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Article

An interactive computerised assessment system

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Abstract

This paper discusses the development of ICAS (Interactive Computerised Assessment System). Self-assessment is a very important aspect of this system. As various types of subject material can be explored, series of questions are posed to prompt further investigation and reflection on what has been learnt. This will foster the development of a questioning and critical reasoning attitude in students. In the absence of 'experts' and pressures of time, the capacity for independent critical thought should be enhanced. ICAS, then, is a student-centred, self-paced learning package with teaching strategies based upon discovery and problem solving.

A review of the unique educational aspects of ICAS is given, including a description of the ICAS design, along with a recount of the implementation of ICAS. This shows that ICAS amplifies the learning experience for students and is a significant step forward in CAL.

Introduction

Many of the processes involved in teaching and training may be regarded as interactive. When a computer is used in a teaching/training context, an attempt is made to augment and extend (and in some cases replace) some of the functionality of the teacher by means of a computer system. High degrees of interactivity between student and teacher (whether human or computer) are achieved by means of a one-to-one dialogue situation involving exchanges of information between teacher and student.

Computers are essentially tools to facilitate and aid information processing tasks that would be difficult (or

impossible) for people alone to perform (Zorkoczy, 1990). Passive CAL involves the use of the computer as a learning/teaching aid, but there is no direct involvement by the student. In contrast, the idea behind ICAS was that of interactive CAL, which promotes active learning in which there are high degrees of participation and involvement by the student.

The ICAS System

The ICAS prototype system consists of four inter-linked modules developed with four separate software applications.

- *The core ICAS system.* Microsoft Visual Basic TM Version 3.0. was found to be the quickest and easiest way to create this application for the Microsoft (r) Windows TM Operating System. The Visual Basic programming system allowed the creation of a highly engaging, powerful, full-featured application that fully exploits the graphical user interface (GUI). Visual Basic was chosen to develop ICAS because it was very fast for prototyping and had good interfacing to other Microsoft (r) products e.g. MS Access.
- *Databases of specialised questions with answers and explanations developed in Microsoft (r) Access TM Version 1.1.* This was the easy way to locate, manage, and share information in ICAS: it provided relational database power.
- *The fully context-sensitive (to specific subject areas) hypertext help system,* which also contained high quality images, and links to the questions in the associated database modules. Multimedia Viewer Publishing Toolkit TM Version 2.0. was used to develop this, and allowed the inclusion of text, sound, animation, graphics, and video.
- *An online tutorial for beginners to the system.* Help Magician TM Version 1.37. was used: this is a standard Windows Help Authoring Tool. Speed, organization, and ease of use were its trademarks. All combined into a highly professional help system.

In its entirety, ICAS has been designed as a shell system with a number of modules of specialised knowledge to accompany it, with hundreds of questions available in the system.

The Core ICAS System

ICAS will authentically test students' ability to operate in the real world of various subject areas. This is probably the single most important thing to know about graduating students before they are permitted to become professionals in a given subject area. The proposed full scale implementation of ICAS will use experienced practising subject matter experts to create problems

which will be run on a computer and which will test a student's decision-making ability, use of laboratory investigations, and ability to work under time pressure. The testing instrument was designed to be used as a teaching tool, an assessment instrument for student performance and as a course evaluation tool. Learning will be improved because of the several uses to which the programs will be put, plus the opportunities presented to students to practise, revise and reflect on the skills needed to successfully complete the programs.

The core ICAS system then provides a test regime for students, and manages the interaction between the module that encapsulates questions and answers with explanations, and the subject area hypertext.

ICAS involves the enhancement and extension of a unique, computer-aided instruction tool which facilitates student learning about various subjects. Authors create questions to allow interaction with the student. The student types in answers to each question and the computer analyses the answers before giving the student individual feedback on the answers. The computer also gives advice as to the correct answers and identifies any important errors or omissions. Various subject matter images are displayed in high quality. The student can view and zoom in for more detailed views of regions of interest. The software in which ICAS was developed is general so the system could easily be used for various other computer-aided instruction.

The system generates a study period for a student from highly specialised and hand-crafted modules of questions. The types of questions included in a module test both diagnostic skills and emergency management skills, with various levels and standards contained within.

There is a pre-determined competitive scoring facility on all questions with an interrelated penalty aspect for those students not completely *au fait* with the subject area. Through the initial viewing of the online tutorial, students realise that it is valuable for them to have a go at answering the questions, rather than pass to the next question - a large incentive not to pass is the deduction of marks from their final score.

An accumulation of penalty points in a particular part of a module causes the system to present the student with context sensitive hypertext (including graphics) to aid revision. As there is an enormous amount of background material available for consultation, this helps students to gauge their improvement rate over time.

An added feature is the realistic timing of student sessions with ICAS, which models the time constraints of the decision process that a student will encounter in the real world. The lesson may simulate a real-life situation. It enables students to 'step-through' procedures so that they are better prepared when they encounter the real task later. Therefore ICAS can supplement both the lecture and laboratory component that a student may face.

Self Assessment Aspect of ICAS

Instructional design may be defined as the art of arranging content and activities in such a way as to best facilitate learning. The instructional strategy behind ICAS could be claimed to be based on the Socratic method of learning, using questions and answers for reinforcement and self-assessment of previously encountered material. This 'drill-and-practice' is therefore in support of conventional teaching, not a replacement for it.

The self-assessment questions are an important feature of ICAS. All the questions in the database are designed to test the students existing knowledge of a subject area. An aspect of ICAS to be highlighted is the choosing of topics from which to answer questions. The student is offered the choice of either answering a set of questions under a specific topic, answering a random set of questions, or answering all questions in the database.

This project addressed the failure of students to apply classroom learning in subject area settings. It was therefore decided to set the following goals for ICAS:

- Specific
- Measurable
- Attainable
- Results oriented, and
- Timebound.

The use of data in problem-based activities will enable students to engage in the construction and development of plans in a way that is linked to the realities of their future practice setting. At the same time the data will be embedded in learning activities which encourage students to develop their problem-solving ability and critically challenge aspects of existing practice, thereby becoming informed practitioners who are able to think laterally about clinically based data.

The author of an ICAS module of information must decide not only how many questions to ask but whether to force the student to answer them and whether to require a given level of mastery before allowing the student to proceed. Individualisation is important from the student's point of view. With ICAS's self-paced learning modules, each student can work at an appropriate level of difficulty and proceed in the lesson at a pace that is appropriate for him/her. If a student finds a topic difficult, help will be available from the context-sensitive hypertext-help facility.

There are a variety of question formats presented to the learner; it is recognised that self-assessment questions quickly become boring if they are all of the same sort. Thus the material needs to be visually attractive. The system is not limited to the common type of self-assessment question found generally in learning packages. There are four question types in ICAS. They include:

- *Stem questions*, which are composed of between 3-6 related parts; one cannot progress until the previous part has been answered;

- *Combo questions*, which are a standard multiple choice question, where the user has a number of options from which to choose the correct answer(s).
- *Drag & Drop lists*; a set of conditions which must be matched correctly to an associated term.
- *Miscellaneous* presents the user with a number of options; they have to choose a correct combination of those outlined in the multi-answer in format.

An associated feature of the system is the responses to self-assessment questions and activities. There was an aim to include proper responses to what the learner had done, along with regular answers to the questions. The answers in ICAS are not just model answers (although they in part reflect the specific answers given in the leading textbooks in the subject area), but responses to what learners do when they have a go at the questions/tasks/activities.

In CAL, feedback refers to the information the computer gives after the student makes a response. The students' behaviour (and responses to instructional material) can be used to help determine the most appropriate pathway through the body of knowledge for each individual student. A very important aspect of interactive learning, and ICAS, is that the student can get instant feedback about the correctness (or otherwise) of what he/she is doing. If the wrong approach is being used, help can be given at the time it is needed and when the student will benefit from it - not in a post-learning phase where its impact may be lost.

Recording responses in ICAS involves ticking boxes to indicate agreement or disagreement with a number of statements, answering a multiple-choice question, again by ticking boxes, or matching items in one list with items in another. The feedback may be as simple as yes or no; it may be as elaborate as an explanation of why the student's answer is incorrect. In ICAS, feedback is judged in terms of value in helping the student meet lesson objectives, and consists of detailed explanations that not only explain why an answer to a question is wrong, but also, if requested, why an answer is correct.

The responses that a system generates for self-assessment questions and activities are by far the most important ingredient of a learning package - and therefore they require special attention. A good way to begin is to think of the best quality face-to-face teaching, and from that note how one explains to students what to do when they cannot yet answer a question; how one helps students to feel a glow when they do something correctly; how one helps students find out exactly what went wrong when they make mistakes.

The response to a good self-assessment question should enable each student to find out two things: 'was I right?' and 'if not, why not?'. The responses must include material that will help learners who were wrong not to feel isolated and incapable. When learning materials are scrutinised by professional learning writers, the first thing that they assess are the responses to assess-

ment questions and activities. If these responses are working well, the package is a good one (Race, 1990).

Responding to open-ended questions is possible, but usually difficult. A good response needs to cover every answer that learners may reasonably have given - and more. Structured questions involve learners making a decision such as:

- which is the correct option?
- which is the most sensible course of action?

With such questions, you can respond directly to learners who choose a 'wrong' or 'less-good' option, explaining exactly why their choice is not the best one.

There are many hours worth of potential study time available; therefore the ability is present to revise topics or test individual knowledge. ICAS is designed to be of use again and again. The questions will examine the student's knowledge of the area and prompt them with revision information if requested.

In designing the ICAS system, a touch of humour was favoured when dealing with responses to questions - whether they were answered correctly or otherwise; a cartoon of Albert Einstein if the learner answered correctly, and an over-dramatised one of a learner in the Electric Chair if an incorrect answer is given. Thereafter, the learner is presented with a range of explanations for their replies. Such responses were important, and will make all the difference to learners working on their own.

The assessment of the learners' performance was carefully thought about from with respect to the knowledge to be assessed, and the point in the lesson they will be assessed? Sometimes the learners can usefully be assessed lesson by lesson, while another approach would be to consider what they have learned on a previous occasion. The feedback that learners were to be given as a result of assessment was considered: for example, marks, grades, comments on their strengths and weaknesses. In ICAS, data are used to evaluate the lesson to report on both individual student and overall class performance. For example, during a lesson a record is kept of learners' incorrect responses. In the future, this record could enable the author to revise the lesson in order to provide feedback specific to those incorrect responses.

Context Sensitive Hypertext System

The hypertext system contains complete subject material with examples, demonstrations, exercises and background reading. This system will:

- improve delivery of course material and increase motivation by allowing students to determine their own balance between lectures, conventional texts and the hypertext system
- motivate many students, adding interest and enjoyment to their learning, and
- enable the ability to extend the better students, while lectures can be focused for students having difficulty with the core material.

The subject area hypertext system is a useful and interesting way to revise the material quickly. Summaries/reviews/checklists provide 'repeats' of crucial points, allowing learners to see what is most important; they also provide useful revision aids. Providing a summary at the end allows the learners to take stock of their learning, and remind them of their objectives.

The essential idea behind the production of ICAS was that of opening up new opportunities for students to learn. ICAS enables them to study what particular subject area they wish, at a time and place that they find convenient, and at their own individual pace. This system encourages the learners to decide their own learning objectives and how they are to be assessed.

Online Tutorial

In higher education, computer-based simulations are available, which are highly interactive; but computer-assisted learning can also refer to the individual student working through a computer-based tutorial, probably of a rather uninspiring linear kind which neither adds to nor complements learning from textbooks. Perhaps the most successful tutorials and demonstrations combine a judicious mix of approaches; certainly a bland hypertext-based presentation of materials, with no additional guidance or incentives for engagement by the student, is unlikely on its own to lead to effective learning (Hammond, 1992).

Tutorial materials can be very boring if they present frame after frame of text without allowing the students to interact or without providing any mechanism for organising their learning. Learners should be kept alert and involved – this is how they learn more efficiently. They should also be purposefully engaged with the material – the effectiveness of a tutorial relies on both its content and its design.

Production of good tutorial lessons requires skill in a number of areas:

- *Appropriate message design.* That is, the ability to arrange information reasonably and attractively in a fashion that best conveys its meaning.
- *Good questioning techniques.* The ability to design good questions, both objective and subjective ones.
- *Response judging.* Preparation of lessons which process various types of responses effectively.

The task of judging student input is perhaps the largest single problem in tutorial preparation. Objective questions (multiple choice, matching, true/false) tend to be safer to use. The more complicated the expected response, the greater the difficulty in having a computer make a judicious assessment of the correctness or incorrectness of the student's response. A wrong judgement may send the student down a wrong path in the lesson, cause considerable frustration, and result eventually in the failure of the instruction.

The ICAS tutorial addresses these areas, and provides complementary material on the question types, how

such questions are linked to the hypertext, the structure of the hypertext itself, and how to use and manipulate the images that are associated with both questions and hypertext.

Introductions, summaries and reviews are given consideration. There is an aim to alert learners to the way that the ICAS system is designed to work, and it is useful for the student to progress through the online tutorial system before attempting the ICAS consultation itself. After all, written study-skills help is the type of help and support you would give face-to-face learners informally.

Planning ICAS

There were a number of major questions to be asked in planning ICAS. The prospective learners needed to be considered from the point of view of their prior experience with self-instruction, along with their previous attainment of knowledge, skills and attitudes to the subject to be assessed.

The objective of ICAS was a statement of what the learners should have been able to do or do better as a result of having worked through the package. Stating objectives had a number of benefits, helping both to make clear the educational intentions behind ICAS and to distinguish between possible and essential content while identifying ways of sequencing it. Furthermore, deciding on the most appropriate teaching media and the most appropriate learning activities was made easier. Setting objectives also facilitated the decision on suitable ways of testing what learners have gained from using the package and the evaluation of the effects and effectiveness of the learning material.

The objectives behind ICAS were as follows: to aid management of learning, testing, tutoring, archiving and the dissemination of material. ICAS modules consist of problem solving, drill and practice, and tutorial mode. One of the important functions of ICAS is that the computer is involved in the management of the learning process. Because of its record-keeping ability (and analytical power), ICAS can monitor a students' progress through the instructional material.

The subject-content was decided upon having considered the main topics, concepts and principles which needed to be covered: it was not an obligation to include everything known about the subject area. A decision was taken not to overload the package because it was felt that learners would not be able to cope with too much content in the time available.

The content of a given module was sequenced topic-by-topic. The teaching methods and media used were chosen to catch the 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 speedy feedback to their responses, to encourage them to practise and review, and to help learners to assess their own progress. A further aspect at the planning stage was how much time to give learners for each activity. Certain topics require the

learner to need a few minutes' calculation, and depending on the nature and extent of the topic, this could multiply.

Structure and Layout

Learner control involves providing the student with a sense of awareness of the lesson and mechanisms for manipulating it. As a general rule the student should be able to answer three questions at any point in the lesson:

1. 'Where am I in this lesson?'
2. 'Where can I go from here?'
3. 'How can I get there?'

Interface design deals with the general characteristics of the student's interaction with the computer; the mechanism(s) by which the student communicates with the computer. The design of this interface requires that one determines the degree and nature of control that the student will have over the learning environment, and define appropriate lesson display conventions and screen layouts.

The ICAS graphical user interface employs the latest human computer interaction techniques, making extensive use of the Microsoft Windows environment; firstly, because of the complex and wide ranging requirements for interaction with the system, and secondly, due to the fact that this type of interface seems to be becoming more and more accepted as the standard in the educational field. The interface was designed to be consistent throughout the application, as the intention when designing ICAS was for the average student to benefit from using it. Attention should be given to user interface design as it is especially important for services aiming to facilitate the learning process. This is also designed to be easy to use due to a standardised screen layout and navigation scheme, letting all levels of students focus on the content.

Creativity is important in ICAS, but one has to be careful not to include every feature of a computer system in its design, for it may not improve the lesson, and may even detract from it. For example, in ICAS, animation is a future consideration, but care has to be given to whether the characters will motivate or facilitate learning; such graphics may bore or slow down the student if they occur too frequently in the lesson. Authors may err by using many attention-getting techniques simultaneously, thus defeating the purpose of drawing attention to the critical feature on the display. For instance, one may use several colours, frames around words, text in several sizes, all at the same time. The author must be wary not to misuse the computer's capabilities.

Future Directions

Among the more immediate plans for future work is an authoring tool for ICAS. Although it is recognised that such a CAL application may need to be highly specific, research and development will proceed in a more gen-

eral nature. However, there are certain requirements for a general-purpose authoring environment.

- the ability to operate in both an autonomous mode and a networked environment;
- the provision of graphics, animation, and audio;
- the capability to provide adequate database support facilities;
- the ability to produce generic material that can be easily modified to meet different requirements; and
- the capability of being made highly reliable and of being easily maintained by local technicians.

There is always likely to be a requirement for some form of 'user-friendly' authoring tool.

Conclusion

ICAS was planned and developed as an interactive computer system in order to provide an alternative learning experience for students, to achieve more efficient use of teaching time, and to increase cost savings with skill-practice equipment. ICAS is not designed to replace specialised subject area teaching: it supplements paper-based learning, but is more fun than a book, and appears much better visually. ICAS can be described as a learner-support environment because it assumes that the intelligence resides largely with the student and thus it concentrates on providing optimal conditions for learning.

Notes

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References

- Brandies, D and Ginnis, P (1986)
A Guide to Student-Centred Learning. Oxford: Basil Blackwell Ltd.
- Graves, N (1993)
Learner Managed Learning; Practice, Theory and Policy. World Education Followship. Leeds: Higher Education for Capability.
- Hammond NV (1992)
'Tailoring hypertext for the learner'. In *Mindtools: Cognitive Technologies for Modelling Knowledge*, edited by Kommors P A M, Jonassen D H and Mayes J T. Berlin: Springer.
- Kelvin, A (1993)
'Increasing Student Participation in the Learning Process'. *Higher Education*, 26 (4), pp 449 - 470.
- Knowles, M (1975)
Self-Directed Learning: A Guide for Learners and Teachers. (Wilton, Conn.): Association Press Chicago: Follett Publishing Company.
- Kulik, C-L C and Kulik, J A (1991)
'Effectiveness of Computer-Based Instruction: An updated Analysis'. *Computers in Human Behaviour*, 7, pp 75 - 94.

- Macintosh, H G (1974)
Techniques and Problems of Assessment: A Practical Handbook for Teachers London: Edward Arnold.
- Race P (1990)
53 Interesting ways to write open learning materials. Bristol: Technical and Educational Services.
- Rowntree, D (1977)
Assessing Students: How Shall we Know Them? London: Harper and Row.
- Rowntree, D (1986)
Teaching Through Self-Instruction: How to Develop Learning Matter. London: Penguin.
- Sampson, P, Niemiec, Weinstein and Walberg, (1986)
 Computer Based Learning - Potential into Practice. *Computers and Education*, 24 (2), pp 137 - 138.
- Shneiderman, B (1987)
Designing the User Interface. Strategies for Effective Human-Computer Interaction. New York: Addison-Wesley Publishing Company, Inc.
- Sims, R (1995)
Interactivity: A Forgotten Art? ITFORUM.
- Zorkoczy, P (1990)
Information Technology - An Introduction. (3rd edition) London: Pitman.