ISSN: 2319-5967
ISO 9001:2008 Certified
International Journal of Engineering Science and Innovative Technology (IJESIT)
Volume 2, Issue 2, March 2013

Computation and Education: Teaching Of the Derivate

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***Abstract*— The present article presents the outline of an approach to the concept of derivative through the handling of tables and graphs that allow us to work with the derivative function. For this purpose we developed a theory of educational software taking semiotic registers of representation proposed by Duval and based on it to propose a series of educational activities.**

***Index Terms*— Calculus, Derivate, Software, Teaching.**

I. INTRODUCTION

This article describes the initial part of an alternative, which is under development for the teaching of the concept derived from analyzing the rate of change is obtained by taking two points on a given function. For this purpose educational software was developed which have different semiotic registers of representation [1]-[3]. As a starting point begins with registration number representation, by introducing ideas related to arithmetic and then interleaving the semiotic register of graphic representation. The authors also note that numerical and graphical treatment of the concept of rate of change is an important basis for further addressing the concept of derivative. Moreover, as mentioned by Mejía [4] (p. 316) "Regarding the handling of tables are very few studies about their treatment" so we consider important to encourage this type of approach, since according to what he says Confrey [5], the algebraic representation of functions obscures the numerical functional connection to a significant extent. Tables can help make sense this connection, part of this type of approach is reflected in the examples presented in the book "Functions on Context" [6] and we have extended such that would allow us to introduce, explicitly, the notion of increase and rate of change.

II. THEORETICAL ASPECTS

It is important to note that various studies have shown that the conversion of a semiotic register of representation to another, causing a conflict that is not trivial; for example Hitt [3] (p.63) errors detected "no context (analytically) the independent variable that appears in a graph," Duval [7]-[9] states that it is most difficult step of an algebraic graph was not so in reverse. Taking into account the ideas on the construction of concepts that provides the theory of semiotic registers of representation proposed by Duval [7]-[9], has highlighted the importance of activities in which the tasks of treatment in the same representation and conversion among representations of mathematical concepts is the core issue. A very clear example on the issue of functions, which is non-proper application of the theory of representation is usually the learner of mathematics tasks are proposed conversion of a representation as to its corresponding algebraic and graphic is unusual to be asked for the reverse process, that is, given a graph of a function, build an algebraic expression associated with that graph. It has also been reported by many researchers that a large majority of mathematics teachers emphasize too much activities in a single system of representation is algebraic.

Another important aspect is to develop in students the ability to display mathematics Hitt [10]-[12]. It understood in terms of what can help a student in solving problems. The display has to do with mathematical understanding of a statement and the implementation of an activity that while not carry the correct answer to the solver itself can lead to the deepening of the situation you are dealing with. One feature of this display is the connection between representations for finding a solution to a given problem. One potential approach of starting with a numerically because students this kind of work is easy and interesting and can motivate the student in finding their own solution strategies to solve problems that are posed in the activities. In some of the new texts are introduced numerical ideas but no activity is carried out on them deeper. In this proposal will further the construction of the concept of derivative pushing numerical approaches.

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III. METHODOLOGY

A) Blocks of the sequence of learning

In the next block the sequence of learning is proposed with this alternative numerical-graphic: The figure 1 shows the first arithmetic progressions related option, this option proposes to carry out a numerical and graphical work. The basic idea of this first section is to highlight the ideas of a variable increase in the rate of change or rate of increase.

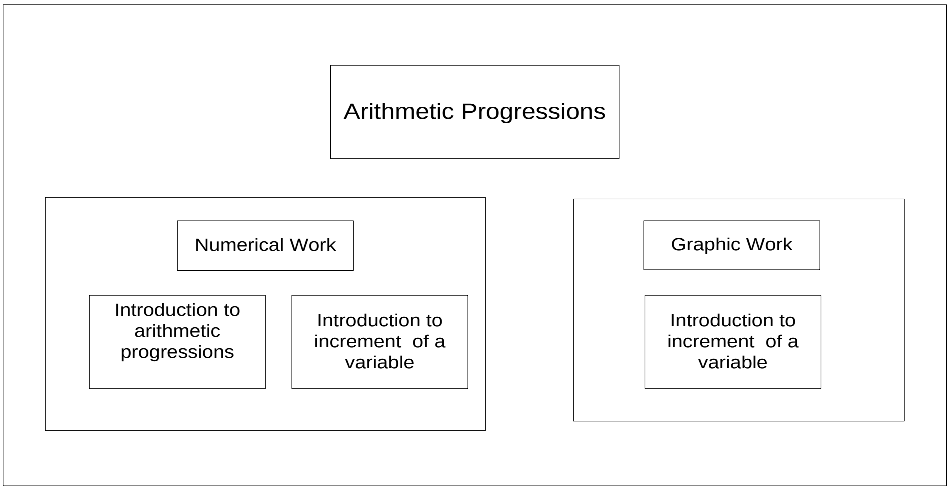

Fig1. First Arithmetic progressions

In block no. 2 (figure 2), it is left to work with arithmetic progressions to start with continuous functions, such as linear, quadratic, cubic, sine etc. From how you get to know the rate of change, building a feature, called rate of change function, which is graphic and can be manipulated with the aim of find the relationship between this new function and derivative function.

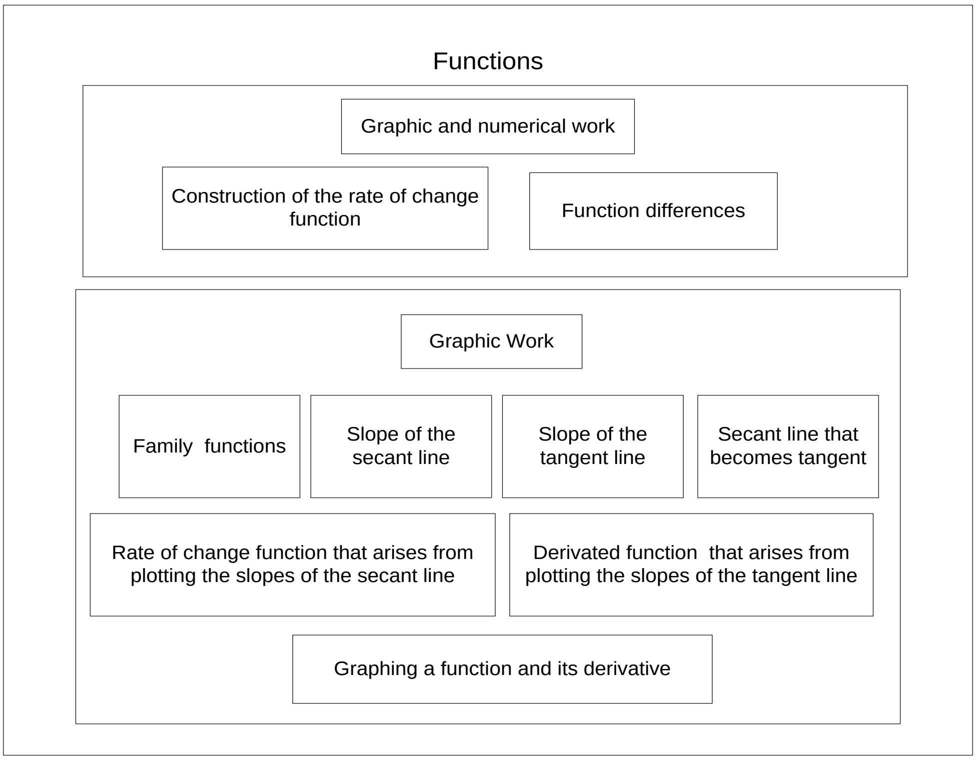

Fig 2. Block No. 2

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These two blocks, which are contained within the software developed, allow a numerical and graphical treatment as well as venture into the conversion between these two semiotic registers of representation. A third block, which is implemented in the software and is outlined below, allows conversion tasks between the semiotic register of representation and algebraic number. Block no. 3 (see figure 3), which is not yet incorporated into the software, is to start work on the algebraic representation semiotic register, in order to find algebraic expressions of the different tables of values you have.

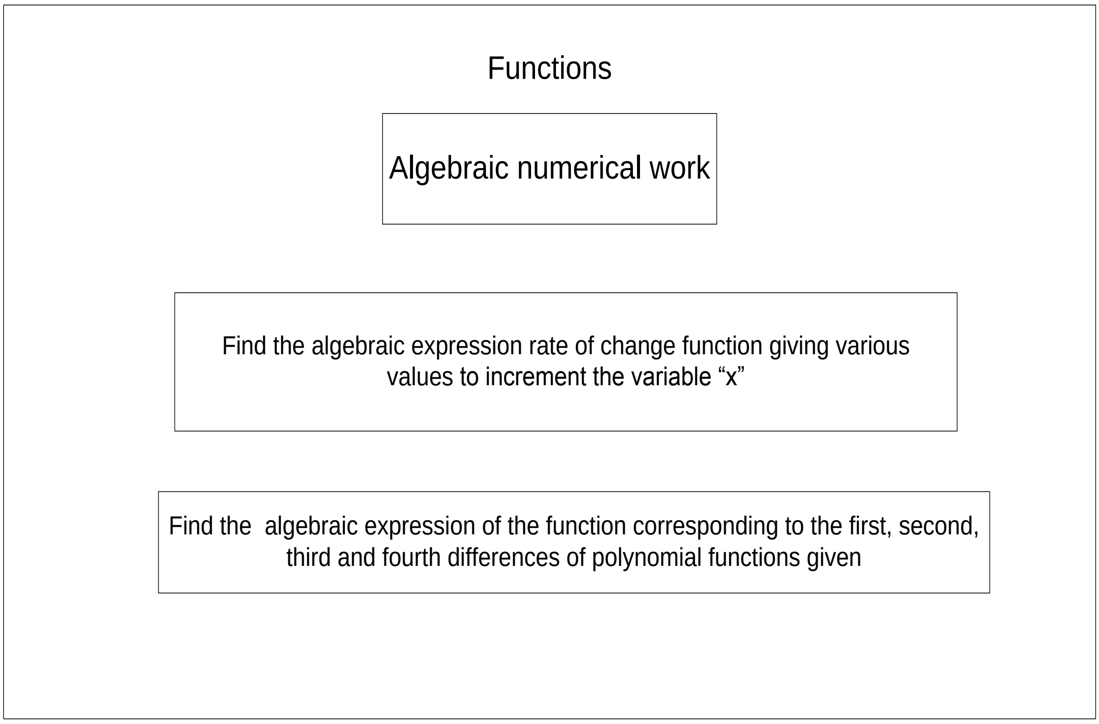

Fig 3. Block No. 3

B) Block 1: arithmetic progression

Through the presentation of arithmetic progressions motivate students to accept the challenge of solving a problem. The initial facility allows students to understand the task to be solved and allows you to gain confidence. We propose an introduction and four levels of presentation. The introduction allows constructing the definition of what is an arithmetic progression. It is done through exercises (for example to make the difference between consecutive terms and ask for them unlike others), also introduces the terminology used throughout this first module, for example: What is position, What is the value?, What is the difference? and Why is it appropriate to order the progression as a table?

The figure 4 shows an arithmetic progression that contains blank spaces and must be completed by the student. Initially the variable is called "value". As in the following levels will work with two related arithmetic progressions (see Figure 5) will call the first position an arithmetic progression since it corresponds to the element's position and the second will be called value that corresponds to the value of the item. This relationship is presented in tabular form and dissimilarity between levels lies in the way it is shown the position, which will change the degree of difficulty to find the next items. Then explain each of the levels and give an example.

valor	18	26	34					

Fig. 4

posición	1	2	3	4	5	6	7	8
valor	3	5	7	9	11	13	15	17

Fig. 5.

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Level I - terms are presented in which position the difference is always 1 (Fig. 6), such that their values have a difference between 1 and 10. The ratio for position-value is displayed in tabular form, where some of the values and will not be given to user input the value that corresponds to the position question. First, some values are generated, asking the following values (progression).

posición	1	2	3	4	5	6	7	8
valor	4	8	12					

Fig. 6.

Level II - terms are presented in which position the difference is other than 1 but constant (Figure 7), such that their values have a difference between 1 and 10. The strategy employed at this level is similar to that used in Tier II.

posición	1	6	11	16	21	26	31	36
valor	9	19	29					

Fig 7.

What happens at Level I and Level II. The way in which students work these two levels, which incidentally makes them very easy, is to obtain the difference between the two positions. After obtaining this result is added to the last value displayed. That is based on Figure 1 would in position 2 value is 8 and in position 3 the value is 12, subtract 12-8 = 4, so add 4 units for each position. Now, at level II there is a difference between the positions but as this difference is constant, according to the data shown, the strategy employed in the level I still correct, so the student level I and II in practice are the same.

Level III - Presents the position so that the difference is other than 1 and is not constant, the value will be a difference between 1 and 10 (Figure 8). The strategy employed at this level is similar to that used in Tier II, adding large positions in order to derive a formula used to calculate these values.

posición	1	4	15	18	30	49	58	77
valor	3	12	45					

Fig. 8

Level IV - Presents the position so that the difference is other than 1 and is not constant (Figure 9). Data for the value appear in different positions. The strategy employed at this level is similar to that used in Level III, adding empty spaces between values in order to derive a formula used to calculate these values.

posición	1	5	16	28	35	39	53	56
valor	3		78					

Fig. 9

To solve exercises III and IV levels must make explicit the strategy used in levels I and II, is obtained as the value increases with increasing a position, that is, they're getting the rate of change. The level III and IV, students, a challenge greater degree of difficulty, in fact in some experiments we see that the solution is not trivial and few succeed. This is due to the lack of information; the information on these issues is not presented explicitly, which is done through work in increments. One way of explaining the information to help solve the levels III and IV is given showing how the increases. Figure 10 shows an exercise for the level II and in Figure 11 one level II. From here introduces an approach to visual appearance (Fig. 10 and 11). This first approach can introduce the notion of increase in rate of change and secant line becomes tangent, points will be crucial over the proposal.

Inc. Posic	6	6	6				
posición	1	7	13	19	25	31	37
valor	5	29	53				
Inc. valor	24	24	24				

Fig. 10

Inc. x	2	19	9				
x	1	3	22	31	45	63	80
y	7	11	49				
Inc. y	4	38	18				

Fig. 11

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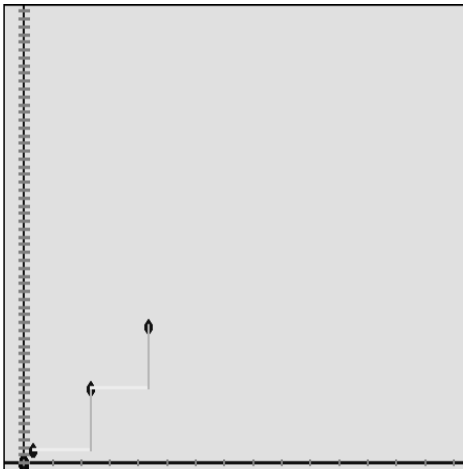


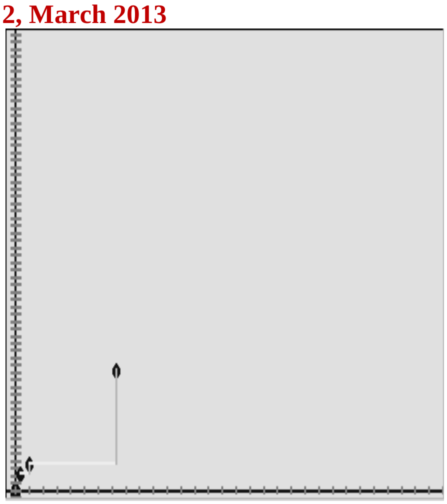


Fig. 12. **Fig. 13**

As seen in Figure 12 is representing the information shown in Figure 10 and Figure 13 corresponding to Figure 11. We have indicated the increase of the position (increasing x) as a horizontal line (yellow) and the increase in value (and increase) as a vertical line (green). Based on these figures (12 and 13) can explain the relationship between what we are getting, i.e. the rate of change, and what is the slope of the line joining two points.

C) Block 2

In relation to the block No. 2 is working with families of continuous functions, begins with polynomial functions up to degree 3 (linear, quadratic and cubic) continuous with trigonometric, logarithmic and exponential concludes.

D) Construction of the rate of change function

When selecting a polynomial function, such as a linear function given the information as a table of values as a function of both the increases (see Figure 14) and seeks to fill the table for rate of change function (Figure 15) which is the result of dividing the increase in and between the increases in x.

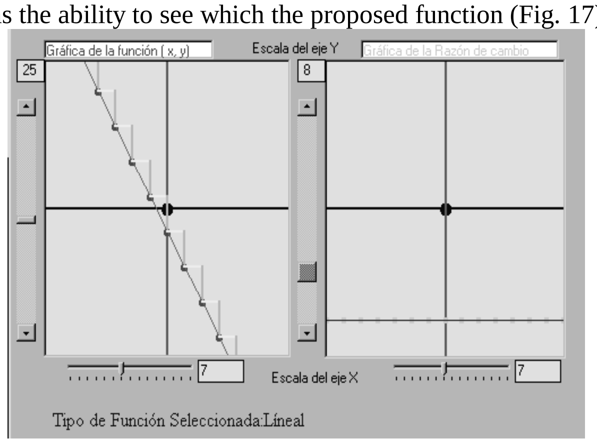
Inc. x		1	1	1	1	1	1	1
x	0	1	2	3	4	5	6	7
y	-4.	-10.	-16.	-22.	-28.	-34.	-40.	-46.
Inc. y		-6.	-6.	-6.	-6.	-6.	-6.	-6.

Fig. 14.

x	0	1	2	3	4	5	6
R. Cambic							

Fig. 15

It also provides information in a graphical format of both the linear and the rate of change function (Fig. 16) as well as the ability to see which the proposed function (Fig. 17) is



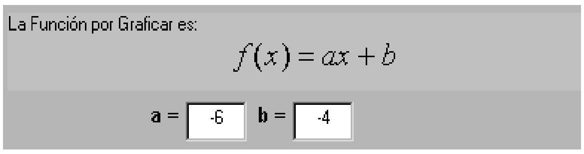


Fig. 16 **Fig. 17**

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Using the tables of values is given in the graph of the linear function to move from one point to another must move in the x-axis (increasing x) and go up or down in the y-axis (increasing y) and that the union of the points proposed in the first table, is actually the slope of the hypotenuse of the triangle formed by each. With this graph we can also explain that the slopes in each of the triangles, in this case, is always the same, ie is constant so the graph of the rate of change is the graph of a constant function.

Let's see if we have a cubic function as follows: The table is shown in Figure 18, the graph of the function and the rate of change function is shown in Figure 19. By extending the graph of the cubic function (Figure 17) we can see that now the slopes of the triangles formed by the hypotenuse is different and that the behavior of the values of the different slopes is so square. That is, the rate of change function is quadratic.

Inc. x		1	1	1	1	1	1	1
x	0	1	2	3	4	5	6	7
y	1.	1.	15.	55.	133.	261.	451.	715.
Inc. y		0.	14.	40.	78.	128.	190.	264.

Fig. 18

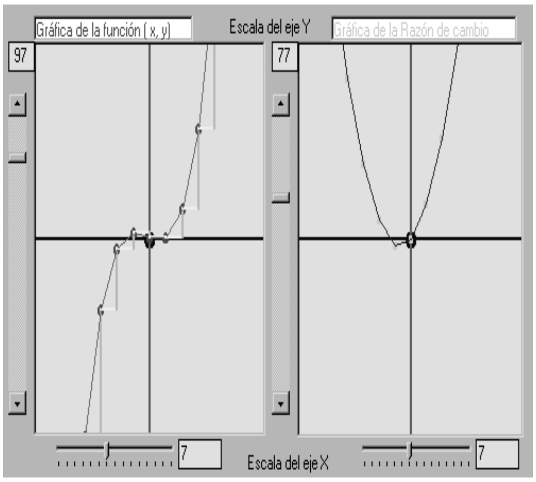

Fig. 19

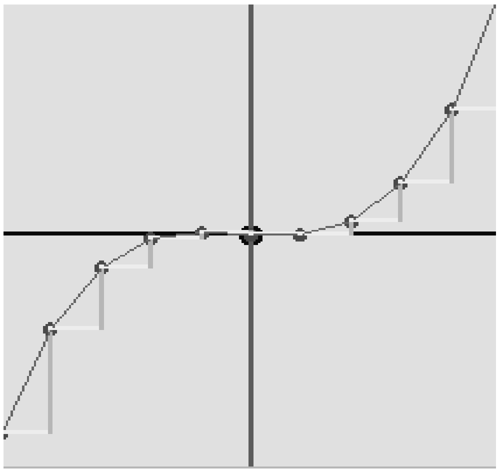

Fig. 20

On the other hand, further expanding the graph above and taking the origin as the centre (see Figure 21) we see that there is a triangle in which there is a decrease in the increase and that is through this kind of relationship we explain the sign of the slope of a line (elevation and is equivalent to increasing positive slope of the increase and decrease amounts to a negative slope, whereas the increase of x is always from left to right).

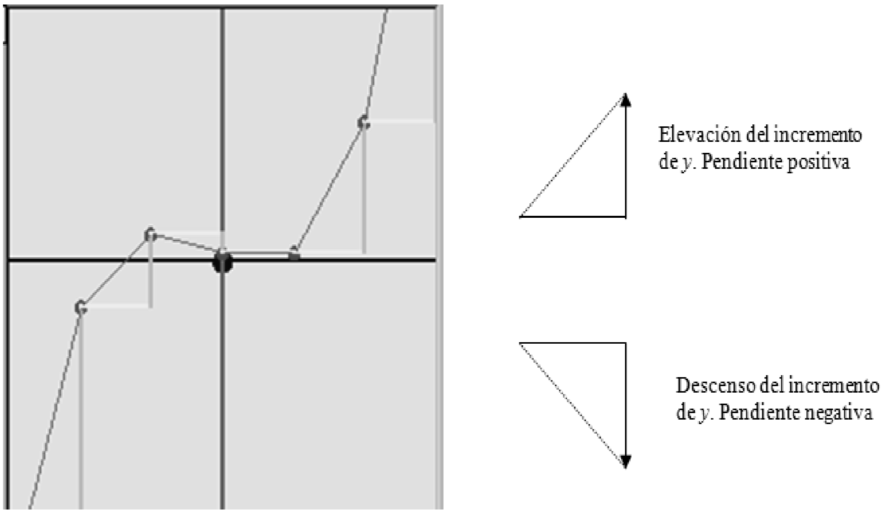

Fig. 21

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Now if we get the numerical value of the slope in each of the triangles formed by linking each data with a corresponding value of x, we will be building a new function (see Figure 22) in which each point is given by P (x , value of the slope) and this new role will be similar to the derivative function.

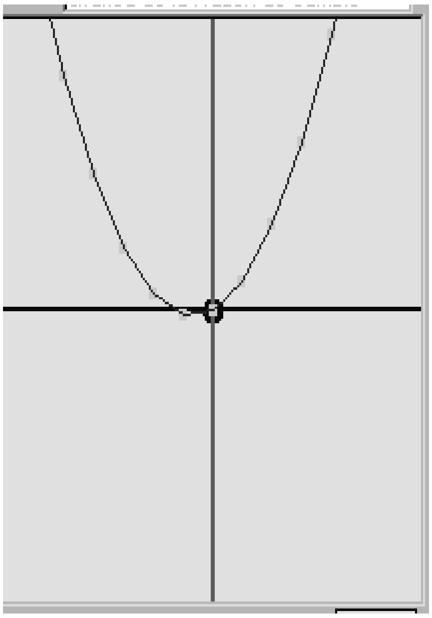

Fig. 22

E) Feature differences

In this same block, we propose an analysis of the functions, especially polynomial, by reviewing the differences in different degrees, for example, first, second and third differences. The purpose of this approach is to visualize how different each represents a new function. In the case of each difference is reduced polynomial degree of the polynomial. For example, in Figure 20 is shown numerically the function $f(x) = -x^3 - 3x^2 - 3x - 1$ is a cubic function, in the first increase and represents the function $f(x) = -3x^2 - 9x - 7$ is a quadratic function, the second increase and is linear, the third increase of y $f(x) = -6x - 12$ is the constant function $f(x) = -6$.

Inc. x		1	1	1	1	1	1	1
x	0	1	2	3	4	5	6	7
y	-1.	-8.	-27.	-64.	-125.	-216.	-343.	-512.
1°Inc. y		-7.	-19.	-37.	-61.	-91.	-127.	-169.
2°Inc. y			-12.	-18.	-24.	-30.	-36.	-42.
3°Inc. y				-6.	-6.	-6.	-6.	-6.

Otra Función

Fig. 23

These functions are built considering the following tabular relationship:

$f(x) = -3x^2 - 9x - 7$ is obtained from (see fig. 24)

x	0	1	2	3	4	5	6
1°Inc. y	-7.	-19.	-37.	-61.	-91.	-127.	-169.

Fig. 24

$f(x) = -6x - 12$ is obtained from (see fig. 25)

x	0	1	2	3	4	5
2°Inc. y	-12.	-18.	-24.	-30.	-36.	-42.

Fig. 25

$f(x) = -6$ is obtained from (see fig. 26)

x	0	1	2	3	4
3°Inc. y	-6.	-6.	-6.	-6.	-6.

Fig. 26

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F) Artwork

Family of functions

Given a polynomial of degree three, of the general form $f(x) = ax^3 + bx^2 + cx + d$ through the modification of the parameters *a, b, c* and *d* we can observe their behavior. Figure 27 shows the graph of the function $f(x) = x^3 + 3x^2 + x + 1$ if we vary the parameter b to a negative value will function $f(x) = x^3 - 3x^2 + x + 1$ represented in Figure 28.

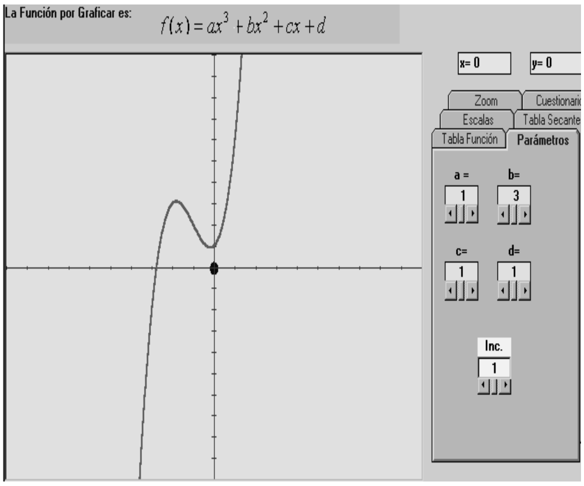

Fig. 27

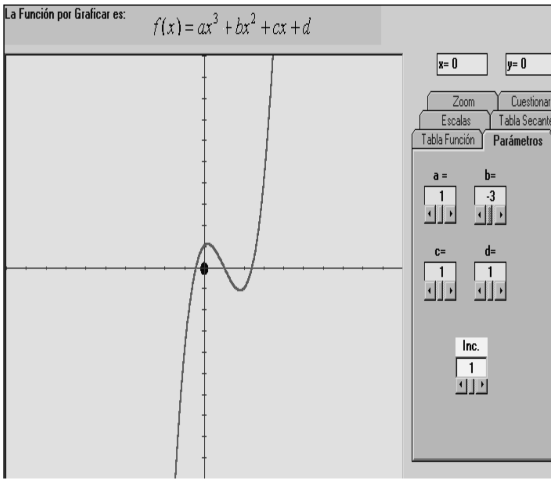

Fig. 28

That is by modifying the parameters *a, b, c* and *d* we obtain a family of polynomials (cubic, quadratic and linear).

Slope of secant line

Plotting a function as $f(x) = x^3 + 3x^2 + x + 1$ and draw on two points on the graph a secant line, we can visualize the variation of the slope of this secant line if we go through the function (see Figures 29 and 30).

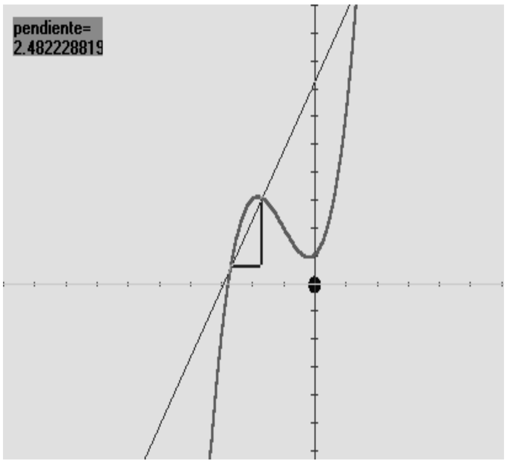

Fig. 29 ***Slope of tangent line***

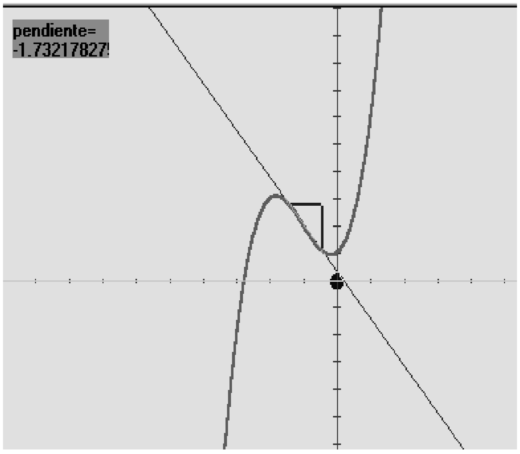

Fig. 30

Plotting a function as $f(x) = x^3 + 3x^2 + x + 1$ and draw on one of its tangent line, we can visualize how varied the slope of the tangent line if we go through the function (see Figures 31 and 32).

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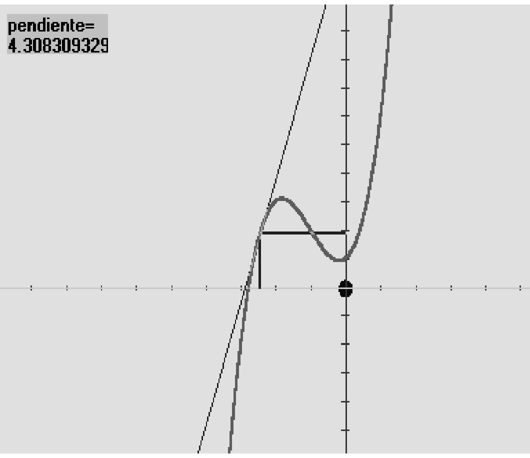

Fig. 31

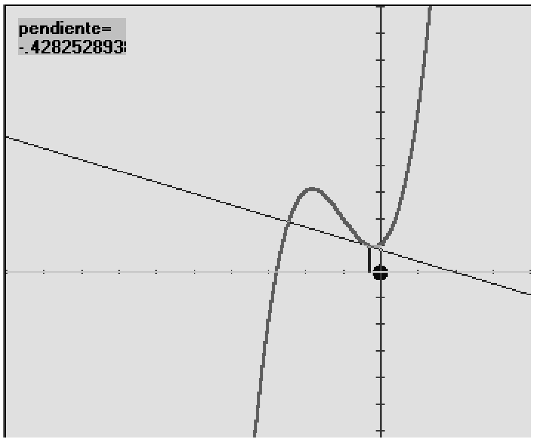

Fig. 32 Secant line becomes tangent

By varying the increase of *x* we can visualize how the secant line becomes the tangent line. In Figure 33 the increase of *x* is 1, in Figure 34 is 0.5 and Figure 35 the increase of *x* is 0.2.

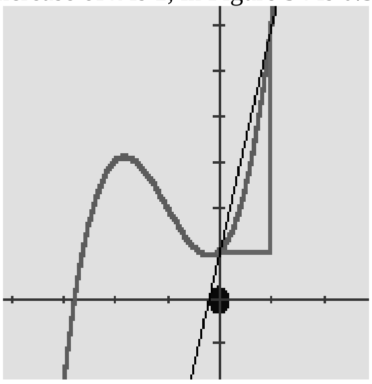

Fig.33

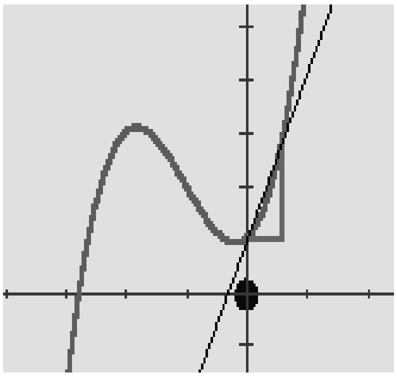

Fig. 34

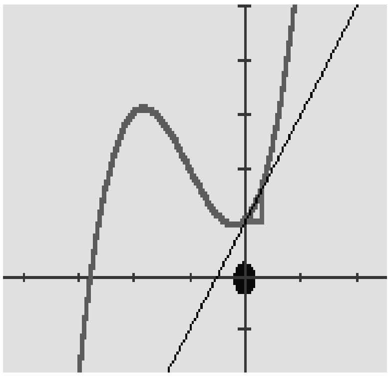

Fig. 35

IV. NUMERICAL AND ALGEBRAIC WORK

A) Construction of the rate of change function by plotting x against the slope of the secant line

This block aims to obtain the algebraic expression from given numerical data through tables of values. We present numerical data for function $f(x) = -2x^3 + 3x^2 - 4x - 3$, the resulting information to obtain the first, second and third difference, through this information provides algebraic expressions for each of the given tables.

Below is the analysis needed to obtain the algebraic expression associated with the numerical data, for this will vary the increase of *x*($\square_x$) giving the following values $\square_x$= 1, $\square_x$= 0.5 and $\square_x$= 0.1 and for each value of $\square_x$ is performed the corres4ponding analysis.

Section I. Increase of *x* equal to 1($\square_x$= 1).

Given the function $f(x) = ax^3 + bx^2 + cx + d$, which is a cubic function, the parameters *a*, *b*, *c* and *d* are obtained as follows by taking the information presented in the figure 36.

Inc. x	1	1	1	1	1	1	1	
x	0	1	2	3	4	5	6	7
y	-3.	-6.	-15.	-42.	-99.	-198.	-351.	-570.
1°Inc. y	-3.	-9.	-27.	-57.	-99.	-153.	-219.	
2°Inc. y	-6.	-18.	-30.	-42.	-54.	-66.		
3°Inc. y	-12.	-12.	-12.	-12.	-12.			

Otra Función

Fig. 36

To obtain the algebraic expression associated with these values, take four points of the function and considers the following system of equations: (see table I)

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Table I

x	0	1	2	3	4	5	6	7
y	-3.	-6.	-15.	-42.	-99.	-198.	-351.	-570.

$P_1(0,-3)$:	$P_2(1,-6)$:	$P_3(2,-15)$:	$P_4(3,-42)$:
$-3=d$	$-6=a+b+c+d$ $a+b+c=-3$	$-15=8a+4b+2c+d$ $8a+4b+2c=-12$ $4a+2b+c=-6$	$-42=27a+9b+3c+d$ $27a+9b+3c=-39$ $9a+3b+c=-13$
Resolviendo el sistema simultáneo por reducción tenemos			
	$a+b+c=-3$ $-4a-2b-c=6$ $-3a-3b=3$	$a+b+c=-3$ $-9a-3b-c=13$ $-8a-2b=10$	$6a+2b=-6$ $-8a-2b=10$ $-2a=4$
por lo que $a=-2;\ b=3;\ c=-4$ y $d=-3$ Por lo tanto la función es $f(x)=-2x^3+3x^2-4x-3$			

B) **The first difference function**

$$f(x)=ax^2+bx+c$$

Table II

x	0	1	2	3	4	5	6
1°Inc. y	-3.	-9.	-27.	-57.	-99.	-153.	-219.

$P_1(0,-3)$:	$P_2(1,-9)$:	$P_3(2,-27)$:
$-3=c$ $c=-3$	$-9=a+b+c$ $a+b=-6$	$-27=4a+2b+c$ $2a-b=-12$
Resolviendo el sistema simultáneo por reducción tenemos		
	$2a+b=-12$ $-a-b=6$ $a=-6$	
por lo que $a=-6;\ b=0$ y $c=-3$ Por lo tanto la función es $f(x)=-6x^2-3$		

C) **It is the second difference function**

$$f(x)=ax+b$$

Table III

x	0	1	2	3	4	5
2°Inc. y	-6.	-18.	-30.	-42.	-54.	-66.

$P_1(0,-6)$:	$P_2(1,-18)$:
$-6=b$ $b=-6$	$-18=a+b$ $a=-18+6$
Resolviendo el sistema simultáneo por reducción tenemos que	
$a=-12$ y $b=-6$ Por lo tanto la función es $f(x)=-12x-6$	

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D) It is the third difference function (see fig. 37).

$$f(x) = c$$

x	0	1	2	3	4
3°Inc. y	-12.	-12.	-12.	-12.	-12.

Fig. 37

➯ Therefore the function is $f(x) = -12$

Section II: Increases in x 0.5(□x= 0.5). (See fig. 38).

Inc. x	.5	.5	.5	.5	.5	.5	.5	
x	-.5	0	.5	1	1.5	2	2.5	3
y	0.	-3.	-4.5	-6.	-9.	-15.	-25.5	-42.
1°Inc. y	-3.	-1.5	-1.5	-3.	-6.	-10.5	-16.5	
2°Inc. y	1.5	0.	-1.5	-3.	-4.5	-6.		
3°Inc. y	-1.5	-1.5	-1.5	-1.5	-1.5			

Fig. 38

A) Is the original function

$$f(x) = ax^3 + bx^2 + cx + d \quad \ldots\ldots(1)$$

Taking the coordinates of four points of the function will approach the following system of simultaneous equations.

P1(0,-3):
$$-3 = d$$
$$d = -3 \quad \ldots\ldots(2)$$

P2(-0.5,0):
$$0 = -0.125a + 0.25b - 0.5c + d$$
$$-0.125a + 0.25b - 0.5c = 3$$

P3(1,-6):
$$-6 = a + b + c + d$$
$$a + b + c = -3 \quad \ldots\ldots (3)$$

P4(2,-15):
$$-15 = 8a + 4b + 2c + d$$
$$8a + 4b + 2c = -12$$
$$4a + 2b + c = -6 \quad (4)$$

Simultaneously by solving the system we have reduced

$a = -2 \quad b = 3 \quad c = -4 \quad d = -3$

➯ Therefore the function is

➯ $f(x) = -2x^3 + 3x^2 - 4x - 3 \quad \ldots\ldots(5)$

B) **Be the first difference function** $f(x) = ax^2 + bx + c$ (see fig. 39)

x	-.5	0	.5	1	1.5	2	2.5
1°Inc. y	-3.	-1.5	-1.5	-3.	-6.	-10.5	-16.5

Fig. 39

Taking the coordinates of three points of the function will approach the following system of simultaneous equations. (see table IV)

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Table IV

$P_1(0,-1.5)$:	$P_2(-0.5,-3)$:	$P_3(1.5,-6)$:
$-1.5 = c$ $c = -1.5$	$-3 = 0.25a - 0.5b + c$ $0.25a - 0.5b = -1.5$	$-6 = 2.25a + 1.5b + c$ $2.25a + 1.5b = -4.5$
Resolviendo el sistema simultáneo por reducción tenemos		
$a = -3$	$b = 1.5$	$c = -1.5$
Por lo tanto la función es	$f(x) = -3x^2 + 1.5x - 1.5$	

C) It is the second difference function $f(x) = ax + b$ (see fig. 40)

x	-.5	0	.5	1	1.5	2
2ªInc. y	1.5	0.	-1.5	-3.	-4.5	-6.

Fig. 40

- Taking the coordinates of two points of the function will approach the following system of simultaneous equations. (See table V)

Table V

$P_1(-0.5,1.5)$	$P_2(0.5,-1.5)$:
$1.5 = -0.5a + b$ $-0.5a + b = 1.5$	$-1.5 = 0.5a + b$ $0.5a + b = -1.5$
Resolviendo el sistema simultáneo por reducción tenemos que	
$a = -3$	$b = 0$
Por lo tanto la función es	$f(x) = -3x$

D) It is the third difference $f(x) = c$ (see fig. 41)

x	-.5	0	.5	1	1.5
3ªInc. y	-1.5	-1.5	-1.5	-1.5	-1.5

Fig. 41

- Therefore the function is $f(x) = -1.5$

Section III: Increment x 0.1 (Δ_x= 0.1). (see fig. 42)

Inc. x	.1	.1	.1	.1	.1	.1	.1	
x	-.9	-.8	-.7	-.6	-.5	-.4	-.3	-.2
y	4.488	3.144	1.956	0.912	0.	-0.792	-1.476	-2.064
1ªInc. y	-1.344	-1.188	-1.044	-0.912	-0.792	-0.684	-0.588	
2ªInc. y	0.156	0.144	0.132	0.12	0.108	0.096		
3ªInc. y	-0.012	-0.012	-0.012	-0.012	-0.012			

Fig. 42

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A) **Is the original function** $f(x) = ax^3 + bx^2 + cx + d$ .... (1)

Taking the coordinates of four points of the function will approach the following system of simultaneous equations.

P1(-0.9,4.488): $4.488 = -0.729a + 0.81b - 0.9c + d$ ....(2)

P2(-0.8,3.144): $3.144 = -0.512a + 0.64b - 0.8c + d$ ....(3)

P3(-0.7,1.956): $1.956 = -0.343a + 0.49b - 0.7c + d$ .... (4)

P4(-0.5,0): $0 = -0.125a + 0.25b - 0.5c + d$ ....(5)

Simultaneously by solving the system we have reduced

$a = -2 \quad b = 3 \quad c = -4$ ....(6)

- Therefore the function is $f(x) = -2x^3 + 3x^2 - 4x - 3$ .... (7)

a) Be the first difference function $f(x) = ax^2 + bx + c$ (See the fig.43)

x	-.9	-.8	-.7	-.6	-.5	-.4	-.3
1ºInc. y	-1.344	-1.188	-1.044	-0.912	-0.792	-0.684	-0.588

Fig. 43

- Taking the coordinates of three points of the function will approach the following system of simultaneous equations. (See table VI)

Table VI

P1(-0.9,-1.344):	P2(-0.8,-1.188):	P3(-0.7,-1.044):
$-1.344 = 0.81a - 0.9b + c$	$-1.188 = 0.64a - 0.8b + c$	$-1.044 = 0.49a - 0.7b + c$
Resolviendo el sistema simultáneo por reducción tenemos		
$a = -0.6 \quad b = 0.54 \quad c = -0.372$ Por lo tanto la función es $f(x) = -0.6x^2 + 0.54x - 0.372$		

C) **It is the second difference function** $f(x) = ax + b$ (See fig. 44)

x	-.9	-.8	-.7	-.6	-.5	-.4
2ºInc. y	0.156	0.144	0.132	0.12	0.108	0.096

Fig. 44

- Taking the coordinates of two points of the function will approach the following system of simultaneous equations. (See table VII)

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Table VII

$P_1(-0.9,0.156)$:	$P_2(-0.8,0.144)$:
$0.156 = -0.9a + b$	$0.144 = -0.8a + b$
Resolviendo el sistema simultáneo por reducción tenemos que	
$a = -0.12$ $\quad b = 0.048$ Por lo tanto la función es $f(x) = -0.12x + 0.048$	

D) It is the third difference $f(x) = c$ (See fig. 45)

x	-.9	-.8	-.7	-.6	-.5
3°Inc. y	-0.012	-0.012	-0.012	-0.012	-0.012

Fig. 45

➭ Therefore the function is $f(x) = -0.012$

As the cubic function $f(x) = -2x^3 + 3x^2 - 4x - 3$ ……………………………………………………(1)

Whose derivatives are:

First derivative $f(x) = -6x^2 + 6x - 4$ ……………………………………………………………(2)

First difference $f(x) = -0.6x^2 + 0.54x - 0.372$ ……………………………………………………. (3)

Divided between □ $_x$ = 0.1 $f(x) = -6x^2 + 5.4x - 3.72$

Second derivative $f(x) = -12x + 6$ …………………………………………………………(4)

Second difference $f(x) = -0.12x + 0.048$ …………………………………………………….(5)

Divided between Δx=0.01

$f(x) = -12x + 4.8$ …………………………………………………………………………(6)

Third derivative

$f(x) = -12$ ………………………………………………………………………….(7)

Third difference

$f(x) = -0.012$ …………………………………………………………………………….(8)

Divided between Δx=0.001

We can see that the functions found in section III where you work with increases in the variable "x" in tenths, after performing the corresponding ratios, functions and found they are more like functions derived in each case.
So we can conclude that the smaller the increase in "x" in the rate of change we get closer to the derivative function.

V. CONCLUSION

The proposal of teaching through the use of a software enables us to have approaches of various kinds, such as from the point on the math as a semiotic system different registers or even purely graphic management, in addition, the theoretical integrated allow the proposed construction of the concept of derivative as a function in solid form so that the student can cope with better approaches to mathematical concepts related to the concept of function. The lessons encourage the student electronic dynamic conceptions of mathematical concepts. This possibility of

ISSN: 2319-5967
ISO 9001:2008 Certified
International Journal of Engineering Science and Innovative Technology (IJESIT)
Volume 2, Issue 2, March 2013
dynamic interaction with the examples help the student construct dynamic mental images that may help you better understand a mathematical concept. We consider the interaction that allows dynamic examples incorporated into electronic lessons will be a good motivator for students and that new proposal can have an excellent complement to these tools.

ACKNOWLEDGEMENT

The author in this study was supported by SIP. IPN.

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