RESEARCH AND DEVELOPMENT
IN COMPUTER-BASED LEARNING

at Edith Cowan University

by Dr Geoff Ring

Keeping a balanced perspective on the value of technology in education is difficult. It is probably true to say that some of the early high expectations have not been realised and that two of the major reasons for this have been the world-wide shortage of high quality educational software and the lack of knowledge about the attributes of effective Computer-Based Learning (CBL) environments. If educators are to maximise the advantages of computer technology, a substantial research and development effort is needed to address these deficiencies. It is hoped that the CBL research and development programme described in this paper will be able to make a valuable contribution to this effort.

CBL environments are unique in many ways; they can represent abstract or complex concepts with dynamic visual models; they can use screen 'objects' to offer a world of 'learning by doing'; they can offer interactive, individualised, learning modes which vary from directed instruction to open-ended enquiry; and they can keep records on individual student performance, providing informative feedback for students and teachers. The essential elements which define a CBL environment are computers and learners. The broad definition adopted here, however, allows for the inclusion of other elements which are generally important to learning environments such as instructors and other curriculum materials. Further, the 'computer component' is considered to have three facets: the human-machine interface; the learner interactions with the software 'content'; and the 'behind the scenes' management and record-keeping functions. This conceptual framework may be represented graphically as shown.

The general aims of the University's research programme in Computer-Based Learning are twofold: firstly, to use the 'windows' provided by CBL environments to better understand how students think and learn; and secondly, to determine how best to use computers in education so that their contribution to the effectiveness of teaching and learning is optimised. While there have been numerous studies which claim to show the superiority of CBL environments over traditional learning environments, much of the research has been criticised for assuming that different instructional media can represent meaningful experimental variables independent of content of strategy. Very few studies have been able to clearly demonstrate that learning gains associated with CBL environments were due to characteristics unique to CBL. Many of the studies were primarily comparing 'messages' rather than media because they tended to ignore the fact that different media place different restrictions on the kinds of messages they present.

The research team took the view that researchers in the field of CBL should discontinue this 'media comparison' model, that CBL was clearly a valuable additional learning medium and that further studies comparing CBL with other media could only be of limited value. What was needed were more manageable and logical kinds of research designs which concentrated on the learning effectiveness of specific attributes of CBL environments which were known to be unique or believed to be advantageous.

The research project has several components and involves a team of researchers, each investigating specific attributes of CBL environments which fit within an overall conceptual framework, the basis of which is the common model of a CBL environment. The principal objective of each of the six research components is given below.

1 To identify optimal characteristics of graphical user-interface design, with particular reference to navigational aids within a CBL environment.

It is intended to use Authorware Professional to generate parallel CBL materials which differ only in the forms of the graphics which are implemented in the instructional format. The intention is to create tutorial type software with specific instructional aims which can be used by students in an independent mode to achieve specific learning goals.

An experimental study will be used to compare the effectiveness of the different forms of graphics used. Third year students studying computer education at Cowan University will be asked to participate in the investigation and will be exposed to one of the different pieces of software. A pre-test will be used to assess initial knowledge and understanding on the chosen topic, the students will be randomly assigned a package for use and a post-test will be used to determine subsequent levels of knowledge. Standard statistical tests will be used to compare the learning differences which may
occur and these differences will be
analysed in the light of the different
forms of graphics which were used
in the programs and the nature of
the learning differences which were
observed to occur.

To investigate the potential offered
by CBL tools to provide an environ-
ment within which children
can represent and explore
their own conceptual
models.

The role of the educator is
often interpreted in terms
of providing learners with
appropriate represen-
tations or models in a
range of domains of
knowledge. To facilitate this
role it is important to
provide learners with
accurate and consistent
models that are appropriate
to their needs. Learners'
misunderstandings can	only be interpreted as
the result of a failure to move
from their own models of a
concept or situation to the
conceputal model held to
be correct or desirable by
the educator. Much of the
current rhetoric of
educational research is
founded on the premise that
it is essential to start the
learning process from the
learner's experience and
understanding. However,
there appears to be little
thought given to the need
and the methods to move
the learner from his/her
own experience and
understanding to that deemed
necessary by the educator. These
educational issues are all relevant
to the study proposed. The conten-
tion is that children can
successfully learn by representing
and exploring their own models and
those of others.

It is intended to study children
between the ages of nine and
eleven years. These children will work
within both quantitative and
qualitative modelling environ-
ments, with small groups of them
being followed for periods of up to
a year in a series of activities that
occur naturally within their
teaching programme. This rel-
atively long time span will help to
diminish the 'honeymoon effects'
of introducing new technology to
teachers and children. A consistent
software environment is to be used,
one that facilitates both exploratory
and expressive activities: exploratory
activities will involve a
learner's exploration of a given
animation (computer created
animation and computer-controlled
videodisk images) on the learning
of theoretical concepts associated
with motor skills in sport.

The project will require the use of
the authoring system Authorware
Professional to create two software-
based sets of instructionional
materials on the techniques
and strategies of tennis. The
first set will include animated
sequences created by using the
graphics capabilities of the
authoring system, while the
second set will be identical
except that the computer
graphics will be replaced by
video sequences retrieved from a videodisk.

Each of two evaluation
phases will require that a
cohort of first year trainee
secondary physical education
teachers be used as subjects;
the 'computer group' will be
selected from the 1991 cohort
and the 'videodisk group' will be
selected from the 1992
cohort. Each group will
participate in a 13 week (one
hour per week) tennis unit in
Semester 2 of their first year of
the secondary physical
education programme at
Cowan University. The actual
group sizes to be considered
will be determined after pre-
testing both groups and
matching subjects on their
knowledge of tennis
techniques and strategies. It is
anticipated that group sizes
will be in excess of 30. After
supervised exposure to one of
the sets of instructional materials,
students in each group will be
tested on their knowledge of techniques
and strategies at the conclusion of
the tennis unit and will be surveyed
to find out their attitudes towards
their computer-based experiences.

To explore teachers' metacognitive
behaviours in using a courseware
authoring system to design learning
activities for children.

This study will add to the limited
knowledge we have about the
influence and effectiveness of
teachers' metacognitive strategies
and beliefs. Results will provide

3 To examine the relative effective-
ness on learning of two forms of
model; expressive activities will
involve learners in representing
their own models. Each of these
activity types will be classed as
separate for analytical purposes but
in actuality both can be expected to
occur within the same learning
context. The authoring system
Authorware Professional is a
software tool that allows activities
of the types described above to be
carried out in a consistent environ-
ment. Data will be collected that
will facilitate analysis of children's
conceptual understandings and
associated teaching methodologies.

4 AUSTRALIAN EDUCATIONAL COMPUTING, MAY 1991
additional guidance in the development of programmes which train adults to use metacognitive skills and assist teachers to transfer their efficient self-regulation skills to other domains where the level of problem solving difficulty is high. The sample required for the study will consist of two groups of teachers. Each group will be undertaking a Bachelor of Education unit at Cowan University entitled Courseware Authoring which will be based on the Authorware Professional authoring system. One group will be studied in each semester of 1991. At the beginning of the unit the purpose and design of this study will be explained to the teachers and they will be asked if they would agree to participate in the research project. The researcher will act as a participant observer for the duration of the unit. Data will be gathered by these observations through the administration of questionnaires and associated interviews. The researcher will maintain a journal and each teacher will also be asked to keep a journal to monitor their own perceptions of their learning.

To determine what features of particular implementation models, especially those involved in group work strategies, enhance student-computer and student-student interactions.

A small number of existing software packages, along with a number of special-purpose packages developed using the authoring system Authorware Professional, would be trialled in secondary classrooms. Each trial would involve a significant portion of classroom time (probably a term) in which the researcher would advise the cooperating teacher with regard to implementation strategies. An implementation model would be constructed for each trial based on the wishes of the cooperating teacher and the advice of the researcher.

Implementation models will be designed to maximise the control the student has in the task environment and to maximise the quality of the student-computer and student-student interactions. The teacher and researcher will reach consensus on the intended interaction patterns and on the nature of the classroom environment. In each trial the purpose will be to determine to what extent the actual interaction patterns and classroom environments reflected the original intentions. Any discrepancies will be analysed in terms of the original implementation model. Implementation models used would be grouped according to variables concerning intended teacher, computer and student roles, software category and hardware access configuration. Differences in interaction characteristics between different model types would be noted and evaluated.

6 To investigate the relative effectiveness of various forms of graphics in CBL environments.

The trend towards multi-pathing and multi-media in the presentation of CBL materials has led to the development of screens of information that contain many diverse elements. Some of these elements provide 'links' to other related information sets (sometimes called 'nodes') and often take the form of 'active' icons, 'hot' text or menus. Links may lead the learner to a video sequence, a more detailed discussion of a particular point, definitions, related tables and graphs or animated displays, the overall aim being to give some control over the learning experience to the user. Other elements of the graphical user interface may serve as 'navigational aids' to assist the user in traversing links and in reducing disorientation. If they style of learning is to be effective, then the learner must be receptive to, but not distracted by, the navigational aids that are presented on the screen.

The subjects for the study will be drawn from the three age groupings described below, with each group consisting of five male and five female students.

Group 1:
Primary students aged 10-12 years

Group 2:
Secondary students aged 15-16 years

Group 3:
Tertiary students aged 20+ years

CBL environments which utilise a variety of navigational aids in their presentation will be developed using the authoring system Authorware Professional. Students' eye, keyboard and mouse behaviour while working in these CBL environments will be monitored and recorded using the CEDRIC eye tracking device. An analysis of the CEDRIC results will yield the following data:

- screen eye-scan patterns (movement of the eyes over the screen);
- screen fixation patterns (time spent looking at a particular place on the screen);
- mouse usage (where moved and when activated); and,
- usage of keys on the keyboard.

The major outcomes of the project are expected to be in the form of research findings and recommendations concerning the effects upon learning of specific attributes of CBL environments. A more immediate outcome has been the establishment of a 'R & D' environment which is creating new research opportunities for University staff and students, as well as encouraging the development of high quality educational software.

Continued from page 15

Due to the size of WA, some of our remote areas have very unique problems when dealing with computers, or any technology, as support is often hundreds of miles away. Our Distance Education has a number of programs it is trialing to find out the optimum solution for these isolated areas. They develop courses for students to follow, provide hardware for their use, and supply telephone and even radio support.

Despite the cutbacks in Ministry support personnel, as an association ECWA receives a lot of assistance. We have received grants, based on submissions from us, to subsidise our professional development activities. This allows us to pay some presenters and acquire equipment or resources necessary for these sessions. The Ministry of Education will also supply us with mailing labels for all schools, or a subset of schools if we desire, and will then deliver items to schools free of charge through their schools' dispatch service. This is a great saving in postal charges when we do mailings to publicise professional development nights, conferences, computing camps etc.