Textbook Problems and the Graphic Calculator

(1) Introduction

The graphic calculator can be used to develop a number of different perspectives for problem solving. Some believe that the advantages of a graphic calculator can be harnessed to use real-life numerical values, giving students the means to obtain a deeper understanding of phenomena around them. However, it is our hope that the graphic calculator can be more easily used in everyday classroom instruction. Here we introduce a number of examples of classroom problems to show that the graphic calculator can also be used for the solution of general problems contained in textbooks.

The focus here is on "changes and corresponding changes in quantities" to show that the graphic calculator can be used in the lower grades as well.

Each student can use the CASIO FX-7700GE to solve any of the problems in this manual.

Application: Changes in a variable and corresponding changes in quantities

Objective: To plan and implement a class that uses problems to develop student abilities by devising methods to explain numeric relationships in a common textbook problem – "changes and correspondence."

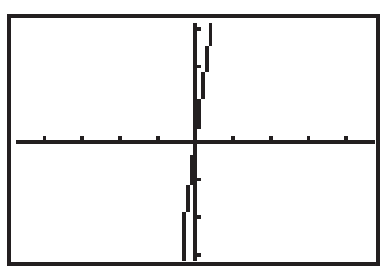
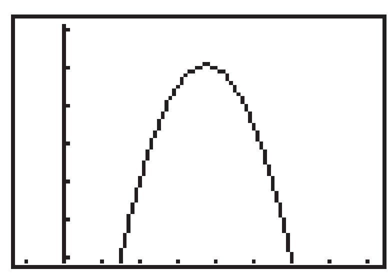
[Problem]

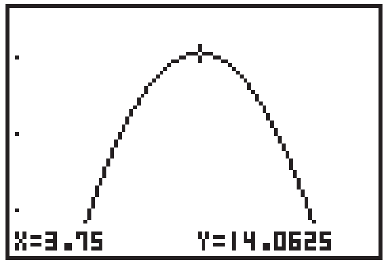
A rectangle has a perimeter of 15 centimeters.

(1) If the width of the rectangle is changed, what else also changes?
(Proceed to item (2) when "area" is understood.)
(2) If the width is changed, does the area really change?
(3) Which width produces the greatest area?

Instruction Plan (Instruction Procedure Only)

Time	Learning Objective and Development	Learning Activity (Expected Student Reaction)	Cautions and Evaluation
10 minutes	1. Confirm that changes in one quantity cause corresponding changes in other quantities. "If the width of the rectangle is changed, what else changes and what does not change?"	• Items that change: "Length of rectangle" "Area" "Length of diagonal" • Items that do not change: "Figure remains a rectangle, despite changes in width." "Figure is a rectangle, so angles do not change."	[Attitude] • Open-ended discussion deepens student interested in solving the the problem.
10 minutes	2. Determine opinions of students. "Does the rectangle's area really change?"	"The perimeter is fixed at 15 centimeters, so the length of the rectangle and the length of the diagonal must change." "Area also changes." "I don't think the area changes."	[Concept] [Attitude] • Value the views of the students.

Time	Learning Objective and Development	Learning Activity (Expected Student Reaction)	Cautions and Evaluation
	3. Confirm whether the area changes. "What methods do we have to determine whether the area changes?"	• Consideration of methods to determine if area changes "It's easy if we assign various values to length and width." "It's easy to understand if we make a table." • Self-confirmation "The area is different if the width is changed from 3 centimeters to 4 centimeters."	[Attitude] [Knowledge] [Procedure] • Try to get students to apply existing level of abilities, including grade school level concepts.
	4. Explain the effects of changes in width "If the width is changed, does area increase?"	• Consider effects of changes. "Area increases if width increases." "Area decreases if width increases." "Area increases or decreases depending on changes in width."	[Attitude] • Stress the importance of considering a number of numerical values.
25 minutes	5. Consider the case of maximum area. "Which width produces the greatest area?"	• Let the width be x (centimeters) and the area be y (square centimeters) to determine the maximum value of y. "The area is greatest when $x = 4$." "The formula is $y = x(7.5 - x)$, so we can graph it." "I think the area is greatest when the rectangle is a square."	[Attitude] [Procedure] • Stress the effectiveness of expressing the relationship as a formula.
	6. Determine which width produces the maximum area value on the screen of the graphic calculator, using the various functions of the calculator. "What does the graph look like?" "Which part of the graph do we want to focus on?" "What can we expect about the values checked using the trace function?"	• Use the graphic calculator to draw the graph for $y = x(7.5 - x)$. "The graph appears to be a straight line." (Figure 1) "I want to see more of the top." • Use Scroll to move along the axis. "It's a curve!" (Figure 2) • Determine the coordinates of the points closest to the vertex with Trace. "A width of 3.7 or 3.8 centimeters produces an area of 14.06 square centimeters. This is the maximum value." "It's strange to have two solutions."  (Figure 1)  (Figure 2)	• Prepare an extra graphic calculator. [Concept] • Have students understand that graphic representation is effective for solving problems and that themaximum value can be surmised from the graph. • Have the students determine the proper graphic calculator functions to use.

Time	Learning Objective and Development	Learning Activity (Expected Student Reaction)	Cautions and Evaluation
	7. Consider methods for determining more exact values. “Isn’t there a method for determining more exact values?”	• Use Zoom to magnify the point closest to the vertex, and check coordinates again with Trace. (Figure 3) “*y*= 14.0625 when *x* = 3.75. This is the maximum value.”  (Figure 3)	[Attitude] • Stress importance of examining the obtained values.
5 minutes	8. Conclusions “What can we say about the relationship between width and area?”	• Students learn that the area of a rectangle changes in accordance with changes in its width. • Students understand that the area of a rectangle is a function of its width.	[Understanding]

(4) Conclusion

Though students are very interested in graphic calculators, if graphic calculators are not used for actually solving problems, the significance of using graphic calculators in mathematics instruction will be lost. In short, student interest must be heightened by better methods for presenting problems and developing student abilities, so classroom teachers must consider which applications are proper for the use of graphic calculators. Each student uses many different procedures and methods for solving problems, and their objectives will not be the same even if graphic calculators are used. In the previous example, for example a width of 3.7 or 3.8 centimeters produced the greatest area, based on a table of corresponding values. However, the student who believed that two solutions seemed unlikely used a graphic calculator to confirm his doubts. That student used the graphic calculator as a “tool to aid in thinking.” On the other hand, the graphic calculator was used as an investigative tool by a student who believed there was only one correct value between 3.7 and 3.8 centimeters, and a student who thought the area was greatest if the rectangle was a square. All this means that students have many different objectives when using graphic calculators, and teachers do not have to force students use them. Instead, teachers should create an environment in which students will freely “choose to use” graphic calculators depending on their needs. The objective is to change student “interest” in graphic calculators to “realization of the potential” of graphic calculators.