Promoting Multiple Representations in Calculus: Examining Student Use of the Graphing Calculator

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In mathematics education, the availability and interest in technological learning tools, such as graphing calculators, have continued to grow. Graphing calculators continue to present new challenges in the teaching and learning of mathematics. As Kaput (1992) suggests, these new technologies resurrect 'age old questions' regarding educational goals and appropriate pedagogical strategies, as well as beliefs about the nature of subject matter and the nature of learners and their learning. Advances in calculator technology have provided an opportunity for external representations of mathematical concepts, especially in processes of learning advanced mathematics, to be presented in an accessible way through a multiple representational approach.

This short session will present the results of a study conducted with sixty-five students in first-term calculus courses at a small liberal arts university. In this course, the instructor used and emphasized a multiple representational approach for instruction and required students to use graphing calculators. The study examines students' responses to tasks presented on a final examination, and presents data from interview tasks conducted at the end of the calculus course. Very few studies have been completed that examine the role of the graphing calculator as used by the students and the students' ultimate possession of conceptual understanding via fluency among representations or via the development of a "web of connections" among representations. The researcher wanted to see which representation (graphical, numerical, or algebraic) or combination of representations students chose to use when they solved problems on their own.

As Dunham (2000) suggests, we need to conduct studies that document the way calculators are used by individual students, in search of answers to questions such as what kinds of students use the graphing calculator, how do they use it, and when are they using it and for what kind of tasks. Also, few studies thus far in this realm examine *how* the calculator is being used by the students (e.g., as a tool for exploratory or confirmatory purposes and/or for graphical or numerical representations). Furthermore, even though many of the reform calculus curricula do incorporate this kind of multi-representational instruction, the subsequent modeling of such approaches as used by students with experience and access to a graphing calculator (for example, when they solve calculus problems on their own that contain unfamiliar functions to them) has not always been examined. Therefore, this study included limit and derivative problems for the students to solve which contained a variety of functions, including some that were unfamiliar functions to the students (or with which they had little limit and derivative experience with) at the Calculus I level. Specifically, the study attempted to understand which mode(s) of representation the students chose to work in; when the graphing calculator was used and by what type of students (successful vs. unsuccessful); and whether students used the graphing calculator as an exploratory or confirmatory tool. The data provides insight into students' conceptual understanding and representational knowledge and fluency.

A primary goal of mathematics instruction at any level is to aid students in building accurate and rich concept images and understandings. And if the strength of these images is measured by the visualization and "web of connections" of multiple representations (graphical, numerical, and algebraic) of these concepts, then the role of the graphing calculator and how it affects the process by which students maintain these representations of the concepts is of utmost importance.

References

Kaput, J.J. (1992). Technology and mathematics education. In D.A. Grouws (Ed.), Handbook of research on mathematics teaching and learning (pp. 515-556). Reston, VA: NCTM; New York: Macmillan.

Dunham, P. (2000). Hand-held Calculators in Mathematics Education: A Research Perspective. In E. Laughbaum (Ed.), Hand-Held Technology in Mathematics and Science Education: A Collection of Papers (pp. 39-47). Columbus, OH: Teachers Teaching with Technology College Short Course Program @ The Ohio State University.