

LEARNING CALCULUS THROUGH TECHNOLOGY

Seifedine Kadry, American University of the Middle East, Kuwait, seifedine.kadry@aum.edu.kw

Ali Kalakech, Lebanese University, Faculty of Business, alikalakech@hotmail.com

Abstract

The first course in mathematics is calculus. It's a core course in the curriculum of the Business, Engineering and the Sciences. However many students face difficulties to learn calculus. These difficulties are often caused by the prior fear of mathematics. The students today can't live without using computer technology. The uses of computer for teaching and learning can transform the boring traditional methodology of teach to more active and attractive method. In this paper, we will show how we can use Excel in teaching calculus to improve our students' learning and understanding through different types of applications ranging from Business to Engineering. The effectiveness of the proposed methodology was tested on a random sample of 45 students from different majors over a period of two semesters.

INTRODUCTION

Teaching methods can best be defined as the types of principles and methods used for instruction. There exist different types of teaching methodologies based on the type of information or expertise the instructor is trying to deliver. Power point presentation, class discussion, problem-solving, and memorization are some of the teaching methods being used. When an instructor is choosing a teaching method, he/she needs to adapt their style according to their students. The efficiency of the teaching methods is the major factor to lead the student to succeed. The computer technology is widely used by students and it's become an important part of their daily life (Bell and Glen, 2008; Mykytyn, 2007). In this paper, we will propose a new visual methodology for teaching instead of the traditional and passive methodology by using computer. We will use Microsoft office excel software to teach calculus course, calculus is a major course for many majors. The experimental test shows the efficient of the propose method. This paper is organized as follows. Section 2 introduces Microsoft Office Excel. Section 3 gives an overview of the existing teaching methods. In the section 4, we will illustrate the using of excel through varieties of calculus topics ranging from business, engineering and sciences. The experimental test and its result are discussed in section 5 and finally the conclusion and the perspective are given in section 6.

WHY MICROSOFT OFFICE EXCEL

Microsoft office is very essential packages for any computers. Excel is a part of this package. Excel is electronic spreadsheet software, that end user use to store and structure their data in a tabular form. By using the spreadsheet, we can do any arithmetic application and use a huge set of mathematics built in function in addition to build our formula (Trim, 2007; Hoffman, 2006). It features calculation, draw graphics, create formulas, and solve equations and many mathematical functions. The usage of excel is easy and straightforward. The recent versions of Excel are 2008 for Mac and 2010 for Windows.

TEACHING METHODS IN EDUCATION

For effective teaching to take place, a good method must be adopted by a teacher. In this section we will describe briefly some of well known teaching methods such as the lecture method, the cooperative method, the demonstration method, the discussion method, and finally computer-based method (Weswood, 2008).

Lecture Method

The traditional and broadly used method is the lecture method. Lecture method takes the form of presentation. The instructors should know how to organize and present the lecture. Moreover, they must understand the drawbacks and the advantages of this method. This method is used to introduce new topics, present graphical subjects, summarize ideas, present coding, and display the main points of the lecture, showing the relation between the theory and the

practice. To add some interactivity, we can combine the lecture method with other teaching methods like the discussion method. This method can be used to teach small as well as large number of students.

Cooperative Method

An attractive strategy of teaching is to have the students working together in groups during the session. This is the concept of the cooperative method. Several researches on this method indicate: the increasing of their participation, improve their communication, augmenting their knowledge, encouraging their development of the social skill, increasing their independence and simply facilitates their effective learning. In a cooperative method, one classroom may shared by more than one instructors and these instructors will share all responsibility including managing groups, planning, coaching, tutoring and grading. In this method, it's important to take into consideration the subsequent points: the size of each group, the selection and the distribution of each task and the choice of each student in its appropriate group.

Demonstration Method

The concept of this method is "learning by doing". This method of teaching supplies the students a comprehensible image of the subject that must be learned. This method is suitable for teaching a skill because it covers all the necessary steps in an effective learning order. It refers to the capability of students to improve their skills by regularly repeating the same type of action. An individual learns to calculate by calculating, to write by writing, to swim by swimming, and to drive by driving. This method allows the students to relate the principles and theories to a practical situation. This method is more relies on the student and consequences of an effective student participation and involvement than any other teaching method. The demonstration method requires a high degree of instructor skill and it's limited to small group of students.

Discussion Method

This method is very active contrary to the passive lecture method. Here the instructor presents information for only a short period of time and query the student then engages them in open discussion for a while on particular issues related to the topic. This not only helps students participate more actively, it can also reveal to the instructor whether the students generally understand and relate to the material being presented. The target of the instructor is to draw out what the students understand, rather than to spend the class period telling them. The larger participation and the dynamic discussion lead to a more efficiency in the learning process. All students in the group should contribute in the discussion and everyone should feel himself/herself as a part of this discussion. The instructor should take care of everyone in fairly manner and should give them confidence, encourage them to ask questions and to answers. Cynicism should never be used, since it inhibits the concentration of the participants and reduce the seriousness. Finally, the session achieves closure when the lecturer summarizes and consolidates main points from the lecture and discussion (Eggen and Kauchak, 2004).

Computer-Based Method

This method is delivering instructional content and activities to students via computers. Here, computers are tools which complete and strengthen the system; they are not alternatives which replace teachers in teaching process. In computer based method, computers are used to support education and instruction. Classroom instructor is the main entity that teaches the subject, and determined objectives and attitudes. In this method, an instructor can use computers in different periods, places and ways while teaching according to the characteristics of the students and the type of the subjects that will be teach (Nilgün and Birol, 2006).

LEARN SOME CALCULUS TOPICS USING EXCEL

In this section, we will illustrate the using of excel through selected topics from calculus course.

Case 1: Plotting functions.

Plotting functions is straightforward in Excel. Let us graph the function $f(x) = 2x + 3$. This is an equation of a straight line.

Step 1: Make a table (table 1) of values in the domain that you are interested in: for example, we will let x range from -2 to 3. Note that the values for $f(x)$ are entered using formulas.

x	f(x)
-2	-1
-1	1
0	3
1	5
2	7
3	9

Table 1: table of values for case 1

Step 2: Select with mouse the whole table region which you want to plot. Step 3: Graph the given data using chart wizard (fig. 1).

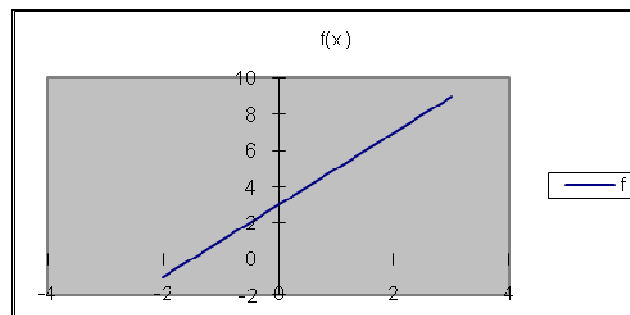


Figure 1: case 1

Case 2: calculate limits.

If the limit of a function exists in a certain point, we can evaluate it numerically. Using a spreadsheet for this purpose is much easier than using a calculator. Example: find $\lim_{x \rightarrow 3} \frac{x^2 - 9}{x - 3}$. Make a table (table 2) of values of x

approaching 3 and the corresponding values of $\frac{x^2 - 9}{x - 3}$. Remark: the fraction is undefined for $x=3$. However, it is defined for all values except $x=3$ (second column in the following table is calculated automatically after entered the formulas).

x	$(x^2-9)/(x-3)$
2.9	5.9
2.99	5.99
2.999	5.999
2.9999	5.9999
3.0001	6.0001
3.001	6.001
3.01	6.01
3.1	6.1

Table 2: table of values for case 2

As x gets close to 3 the expression $\frac{x^2 - 9}{x - 3}$ gets close to 6. Therefore $\lim_{x \rightarrow 3} \frac{x^2 - 9}{x - 3} = 6$

Case 3: optimization problem.

The total cost of producing x products is $C(x) = 42x + 16800/x$. our goal is to search the value of x , where the cost function $C(x)$ is minimum. Step 1: First graph $C(x)$ by making a table and invoking ChartWizard (fig. 2):

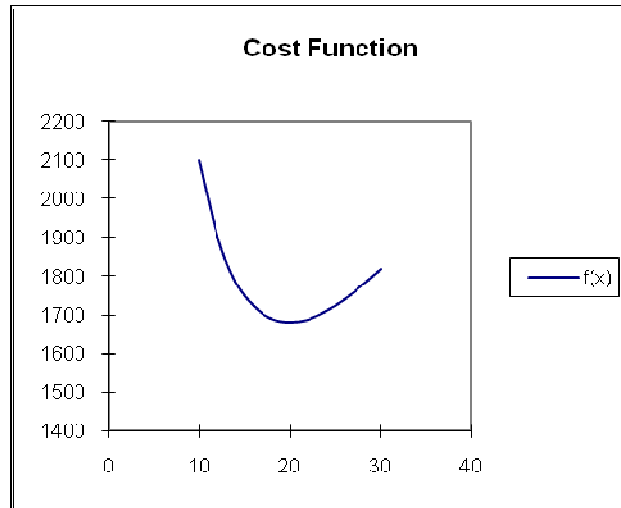


Figure 2: case 3

Using the above graph, the minimum approximately is between 10 and 30. Now use Goal Seek with $f(x) = 42 - 16800/x^2$. Step 2: Since $f(x) = 0$ when the function has a maximum or minimum, we can use Goal Seek to figure out when $f(x) = 0$. Set initial value to 3 since minimum occurs close to 3 (table 3):

x	f'(x)
3	-12

Table 3: value for case 3

From the Tools menu, select the Goal Seek... option, you will see a dialog box. You want to vary x so that the $f(x)$. Now, the true value of x should displays in the above table.

P.S.: The minimum and the maximum lead to $f'(x) = 0$. Generally, Goal Seek gave the solution closest to initial value of x (3 in this example). For this reason is better to sketch the graph.

Case 4: calculation of the interest.

In this example, we shall explore how compounded interest is calculated. To illustrate the process, we will produce tables to get a perceptive feel. Example: Suppose you earn 4% interest, compounded quarterly, on a bank account. You deposit an amount of \$100 in the bank. How much interest do you accrue provided you do not withdraw any money?, first we make a table (table 4) as follows:

Date	Deposits	Interest	Balance
1/1/1994	\$100.00		\$100.00
4/1/1994		\$ 1.00	\$101.00
7/1/1994			
10/1/1994			
1/1/1995			

Table 4: values for case 4

Note that the interest is calculated by multiplying the previous balance by 1%. Since the interest is compounded quarterly, the interest rate per quarter is annual rate/ # periods = $4\%/4 = 1\%$.

Case 5: exponential growth and decay.

Growth and decay processes can be modeled by suitable differential equations. In this case, we will analyze such models. Example: the following equation for the amount of strontium 90 after t years is given by: $P(t) = P_0 \exp(-0.0244t)$. How does an initial quantity decay over time? Let us take $P_0 = 1$ mg. We see that every year, the amount will decrease since we are multiplying by a number less than one (fig. 3).

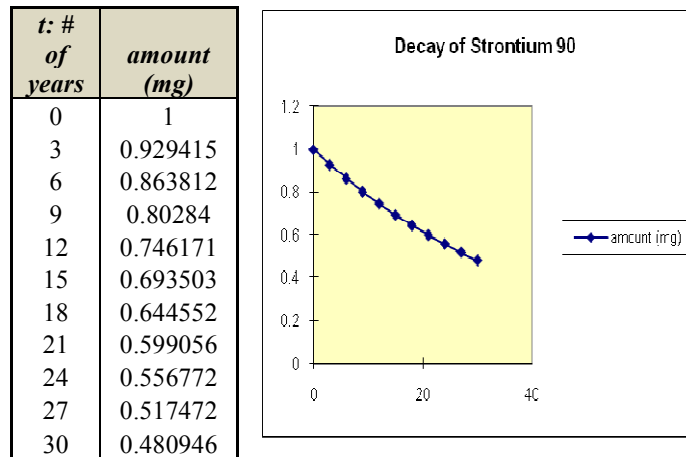


Figure 3: values (left) and chart (right) for case 5

As you see, once the equation is known, generating tables and graphs is a relatively simple matter. You should use tables and graphs to confirm your expectations about the behavior of a model. If your analytical solution says one thing, and the graph says something else, then you have made an error somewhere.

Case 6: areas and Riemann sums.

We will show how we can use Excel to approximate the value of a definite integral via Riemann sums. Example: Approximate the area under the curve $y = x^2$ from $x=1$ to $x=3$ using 10 equal subintervals and the right endpoints of the subintervals to construct the rectangles. We construct a table (table 5) as follows - since the interval is 2 units, each subinterval will be of length 0.2. The right endpoints will then be 1.2, 1.4...3:

x_i	Δx	$f(x_i)$	$f(x_i) \cdot \Delta x$
1.2	0.2	3.2	0.64
1.4	0.2	3.4	0.68
1.6	0.2	3.6	0.72
1.8	0.2	3.8	0.76
2	0.2	4	0.8
2.2	0.2	4.2	0.84
2.4	0.2	4.4	0.88
2.6	0.2	4.6	0.92
2.8	0.2	4.8	0.96
3	0.2	5	1
		Total	8.2

Table 5: values for case 6

EVALUATION OF THE EXPERIMENTAL TEST

To show the efficiency of the proposed method, we selected randomly 45 students from different majors over a period of two semesters. Following the statistical result (table 6):

methods	Lecture method	using Excel
Mean	66.2	80.1

Table 6: average grade comparison

A paired t-test was performed to determine if the proposed methodology was effective, the following result (table 7) shows clearly that the proposed method is better than the traditional method:

t-Test: Two-Sample Assuming Unequal Variances

	Variable 1	Variable 2
Mean	65.93478261	80.45652174
Variance	260.5956522	304.2980676
Observations	45	45
Hypothesized Mean Difference	0	
Df	89	
t Stat	-4.14394682	
P(T<=t) one-tail	3.88116E-05	
t Critical one-tail	1.662155326	
P(T<=t) two-tail	7.76231E-05	
t Critical two-tail	1.986978657	

Table 7: result of T-test

After the t-test, we performed ANOVA test (table 8-9-10) by partitioning the selected students into three groups based on their major. The result shows an efficient difference between the majors (Business, Engineering and sciences) using the proposed methodology:

SUMMARY				
Groups	Count	Sum	Average	Variance
Engineering	15	1241	82.73	238.49
sciences	15	1185	79	304.42
business	15	1180	78.66	408.80

Table 8: summary of the groups

ANOVA			
Source of Variation	SS	df	MS
Between Groups	152.93	2	76.4667
Within Groups	13324.26	42	317.2444
Total	13477.2	44	

Table 9: ANOVA test result

<i>F</i>	<i>P-value</i>	<i>F crit</i>
0.241033903	0.786894473	3.219942293

Table 10: P-value

The details (table 11), the statistic result (table 12) and the box plot graph (figure 4) between different majors is given in the following:

Engineering	sciences	business
89	97	61
60	79	51
97	94	94
95	76	100
89	53	74
91	45	89
46	76	48
95	57	99
78	64	96
72	97	56
68	88	85
83	99	87
98	84	48
82	79	98
98	97	94

Table 11: average of each student

Statistic	Engineering	Sciences	Business
q1	75	70	58.5
min	46	45	48
median	89	79	87
max	98	99	100
q3	95	95.5	95

Table 12: statistic result

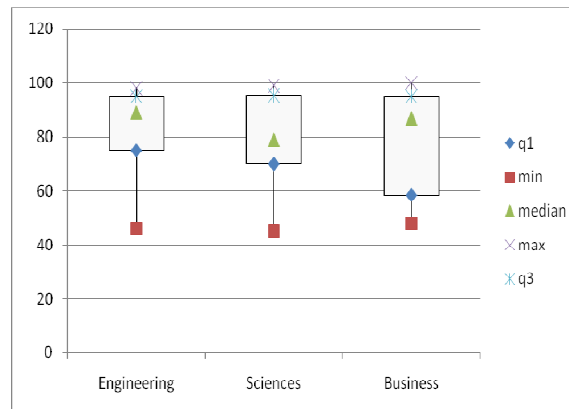


Figure 4: Box plot of different majors

CONCLUSIONS

The visual approach increases the percentage of concentration of the students and especially when the student can produce result in a short time like using Excel. The advantages of using Excel to learn calculus are: understand very well the different topics in calculus in an interesting way, get more experience and knowledge in Excel which will be using it in the future. In the future works, we will test others mathematics software like Matlab, MathCAD and Maple and to compare their efficiency with Excel to a different students majors.

Biography of Authors

Seifedine Kadry is an associate professor and department head of applied mathematics at the American university of the Middle East, Faculty of Engineering. He got his Master Degree in Computer Science and Applied Math from AUF-EPFL-Inria, Lebanon in 2002. He received the Doctor degree from the Clermont Ferrand II University, France in 2007. His Research interests include applied mathematics and computing.

Ali Kalakech is an associate professor at the Information Systems Department in the Lebanese University, Faculty of Economics and Business Administration. He got his Master Degree in Computer Systems from the National Institute of Applied Sciences, Toulouse, France in 2001. He received the Doctor degree from the National Polytechnic Institute, Toulouse, France in 2005. His Research interests include testing and evaluating the dependability and the performance of computer systems.

REFERENCES

- Bell Jr, R. and Glen, A. (2008). Experiences Teaching Probability and Statistics with Personal Laptops in the Classroom Daily. *The American Statistician* 62(2), 155.
- Mykytyn, P. (2007). Educating Our Students in computer Application concepts: A Case for Problem-Based Learning. *Journal of Organizational and End User Computing* 17(1), 51-62.
- Trim, D. (2007). *Calculus for engineer*. Pearson publisher.
- Hoffman, L. (2006). *Calculus for Business, Economics, and the Social and Life Sciences*. Mc GrawHill 2006.
- Weswood P. (2008). *What teachers need to know about*. Acer publisher.
- Eggen, P., & Kauchak, D. (2004). *Educational psychology: windows on classrooms* (6th ed.). Upper Saddle River, NJ: Pearson-Merrill.
- Nilgün T. and Birol Y. (2006). The effect of computer assisted and computer based teaching methods on computer course success and computer using attitudes of students. *TOJET journal*. ISSN: 1303-6521 volume 5 Issue 3.