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# The Planning and Development of an Interactive Computerized Information Technology Tutor for Postgraduate Students

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## SUMMARY

This paper describes the design and implementation of a computer-assisted learning tool to support the learning environment provided for postgraduate students following courses in Information Technology. The tool is called 'ICITT' – an acronym for Interactive Computerized Information Technology Tutor. The paper presents the unique aspects of this tool and the overall educational benefits of the system are briefly discussed.

## INTRODUCTION

Computer-assisted learning (CAL) is often used to provide a learning experience in which a learner and a computer system interact with each other. During this process the computer usually provides a stimulus to which the student must respond. The computer then analyses the response and provides feedback to the learner. By facilitating individual learning needs, self-paced instruction has the effect of motivating students. More significantly, by *observing* the use of the medium by the student, it allows software simulation of the human tutorial process with the computer acting as a mentor or coach. Through the use of suitably designed interfaces, students are able to interact with the computer in appropriate ways – thereby adding significant benefits to the educational process.

The future potential of CAL in the context of the development of interactive learning environments for higher education students has been discussed in some detail in the Teaching with Independent Learning Technologies (TILT) initiative. Some of the advantages include:

- Students learning at their own pace thus stimulating interactivity and motivation. Experimental studies (TILT, 1996) show that many students learn in a one-to-one environment. The possibility of having an entire lecture group tutored by a skilled teacher is not realistic, since there is a lack of skilled teachers and it is too costly.

- Students believe they have increased confidence in themselves and with the computer, thus encouraging them to be more proactive.
- The provision of an interactive multimedia group-learning environment.

There is also an *economic* argument for the use of CAL in education. Evans (1995) concludes 'that CAL is no longer expensive; it competes favourably with other forms of learning and offers an attractive and cost-effective solution to many learning situations. Introducing CAL is believed by the decision makers in higher education to provide a solution to the problems of larger classes'.

Research by Awbrey (1996) and Vandusen and Worthen (1995) on the costs of instruction delivered via distance learning, teleconferencing, and computer software indicates that savings are often achieved with no loss of effectiveness. Technology-based methods can have a positive impact on a learner's motivation and can frequently save instructional time. Of course, savings in training time can produce benefits both by reducing training costs and by reducing the time required to become and remain productive in the workplace.

In the USA in 1991, a review covering 47 comparisons of CAL and multimedia instruction with more conventional approaches to instruction showed time savings of 30%, improved achievement, cost savings of 30–40%, and a direct, positive link between the

amount of interactivity provided and instructional effectiveness (Fletcher, 1991). Furthermore, a comparison of peer tutoring, adult tutoring, reducing class size, increasing the length of the school day, and computer-based instruction found computer-based instruction to be the least expensive instructional approach for raising mathematics scores (Fletcher *et al.*, 1990).

There is also evidence which supports the educational argument for the use of CAL in education. Vandusen and Worthen (1995) maintain that there is, as yet, no conclusive evidence that teaching delivered by the computer is any better or any worse than conventional teaching. However, they further state that lecturers are prepared to make CAL materials available to students on the basis that the widest possible range of resources for learning should be offered to them.

A report from the Advisory Council for Science and Technology on the use of CAL materials for increasing productivity in higher education claims that 'new learning technologies such as computer-assisted learning should be introduced to facilitate productivity in higher education institutions and the expansion of student numbers' (Advisory Council for Science and Technology, 1991). A report to the Inter-University Committee on Computing in 1991 also agreed with this premise. In preparing students for the workplace, experience suggests that interactive, high performance technology can produce immersive, real-world instructional environments. These environments can smooth long-term school-to-work transitions while helping to meet the immediate objectives of both schools and workplaces.

CAL has been proven to be a powerful tool in reaching the highest levels of educational performance (McInerney *et al.*, 1994). In their meta-analysis of the findings from 254 controlled evaluation studies, Kulik and Kulik (1991) suggested that CAL usually produces positive effects on students. Findings from a number of similar studies also reinforced this outcome (Becker, 1988; Blomeyer, 1989). Duguet (1990) contends that, as an integrated tool, CAL can have a profound impact on the learning process, the content of courses; the role of teachers and classroom organization.

In 1993, a survey of studies on the effectiveness of technology in schools concluded that 'courses for which computer-based networks were used increased student-student and student-teacher interaction, increased student-teacher interaction with lower-

performing students, and did not decrease the traditional forms of communications use' (Software Publishers Association, 1993). Similarly, a review of computer-based instruction used in military training claims that students reach similar levels of achievement in 30% less time than they do when using more standard approaches to training (Orlansky and String, 1979).

The beneficial aspects of computer-assisted learning, as they have been outlined above, have been used within our department for the solution of a teaching and learning problem relating to Information Technology (IT) courses. As is discussed in the remainder of this paper, the problem has been overcome through the development of a CAL tool called ICITT. This system has been used in order to enhance the quality of the teaching and the learning environment for students following some of our IT courses.

## RATIONALE FOR THE ICITT TOOL

The aim of the study described in this paper was to discover why students who were enrolled in our Information Technology module (within the Public, Administrative and Legal Studies MBA course) disliked the IT subject matter and the use of lectures for course delivery. Until this research was conducted, students on the IT course module were given lectures but no practical tutorials. It was thought that the provision of tutorials would be an extremely useful mechanism for consolidating and elaborating on the subject matter of the course.

Prior to the study we had an awareness of resentment and dislike of the subject matter by both academic staff and students. This became apparent as a result of: (1) listening to students' complaints and apprehensions about the present learning environment; and (2) feedback from the follow-up staff-student consultative meetings. The conclusions drawn were that there was a degree of frustration and anxiety in learning about IT. Students struggled to learn aspects of the course. Indeed, many students had a long-standing aversion to the whole area of computing in general.

Research by Shneiderman (1987) indicates that many students encounter serious cases of computer shock, terminal terror, or network neurosis which force them to avoid using computerized systems. Bertino (1985) also supports this premise - concluding that 'interfaces were incomprehensible, ambiguous and

intimidating, leaving students feeling frustrated, insecure and even frightened'. McInerney *et al.*'s (1994) research also demonstrated the debilitating effect of computer anxiety on achievement in computer-related learning. More recent research (conducted at the University of Ulster) on computer anxiety reduction, also reinforced these conclusions (Kelly, 1994).

For the purpose of this study computer anxiety is defined as 'an affective response of apprehension or fear of computer technology accompanied by feelings of nervousness, intimidation, and hostility'. The evidence from the McInerney *et al.* study clearly supports the notion that increased experience leads to a diminution in computer anxiety.

A further reason for the students' dislike of IT was as a result of there being no practical classes time-tabled for the subject. Research clearly indicates that a practical element to a course can encourage students collectively to enjoy learning IT (Fletcher *et al.*, 1990). For these reasons, a decision was taken to investigate the area of CAL to find a solution to this problem. It was hoped that this would increase students' regard for (and interest in) the subject by leading towards an increased understanding and knowledge of IT. This should overcome the difficulty of engaging the interest of students in a subject which for many was not intrinsically appealing. By using the ICITT system it was anticipated that students would gain increased practical experience in IT.

In order to discover why students disliked the subject, data were collected using a two-stranded research methodology. It was deemed important to establish the nature and extent of the problem from the students' perspective while at the same time conducting a parallel analysis of the part that the teacher's practice and that of colleagues might be playing in the problem. A number of informal interviews were therefore conducted with students and colleagues. These were intended to be used as a means of gaining a basic understanding of the nature of the problem. In addition to this, a student questionnaire was devised in which the students were asked a range of questions about their current and previous experiences with computers. A second questionnaire was also devised; this was used to ask students a series of questions about how they felt about the way in which they were presently being taught on their IT course.

It was anticipated that the production of a CAL package (ICITT) would provide a much-needed

practical element to the previously discussed IT module. By using ICITT, the students would be able to gain hands-on experience of the subject matter. Obviously, different learners may wish to use CAL materials for different purposes – for example, new learning in the subject area, a refresher course or studying for an exam. ICITT will support each of these types of activity. Students can study any subject area they wish (there would be a range of IT skills available), when and where they find it most convenient (for example, working in the laboratories in their own time to supplement lectures) and at their own individual pace. Using ICITT should be an incentive to enjoy the subject – as existing subject matter which previously bored the students can now be 'rejuvenated' to help increase their overall understanding and learning capabilities in IT.

ICITT has also been developed to enable a significant reduction in the time spent by both students and teachers in managing resources. The extent of such reductions can be measured by formative evaluation of the system's use across a range of IT areas.

## THE ICITT SYSTEM

ICITT was planned and developed as an interactive computerized assessment system in order to provide an alternative learning experience for students and to achieve a more efficient use of teaching time. It was not designed to replace specialized subject area teaching. Instead, it supplements paper-based learning, *but is more fun than a book, and appears much better visually*. It can be described as a *learner support environment*, since it assumes that the intelligence resides largely with the student and thus it concentrates on providing optimal conditions for learning. It makes use of interactive CAL – by promoting active learning in which there are high degrees of participation and involvement by the student.

The rationale underlying the planning and subsequent development of ICITT was based upon the need to aid the management of learning, testing, tutoring, exercising, dissemination and archival of material. One of the important attractions of ICITT is that the computer is integral in the management of the learning process. As a result of its record-keeping ability (and analytical power), ICITT can monitor a student's progress through the course of the instructional material.

The ICITT system consists of four inter-linked components:

- The core ICITT system.
- Modules, each containing a database of specialized questions with answers and explanations.
- An online tutorial for beginners to the system.
- A fully context-sensitive (to specific subject areas) multimedia hypertext help system which contains high quality images and links to the questions in the associated database module. This is a useful and interesting way to revise the material quickly.

The basic philosophy underlying ICITT's multimedia approach to instruction is that a number of different media are used (simultaneously or in sequence) in order to implement a learning task. The full ICITT system utilizes the latest multimedia technology by integrating text, photographic quality colour still-images (which greatly enhance the capabilities of the hypermedia tutorial) and online help, in addition to the planned use of video, sound and animation.

The teaching methods and media used in the development of ICITT were chosen to hold learners' interest, to remind them of earlier learning, to stimulate new learning, to explain subject-matter and provoke thought, to get learners to respond actively, to give them rapid feedback to their responses, to encourage them to practise and review and to help them to assess their own progress. There are many hours-worth of potential study time available; therefore the ability is always present either to revise topics or test individual knowledge. ICITT has been designed to be of use again and again. In its entirety, ICITT is a shell system with a number of modules of specialized knowledge to accompany it – with hundreds of questions available in the system. To date, modules have been developed in Information Technology – but it obviously has potential in other areas.

Students are able to interact with ICITT and their abilities are amplified, not impeded, by using it. ICITT is adaptable to students' working patterns. It can be used wherever there is a suitably connected workstation and at times when the laboratories in which it exists are accessible. Provided suitable access arrangements can be made, workstation rooms can be used for many more hours in the week than lecture theatres, and a shift from lectures to this CAL package can enable more students to be taught without more lecture theatres. Even where ICITT is used as a supplement to conventional teaching, it can mitigate

the negative effects of larger class sizes through the interaction it offers.

ICITT is a great deal more interactive than passive participation in a lecture, and can offer more interaction than a typical group tutorial. Feedback to students is individual and instant. Staff (as well as students) benefit from this extended learning as information on student performance can be made readily available to tutors as well.

It should not be overlooked that learning with computers is often fun! ICITT can be both motivating and stimulating. The essential pedagogical idea underlying the production of this CAL package is that of opening up new opportunities for students to learn. It enables them to study whichever particular subject area they wish (there is a range of IT areas available), when and where they find it most convenient, and at their own individual pace.

The full analysis and design process that was conducted for ICITT involved a comprehensive range of steps – from logging students on to the system (to record their performance) to presenting a range of IT topics for them to peruse. The authoring software used to develop ICITT included Microsoft's Visual Basic, Access, Help Magician and Multimedia Viewer Publishing Toolkit; Autodesk Animator Pro was also utilized for some parts of the system. These software tools were used to support the creation of an interactive, non-linear experience which allowed several pathways through the learning material. Using these resources, students can make choices regarding navigation through any given presentation. The facility also exists to modify how long a student wishes to view each screen. Testing of students' knowledge is supported in ICITT in the form of maintaining individual scores. A future possible development in this area will be to track the paths that a student can take through the courseware.

Microsoft Visual Basic provided a quick and easy way to create the ICITT application for the Windows environment. The Visual Basic programming system allowed the creation of an attractive, powerful, full-featured application that exploited the graphical user interface (GUI) to full effect. This language was chosen to develop the system for the following reasons:

- It was easy to get a program up and running.
- It was very fast for tool development.
- It had much well-thought-out functionality.

- It has good interfaces to other Microsoft products such as Microsoft Access.

Microsoft Access offered an easy way to locate, manage, and share information in ICITT. It provided the relational database facilities that were needed to drive the development of ICITT forward.

## MULTIMEDIA IN ICITT

Implicit in the design of ICITT was the provision of appropriate support for the use of multimedia techniques. It is widely accepted that multimedia empowers teachers to create interactive and exploratory classroom experiences (Desmarais, 1994). Hartley (1993) asserts that, 'interactive multimedia is attracting increasing interest as a support for teaching and learning'. Indeed, multimedia systems hold the promise of great benefits in terms of increased productivity, efficiency, effectiveness and information enjoyment (Koegel Buford, 1994).

By using the Multimedia Viewer Publishing Toolkit, it was possible to provide ICITT with the benefits of blending together the use of text, sound, animation, graphics, and video to provide a multimedia tutoring environment. Considerable thought had to be given to the design of this tutoring environment since it provides context sensitive help on all the IT topics in the system – thus allowing students to learn while actively participating in consultations. Help Magician, the standard Windows help authoring tool, provided a professional online help system to accompany ICITT. Autodesk Animator Pro was used to facilitate the playing of animations and display of pictures within the ICITT system.

ICITT provides a computer-assisted learning environment designed to operate with a minimum of teaching contact. The system is completely free-standing – thus allowing learners to work alone at their own pace and without a tutor. Although learners work through the system on their own, they may also meet together on occasions in order to ensure that they gain the optimum benefits from using the system. ICITT also facilitates contact with lecturers who act as advisors to the system.

The most significant difference between ICITT and previous methods of classroom instruction (lectures) for the IT module is that in ICITT students interact

with computers rather than with other peers or teachers. Each student is required to respond to each question. The computers are programmed to react to each response with an individualized message depending on the nature of the responses that are made. Learners answer in the privacy of their own computer terminals. An ICITT lesson can assess a student's understanding only by asking pertinent questions and monitoring responses.

A further advantage of ICITT is that it is individually paced. Students can work at appropriate levels of difficulty and proceed in the lesson at a pace that is appropriate for them. Such individualized instruction is a significant feature of CAL (Steinberg, 1984).

## CONCLUSION

ICITT provides a new innovative approach to our teaching of Information Technology courses. It enables students to step-through procedures so that they are better prepared when they encounter real tasks at a later stage. Students are thus able to make decisions and experience the consequences of making them. We believe that ICITT helps students to develop their understanding and skills in the area of IT. At the same time they become more interested in the course material that they are required to learn.

Based on the information gathered from both interviews and the students' responses to questionnaires, there was a desire to introduce CAL into IT lessons in order to structure learning, increase motivation, encourage activity and independence in learning and establishing interpersonal relations conducive to learning. As a result of this study, these changes were implemented through the realization of the ICITT system.

The result of this study has encouraged a more positive attitude to the learning of Information Technology in third level education – generally, by improving the present teaching practice. Obviously, the 'Interactive Computerized Information Technology Tutor' has provided a concrete mechanism for achieving this. In addition to developing a new practical interactive method of learning for students, a further goal that was achieved as a result of the ICITT development was ensuring that students attain a competent performance in the various skill areas that make up IT.

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## BIOGRAPHICAL NOTES

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