Casio ClassPad 300

An integrated system of computer algebra, dynamic geometry, electronic class activities, and more.

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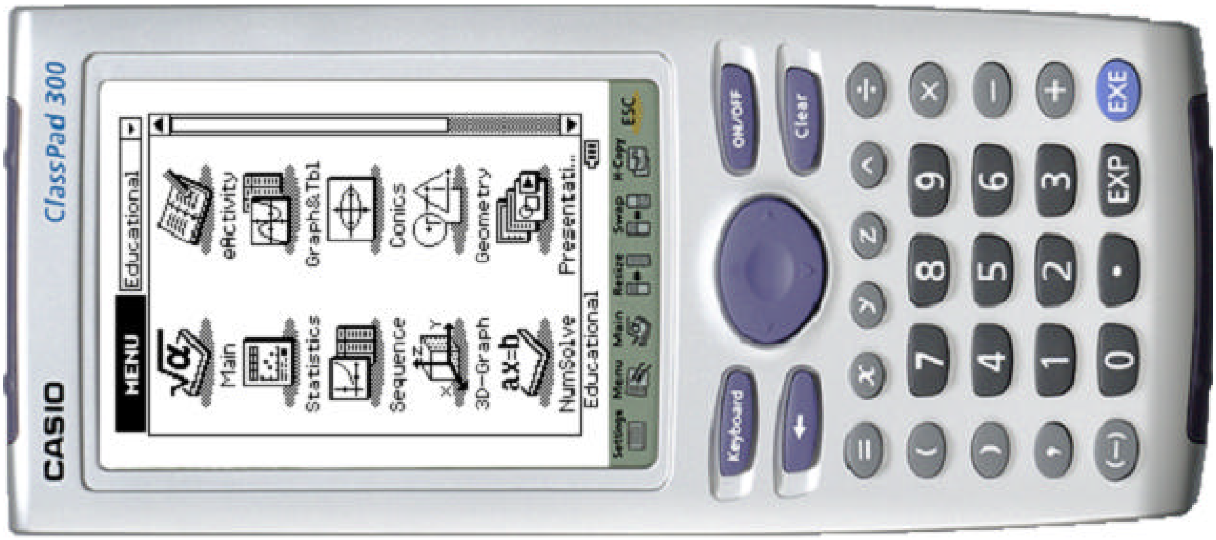
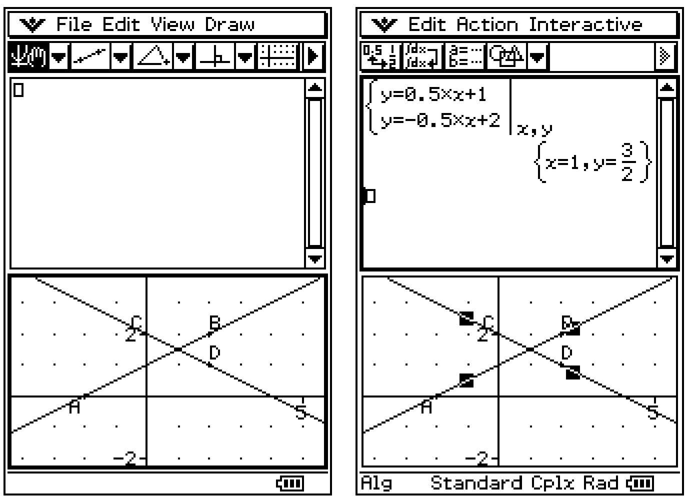
Abstract

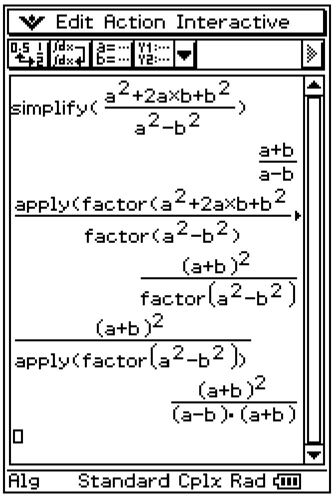
Casio will present a totally new tool for mathematics education this spring, ClassPad 300.



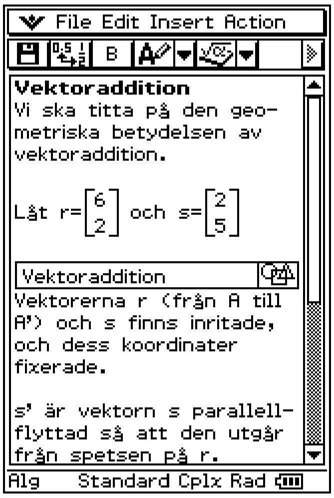
In the size of a graphing calculator ClassPad has features like computer algebra and dynamic geometry. It has a very large touch sensitive display, where you have soft keyboards for mathematics, text and much more. The Drag and Drop feature makes it very easy to work between different kinds of windows. In these images below, we show how two lines drawn in the geometry window can be dragged into the algebra window, where they will be presented as a system of equations.

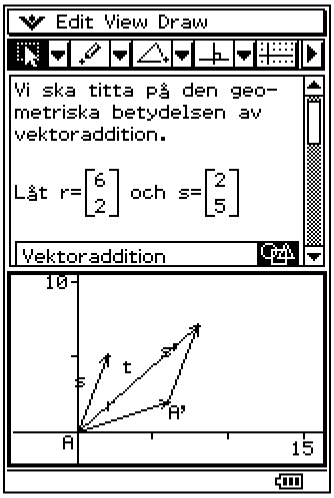


When working in the algebra window, you can allow ClassPad to do calculations automatically, but you can also work with algebra step by step. By using a 2D keyboard you can write mathematical expressions as they appear in a mathematics textbook.



One very important feature is the eActivity window. This is a window for text, calculations and imbedded windows of other kinds.





There are two major ways to use the eActivity window. Students can store their own work if they work in an eActivity window with or without embedded windows. The teacher can hand out eActivities to the students ClassPads.

In my talk I will give different examples of how ClassPad can be used in order to improve mathematics learning in upper secondary school level. I will emphasise on concept building, problem solving, and mathematical modelling.

Examples I will talk about:

Equations and simplifications. You can use tools like Simplify(...) and Solve(...), but you can also do the calculations step by step. This helps the study of algebra a hole lot, since ClassPad will perform “correct” calculations in an incorrect strategy. When doing these activities in an eActivity, the student can hand in her calculations to her teacher.

You can interact between the algebra window and the geometry window both ways. Since students normally think in images rather than in terms of mathematical formulas, it is an advantage to be able to work in the order image $\rightarrow$ expression.

I will show an example on how you can use dynamic geometry in a triangle to find an equation showing the area of an inscribed rectangle's area as a function of its base. This is an example that is very hard to solve using traditional methods. By using technology the problem becomes much easier to solve. Technology gives an opportunity to emphasise more on mathematical modelling in the mathematics curriculum than is common today.

Reference:

Per Broman, ClassPad 300 en introduktion för lärare, Broman Planetarium 2003.

Paper

Like all Casio graphing calculators ClassPad has a lot of different windows, as you can see in the Menu window. A lot of icons you will recognise, if you are somewhat familiar with the graphing calculators, like the Statistics window, the Raph & Table window etc. But there are differences.

The Run window is replaced by a Main window with features like symbolic calculations.

The Geometry window is new, with the features of dynamic geometry; drawing, constructing, measuring and animation abilities.

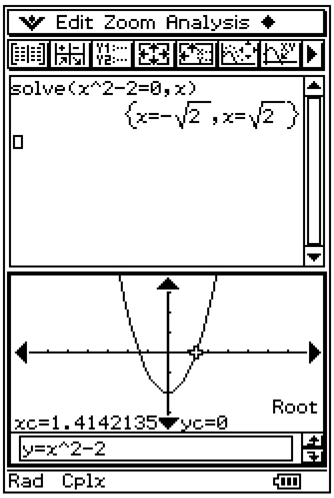
The eActivity window is a window where you can enter text and (symbolic) calculations. Here you can also open embedded windows of other kinds. Whatever you m do in an eActivity you can store for later use, and you can transfer it to other ClassPads or save it on a computer.

The Presentation window, finally, is a window you can use to make and run "slide shows" from any of ClassPad's windows.

The Main window

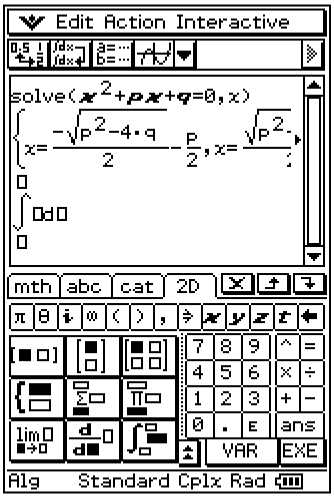
Let me enter a simple 2:nd degree equation: x^2-2=0. To solve it I can simply use the pen to mark the equation, and choose ***Interactive Equation/Inequality Solve***. If I want the solution in a decimal form, I can put the cursor somewhere in the equation and use the tool that toggles between exact and approximate result.

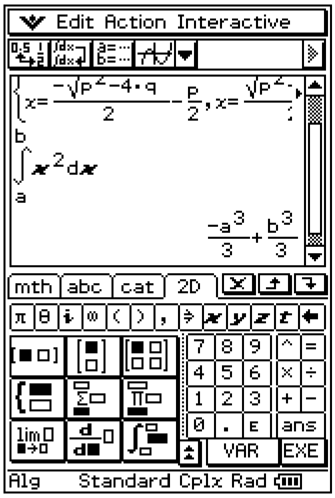
If we want to look at a graphic solution to the equaltion, I can open a graph window from the main window. Then I mark the left hand side of the equation and drag it into the graph window. Here I can use ***Anlaysis G-solve Root*** to see the graphic solution. Use the arrows key to toggle between the solutions.



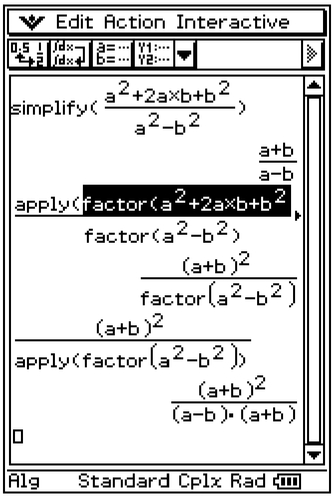
Of cause I can solve the general 2:nd degree equation; $x^2 + px + q = 0$. But to enter the equation we need to use the soft keyboard. I can enter the equation in a natural form by using the 2 D keyboard. Here I can enter fractions, powers and much more. I also use the MTH VAR keyboard to enter the "p" and the "q". They will be printed in a bold font, and will serve as one letter variables. So ***px*** really means $p \cdot x$. If you want to use long variable names, you can use the abc keyboard instead. A px is *one* variable.

The 2 D keyboard gives not only a way to enter expressions in a natural way. It is also much easier to get a correct syntax for various calculations. The 2 D integral sign, for instance, give little boxes where I have to writ things:





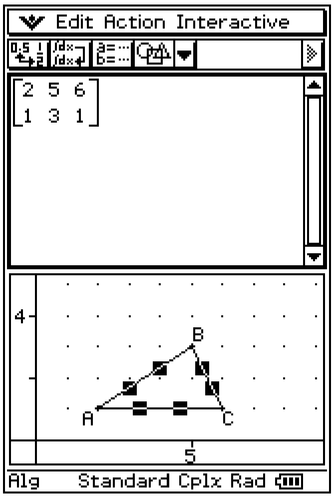
We will look into the algebra of simplifying an expression; $\frac{a^2 + 2ab + b^2}{a^2 - b^2}$. ***Simplify*** under ***Action*** or ***Interactive Transformation*** will simply do the job for us. We would rather want to see the factorised expression, so I type the expression using ***factor*** under ***Action*** in both numerator and denominator. Then I mark the numerator and choose ***Interactive apply***. I do the same thing with the denominator, and now it is easy to see why we can cancel (a+b).



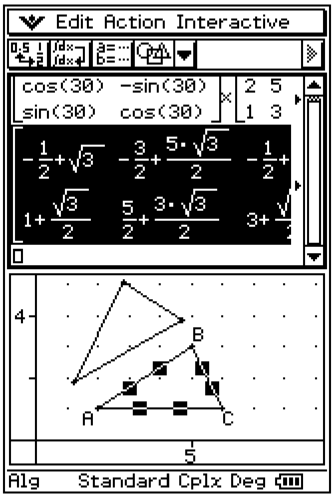
We will look at two examples where we integrate between the geometry window and the main window. First we look at a triangle.

I can open the geometry window inside the main window. I can equip the geometry window with a coordinate system as well as with an integer grid.

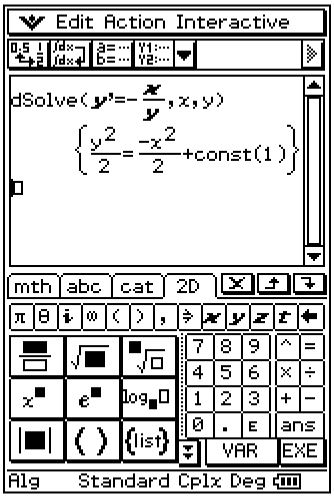
If I mark all sides of a triangle and drag them into the main window, I will get a matrix of the vertices.

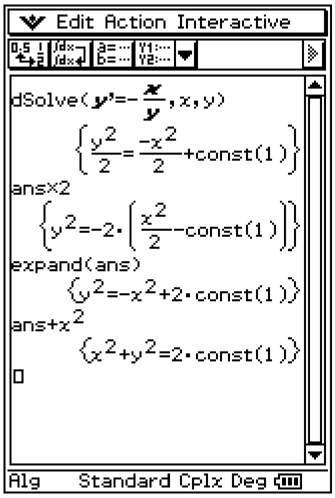


If I multiply the matrix $\begin{bmatrix} \cos(30) & -\sin(30) \\ \sin(30) & \cos(30) \end{bmatrix}$ with the triangle matrix, I will get a matrix of a triangle turned 30° around the origin. (We just have to make sure that the calculator is set for degrees rather than radians.) This matrix we can mark and drag back into the geometry window.

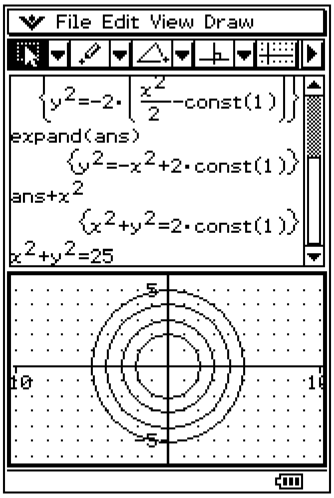


The next example is a simple differential equation, $y' = -\frac{x}{y}$. We can solve it in the main window using ***dSolve*** under ***Interactive***, and simplify the solution in a few steps:





Now I can copy the solution into the next row, and drag a number of solutions with different values of the constant into the geometry window. We get concentric circles centred at the origin.



The paddock problem

This problem was given in a national test in Sweden:

Two girls wanted to build a rectangular paddock for their horses inside a triangle of roads, 175, 140 and 105 meters long respectively. The long side of the paddock will be situated along the longest side of the triangle. One can show, that the area A(x) of the paddoc as a function of the long side is

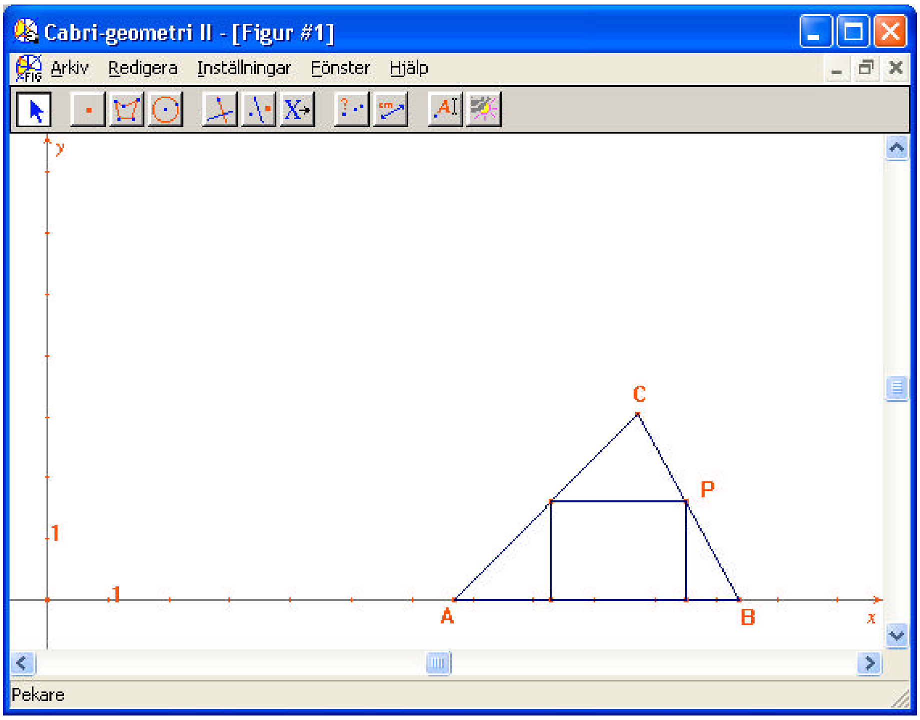
$$A(x) = 84x - 0{,}48x^2$$

What is the maximum area of the paddock?

The fact that it is a paddock the girls want to build and the lengths of the roads is just a lot of context as this problem is stated. The problem grows a lot more interesting if we remove the equation. We could even state the problem like this:

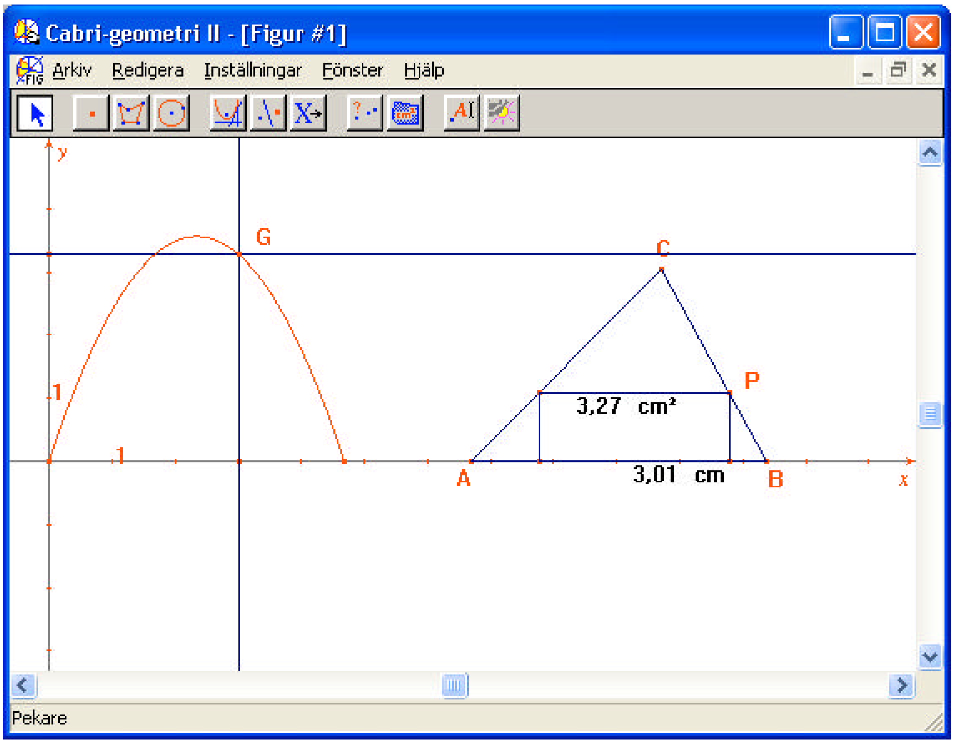
If you inscribe a rectangle in an acute triangle, what can you get?

Let's start looking at this problem in the program Cabri Géomètre. We draw a triangle ABC with the side AB on the x-axis. We draw a point P on the side BC, and out of that point we can construct a rectangle.

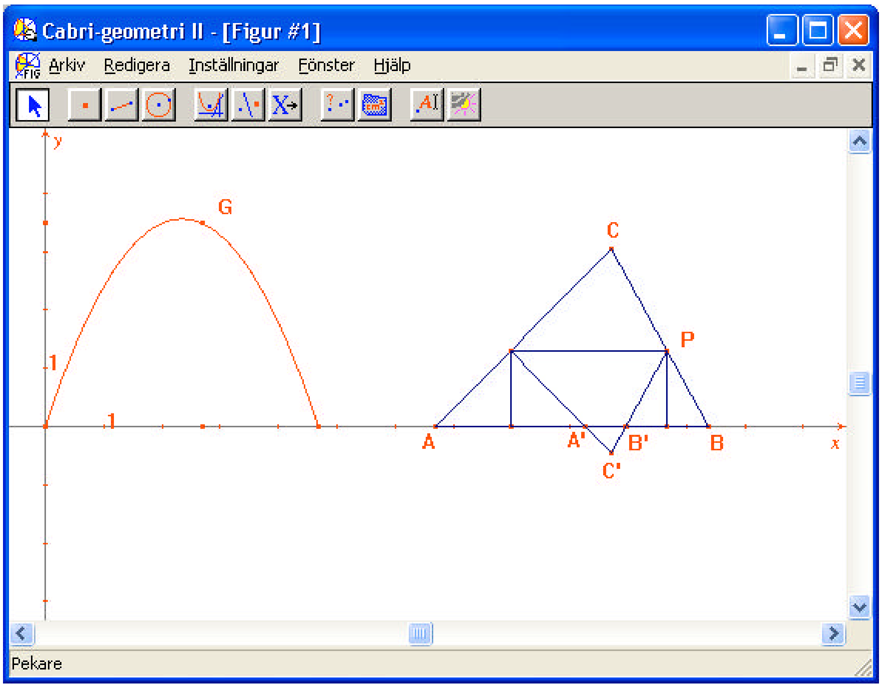


We can drag P along BC, and we can measure the rectangle area. We can also measure the length of the rectangle side along AB. These measurements will be updated as I drag P.

I can transfer the area onto the y-axis as a point, and the length of the rectangle base as a point on the x-axis. By using two perpendicular lines I can make a graph point G of a function giving the area as a function of the length. Finally I make the locus of C as P is dragged (the red curve).

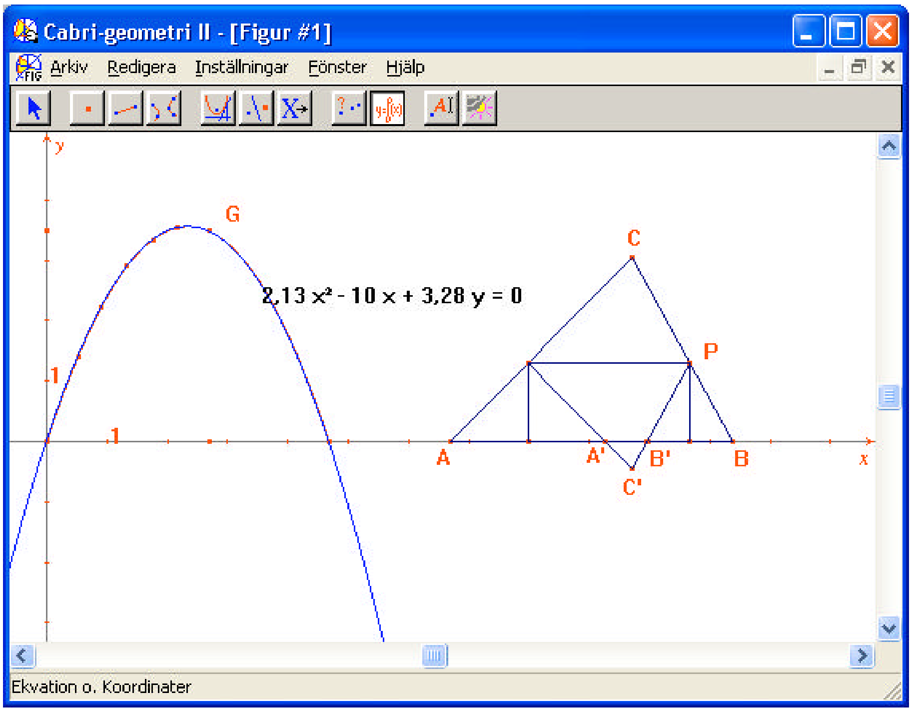


Now we can easily believe that the maximum rectangle has P halfway between B and C. By reflecting the points A, B and C in the rectangle it is reasonably easy to prove that this is the fact.

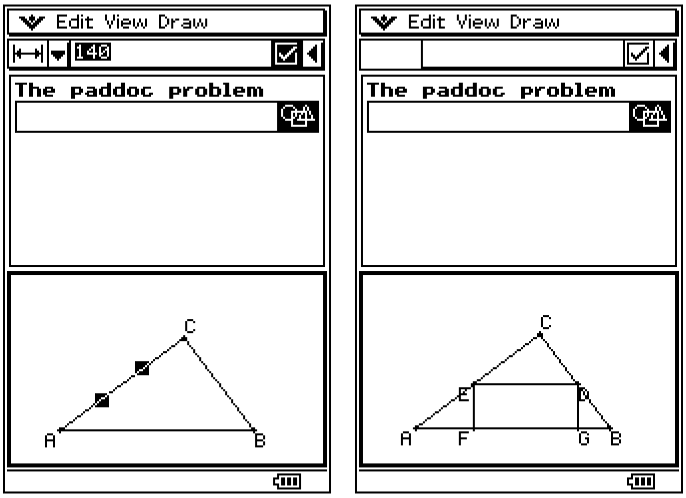


Now we also see that the maximum rectangle area is exactly 50 % of the triangle area

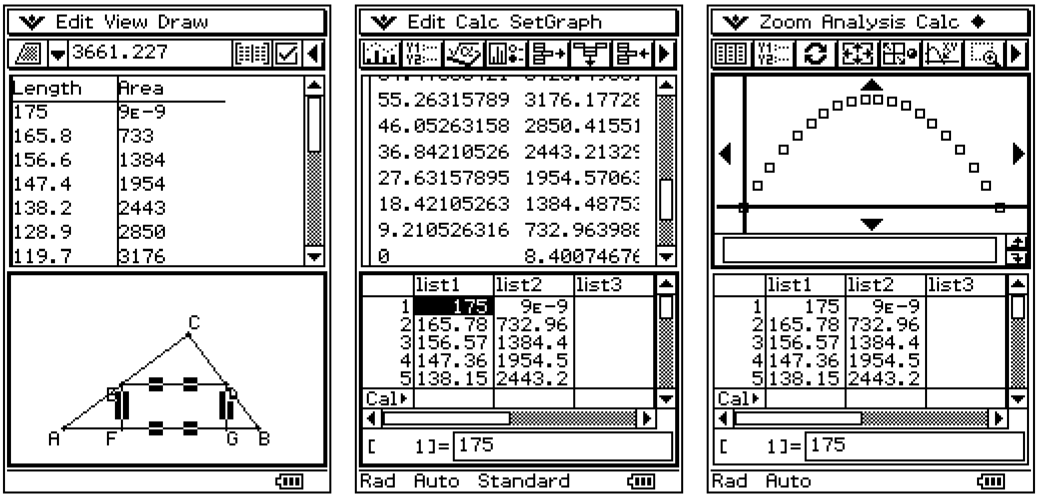
In Cabri, a conic is defined by five points, and we can attach these points to the locus curve. Then we can actually measure the equation of the curve. We have a nice second degree equation, a parabola.



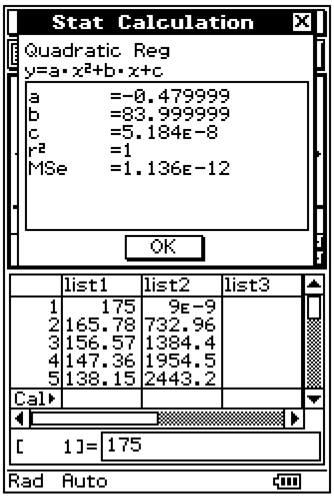
What we can do on a ClassPad that we cannot do in Cabri is to give the measures of the triangle sides 175, 140 and 105 respectively. We do that in a geometry window opened inside an eActivity. Here we also construct the rectangle.



Now I can run an animation of the point (in this case) D running along BC. From this animation I can make a table with lengths of FG and the areas of rectangle. This table I can export into a statistics window via the eActivity itself.



From this scatter plot we can use quadratic regression to find the equation that gives the rectangle area as function of its base.



The equation is $A(x) = 84x - 0.48x^2$. The junk decimals come from the fact that the regression is a numeric operation, as the area measuring is.