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USING SMALL SOFTWARE ON GRAPHIC CALCULATORS

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During Autumn 2000 and Spring 2001 two teachers in each of four secondary schools (two 11-16, two 11-18) were provided with class sets of graphic calculators, a PC link and a view screen. The graphic calculators had been programmed with some small software applications intended to support the learning of mathematics in Key Stages 3 and 4. Training and support was offered to the teachers through the SMILE team. At a series of four one day meetings teachers had the opportunity to debate issues, share experiences and develop teaching approaches. This report describes the range of teaching approaches used, the impact on children's learning of mathematics and discusses the issues that arose. This work was funded by BeCTa as part of their Handheld Technology Project.

INTRODUCTION

The aim of the project was to investigate the effectiveness of using small, portable technology (graphic calculators) running small software applications to teach mathematics at KS3/4. The benefits of graphic calculators in supporting the development of mathematical understanding particularly in relation to the visualisation of functions (Smart, 1995) and relating graphic and symbolic representations is well documented (Ruthven, 1990, Drijvers & Doorman, 1996). The use of graphic calculators at A level is widespread and the two 11-18 schools involved in this project were typical in that they expected A level students to have their own calculator and regularly used them as a resource in teaching at that level. It is worth noting that in Scotland the use of graphic calculators is actively encouraged for all levels of secondary mathematics teaching. As well as providing schools with equipment there is an intensive programme of professional development for secondary mathematics teachers to enable them to make best use of the technology in their teaching (for example the T^3 project in Scotland).

The use of graphic calculators in the teaching of 11-16 mathematics is not widespread in English schools despite various publications promoting their use (see for example Green & Pope (1993) and NCET (1994)). There have also been regular articles in the journal Micromath (e.g. Butler & Fleming (1997)) discussing the way in which graphic calculators support mathematical understanding for students. Graphic calculators allow a range of topics in mathematics to be addressed in an investigative way as exemplified in the recently published Key Stage 3

National Strategy Framework for Mathematics (DfEE, 2001) which contains examples in number, algebra, problem-solving and data handling.

It is the increased memory and the ease with which programmes can be transferred from PC to calculator and calculator to calculator that made this project possible and indeed timely. For an excellent summary of the capabilities of current graphic calculators see the BeCTa website http://www.becta.org.uk/technology/infosheets/pdf/graphcalc.pdf

BACKGROUND

Four mixed comprehensive schools who have worked with the SMILE centre in London were selected for the project; two schools were 11 to 16 and two were 11 to 18. Two teachers from each school agreed to make use of the calculators with their classes, to attend four one-day meetings at the SMILE centre and to contribute to the development of materials, the evaluation of the project and the dissemination of the outcomes. Each school was provided with at least one class set of graphic calculators, a PC link and a view screen to facilitate the use of a large screen display with classes. Two types of graphic calculator were used in the project provided by Casio and Texas Instruments: the Casio FX9750G and the TI-73 respectively.

On the first one day meeting representatives of the two companies provided training for the teachers involved. As well as the usual graphic calculator functionality: graphs, data handling, arithmetic, fractions etc. the calculators had been loaded with some programmes that would allow the practice, consolidation and exploration of properties of graphs, number sequences, arithmetic, fractions and more. Having been introduced to the machines, teachers discussed how the calculators might be used in their teaching and planned activities to try in school.

Subsequent meetings were spent reviewing the activities that had been planned and other activities that had been tried, sharing ideas, discussing issues and developing further activities for the classroom. Members of the SMILE team, the BeCTa representative and the author attended the day meetings to provide support and encouragement and help ensure that issues were dealt with as quickly as possible. A member of the SMILE team and the author visited each teacher in school and observed teaching of mathematics using the graphic calculators.

OUTCOMES

Teachers made regular use of the calculators in their teaching, as well as using the programmes, they made use of the graphing facilities, the large screen facilities for viewing calculations (including fractions) and the data

handling facilities to calculate statistics and display data. They found it was possible to incorporate the calculators into their teaching for all students from Y7 to Y11.

The way in which teachers used the calculators varied enormously from a whole class lesson with each student having their own calculator to a lesson starter where one calculator was used to provide an interactive visual aid. In addition calculators were used with pairs in order to facilitate discussion, or with small groups or individuals in classrooms where a number of different activities were happening at any one time. In the latter case, the use might be teacher *initiated 'I'd like to show you how to ....'*, or student initiated *'Can I use a graphic calculator for...?'*. Teachers often found it was more helpful in their teaching to use the graphic calculators for a part of the lesson rather than for the entire lesson, although this did depend on the nature of the activity.

In observed lessons there was often considerable discussion between students about ways of solving problems, or overcoming difficulties. Teachers reported students in Y8 developing proofs of their winning strategy for one of the programmes ('Minimax' with multiplication).

All the teachers used the calculators for exploring straight line graphs. The tables of values proved valuable in helping students understand how to use the equation to generate graphs on paper.

The use of the calculator to display data, generate random numbers and calculate statistics was also used by teachers in KS4. In a Y10 lesson, the teacher collected each student's pulse rate and then ended the lesson by discussing ways of displaying that data. He showed the histogram of results and was able to show the effect of different numbers of classes easily.

The majority of students were overwhelmingly positive about the use of graphic calculators. Even students who found some of the idiosyncrasies of the technology frustrating felt that their use had enhanced their understanding of the mathematics being covered.

'I enjoyed using the calculator, it was quite exciting and fun to use...I think everyone should have a go on them'

'The calculator helped me understand what the numbers after the decimal point mean' (using the number line application).

'The calculator let me look at lots of examples easily' (student investigating straight line graphs)

The teachers found that their own confidence in using the technology developed during the project so that they were more quickly able to

identify ways of exploiting the graphic calculator in their teaching. Many schools were keen to further develop the use of graphic calculators, so that all teachers would use them in their teaching and that all students would benefit from working with them.

'It has made us start using them (graphic calculators) in the classroom - they will be incorporated into teaching for all students and all teachers will be using them next year'

Some teachers also chose to write small programmes for use in their teaching, they found the calculator '*useful for teaching things the way I want to*'.

The project ran for just two terms and as not all the schools received the calculators at the outset some had a relatively slow start. Despite this initial set back by the start of the second term all schools were able to make use of the graphic calculators in their teaching.

Although the teachers frequently found that the programmes lacked the level of sophistication they would like, for example, answers were given when students got something incorrect rather than being invited to have another go, they were generally positive about the benefits of using the programmes in their teaching. Teachers were also using other features of the calculators in their teaching, for example graphing in the teaching of straight lines and quadratics. Some schools didn't have blinds at the windows of their classrooms which meant they were unable to make use of the viewscreen for the calculator. Some teachers found that the use of a large poster of the graphic calculator and the viewscreen made it much easier to do whole class demonstrations and to instruct the students in the use of the graphic calculator.

CONCLUSION

This short project demonstrated the potential of graphic calculators to enhance the teaching and learning of mathematics throughout the 11-16 curriculum. Both teachers and students were positive about the use of the calculators. Given the difficulty of accessing computer suites in school, graphic calculators offer mathematics teachers a dedicated resource that can be used to target particular areas of the curriculum in a way which encourages mathematical thinking. The outcomes show the flexibility of usage that graphic calculators allow: whole class with one demonstration machine, whole class with individual or paired use, small group or individual use when other activities are also going on in the classroom. There is also tremendous potential for covering a range of mathematics content: number, algebra and data handling.

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