

Chapter 14

Dynamical Software and the Derivative Concept

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ABSTRACT

Modern teaching trends impose the need of spending less time on the manipulative approach to differential and integral calculus, putting the accent on the conceptual understanding of the subject. This chapter presents the standard approach and method used to teach the derivative of a function and indicates some critical points in the teaching of the derivative, offering, at the same time, suggestions for overcoming them. As a supplement, the author gives e-resources that can make possible the implementation of a stimulating, visual, dynamic, and broadened method for teaching the derivative of a function.

INTRODUCTION

The National Council of Teachers of Mathematics (NCTM) Standards of America called for a mathematics curriculum that “emphasizes conceptual understanding, multiple representations and connections, mathematical modeling, and mathematical problem solving” (NCTM, n.d.).

The representation process includes the use of different models for organizing, memorizing and exchanging of math ideas with the aim of solving math problems and for a better interpretation of mathematics. Such models can be used for mathematics to be “seen, touched, presented” by use of multimedia materials, diagrams, graphic reviews or symbolic expressions. Representation should become an important supplementary element in teaching mathematics; so every teacher

should choose a particular type and amount of representation materials to enrich the conventional form of a math lesson.

Representation—graphic and otherwise—in the function of reasoning has been explored by many researchers. One conclusion is that switching representations may often be a key to problem solving (Samdani, 2009). The standard representational forms of some mathematical concepts, such as the concept of function, are not adequate for students to construct the whole meaning and grasp the whole range of their applications (Monoyiou & Gagatsis, 2008).

The question, i.e. “How can a mathematical concept or relation be represented?,” on the other hand, invites an answer to how a mathematical concept can be ‘represented as’ and it concerns our attempts to visualize the concept in a particu-

lar context for a particular problem solving task (Portides, 2008).

Finally, in order for future teachers to make an effective use of multiple representations in their teaching, they themselves need to experience and explore the potentials of technology as a learning resource rather than a computational device. As NCTM suggests, digital technologies provide visual models or representations that many students are unable to generate through their independent efforts (Ozmantar et al., 2010).

Calculus is the name for the symbolic calculation of the rate at which a function changes (differentiation). Derivatives and their applications are studied as a part of differential calculus which is one of the most important areas of mathematical analysis. In general, we can say that derivative is a measure of change, so its application helps in finding the area of monotony, concave monotony, finding the points of local extrema, and so on, which is extremely helpful in solving many engineering, financial and other real-life problems; Consequently, full mastery and understanding of the fundamentals of differential calculus is a requirement for every student.

BACKGROUND

The major obstacle to understanding the teaching of differential calculus is a large number of complex mathematical and dynamical concepts that the students did not encounter in their previous schooling. It is well known that students have great difficulty with the concept of the limit, derivative and integral, which are strongly linked. Currently many students are unprepared to study calculus, see no relevance in the topics taught, and fail the calculus course (Anderson & Loftsgaarden, 1988).

To alleviate these difficulties and obstacles, teachers often make the mistake of trying to reduce the teaching of differential calculus to a series of manipulative rules, which is still unacceptable for students, because it does not contribute to the

fundamental, conceptual understanding of the matter in question. Why calculus cannot be made easy? What is the role of technology in teaching and learning calculus?

Modern teaching trends impose the need of spending less time on the manipulative approach to calculus, putting the accent on the conceptual understanding of the subject. The various technological tools (e.g., graphing calculators, Web-based mathematics applets, etc.) could be integrate in a high level mathematics course (e.g., Calculus) in order to stimulate visual, dynamic and broadened method for teaching the derivative of a function.

If mathematicians need to think visually, why do we keep such thinking processes from students? The dynamic nature of calculus should be in conjunction with a dynamic/interactive method of display. The Internet has many e-resources to help students get an intuitive feel and to visualize the derivative concept, allowing visual demonstrations and individual investigations into the mathematical ideas, which suggest new ways of approaching the derivative. This paper considers different ways in which student process information and focuses on the need to complement deductive thinking with different aspects of the derivative through numerical, symbolic, and graphical representations.

This form of learning is not a replacement for formal deduction, but a complement to it. It enables the less able student to grasp essential ideas that would previously be too difficult when framed in a purely formal theory.

The choice of the e-resources available on the Internet and used in this paper, simulates in an interactive, visual and animated way the very fundamentals of the differential calculus processes; the fundamentals which are, by their nature, dynamic and active. A flexible, graphic approach to calculus is based on our sensory perception of some physical activity of what we see changing and of how fast it changes, which is-inversely- related to the accepted symbolic meaning. That explains

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