TI- INTERACTIVE!™ – GETTING INVOLVED

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" *There is too much preoccupation with what might be called the magic in calculus. For instance, too much time is spent in pulling exact integrals out of a hat, and, what is worse, in drilling students how to perform this parlor trick.*" *Peter Lax*

Introduction

In this paper we take a foray into some of the exciting aspects of the software package TI-INTERACTIVE!™, presenting some of our current experiences of using it on degree courses at Sheffield Hallam University. We have been using TI graphical calculators since 1994 [1] together with Derive [2] and there is now (eventually!) an established culture involving these. We also have considerable experience of spreadsheets [3] and ran the Spreadsheet User Journal for many years. In addition we have from the beginnings of the WWW (in 1994 for us) used this medium in delivering many of our courses [4],[5].

Looking back it is perhaps apparent that using TI-INTERACTIVE!™ is a natural amalgamation of what has gone before. Our developing concept of what "doing" mathematics is now that technology is here [6] gives us and our students exciting opportunities both to develop and to communicate mathematics. Students can work on improving their performance not only in traditional mathematical skills but also in transferable skills. Thus they can improve their skills in general IT use, communication, team working, independent working and learning and problem-solving. They can also expect their skills in numeracy to be highly developed (although there is an interesting debate to be had about the extent to which degree level study in Mathematics guarantees this, or indeed precisely what one means by numeracy!)

Getting started - Pictures

Many mathematics students can, upon arrival at university, manipulate symbols and equations with little concept of what they are doing or picture in their minds of the processes involved. Initially we aim to address this deficiency by setting up tools which graph some of the standard functions which will accompany and be used by the students throughout their mathematical life. Indeed the ability to fit any real life data/situation with an approximate curve is one of the essential skills of mathematical modelling.

We have developed a set of interactive picture books to enable the students to be aware of all the properties of these common functions. Figure 1 gives a screen from the active work sheet for an example with trigonometric functions. It is worth noting that "sliders" which are easily set up (compared with a spreadsheet) enable the student to investigate

both algebraically and pictorially. Our experience is that the animation process with sliders is very engaging especially with a wireless mouse and keyboard, but if using this package with an interactive white board in the classroom it is a good idea to choose appropriately large and readable font sizes.

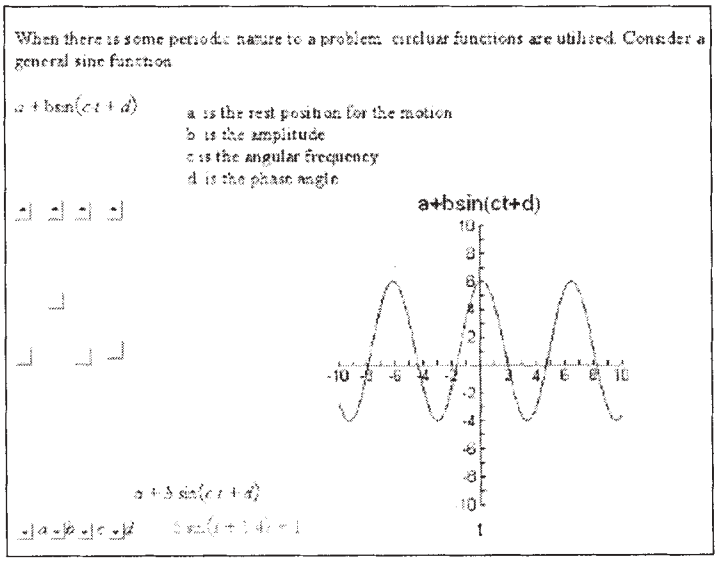

Figure 1 Exploring trigonometric functions

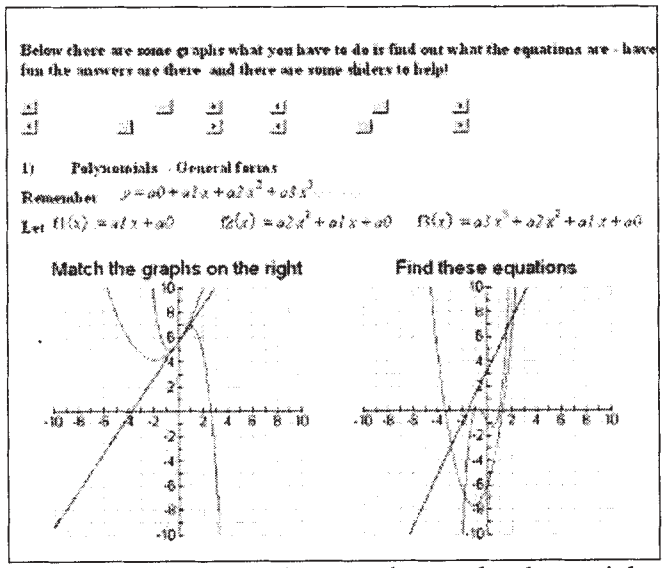

Figure 2 Checking if you understand polynomials

Picture books such as this are followed up by a "test" where students have to match algebraic functions to some given graphs. For instance Figure 2 shows such a test involving polynomials. Once more sliders are involved. Students have to comment on their results and justify how they have approached the problem and how they know they

are correct. One essential part of doing mathematics is to check and convince oneself (and others) that you are correct. This convincing is easily done by visual software.

Doing Algebra and Calculus –Mindless Symbolic Manipulation

Students find the processes of algebraic manipulation daunting, whether basic such as factorisation or expansion, or conceptually more advanced such as differentiation. This can put some students off the learning of mathematics, and the situation is complicated by staff who went through years of training in the processes (as we did) and expect their students to do the same. It is of course necessary for students studying a major mathematics component to develop the full range of basic mathematical skills - including symbol sense - so that they can communicate with other mathematically competent people. However the pool of such people is very small and getting smaller by the day, and it is also necessary for a wider range of people to have some grasp of mathematical concepts, and also for those who are mathematically competent to be able to talk to them!

Now what role can TI-INTERACTIVE!™ play here? Figure 3 shows an example. On the one hand the interactive software allows us to throw away mathematics tables and get answers readily. The checking of answers becomes a different process, no longer "do by hand then look in the back of the book". The package will get the right answer, but have you asked it the right question? The issue here is of course communication with machines, and one skill which all students must still possess is an awareness of the importance of an agreed hierarchy of operations. Technology requires BODMAS or "Please Excuse My Dear Aunt Sally" just as much as paper and pencil does.

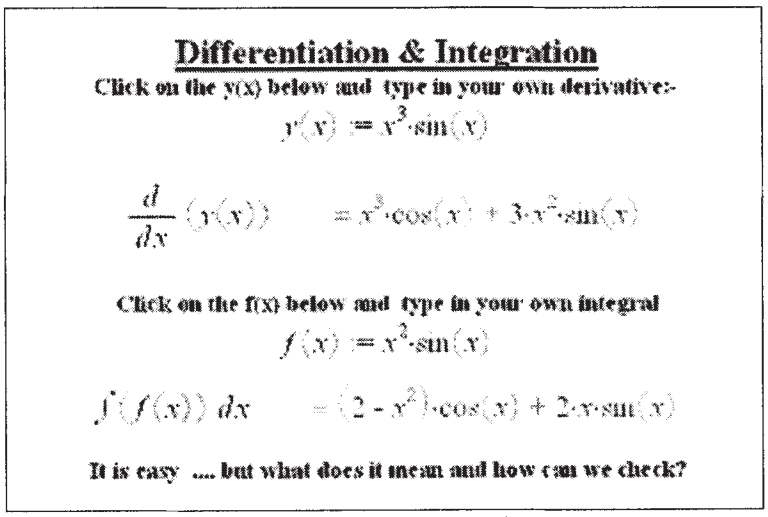

Figure 3 Calculus conversation piece

On the other hand, the software can be used to inspire and add interest to the learning of the traditional and basic skills. For instance it can provide a conversation piece allowing you to pose questions such as "Here is the answer to an algebraic problem - how do you know it is right? Can you get the same answer by hand? What does it mean?"

Taylor Series – a Pivotal Procedure

The idea of a Taylor series lies at the heart of many mathematical approaches - from numerical techniques for modelling reality which are viable only when implemented on technology, to the very algorithms used in the technology for instance for evaluating common functions. Figure 4 shows how, although algebraic demands can obscure the idea, a dynamic sheet linking the algebra to a picture can bring the main concept to life.

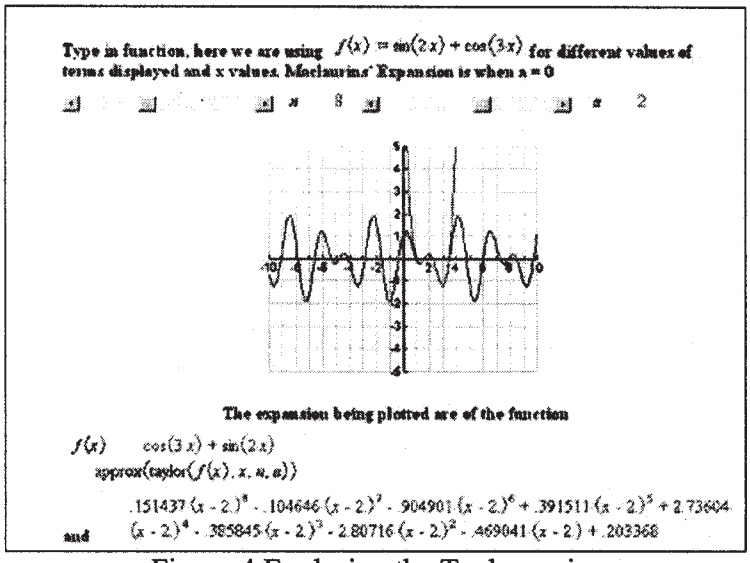

Figure 4 Exploring the Taylor series

The sliders control, and allow the exploration of two parameters: the value of the pivot about which the Taylor series expansion takes place, and the number of terms in the series. The concept can thus be explored in a way which would be impossible without integrated interactive software, because of the amount of computation required.

Modelling with Data - Getting Real – Probing

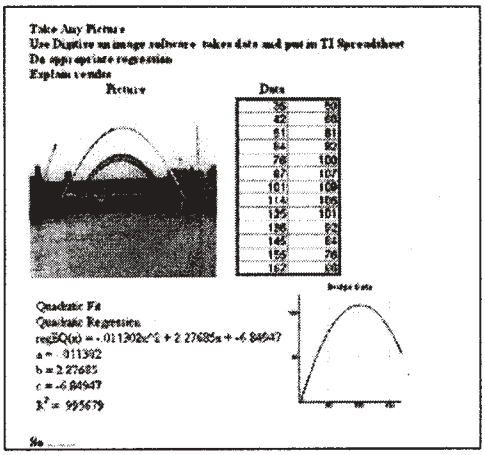

Figure 5a Digitising a picture

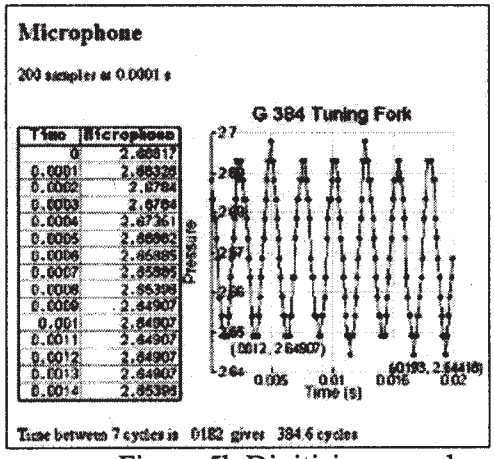

Figure 5b Digitising sound

If we wish to model a real problem one stage of reaching understanding is to digitize! There are many websites about data, for example: the TI Interactive data site at http://education.ti.com/us/product/software/tii/datasites/category.html and videos for instance at http://www.csmedia.demon.co.uk. Pictures can be digitized using the "free" Digitise software which can found at http://maths.sci.shu.ac.uk/digitiseimage/. Figure 5a shows a picture where the software Digitise has been used and the data extracted into the interactive spreadsheet. The "McDonald" sign treated similarly gives a surprisingly simple result! Alternatively the TI Interactive package can be used with probes directly attached via the graph link cable to the PC! Figure 5b shows the result of collection of data from a tuning fork.

Conclusion

We have presented some of the uses we are making of the integrated capabilities of TI-INTERACTIVE!™. Our students are our sternest judges, and record their thoughts in their own personal progress files [4]. Their comments about this kind of approach tend to be positive. "I found this software very easy and simple to use and found that it basically has the qualities of Graphical Calculators, Derive 5 and Excel all into one software package." "Provides very useful inbuilt functions like sliders and animating graphs etc." "Interface is very user friendly with really good help tutorial." "A large amount of graphical options and techniques." Don't believe them try it yourself!

References

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[5] Waldock J ,Gretton H.W. and Challis N.V. (2002), "Assessing Mathskills using the web 100 marks is not enough!" *Proc. 15th International Conference on Technology in Collegiate Mathematics*, Addison Wesley Longman

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