INTEGRATING MICROSOFT WINDOWS APPLICATIONS WITH MODULES FOR LEARNING STATISTICS, MATHEMATICS AND OTHER CORE CURRICULUM AREAS

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In this paper we present the interim results of a 3-year (1997-1999) UK national project, a Teaching Company Scheme (TCS) which will integrate Microsoft Windows applications into the core activities of teachers and school managers. Computer based statistics, mathematics, and other main curriculum subjects are being authored, and these will be evaluated for their effectiveness using properly designed experiments and analyses. In this paper we describe two modules. The first is for mathematics and it provides the template for design, evaluation and measuring issues for all modules, while the second is a statistics module.*

INTRODUCTION

The UK TCS was established in 1975 to develop partnerships between companies and universities, with financial support through a government grant. In a typical TCS a company draws on university expertise to support key strategic projects, whilst developing able graduates into future leaders. The appointed graduates, who are employees of the university, are called *TCS associates* and work within the company on two-year contracts. Their project work is designed to help realise the company's commercial aims, and is supervised jointly by company staff and the academic collaborators. Since 1975 some 2000 companies have improved their commercial output through TCS partnerships.

It is with this background that The Nottingham Trent University (NTU) and the Nottingham-based company, The Data Base (DB), won a TCS grant for two associates to be employed over a three-year period, with the first associate starting in March 1997. The project is to develop self-paced computer based learning systems using generic and original software for mathematics, statistics and other core curriculum areas. These will take full advantage of developing technologies using the World Wide Web. The partnership is with the education division of the DB, which works at the leading edge of educational IT developments in the UK, providing PC-based industry standard networking solutions for schools, colleges and universities. The first named author provides academic supervision, the second and third named authors provide the company supervision and the last author is the TCS associate.

Over a number of years the DB has established a number of schools (in excess of 60) with which it has very good working relationships in providing hardware, software and training solutions. The initial stage of the TCS project involved identifying partner schools from both existing customers and new prospects. From 40 or so schools who expressed interest, 12 were selected to get involved in the design, writing and monitoring of core curriculum modules for computer based learning in mathematics, statistics and other curriculum areas. Part of our specification was that standard Microsoft Windows applications, as found in Office '97, were to be the engine to drive the development of the modules. The TCS associate has the role of managing the design and programming activities of teachers in the selected schools, and this involves liaison, product development, assessment, refinement and marketing by: Making sure that consistent and user-friendly templates are used for all modules; Providing a support service and appropriate documentation; Designing and implementing methods of assessing the effectiveness of the modules in terms of learning gain - user trials; Analysing of the results of such evaluation trials; Modifying the modules in the light of the outcome of the evaluation trials and experience of teachers using them.

The second TCS associate will have been appointed in March 1998, and the second part of the project will focus on the integration of the modules created in the first part of the scheme into the World Wide Web.

COMPUTER BASED LEARNING MODULES

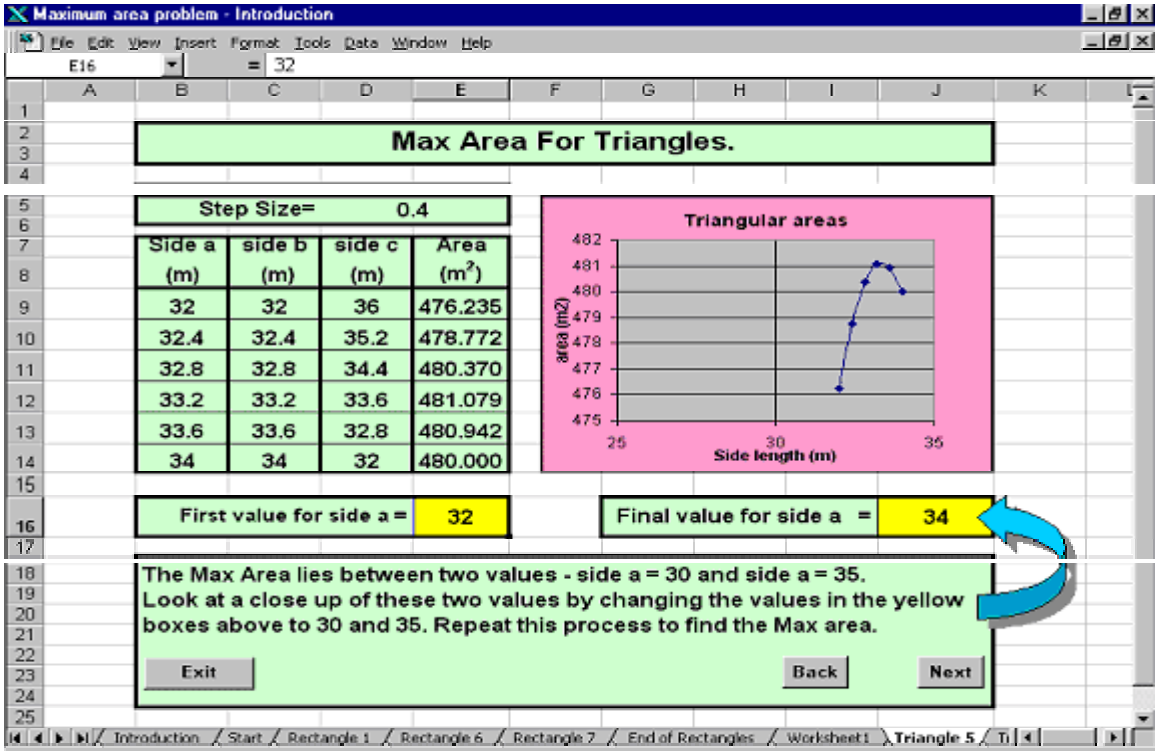
To illustrate our approach, we choose the benchmark standard module entitled 'The Farmer's Field', which has been developed, from scratch over a period of 6 months, by the first TCS. Simultaneous development of statistics modules is taking place and these will use the Farmer's Field as a template for good practice. The mathematical problem is well known: a farmer has 100 metres of fencing and wishes to construct a totally enclosed field that has maximum area. There are many core curriculum issues that can be addressed in teaching the material to solve this problem, and these are clearly identified as part of the teaching, learning and assessment process in the computer based module. Also, it is important that modules are designed so that, in the case of the UK at least, existing national curriculum assessments tests can be administered after students have used tailored CBL software. In the case of the Farmer's Field module, its content addresses MA1 assessment criteria at levels 4-7, each over three strands.

For all the modules that we are producing we believe that IT and its capabilities should be *integral* to them, rather than, as is common at school level, bolted on in separately taught classes. Thus, even though the Farmer's Field module has been written within Excel '97, employing conveniently placed buttons on each screen, navigational facilities and cross-linking properties, we have implemented digressions that illustrate the *pure spreadsheet* capabilities of the software.

We have used the excellent manual by Tidball (1995), and have created a general house-style for all of the modules. Each uses standard navigational controls with 'back' and 'next' buttons on each page to take the user through a number of linear routes through the material. A 'map' page is also accessible, which allows the user to move between each section of the module and to review his/her progress. Aims and objectives are clearly stated on opening screens for each module, and progress is linked to attainment targets as specified within the UK national curriculum. A student's progress towards these targets can be measured as they complete exercises and questions within the module.

The figure on the next page shows a typical screen from the Farmers' field module. Note that we have *deliberately* attempted to maintain the look and feel of the Microsoft Excel environment by keeping grid lines and standard toolbars. We feel that this helps to *integrate* the subject and IT methods. On this screen, the user is asked to specify the lengths of side that will give an isosceles triangle of maximum area. As values are input to the boxes on screen, the area is re-calculated and the graph is automatically re-plotted. As students progress through the workbook, a number of screens ask for calculations to be made using the standard features of Microsoft Excel.

The Farmer's Field module was used as an example to test and measure the effectiveness of computer based learning methods in mathematics at the UK key stage 3 level. One of the selected schools in the TCS is St George's Technology College in Sleaford, Lincolnshire. Late in 1997 all the year 9 pupils were divided into two groups, 1 and 2, say. Each group was then further divided into two sections A and B, so the groups 1A and 2A, and 1B and 2B were approximately of the same ability, respectively. Groups 1A and 2A were deliberately chosen to be of better ability than 1B and 2B. Randomisation was used to allocate students to 1A and 2A, and 1B and 2B. One subgroup from each ability group was then randomly chosen to be taught the curriculum material, either using the farmer's Field software, or using traditional methods.

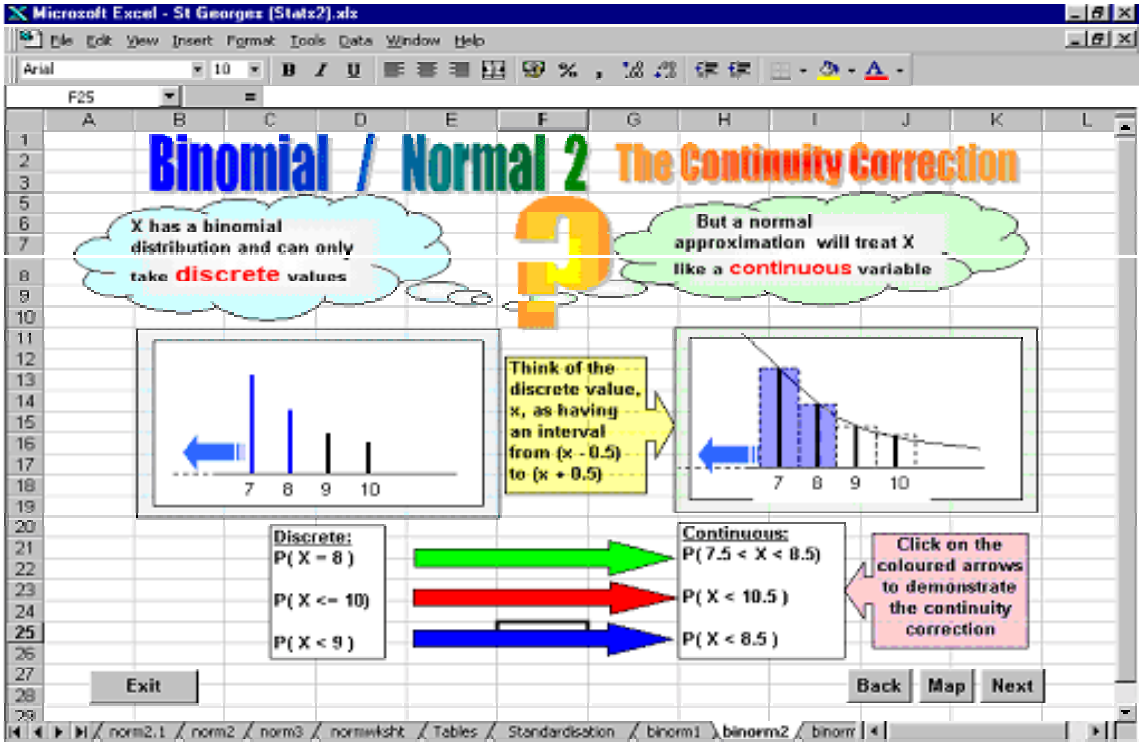


The designed experiment, using both computer and traditional methods, was administered over one week of the teaching term. The TCS associate was closely involved in managing the computer version of the teaching, and each pupil was given a questionnaire after using the CBL module. After 3 weeks, all the year 9 pupils were assessed using the MA1 assessment criteria for the level of mathematics covered by the Farmer's Field module. Detailed results of the experiment will be reported elsewhere, but the key points that emerge are: As expected, there is a clear and significant difference between the average scores achieved by the students in the groups categorised by ability; There is no significant difference between the average scores attained by those students who did and did not use the CBL module, in both the higher and lower ability categories; After using the CBL module the scores attained by the students using their acquired knowledge of the mathematical topics were consistent with the scores obtained in the national curriculum tests administered earlier in 1997.

The first two of these points are consistent with earlier studies at school and first year university level. See, for example, Bowman, Constable, Davies, Gilmore, Gilmore and Redfern (1998) and Antcliffe (1998). The key points to emerge from the results of the attitude survey are: Overall the feedback was positive as pupils found the module was easy to understand, they enjoyed using the computer, working at their own pace and their knowledge of the subject material had improved; Nearly everyone felt that his or her

understanding of the topic had improved; No-one felt that that his or her understanding had worsened.

The variation of abilities between the two groups was shown in their ability to work through the module at their own pace. The higher ability group found it easier to navigate around the module and it allowed them to proceed at their own speed without the need for teacher intervention. Many in the higher ability group found the module easy to work through and they enjoyed learning this way and preferred this lesson to their normal lesson. Although the lower ability group handled the module very well, and felt that it was paced just about right, they were more dependent on the teacher. The majority did enjoy the method of learning and found that the text and graphics helpful. However their progress through the module was slower and on the whole the group were less positive about the module than the higher ability group.



The previous diagram illustrates a page from one of the suite of modules we are developing within Excel to illustrate the relationships between the normal, binomial and Poisson distributions. The design template we have set up for the Farmer's Field module is being used, and we are attempting to integrate IT aspects of the spreadsheet with

learning statistics. We shall be running designed experiments to measure the statistics modules' effectiveness in a range of schools within the UK. We shall report our findings elsewhere in due course.

CONCLUSIONS

In the development of CBL courseware for schools, we have demonstrated advantages of a collaborative approach between: (1) Academics from Higher Education with extensive experience of using CBL effectively; (2) Commercial software developers with an understanding of the potential uses of the latest technologies and (3) Teachers in schools, with an in depth knowledge of the National curriculum, and issues relating to its effective delivery. All three parties have benefited from the experience of working on the project. In particular:(4) NTU has developed close links with a number of high quality schools. This opens up the potential for students to come to this university to study; (5) The DB has developed and tested a specialist product for the education sector, thus opening up a number of commercial opportunities; (6) Partner schools have benefited in a number of ways, including gaining Office '97 skills, acquiring a suite of curriculum software and by strengthening links with the DB and NTU.

A number of important lessons have been learned from the evaluation of the software within schools. In particular, students: (7) Using CBL materials exhibited neither more nor less learning gain compared to students studying by conventional means; (8) Found the materials easy to use and were positive about the use of computers for learning; (9) With a higher ability were able to work through the materials at a faster pace, and as a result were more positive about the use of the materials than lesser ability students. The project has demonstrated that both HE establishments and commercial organisations could have an important role in helping to develop core curriculum material outside this project. We feel that we are only scratching the surface with what is needed across the UK.

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