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How to adapt CAS on the basis of Mathematical Background and Computer Background at EUL

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Abstract

The objective of this study is to suggest some theoretical basis for teaching Calculus at the beginner level in the European University of Lefke (EUL). In EUL, Calculus courses are services courses, so classrooms are crowded and the numbers of instructors are few. The lecturers have faced different student profiles based on different mathematical and computer backgrounds with lack of motivation, lack of performance, poor interaction, and limited questions solving with low speed based on the level of students by using practice in class. Upon these problems, we are looking for not for the best but for the most effective environment to motivate and to create a good environment for the teaching of Calculus. In this paper we discuss the advantages of CAS towards traditional teacher centered practice in class. On the basis of the literature review, we certainly know that these kinds of problems can provide a high-level of motivation because of its interactivity and instant feedback and attention.

Keywords:Mathematics education, Technology, CAS, advantages of Maple.

1. Introduction

Educational technology is used to increase the efficiency of education in educational settings. When we say technology it means computer. Computers are a powerful technological machine to promote development of learning. The review says that, computers are able to create a more attractive and effective learning environment. Today, there are many types of educational software that can be found in the market for making drill and practice, tutorials, simulations, supplementary exercises, programming, database development and other applications (Ayub M. F. Ahmad et. al, 2009).For Calculus education the tutorial is important. The biggest advantage of computers is that they have been able to operate more sophisticated and complex software. All of these developments, surely, have led some approaches in mathematics programs to appear (Güyer T., 2008; Awofala, 2012). In traditional teacher- centered classroom, the students are listeners and followers. The teacher is the one who gives the facts and defines the important ideas (Muir-Herzig, 2004). As a result many students cannot achieve a deep understanding even when they have finished learning it. Many students find that calculus is abstract, boring and hard to learn. (Khouyibaba, 2010). Computer –aided instructions have many different effects on education especially in enhancing student learning in a way that thinking actively about information, making choices and executing skills that are typical in teacher-led lessons. (Güyer T., 2008). Today there are several popular technological tools that are widely

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used in mathematics education. For instance one of the most important systems are Computer Algebra Systems which denoted by CAS. CAS(s) are computer based software packages for performing mathematical symbolic computations. The major benefit of the computer algebra software is that replaces an often tedious pencil paper approach for generating symbolic solutions. The user is only required to define the problem in software understandable from while the computer performs actual calculations (Tomovic et al, 1994).

In EUL, in my day-to-day teaching, we have students of different mathematical background in various groups with lack of motivation, lack of performance, poor interaction, and limited question solving, with the pace of instruction low, based on the level of students in class. Upon this problem, we are planning to use CAS(s) packages for mathematics courses such as Mathematica, Maple, Mathlab etc. to make equity between different levels of students. Maple is one of the most popular systems since it is well-suited to aid university students to learn mathematics through verifying calculation and plotting complicated graphs and it also combines mathematical capabilities with a text editor (Kılıcman A. et. al, 2010). For this reason, in this paper, we focus on the use of Maple in teaching calculus tutorials based on students that have different mathematical and computer backgrounds at European University of Lefke, because it is easy to learn, which allows students to spend more time on Calculus (Tomovic M. et al, 1994). In this paper we review the advantages of using Maple computer algebra systems in a teacher centered Calculus tutorial.

2. Tutoring Calculus

Calculus is one of the most important and fundamental courses for students in tertiary education especially for students pursuing the engineering and science field ((Ayub M. F. Ahmad et. al, 2009).

Excellence in mathematics education requires equity- high expectations and strong support for all students. Effective mathematics teaching requires understanding of what students know and what they need to learn and the challenges and support it needs for to learn it well. The teacher is responsible for creating an intellectual environment in the classroom where serious engagement in mathematical thinking is the norm. Also, effective teaching requires deciding what aspects of a task to highlight, how to organize and orchestrate the work of students, what questions to ask students having varied levels of expertise and how to support students without taking over the process of thinking for them (Equity Principle).

Designers of mathematics have to consider the development of students' generic or key skills such as numeracy, information technology, communication skills, ability to work as part of team, ability to improve one's own learning performance, problem solving etc. (Leinbach C. et. al, 2002; Persico & Pozzi, 2011).

If the Calculus tutorial presents information without interaction, the learner cannot be successful (Alessi M. S. et.al, 2001). In tutorials the most common method of motivation and interaction is to pose questions that the learner must answer. According the Merrill theorem, presentation, examples, and practices are important for taking feedback that is shown in Figure 1 below. In the theorem of Merrill, presentation of information, examples and practices should be from easy to difficult. This means, the motivation and interaction is supported (Merrill, 1983).

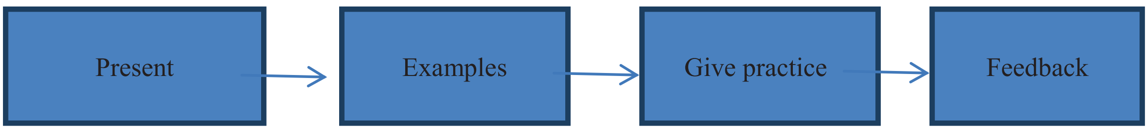


Figure1. Merrill Theorem

2.1. Tutoring Calculus in Class

In a traditional teacher-centered classroom, the students are listeners and followers. The teacher is the one given freedom to develop the content, what will be initiated in terms of actions and interactions, to ask questions and to set limits on activity times. The teacher is the one who gave the facts and defines the important ideas (Muir- Herzig, 2004). Many students cannot achieve a deep understanding even when they have finished learning it. Students find calculus is abstract, boring and hard to learn. Besides that, there is a wide range of calculus concepts that cause problems for students that have been identified in the limits and use of notations and function (Ayub M. F. Ahmad et. al, 2009). At the European University of Lefke, in teaching calculus tutorials we face these kinds of problems plus lack of motivation, poor interaction, poor performance, low levels of feedback, and huge gap between the weak and strong students, which limits solving questions, and slows the pace of solving questions.

2.2. Tutoring Calculus with Computer Algebra Systems

Educational technology is used to increase the efficiency of education in educational settings. Computers are able to create a more attractive and effective learning environment (Ayub M. F. Ahmad et. al, 2009; Hussein, 2010). Technology or computer supported learning allows more students to be actively thinking about information making choices and executing skills (Tarmizi A.R et. al, 2010), with technology students are able to collaborate to use critical thinking and to find alternatives to solution of problems (Muir- Herzig, 2004). The students are in the position of defining their goals, making design decisions and evaluating their progress. The teacher's role changes as well. As students work on their technology supported products, the teacher moves around the room, looking over shoulders, asking about the reasons for various design choices and suggestions resources that might be used. Meanwhile with the integration of technology such as computers, software, students are encouraged to get deeper understanding of concepts. Furthermore use of the technology can also enhance understanding of abstract mathematical concepts by enhancing their visualization or graphic representation where by enhancing their visualization or graphic representation where it shows the relationships between objects and their properties. Deeper understanding of concepts will increase the ability of the students when working with mathematics (Ayub M. F.Ahmad et. al, 2010). On the other hand, computers have provided mathematics teacher with brand new channel of teaching difficult and abstract concepts using multimedia technologies. Learning mathematics on the computers screens can be regarded as a mode of visual entertainment for students. By using technology during the classroom the educator will play a different role, instead acting as presenter of the class materials provide of methods to meet the needs of the individual learners (Muir- Herzig, 2004).

Computer –aided instructions have many different effects on education especially in enhancing student learning in a way that thinking actively about information, making choices and executing skills that are typical in teacher-led lessons. (Güyer T., 2008). Today there are several popular technological tools that are widely used in mathematics education. For instance one of the most important systems are Computer Algebra Systems which denoted by CAS. CAS(s) are computer based software packages for performing mathematical symbolic computations. The major benefit of the computer algebra software is that replaces an often tedious pencil paper approach for generating symbolic solutions. The user is only required to define the problem in software understandable from while the computer performs actual calculations. Furthermore, CAS(s) packages such as Mathematica, Maple, Mathlab etc… are user friendly software. With these software packages, students can focus on technical problems, solving with rapid computational speed which allows the students to analyze a large number of solutions, providing them with practice in design optimization. Also, the software allows a student to concentrate on a final solution without spending time on the often lengthy mathematical computations (Tomovic M. et al, 1994). In this paper, we focus on Maple software because it is easy to learn, which allows the focus to be on the concepts and understanding of principles without the distraction of large amounts of 'routine' manipulation, as such motivation can be enhanced through use of more realistic problems, and many more examples can be covered by students allowing them to experience learning as more active participants in discovery learning (Lawson Duncan, 1997). Students can create plots and animations easily by using visualization commands, it removes the drudgery of repetitive calculation, provides standard tools, and lecturers can construct complex/animated visualizations and improve instructions (Clements R.R., 1997).

3. Objectives

The objective of this study is to assess the efficiency of CAS (Computer Algebra Systems) using in Calculus Tutorial teaching at the European University of Lefke (EUL). In EUL, Calculus courses are services courses, for this reason, computer, civil, software, electric and electronic engineering and electric and electronic communications groups are take these courses together. In our day-to-day work experience in Calculus tutorials, we see students who are in the software engineering department and have a much lower level of mathematical background than the students from computer, electric and electronic, civil engineering and electric electronic communications departments. Furthermore, students who are in civil engineering have a lower level in computing compared to other departments. Because of this, we have face different student profiles with different mathematical and computer backgrounds, together with lack of motivation, lack of performance, poor interaction, and limited question solving abilities, which in turn reduces the pace of practice in class. Upon these problems, we are looking for not for the best but for the most effective environment for learning, to motivate and improve our teaching of Calculus. In this paper, we discuss the advantages of CAS towards traditional teacher centered practice in class. On the basis of the literature review, we know that these kinds of problems can provide high-level of motivation because it provides interactivity and instant feedback and attention.

4. The advantages of Maple towards Conventional Teaching of Calculus Tutorial

In this paper we focus on Maple software because it is easy to learn, and wonderful tool that can perform numerical computations, manipulate symbolic expressions and plot graphs (Khouyibaba, 2010).

Maple helps you analyze, explore, visualize, and solve mathematical problems. With close to 5000 functions, Maple offers the breadth, depth, and performance to handle every type of mathematics. Maple's intuitive interface supports multiple styles of interaction, from Clickable Math™ tools to a sophisticated programming language. Using the smart document environment provided by Maple, you can automatically capture all of your technical knowledge into an electronic form that combines calculations, explanatory text and math, graphics, images, sound, and diagrams (www.maplesoft.com).

a) *Maple reduces the premium on pure manipulative ability*. Students can use the Maple to assist or confirm their own calculations. As result weaker students can be enabled to follow more sophisticated or complex mathematical arguments. Figure 2. shows a Maple session in which a student enters an expression, differentiates it twice with respect to t and then uses simplify command to combine the result into simplified form.

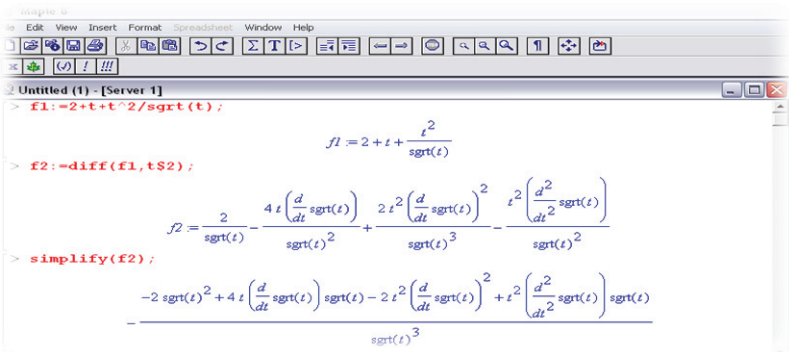


Figure2.Calculus manipulation

b) *Maple enables students to concentrate on concepts, not detail.* With confidence in the ability of the Maple to deal with the details, students are better able to look at the overall structure the wider strategic picture, of the mathematical ideas and proofs. Figure 3 is taken from an example of implicit differentiation.

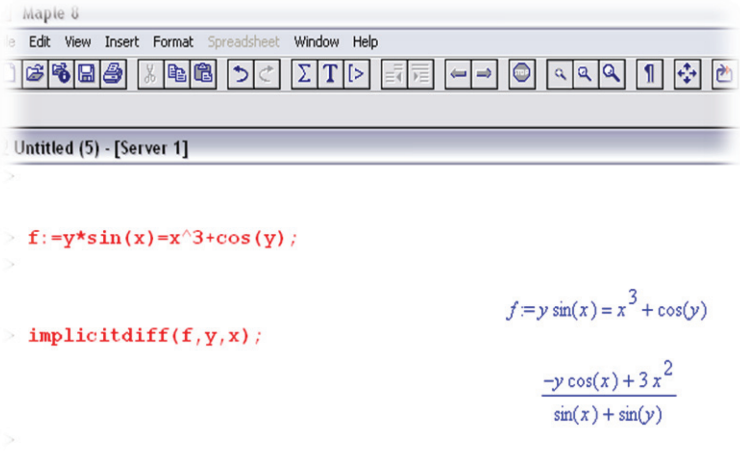


Figure 3.Impilcit differentiation

c) *Maple makes graph drawing and visualization easier.* Maple can help comprehension of mathematical ideas through visualisation for sophisticated graph plotting facilities. In Figure 4 Maple is used to calculate and plotting volume of revolution of functions $\mathbf{cos}(\boldsymbol{x}) + \mathbf{3}$ and $\mathbf{sin}(\boldsymbol{x}) + \mathbf{2}$ on the interval **x=0 to 4$\boldsymbol{\pi}$**.

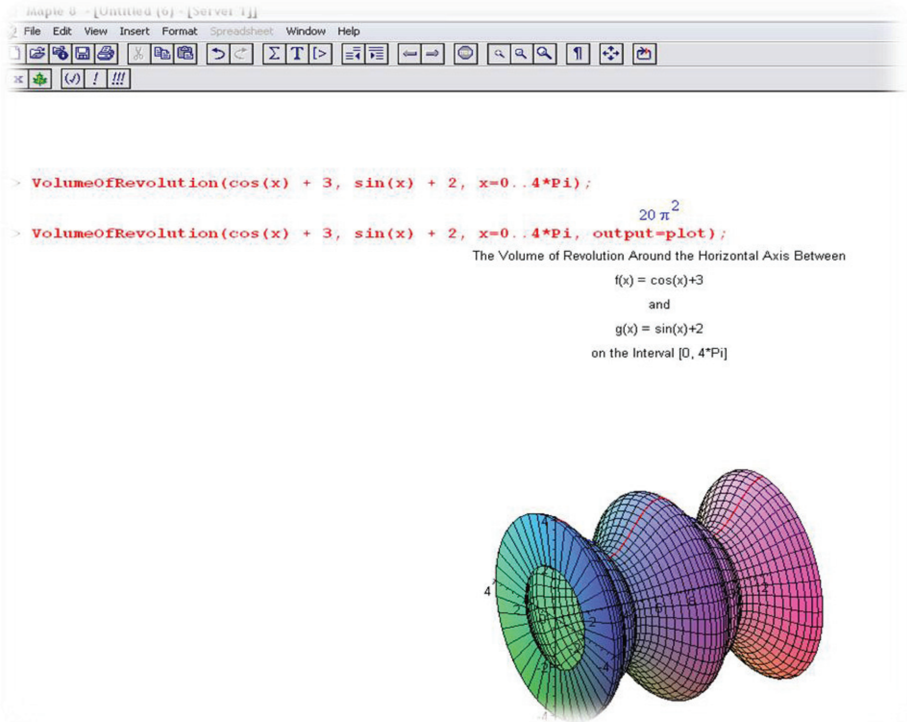


Figure4.Volumes of revolution

d) *Maple provides standard tools.* Extending the precious point, there are standard procedures and tools which Maple can provide, thus allowing students to tackle larger problems at a strategic level.

e) *Maple encourages exploration.* Maple removes the drudgery of repetitive calculation, provides standard tools and generally makes experimentation easier, more exciting and more rewarding.

f) *Maple acts as an expert system.* Mathematically less well qualified users can call upon Maple to carry out manipulations which they might not feel confident to complete by hand for lack of manipulative skill. Maple is acting as a mathematical advisor and expert. Students move backwards and forwards between different types of use as they study for different topics and of course as their knowledge and skills increase. On the other hand educators use this way to design courses to develop the skills required to use.

g) *Maple acts as a computational assistant for routine procedures*. Maple can reduce the labour and allow lecturers to set a wider range of illustrative work in assignments. Figure 5 shows the normal solving of the function $\int \sin(x)\, e^{x} dx$ students should apply twice the rule of integration by parts to solve it. Here with Maple the routine manipulations are eliminated. (R.R.Clements, 1997).

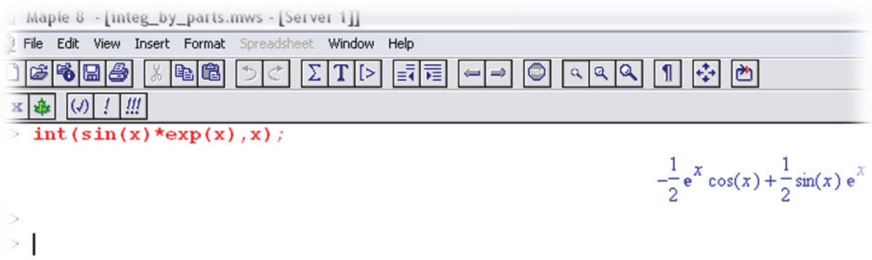
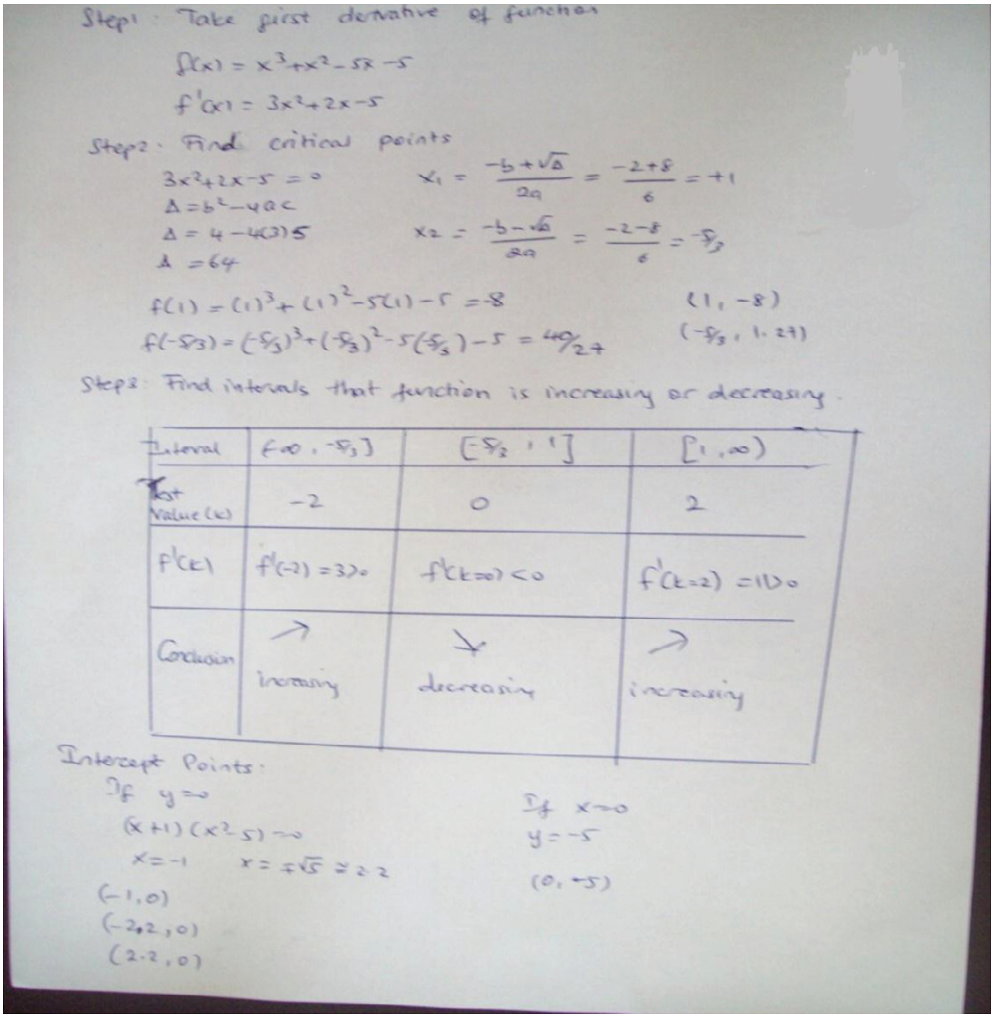


Figure 5.Integration by parts

5. Step by step graph sketching

5.1 Sketching by hand

Here we include examples of using sketching graphic by hands by using first derivative test in Calculus (Figure 6 and 7).



Step1 · Take first derivative of function

$f(x) = x^3 + x^2 - 5x - 5$

$f'(x) = 3x^2 + 2x - 5$

Step2 · Find critical points

$3x^2 + 2x - 5 = 0$ $\quad x_1 = \frac{-b+\sqrt{\Delta}}{2a} = \frac{-2+8}{6} = +1$

$\Delta = b^2 - 4ac$

$\Delta = 4 - 4(3)5$ $\quad x_2 = \frac{-b-\sqrt{\Delta}}{2a} = \frac{-2-8}{6} = -5/3$

$\Delta = 64$

$f(1) = (1)^3 + (1)^2 - 5(1) - 5 = -8$ $\quad (1, -8)$

$f(-5/3) = (-5/3)^3 + (-5/3)^2 - 5(-5/3) - 5 = 40/27$ $\quad (-5/3, 1.27)$

Step3: Find intervals that function is increasing or decreasing.

Interval	$(-\infty, -5/3]$	$[-5/3, 1]$	$[1, \infty)$
Test Value (k)	-2	0	2
$f'(k)$	$f'(-2) = 3 > 0$	$f'(k=0) < 0$	$f'(k=2) = 11 > 0$
Conclusion	↗ increasing	↘ decreasing	↗ increasing

Intercept Points:

If $y = 0$ $\quad$ If $x = 0$

$(x+1)(x^2-5) = 0$ $\quad y = -5$

$x = -1 \quad x = \mp\sqrt{5} \cong 2.2$ $\quad (0, -5)$

$(-1, 0)$

$(-2.2, 0)$

$(2.2, 0)$

Figure 6.First Derivative Test

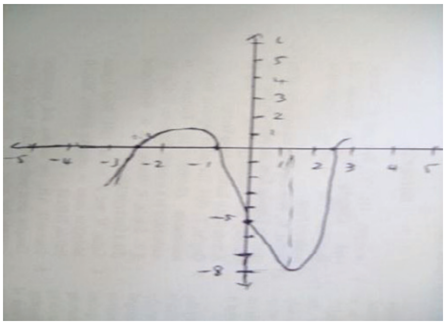


Figure 7.Graphics

5.2 Sketching by Using Maple

Here we include examples of using Maple to see solutions step by step of the problems in Calculus. The following in example shows the step by step sketching graph by using fist derivative test (Figure 8).

```
> f(x):=x^3+x^2-5*x-5;
```

$$f(x) := x^3 + x^2 - 5x - 5$$

```
> g(x):=diff(f(x),x);/*First derivative*/
```

$$g(x) := 3x^2 + 2x - 5$$

```
>
```

$$3x^2 + 2x - 5$$

```
> solve(g(x));/*Finding roolts*/
```

$$1, \frac{-5}{3}$$

```
> eval(f(x),x=1);
```

$$-8$$

```
> eval(f(x),x=-5/3);
```

$$\frac{40}{27}$$

```
> eval(f(x),x=0);/*Finding intercept points*/
```

$$-5$$

```
>
> f(x):=x^3+x^2-5*x-5=0;
>
```

$$f(x) := x^3 + x^2 - 5x - 5 = 0$$

```
> solve(f(x));
```

$$-1, \sqrt{5}, -\sqrt{5}$$

```
> plot(x^3+x^2-5*x-5,x=-3..3,y=-8..40/27);
```

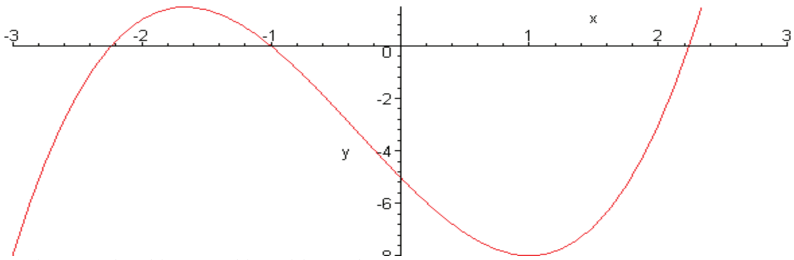


Figure 8.Sketching Graphics with Maple

6. Conclusion

As a result Maple is ability to perform manipulations quickly and accurately rather than doing by hand. It allows a student concentrate on the final solution without spending time on the often lengthy mathematical problems. In this study we focused on how Maple is suitable for creating an effective environment in the way of creating good motivation and interaction. We discussed the advantages of Maple in the solving of Calculus problems. In the next study we are planning to setup a computer lab for Calculus tutorial for investigates the effectiveness of Maple systems on our educational problems in EUL.

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