigations.
- The project can be taught as an introduction to cones, as well as a mid-part of the instruction on volumes.