# ED464804 2001-08-00 The Graphing Skills of Students in Mathematics and Science Education. ERIC Digest.

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**ERIC Identifier:** ED464804
**Publication Date:** 2001-08-00
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**Source:** ERIC Clearinghouse for Science Mathematics and Environmental Education Columbus OH.

# The Graphing Skills of Students in Mathematics and Science Education. ERIC Digest.

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"Instructional programs from prekindergarten through grade 12 should enable all students to:

* create and use representations to organize, record, and communicate mathematical ideas;

* select, apply, and translate among mathematical representations to solve problems;

* use representations to model and interpret physical, social, and mathematical phenomena." (NCTM, 2000, p. 66)

The effective use of representations in mathematics and science education has gained more importance as we enter the new millennium. National Council of Teachers of Mathematics even added, Representation, to their four process standards which "highlight ways of acquiring and using content knowledge" (NCTM, 2000, p.29) in their new reform document, "Principles and Standards for School Mathematics". Even though all types of representations are being encouraged in the teaching and learning of mathematics and science, graphical representations play a special role.

Graphs can summarize very complex information or relationship very effectively. Although graphs are explicitly taught in mathematics classrooms as an end in themselves, many subject areas such as science or social studies utilize graphs to represent and interpret relationships. So being able to interpret or construct graphical representations is a crucial skill for every student whether they want to pursue science or mathematics related careers. However, many researchers detected that many students lack graphing skills.

Brasell and Rowe (1993) studied high school physics students' graphing skills and they concluded that "[students] do not understand the fundamental properties and functions of graphs in representing relationships among variables." Their facility with graphs was generally superficial, grounded on a few, simplistic algorithms such as plotting data points" (p. 69). Janvier was one of the first mathematics educators to mention the problems that students have in interpreting graphs (Bell & Janvier, 1981; Janvier, 1981). Mostly he argues how global meanings of graphs and interpreting graphs are left out in mathematics classrooms, while reading data and constructing and reading certain points on graphs are emphasized.

# WHAT RESEARCH SAYS ABOUT HOW TO IMPROVE STUDENTS GRAPHING SKILLS?

In this age of technology, many researchers advocate the use of computers, calculators, Microcomputer-Based Laboratories (MBLs) or Calculator-Based Laboratories (CBLs) in improving students' graphing skills.
Mokros & Tinker (1987) studied the effects of MBLs in students' understandings about graphing. The use of an MBL or CBL allows student to collect real-time physical data such as temperature, motion, light, or sound. Then these data can be transferred into a computer or a calculator to be studied through a variety of representations such as graphs or tables. They conclude that "in three-month longitudinal study of MBL, students showed a significant gain in understanding on 16 graphing items, although the instruction targeted science topics, not graphing skills" (p. 369). They add that "MBL may also help children develop graphing skills because it eliminates the drudgery of graph production" (pp. 381-382).

Dugdale (1993) discusses the potentials for graphing software, such as Green Globs, to enhance students' understanding of functional and graphical relationships. Green Globs is a game where 13 "green globs" are randomly placed on the grid. Players earn points by entering equations that pass through as many green globs as possible. She argues that it is crucial to go beyond plotting and reading points to interpret the graphs.
Sivasubramaniam (1999) compares students' graphing skills in a learning experiment with and without the use of computers. The paper concludes that "the computer group improved significantly more than the paper group in their graphing skills from the pretest to posttest."

Many educators went beyond teaching graphs as an end to themselves and used a graphing approach to teach other mathematical or scientific subjects. Oakes (1997) suggests an approach in teaching which combines the discovery method with graphing skills in science instruction which "allows students to discover the actual laws of nature rather than be given the equation and just plug in data" (p. 35). Hollar and Norwood (1999) use graphing calculators in teaching algebra with a graphing approach curriculum in which they could focus on real-world situations. They concluded that the students in the graphing approach curriculum showed better understanding of functions than the traditional students.

# ELECTRONIC RESOURCES ON GRAPHING SKILLS

* Collecting, Representing, and Interpreting Data Using Spreadsheets and Graphing Software: Collecting and Examining Weather Data

standards.nctm.org/document/eexamples/chap5/5.5/index.htm

This site provides one of the electronic NCTM examples which are interactive activities

that support Principle and Standards for School Mathematics.

Spreadsheets and graphing software include tools for organizing, representing, and comparing data. This activity illustrates how weather data can be collected and examined using these tools. In the first part, Collecting and Examining Weather Data, students organize and then examine data that has been collected over a period of time in a spreadsheet. In the second part, Representing and Interpreting Data, students use the graphing functions of a spreadsheet to help them interpret data. Students learn to set up a simple spreadsheet and use it in posing and solving problems, examining data, and investigating patterns, as described in the Representation Standard.

* NCTM's indexes for GRAPHS and GRAPHING list articles that have appeared in three journals:

"Mathematics Teacher" (8-14 grade levels)

www.nctm.org/mt/indexes/subjects/graphs.html

"Mathematics Teaching in the Middle School"

www.nctm.org/mtms/indexes/subjects/graphs.htm

"Teaching Children Mathematics" (K-6 grade levels)

www.nctm.org/tcm/Indexes/subjects/graphs.html

* Graphing Activities

MathCentral.uregina.ca/RR/database/RR.09.97/penner2.html

This site contains ideas for 18 graphing activities.

* Graphing Equations From Software (SMILE)

www.iit.edu/~smile/ma8717.html

Author: James Webb, Harlan High School

A lesson designed to reinforce previously learned equation-graphing skills; and to develop new strategies (other than memorizing equations) for equation graphing, using "Green Globs" software.

* Interactive Algebra

www.accessone.com/~bbunge/Algebra/Algebra.html

Author: Robert Bunge

Java applets for practicing equations, factoring, and graphing skills, with multiple levels in each category.

* ExploreMath

www.exploremath.com/index.cfm

Activities create real-time correlations between equations and graphs that help students visualize and experiment with many of the major concepts from elementary algebra through pre-calculus.

* ExploreScience

www.explorescience.com

This site provides Shockwave (tm) interactive activities which offer real-time correlations between equations and graphs that help students visualize and experiment with many scientific concepts for grades K to 12.

* Valentine Candy Count (CEC)

forum.swarthmore.edu/ces95/candymath.html

Author: Judy Dale; Bosque Farms Elementary, Bosque Farms, N.M.

This site offers an activity for grades 1-4 in which students observe, sort, and predict by using Valentine candy. It uses a method through which children can explore and internalize graphing skills.

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This digest was funded by the Office of Educational Research and Improvement, U.S. Department of Education, under contract no. ED-99-CO-0024. Opinions expressed in this digest do not necessarily reflect the positions or policies of OERI or the U.S. Department of Education.

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**Title:** The Graphing Skills of Students in Mathematics and Science Education. ERIC Digest.
**Document Type:** Information Analyses---ERIC Information Analysis Products (IAPs) (071); Information Analyses---ERIC Digests (Selected) in Full Text (073);
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