

Geometer's Sketchpad in Classroom

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Abstract

In an abstract subject like Mathematics, technology has a special role to play. Visualization of concepts is an effective teaching technique that ensures that the concept is learned correctly and remains with the student for a longer period of time.

The use of technology in the form of special software like Geometers Sketchpad, Graphic Calculators, PowerPoint presentations as well as On line Tutorials helps translate many of the abstract concepts into easy to follow illustrations.

The Geometer's Sketchpad is a tool to facilitate students' and teachers' visualization and exploration of mathematics concepts. Its dynamic features can support the conceptual development of students in elementary school, middle school, and high school classes, including algebra, geometry, precalculus, and calculus.

In this paper I will illustrate use of Sketchpad as a demonstration tool (as used in senior school classes) and an exploration tool (as used in middle school classes).

As a demonstration tool:

The use of this software has created new teaching possibilities. It has led to visualization of concepts of Trigonometric Functions and their graphs in a manner, which would have been impossible using the traditional methods of teaching. The students can see the graph of trigonometric functions being traced as a point moves around a unit circle. The characteristics of the trigonometric functions viz. the maximum and minimum value attained, the continuity and discontinuity of the graph, the shape of the curve etc are highlighted as the curve is traced. The abstract concept of derivatives can be demonstrated as the slope of the tangent. Dynamically changing graphs redefine the concepts.

As an exploration tool:

Use of geometers sketchpad in Middle School encourages students to explore concepts and discover various geometric results for themselves. As the software is specifically designed for geometry, easy to navigate tool bar allows the child to draw, construct and measure. Verification of Pythagoras theorem, angles in a circle, points of concurrency in a triangle are some of the results which student explore on their own.

Observation:

The use of computers and sketchpad has generated enthusiasm among the students to learning mathematical concepts. The increased activity enables them to develop and sustain interest in the subject while at the same time increasing their confidence. It has also helped to overcome the 'maths phobia' many students suffer from.

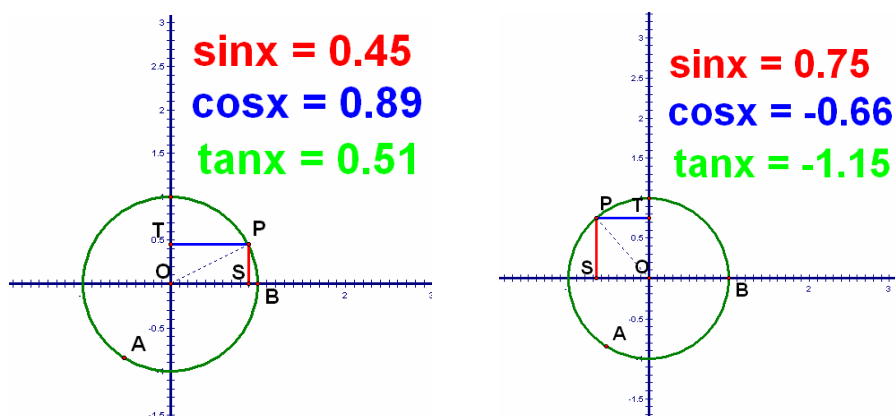
Why Geometer's sketchpad (GSP):

GSP is dynamic software that allows students flexibility in representing their ideas while allowing them to examine these representations. The program is “dynamic” and “flexible” in that when given parameters are changed, the constructions that rely upon these changes accordingly. This allows students to test conjectures (which were based on particular parameters) for more general cases, without needing to repeat their constructions. For example, if a student constructs the circumcircle of a triangle defined by three given vertices the construction should also work for the triangle obtained after clicking and dragging one of the vertices. When appropriate, students may also use the measurement tool in GSP to test conjectures about relationships of sides, angles and areas.

Animation using action buttons, display with various possible line thickness, choice of colour, “trace plotted point” tool and many other possibilities help in creating effective presentations which can present abstract concepts visually and build a strong base for further extension of the concepts.

Geometer's Sketchpad as a demonstration tool

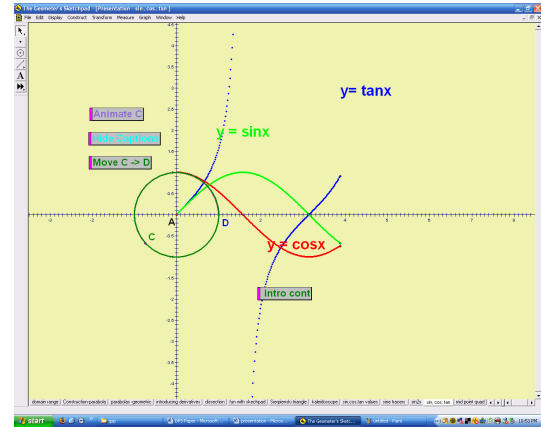
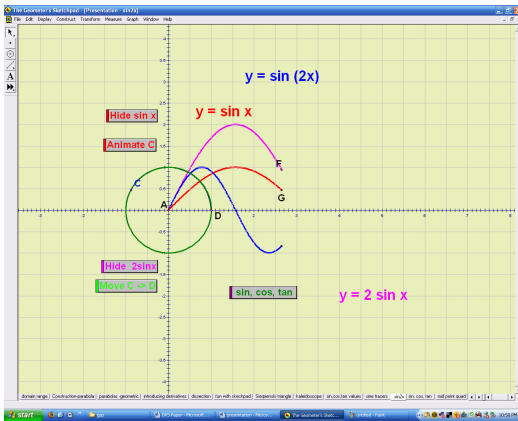
Geometer's Sketchpad as the name may suggest is an excellent software to explore Geometry, but it has many other features which are used to learn algebra, conic sections, precalculus topics like functions, circular functions, trigonometric properties, instantaneous rate, limits, derivatives and antiderivatives.



Using simple to construct activity, Trigonometric functions are defined as a point moves around a unit circle. It can be effectively shown how the signs of t-functions vary as the point moves through the four quadrant, students can also observe the change in the value of each of the t- function and record them.

Sketchpad gives us a possibility to discover the graphs of t-functions in a most interesting manner. To observe the graph of sine function (or any other t- function) as a point moves around a unit circle is quite a visual treat!!

To top this if one gets the freedom to play with two or more of them simultaneously and observe and compare the graph of $\sin x$, $\sin 2x$ and $2\sin x$ (or any other t - function) with just a click of a button, the mathematics becomes a much more appealing and approachable subject. Students are asked to make conjectures about the behaviour of various functions such as $\sin 2x$ and $2\sin x$ and then shown the curves being traced as a point moves around a unit circle and test their conjectures. With slight modifications one can trace curves of any of the other trigonometric functions as well.

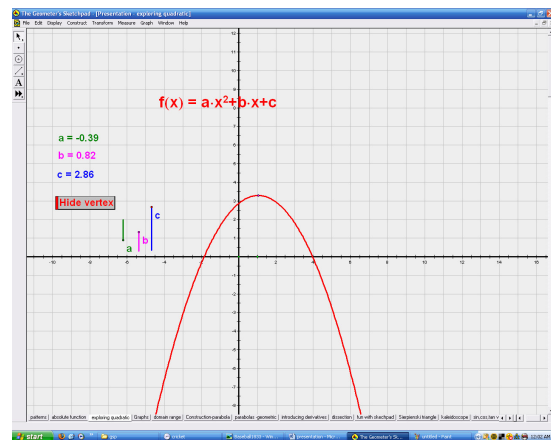
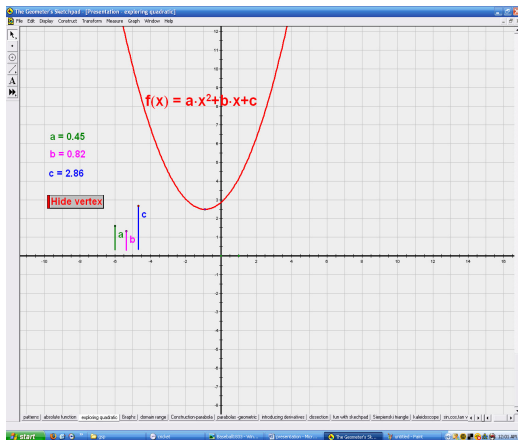


Trigonometric tracer activity takes away the drudgery of drawing the graphs on graph paper and gets the focus of students on learning the characteristics of each curve. Students can observe the

- domain and range
- maximum value and minimum value
- periodicity of each function
- symmetry
- compare graphs of various functions
- Continuity and discontinuity of a curve.

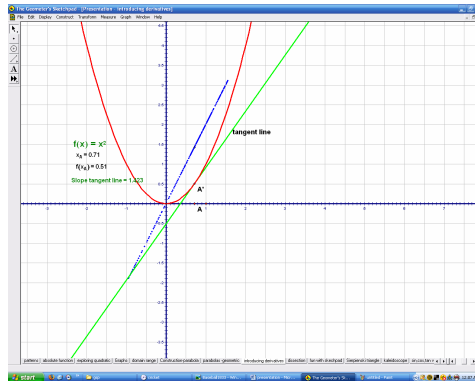
• **Algebra and sketchpad**

Linear and quadratic function can be explained with the use of sliders. Sliders allow us to change the values of the parameters like m (slope) and c (y-intercept) in straight line and values of coefficients a, b and c of a quadratic. As the student changes these values he can observe its effect on the line (curve) and make as well as verify conjectures. This enables student to understand the families of line and quadratic or any other function effectively.



- **Introducing Derivatives:**

This activity demonstrates one of the many ways *Sketchpad* can be used in a calculus or math analysis class. Students manipulate a tangent line to a curve to investigate what it means for a curve to have slope. They explore the first derivative as a function which determines the slope of the curve for different values of x and express the derivative as a limit statement.

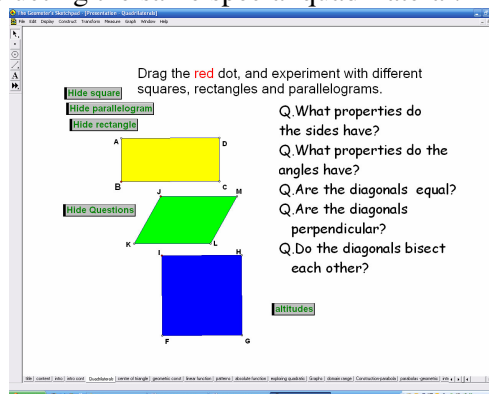


Geometer's sketchpad as an exploratory tool:

Geometer's Sketchpad is a very useful tool for teaching geometrical concepts and more, in an exciting and meaningful way. Students can construct geometrical figures onscreen and save them for future use, making them more dynamic than they would achieve by simply using a pencil and paper or a geometry set. The program's main strength, however, lies in its function as an exploratory tool that allows 'concrete operations' in many areas of maths and especially those associated with geometry and algebra. The program gives students a clearer idea of how a number of mathematical concepts work and what happens if you change certain aspects of them. Students can 'play' with the figures and gain real insight into how they operate on their own and in relation to others. This dynamic experimentation is not something that can be achieved by using the traditional tools of construction or a textbook where diagrams are static.

- **Special Quadrilaterals**

Trapezium, parallelogram, rectangles, rhombuses and squares have special properties that distinguish them from other quadrilaterals. In this activity while constructing these special quadrilaterals children came across characteristics or properties of each one of them which make them different from each other. For example while studying the parallelogram one student hid one of the diagonals and concluded that opposite angles are equal due to alternate interior angle result before using the measurement tool of GSP. While doing this activity children came up with so many different ways of constructing the same special quadrilateral.

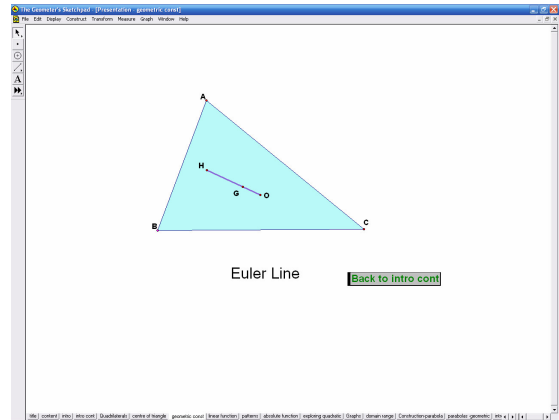
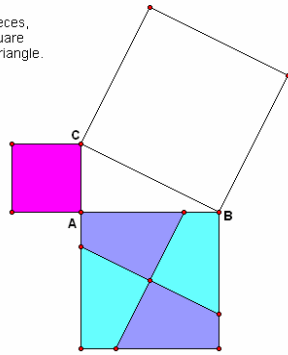


- **Triangle centers and Euler's line**

In this activity children continue to hone their skills at geometric constructions by constructing a triangle's centroid and other classical triangle centers. Then they harness sketchpad's power by turning their constructions into custom tools and then by using the custom tool constructing all the triangle centers in one triangle. The students themselves draw certain conclusions like orthocenter, centroid and circumcenter are collinear for any triangle and the distance from the orthocenter to the centroid is twice the distance from the circumcenter to the centroid.

Drag the five polygon interior pieces, rearranging them to fit in the square on the hypotenuse of this right triangle.

Reset



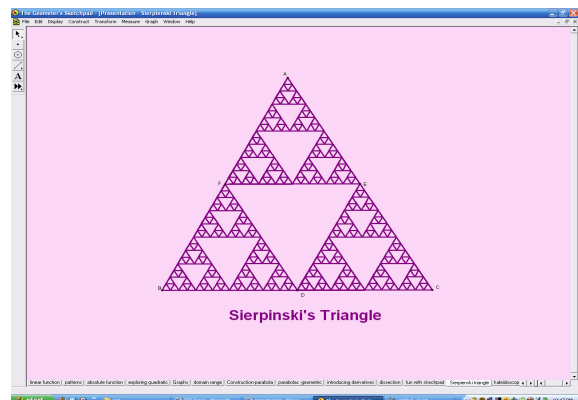
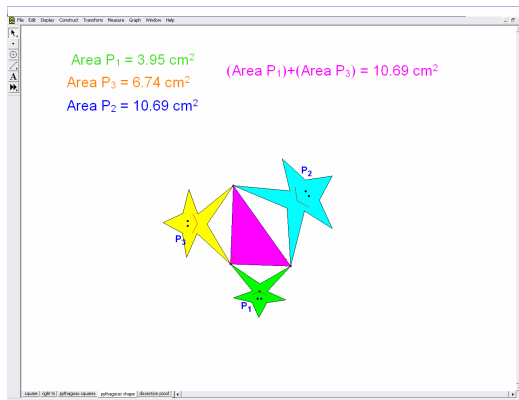
- **Alternative proof of Pythagoras Theorem**

Many demonstrations of Pythagoras Theorem involve cutting up the squares on the legs of a right triangle and rearranging them to fit into the square on the hypotenuse. These demonstrations are called dissections. Sketchpad enables us to do these proofs and also the dynamic features of the software verify the result for changing values within matter of seconds.

- **Mathematics is fun with sketchpad**

Moving away from the conventional proofs, we can show the Pythagoras theorem to hold true whenever any symmetrical figure e.g. circle, equilateral triangle or a non geometrical but symmetrical figure is described on the sides of a right angled triangle. The area of the figure on the hypotenuse is always equal to the sum of the areas of the symmetrical and similar figures on the other two sides of right triangle.

Using iterations, Sierpinski's Triangle, Koch curve, Pythagorean tree can be constructed. Students can enjoy the beauty of maths and learn beyond their curriculum.



Student's feedback

When questioned, many children said they enjoyed using the sketchpad and that it was easier and quicker than drawing the shapes on paper. They appreciated the fact that a sketchpad drawing can be instantly altered by dragging its vertices to another position.

Sketchpad gave students an opportunity to explore graphs of various functions and study their characteristics dynamically.

In our education system there will always be a place for traditional pencil and paper constructions, but it was seen that using this software encouraged the students to comment on mathematical relationships and make important generalizations. The impact of the presentations on trigonometric graphs had a lasting impact. The students could easily visualize, compare and draw the graphs.

After learning the Quadrilaterals using Sketchpad many students of grade 8 asked if they could have some other topics taught in the same manner.

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