Integrating ict in teaching and learning mathematics

Investigate and discuss the use of ICT in teaching and learning Mathematics. Explore the use of MAPLE.

Illustrate and discuss:

1) Competence with the main features of a range of ICT:

ICT in teaching and learning mathematics is a requirement of the National curriculum and computer simulations can now place mathematics in a real life context. [1] There are a number of superior computer-based environments available to support this process. Some of these include dynamic geometry environments, graph-plotting packages, statistics and data holding packages and computer- algebra packages.

Graphing calculators can be used to teach the beginning of Algebra. Similarly pocket calculators are convenient and quick to access as well as being relatively inexpensive today and is a useful mathematical tool.

With the graphing calculator it is possible to determine that ‘ every classroom could be turned into a computer lab and every student could own his or her own inexpensive personal computer with built-in mathematics software’ [2]

The researchers Arnold and Aus identified three generations of graphing calculators: scientific calculators with large viewing windows, e. g. The T1-82, those which were more versatile with a range of mathematical functions like the Casio – 98JOG and those with CAS and dynamic geometry like the TI-92. Several discussions can be had around the implementation of calculators in mathematics teaching and learning and the subject continues to spark debate. Although the resolution of a hand held calculator is not comparable

with that of a computer screen there is no need to alter the setting of the classroom or have to gain access to a number of computers to use it for learning. With regard to computational skills and mental arithmetic again calculators come up for criticism although there is a definite argument to be had that suggests calculators do not compromise the application of basic mathematical skills, as long as those skills are developed first in a conventional environment using pen and paper based calculations. [3]

ICT can assist with turning algebraic symbols into graphical representations and vice versa. Using spreadsheets for algebra can encourage the use of letters to be interpreted as symbols and spreadsheet symbols can be used to solve mathematical problems [4] . Spreadsheets can be utilized to introduce students to a range of mathematical ideas and as a more generic mathematical tool. Recent research also provides evidence that young people are beginning to use spreadsheets on their own home computers. [5] Dynamic geometry can be used to teach transformation geometry as it can for establishing properties of circles, functions and graphs.

Secondary level curriculum mathematics skills and the application of IT can be linked intrinsically by way of some of the following examples.

The pupils ability to develop skills of mathematical modeling through the exploration, interpretation and explanation of data can be enhanced by using the appropriate graphical representations for displaying information from a data-set, by experimenting with forms of equations in producing graphs which are good fits for data plots and using motion sensors to produce distance-time graphs.

Software can be applied in the context of learning about shapes, space and links with Algebra which automates geometric constructions, carries out specific geometric transformations and performs operations on co-ordinates or is able to draw loci.

Finally by entering a formula in algebraic notation to generate values and match a given set of numbers, this can support the Secondary level skill to explore, describe and explain patterns and relationships in sequences and tables of numbers. [6]

There are many reasons why mathematics teachers are reluctant to integrate ICT into teaching in the classroom. Many of the computer-based environments are complicated and teachers need to learn themselves how to use these tools effectively for doing mathematics. Although newly qualifying teachers have to pass a basic ICT test as part of their training, it is still difficult for teachers to know where to start, particularly some of the older generation of mathematics teachers. In the practical sense access to computers is not always possible for the benefit of every child being able to learn at the same time and sub-groups and individuals may have to be established in order to take it in turns to use a single computer in the classroom which can be time consuming and logistically difficult.

However computers and calculators can be considered to provide six major opportunities for students learning mathematics:

- Learning from feedback – the computer can provide fast and reliable feedback which is non-judgmental and impartial. This can build students confidence and help them construct their own ideas.
- Observing patterns – The speed of computers and calculators enables students to provide many examples when exploring mathematical problems.
- Seeing connections – The computer enables formulae, tables and numbers and graphs to be linked easily. The result of seeing one representation and changes in the other helps pupils to understand the connections between them
- Working with dynamic images – Students can use computers to manipulate diagrams and encourages them to visualise the geometry.
- Exploring data – Computers enable students to work with real data which can be represented in a variety of ways. This supports its interpretation and analysis.
- ‘ Teaching’ the computer – When students design an algorithm to make a computer achieve a specific task, they are urged to express their commands literally and in a correct order. [7]

2) Demonstrate the ability to explore maths and solve maths problems using MAPLE in-depth.

MAPLE can be defined as a fundamental computer algebra software package which uses simple commands to perform complex operations and enables like by like analysis similar to using a pen and paper. It also allows pupils to focus on the underlying mathematical principles. [8]

In Darlene Wu’s Understanding of Calculus she uses a number of experiments to determine the benefits of MAPLE on a series of students. She adheres to the notion that most traditional algebraic features can be delegated to a computer. In particular using MAPLE most problems can be resolved and believe this should be riled out for the benefit of all students studying mathematics. The problem below was assigned to a group of students in a research environment:

Graph f(x) = ln(sin(x)*cos(x)) and

g(x) = ln(sin(x)) + ln(cos(x)). What is the relationship between the graphs? Does it

contradict the property ln(x*y) = ln(x) + ln(y)?

By using the graphs of these two functions together with the graphs of sin(x) and

cos(x), the students investigated the properties of sin, cos, and ln

and show their answers in writing.

Students used Maple to draw the two graphs easily, but they looked

entirely different. This led the researchers to wander whether this contradicted

ln(x*y) = ln(x) + ln(y)? And if so how would students explain it?

The experiment needed to be repeated several times, recalling the definitions and properties of ln, sin and cos and concluded that the students assumed the two graphs looked different, whereas they are identical as long as ln(sin(x)cos(x)) and ln(sin(x))+ln(cos(x)) are defined.

Wu's paper concludes that it is necessary to train students to use mathematical methods effectively not just for the purposes of their job but for ' the real world' and that software programmes that help in this process are fundamental to their learning. However as a number of contradictions and problems emerged with equations through using MAPLE not only does Wu concede that students may become confused and panic if they cannot attribute the Mathematics problem to themselves or the Mathematics problem itself. She also notes that when teaching calculus it is important to consider whether such technology is still too overwhelming as well as students becoming dependent on its solutions, rather than working them out traditionally. [9]

In comparison to this notion another paper with MAPLE as its core area of study is Fitz-Gerald and Healey's *Enlightening the mathematics curriculum with MAPLE.* This discusses the implementation of MAPLE to the undergraduate Mathematics curriculum in a large University in Australia. The overall consensus was that in applying MAPLE, traditional topics that were once unpopular with students were now being approached in a much more understanding and enthusiastic way. This experiment demonstrates the advantages of being able to encourage Mathematics by way of helpful

software across new audiences who might not have been inspired previously to study in this area. [10]

3. Identify the ways in which a particular ICT Software or graphics calculator can be used within a learning environment and the advantages/disadvantages of each in enabling effective maths learning.

In Horton et al's *The graphing calculator as an aid to teaching algebra* the paper points out that calculators have become popular in the classroom for the benefit of convenience and speed. What the researchers also determined was that tutorials on the Casio FX2. 0 and FX 2. 0 PLUS models actually improved manipulative skills. Students beginning a college algebra course following the tutorial scored significantly higher on a test which involved solving linear equations and in addition made suggestions for the tutorial also contributing to an improvement in attitudes. [11]

It is interesting to consider their benefits for something other than the obvious assumptions to be made about graphics calculators. In absolute contrast to all perceived theories *Graphic Calculators In The Classroom: Students' Viewpoints* presents the results of a piece of research carried out amongst low achieving eleventh grade pupils in Portugal. This revealed that little improvement was gained from introducing graphic calculators to mathematics lessons as the pupils considered the impact of their teacher; their teaching style and personality to be of more educational value to them than the calculator, which improved very little in terms of their academic improvement where mathematics was concerned. [12]

Another perhaps more important everyday negative aspect of graphic calculators is their inclusion of games and other non-educative devises such as phonebooks and personal organizers which can detract pupils away from the learning process in the classroom. In addition, the potential for students to store information and consequently cheat during examinations when they are allowed to take calculators in with them in a test environment. The other argument when weighing up some of the differences between hand-held devices and computer programmes is that a calculator can accompany a student into an examination, whereas a computer cannot. They are flexible and user- friendly as well as being able to be powered by solar energy which is of course far more beneficial to the environment.

Another advantage is the diminishing cost of calculators. They can be easily purchased anywhere at a relatively small price in comparison with a computer which ‘ It has been suggested recently render(s) the use of graphics calculators much more attractive to schools than computers’ [13]

Interestingly in his research *Spreadsheets, graphics calculators and mathematics education* , Barry Kisane provides a suggestion for combining programmes into graphics calculators in order to maximize their potential, thus making them less of a calculator and more of a computer. And notes that ‘ The inclusion of these essential features on graphics calculators seems to extend the range of influence of the spreadsheet as a useful device for mathematics education in secondary schools, and is deserving of attention to exploit it appropriately’. [14]

Essentially perhaps the way forward with graphics calculators is to then modify and technologically enhance them further so that they can take on many of the characteristics of the computer whilst not having the capacity to store information that might prove potentially incriminating to a student in the examination room.

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Footnotes

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[2] Bishop, A. J, Clements, M. A (2003) Second International Handbook of Mathematics Education: Springer

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[6] Cowan, P (2006) Teaching Mathematics: A Handbook for Primary and Secondary School Teachers: Routledge

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[10] Fitz-Gerald & Healey *Enlightening the mathematics curriculum with MAPLE,* Essay taken from Maple V: Mathematics and Its Application : Proceedings of the Maple Summer Workshop and Symposium, Rensselaer Polytechnic Institute, Troy, New York, August 9-13, 1994By Robert J. Lopez: Birkhäuser

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