THE INFLUENCE OF DATA-COLLECTION DEVICES ON STUDENT UNDERSTANDING OF THE CONCEPT OF FUNCTION

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BACKGROUND AND PURPOSE

The concept of function is of critical importance in mathematics. Often taught for the first time in algebra, functions are revisited in advanced algebra and become the focal point of pre-calculus. A thorough understanding of the concept of function is then essential for success in calculus, differential equations and beyond. As early as 1930, the notion of function was referred to as the "keynote of Western culture" (Schaaf, 500). More recently, the National Council of Teachers of Mathematics has declared that the function concept should be the central organizing principle for secondary and higher mathematics (NCTM 1989).

The importance of the concept of function is also reflected in the large amount of literature devoted to this topic. In particular, the research on student understanding of the concept of function is vast and diverse (see Breidenbach, D. et. al, Eisenberg, T. & Dreyfus, T., Ponte, J. P., Thompson, P.W., Vinner, S. & Dreyfus, T.). Recently, several studies have examined the influence of graphing calculators and similar instruments on student learning in mathematics. Adams, Dunham & Dick, O'Callaghan, and Park have all reached similar conclusions in regard to the impact of these graphing devices upon student understanding of function. Their research has indicated that the use of graphing software facilitates a deeper conceptual understanding of function without hindering student performance on related procedural tasks.

These and similar studies have supported the use of graphing technology in the secondary and post-secondary classrooms and many students now study courses like Advanced Algebra and Calculus with the aid of these familiar devices. As the use of the graphing technology has grown, so too has the use of compatible data collection devices such as the Calculator Based Laboratory (CBL) and Calculator Based Ranger (CBR), both products of Texas Instruments. These devices and others like them allow students to quickly gather data on height, distance, time, volume, pressure, temperature, and several other variables. This data can then be transferred to a graphing calculator for further investigation and analysis. The functionality, portability, and relatively low expense of these data collection devices has made them popular in both science and math classrooms.

Despite the growing popularity of these data-collection devices, little research exists on the effect of these instruments upon student understanding. The purpose of this study then is to examine the influence of these data-collection devices on students' understanding of the concept of function.

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METHODOLOY

The subjects of this study are all students at a large Midwestern high school. The experimental group is composed of students from a senior level Interdisciplinary Math and Science course which made extensive use of the CBRs, CBLs, and graphing calculators. The control group is made up of representative peers from several pre-calculus sections in the high school. Both groups were exposed to the same function-based curriculum in their courses and both groups were taught with the aid of a graphing calculator (specifically, the TI 83). Many of the students from both groups also had the same mathematics instructor. However, only those in the Interdisciplinary course were given the opportunity to collect real world data by using the CBLs and CBRs.

How did the addition of these data-collection devices affect the mathematical learning of these students? In particular, did the ability to use these instruments influence the students' understanding of the concept of function? Did the application of these devices have any impact upon the procedural skill of these students? This research seeks to provide answers to those questions.

The thirteen students from the Interdisciplinary course were compared to their thirteen peers from the traditional pre-calculus sections using two forms of assessment. One instrument required the students to construct a concept map for the concept of function. The role of concept maps in assessing mathematical understanding can be further studied in Williams (1998). These concept maps were then scored by three independent evaluators using a rubric established by Mann (p. 105-108). The students were also given a small traditional exam consisting of questions typically seen on the pre-calculus final. The intent was to compare both their conceptual and procedural understanding of functions.

RESULTS

The concept map results indicate that the students with access to the CBLs and CBRs had significantly ($p<.05$) higher scores on the concept maps than their pre-calculus counterparts.

Table 1.1 Concept Map Summary Statistics

	Number	Mean	Standard Deviation
ADAGE	13	79.2	15.2
Pre-calculus	13	69.1	13.7

The results from the traditional function exam reveal that there was not a significant ($p>.05$) difference in the procedural skills of the students.

Table 2.1 Function Evaluation Summary Statistics

	Number	Mean	Standard Deviation
ADAGE	13	27.7	10.9
Pre-calculus	13	29.5	5.8

The general conclusion is that students who used the CBLs and CBRs on a regular basis developed a richer conceptual understanding of function than their

peers who used only the graphing calculators, In addition, these students were able to achieve this deeper conceptual understanding without sacrificing valuable procedural knowledge. This researcher believes that this enriched conceptual understanding can be attributed to the ability of the CBLs and CBRs to expose the students to real data, real analysis, and real applications of mathematical functions.

The results from this small study are not enough to conclude that data collection devices should be a part of every pre-calculus classroom. However, the findings do indicate that these instruments have a positive influence on student understanding of the concept of function and that more research should be dedicated to the further examination of the role and impact of data collection devices in the math classroom.

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