

Introduction

In today's classrooms, teachers are faced with diverse student populations who have a wide range of academic levels, various learning styles, and different social needs. Teachers must be able to manage the varying dynamics of these diverse classrooms as well as increase student achievement. The graphing calculator, in partnership with the How-to Cards and projects in the *Tech Tools Resource Kit for the TI Graphing Calculators*, can be effective tools in meeting the needs of all students by promoting higher levels of thinking and increased student performance in math, science, and technology.

The How-to Cards are specifically designed for new users, as well as more proficient users, of the graphing calculator. The cards are written in a step-by-step fashion, and include a picture of the calculator, calculator screen shots, and arrows to help locate specific calculator keys and functions and their corresponding screen shots. With these features, students will be able to quickly and easily determine if they are following the card correctly and locate the appropriate keys with the efficiency of a schooled user. The repetitive language, style, and text structure of the cards, as well as the visuals, provide students at a variety of reading levels and ELL levels with the opportunity to learn how to use the graphing calculator in math and science. In addition to the How-to Cards are the problem-based projects. These projects include a Lesson Plan, Student Project Card, Data Collection Sheet, and Rubric.

The lesson plan provides both new and veteran teachers with guidelines for implementing the projects in their classrooms. The lesson plan indicates the types of calculator skills needed to complete the project, as well as the objectives students will fulfill by completing it. These objectives are correlated to each state's standards on the Teacher Created Materials website.

The Student Project Cards combine easy-to-follow steps with real-life scenarios that provide students with the opportunity to apply math/science concepts and calculator skills to authentic problem-solving tasks. From these projects, students will develop the higher-level thinking and problem-solving skills that are required on many standardized tests and that are needed outside of the classroom environment.

The Data Collection Sheet in each project provides the framework for the processes of data analysis. There is an increasing need in today's society for students to understand, analyze, and evaluate data and these sheets help meet this need. The projects not only model how to collect, organize, and read data, but also require students to draw conclusions from the data, make decisions using the data, and support their reasoning. The language arts tasks associated with many of the projects facilitate the development of the students' creativity and writing skills in math, science, and technology.

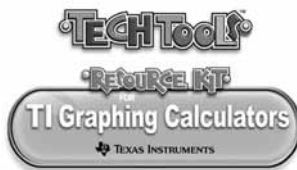
The rubric template is located in the *Management and References* book. This performance-based rubric, which is aligned with the objectives and standards, can be easily modified. It can be completed as is, or items can be added to or deleted from the existing rubric, allowing for specific goals to be set for each individual student on a project-by-project basis. The projects in the *TechTools Resource Kit for the TI*

Graphing Calculators were designed with this in mind; thus, each can be easily differentiated for various student populations, such as Gifted, ELL, and Special Education, because each project includes a variety of tasks at varying levels of complexity. Teachers can easily modify the projects to meet the students' individual needs by picking and choosing tasks that align with the students' academic goals. Additional challenges can be added to the project for those students who are performing at higher academic levels, by using the extensions listed at the end of the lesson plans.

As a technologically advanced tool, research has shown the graphing calculator to be very effective in increasing student achievement and assisting teachers in differentiating instruction. It provides teachers with the opportunity to move students beyond skill driven instruction to conceptual understanding. Based on the research compiled by Heidi Pomerantz, Dr. Waits (1993), a professor of Mathematics at Ohio State University and cofounder of the developmental program *Teaching with Technology*, maintains that “graphing calculators can improve classroom dynamics, boost students' confidence levels, and promote the understanding of mathematical concepts and functions.”

One of the proven benefits of using graphing calculators is the reduction in time needed for whole class instruction. In a recent study, students were given calculators to explore, communicate solutions, and share problem-solving dialogue with other students and the teacher when given mathematical problems. The results show that the teachers in two experimental groups gave students 28% to 30% more time, respectively, to spend on mathematical problems, compared to the teacher in the comparison group which gave students 19% more time. In the same study, students were given graphing calculators so teachers could explain the use of graphs and tables rather than using the board to create the graphs. The results show that of the teachers in the two experimental groups, 24% and 18%, respectively, gave students more time to spend on using graphs and tables compared to the teacher in the comparison group, who gave students only 1% of class time to use graphs and tables.

In addition, graphing calculators allow students access to mathematical concepts and experiences previously limited to paper and pencil. A study was conducted on 12 classes that were divided into three treatment groups—three classes in the first experimental group, five classes in the second experimental group, and four classes in the comparison group. Classes in the first experimental group used graphing calculators with all four topics: functions and graphs, rate of change and derivatives, exponential functions, and periodic functions. Classes in the second experimental group used graphing calculators with the first topic only. A pretest and posttest were given to the students, and the results proved that students in the experimental groups achieved a significantly higher mean posttest score than students in the control group. Those students in the first experimental groups, who used graphing calculators for the entire year, outperformed students in the control group. “Taken together, these results demonstrate a general advantage for low-achieving students to use handheld graphing technology as an integrated part of a pre-calculus level course.” (Interactive Educational Systems Design [IESD] 2003)



For those students who struggle with the mechanics of mathematics, the calculator helps them move beyond the frustrating calculations to higher-level problem-solving activities. In a study that included 35 middle school students using TI-73 Explorer™ graphing calculators, the students were to develop an understanding about variables, basic concepts of algebra, and explore mathematical topics. Balancing paper and pencil activities with calculator activities, the teacher introduced these concepts through numerical computation and problem-solving methods. After the study, 23 out of the 35 students had a better understanding of variables. (Demana 2000)

Math and science courses are often viewed as gatekeepers, preventing students from reaching higher levels of education. The graphing calculator in combination with the *TechTools Resource Kit for the TI Graphing Calculators* can serve as an effective key in unlocking the gate.

Demana, Franklin. "Using Technology to Prepare All Students for Success in Algebra." Paper presented at the T3 World-Wide Conference, 2000.

Interactive Educational Systems Design, Inc. (2003, May) "Using Handheld Graphing Technology in Secondary Mathematics: What Scientifically Based Research Has to Say." Retrieved January 9, 2006, from <http://education.ti.com/sites/US/downloads/pdf/execsumm.pdf>

Waits, Bert, and Heidi Pomerantz. (n.d.) "The Role of Calculators in Math Education." Retrieved January 9, 2006, from <http://education.ti.com/us/resources/therole.html>