

## A Comprehensive Graphing System on the Web: Bringing Graphs to Life

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This presentation is about a new web site that provides a unique approach to learn about graphing. The web site offers a comprehensive graphing system that is more informative, more powerful, and easier to use than a graphing calculator. It is intended for math students at all levels: algebra, precalculus, and calculus. This presentation will focus on the calculus component.

Unlike a computer algebra system, the web site requires no technology to learn, and unlike a graphing calculator, there is no need to use trial and error to determine an appropriate plotting interval. Only the function need be entered. The comprehensive graphing system determines a plotting interval that includes and identifies all the important mathematical features: local maxima and minima, points of inflection, and, where appropriate, vertical asymptotes, vertical cusps, and vertical tangents.

For calculus students, two color-coded graphs are delivered. One graph shows increasing curve segments in red and decreasing curve segments in blue, while the other graph shows concave up curve segments in purple and concave down curve segments in green. The contrasting color coding brings the graphs to life, enabling students to grasp visually the concepts being illustrated.

Graphs are of textbook-quality and include dashed lines for asymptotes (vertical, horizontal, slant, and other polynomial end behaviors for rational functions). Auxiliary graphics are also used to highlight singularities. Small filled circles are used to designate isolated values of a function or endpoints of a curve segment when a function has continuity from only one side, while small empty circles are used to designate undefined points when a function would otherwise have continuity from at least one side.

To help students learn about graphing, we start with the basics: students are requested to enter functions by type, either polynomials, rational functions, algebraic functions, or the transcendental functions—trig, exp and log. Incorrect entries are treated to a respectful message: “Oops!” For each function entered, step-by-step details are provided so that students can read and learn how important features of a graph are analyzed and determined. Learning through reading worked-out examples has been used successfully at other stages of mathematics education. The ability to interactively specify a function of interest and subsequently obtain a complete analysis of its graph adds a new dimension to learning about graphing.

The web site can be used as a standalone for independent learners or as a supplement to regular coursework. Students can use the web site to check their homework, help get past

being stuck on a graphing problem, or get an overview of graphing at their own pace. The ease of use and access via Internet make this a convenient supplement for students seeking help with graphing. The color-coding and mathematically-enhanced graphs serve to strengthen students' visualization skills and understanding of mathematical graphing.