FOCUS
on university teaching and learning

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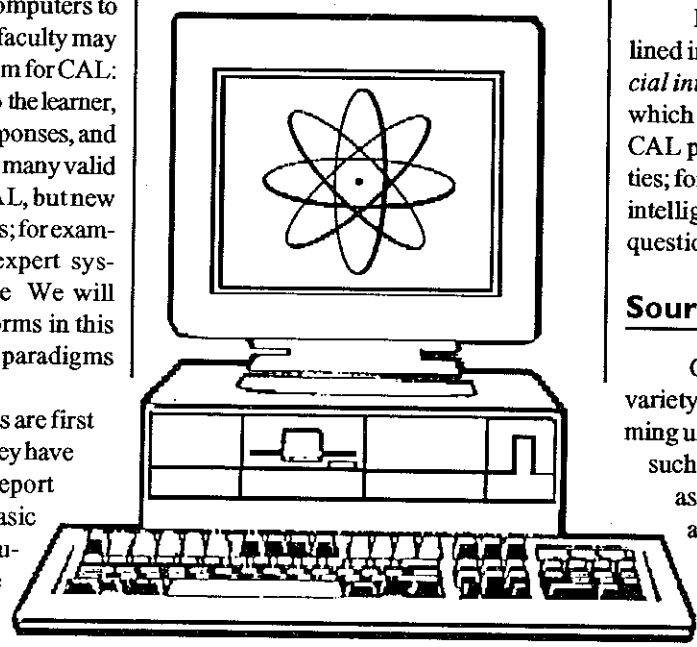
Computer Assisted Learning on Campus

What is computer assisted learning (CAL)? Does computer assisted instruction (CAI) or computer managed learning (CML) sound more familiar? There are many other terms that refer to variations on a theme - using computers as an integral part of the teaching/learning process. For our purposes, computer assisted learning is described rather broadly as "the use of computers to assist student learning." Some faculty may be familiar with an early paradigm for CAL: computers present information to the learner, ask questions, accept learner responses, and provide feedback. There are still many valid applications for this form of CAL, but new forms have evolved over the years; for example, simulation, multimedia, expert systems, and artificial intelligence. We will touch on some of these CAL forms in this issue and go on to discuss other paradigms such as computer conferencing.

Many faculty and students are first introduced to computers when they have to write a paper or research report using word processing. With basic keyboarding skills, faculty or students can more easily prepare and revise their papers, reports, and other documents. They might progress to use other general-purpose computer packages for doing graphics, course record keeping, and so on. Many individuals find this level - *computer literacy* - to be sufficient to meet their immediate needs. However, computers can do much more for both faculty members and students. For example, computers can be used to break down classroom walls when they are used to *network*. Many students are now using such networks to communicate with each other or with their professors outside class. Faculty and students are also tapping electronic highways to dialogue with international colleagues or gain access to thousands of computerized information sources. *Information retrieval and management* is made easier by communication packages and search programs available on campus from Academic Computing Services in the Killam Library. Readers are encouraged to explore the local opportunities for developing computer literacy or more advanced computer skills. This issue of FOCUS is intended to give readers a few ideas for exploiting the potential of computer assisted learning in university education. □



Computer Assisted Learning

Many readers will not be familiar with the rich variety of computer assisted learning courseware available. A very brief overview is provided on the next page so that specific CAL applications at the University can be put into perspective.

In addition to the CAL varieties outlined in the table, *expert systems* and *artificial intelligence* are emerging applications which are used in education. Also, some CAL programs incorporate several varieties; for example, tutorial and simulation, or intelligent programs used to generate test questions in response to student answers. □

Sources of CAL Programs

CAL programs can be created using a variety of techniques - straight programming using traditional computer languages such as BASIC, authoring languages such as PILOT, and authoring systems such as TENCORE. The most obvious difference between these techniques is in the amount of computer programming needed. Authoring systems require virtually no programming; lesson templates are provided, the instructor fills in the lesson objectives, content, test questions, and so on. Although relatively easy to use, the resulting course software is often restricted to the drill and practise or tutorial type. Although authoring systems can be very expensive, they have the advantage of allowing faculty to start creating courseware without formal training in programming techniques. As an alternative,

CAL Variety	Description	Sample Applications
Drill and Practise	Content previously presented Question/answer drills (repeated as necessary)	Test bank of questions Practise problem solving
Tutorial	Presents new information Often in "present information, ask question, accept student response, provide feedback" mode	Replace or supplement parts of lectures Present concepts that are difficult to show traditionally
Simulation	Based upon realistic models Approximates real life situations	Business management Medical simulators Process simulations Spectral simulations
Discovery/Inquiry	Tests hypotheses Inductive approach Trial and error	Looking for trends in databases Change value of variables to see effect (what if?)
Multimedia CAL	Uses the multimedia (sound, pictures, video) capacity of newer micro-computers Used in a variety of modes	Use colour, sound, motion to illustrate processes or procedures
Computer Conferencing (eg. COSY)	Powerful form of electronic communication Independent of time and space	In conference mode, allows electronic meetings to take place In mail mode, allows exchange of e-mail In moderate mode, allows faculty person to design conference arrangements

some departments choose to go with a team development approach, combining subject matter specialists with computer programmers. This approach, although expensive in terms of time and money, allows the team to use more of the computer's capacity to create the CAL courseware most appropriate to the teaching/learning situation. Another source of courseware is the purchase of commercially produced products. There is a surprising amount of this courseware on the market, some of it excellent, a lot of it less than inspiring. To experiment with CAL, why not try one of the computer tutorials that come with newer word processing, data base, or spreadsheet programs.

Potential buyers of CAL courseware should first ask for published evaluations of the material and, if possible, try it out on a computer system. □

Applications of CAL at Dalhousie University

Computer assisted learning is being developed and used in various departments on campus. A representative, though not exhaustive, listing is provided here.

Chemistry

The Department of Chemistry has its own computer network with about 30 workstations. There are some 1200 undergraduate users on the system with roughly 250 log-ons to the system every day. Depending on the courses students take, CAL programs allow them to do practise exercises (electronic homework), complete tests (with marks included in final grades), or learn new material in tutorials. The Department has developed a computer management system to keep track of students, exercises attempted, scores, and the like, as individuals proceed through the courseware. Simulations are used extensively as enrichment or to support class assignments (eg. NMR simulations, kinetic simulation of consecutive reactions). Computers allow sophisticated modeling and computer graphics to enhance the learning of difficult concepts.

In another application, a computer program is used in analytical chemistry to grade student lab results. The student enters data in response to questions on the screen and the program compares these results with the true values, grades the work, records an evaluation of the work, and presents the student with a report. A variation of this program is also used in a physical laboratory class.

Recently, the Department was lauded as "a leader in Canada and North America" for its CAL efforts in the undergraduate program. Much of the CAL courseware was produced in the Department by Thomas Forrest, Charles Warren, and colleagues.

English

David McNeil is an avid fan of computer conferencing because it enables him to make better use of classroom time. For instance, he posts sample exam questions on his COSY conference near the end of the course for students to review, query, or try out. To encourage participation during the course, Dr. McNeil sets both

number generation (especially useful in accounting). Networking is just one application of a powerful computer-managed learning system developed by The Training Technologies Group in the School.

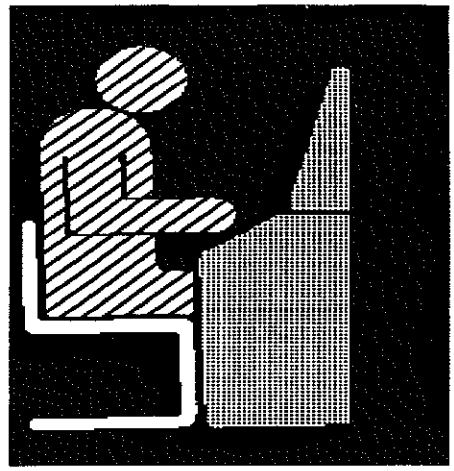
STYLE

The system called "STYLE" (Systems Tailored to Your Learning Environment) was designed to assist in the management of a course, and be consistent with an instructor's educational goals. It is a computer-managed environment for a course of study that includes a test bank, a scheduling module, a registry of students, and their associated demographic and performance data. It also provides access to utilities such as E-mail.

How does STYLE work? The instructor takes course objectives and sub-objectives and enters them into the system. Each objective or sub-objective can have tutorial components attached to it (for example, a reading or activity) followed by an on-line or off-line quiz. The instructor prepares quiz or other forms of test items and adds them to STYLE. The system will provide immediate feedback on each test item as well as summative evaluation (progress reports) on objectives. In this way, the instructor develops a "thick" blueprint of the course along with means for both student and instructor to follow student progress. The STYLE system is used by many faculty in the School: Don Sheridan and Gus Gassmann in introductory business computing, and Ray Klapstein and Ray Carroll in introductory business principles.

STYLE is adaptable to many situations; it allows easy registration of students, full learner control or limited access, and scheduling of lessons and deadlines. Instructors find it allows them to bring higher levels of skills to teaching. Because they know where students are having difficulty, it is easier to target lectures and respond to student needs. STYLE may be particularly useful in large classes. User statistics show that as many as 20% of students are able to successfully complete such computer-managed courses on a self-study basis. Many students actually complete STYLE courses more quickly than regular courses and have additional time to concentrate on other studies. For those interested in more details on STYLE, pamphlets are available.

Other uses of CAL in the School include multimedia applications, such as commercial laser-disk based tutorials for speadsheet, word-processing, and database software. It is anticipated that real-time video will soon be integrated into some CAL courseware.



These are just some of the examples of innovative CAL applications in the School of Business Administration. They show the School has been very successful in implementing many of the computer initiatives suggested by a 1984 steering committee of innovative faculty and staff. □

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on university teaching and learning is the bulletin of the Office of Instructional Development and Technology of Dalhousie University. This issue was produced by Arthur E. Shears, with contributions from Tom Forrest, David Kaufman, Scott MacKinnon, Phil O'Hara, Barry Paton, and Grace Patterson.

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E-Mail Communication

The **Society for Teaching and Learning in Higher Education** has provided an electronic mail network for several years. Professors and instructional developers from across Canada, the US, and beyond discuss many aspects of university teaching and learning. The amount of expertise and support available from this network is tremendous. If you would like to subscribe, simply send the following message through an electronic mail system to:

IN%"listserv@unbvm1.bitnet"

SUBSCRIBE STLHE-L Pat Prof
(Enter your name instead of Pat Prof.)

For further information on the network, call the Office of Instructional Development and Technology at Dalhousie University, 494-1622.

All That Glitters...

Of course, CAL is not the solution to every instructional problem. Before deciding to adopt CAL, faculty should consider four important areas:

1. **The learning environment**

Is CAL to be used during class, during labs, at home, in the computer lab? How many computers are available? Are they suitable for CAL?

2. **The nature of the teaching/learning problem**

Some kinds of tasks are not suitable for demonstration using the computer screen.

3. **The financial and related support available**

Is money available to buy courseware, or is expertise available to develop it? Do faculty recognize CAL development/ promotion as legitimate academic activity? Is release time available for CAL development?

4. **Structuring the CAL experience**

Do students use CAL individually, in pairs, in small groups? Is it stand-alone or used in conjunction with specific labs or classes?

In short, introducing CAL may not be as simple as one first thinks. However, as we see from the examples at Dalhousie University, there are many situations where CAL can and should be used. Do you have the interest and resources to try computer assisted learning? If you do, but are not sure where to start, read on for some suggestions.

Learning About CAL:

Review the Literature

Try reviewing some of your own professional publications. You will often find articles on CAL applications in your field. For more generic information on CAL in education, the following journals in the Killam Library either specialize in CAL or have regular articles on the subject.

- *Journal of Research on Computing in Education (JRCE)*
- *The Computing Teacher* (for school teachers but many ideas are adaptable)
- *Educational Research and Development (ERD)*
- *Educational and Training Technology International (ETTI)*

Some other useful reference material:

- *COSY Computer Conferencing System Reference Manual*, Dalhousie University Academic Computing Services.
- *HyperCard Stack Design Guidelines* Apple Computer Inc., Published by Addison-Wesley.
- *Interactive Multimedia Instruction*, Richard Schwier & Earl Misanchuk, Educational Technology Publications.

Common Acronyms	
CAL	Computer Assisted (or Aided) Learning
CAI	Computer Assisted (or Aided) Instruction
CML	Computer Managed (or Mediated) Learning
CBT	Computer Based Training
CBL	Computer Based Learning
MML	Machine Mediated Learning
CDI	Computer Designed Instruction
CAD	Computer Aided Design
CMC	Computer Mediated Communication

Dialogue with Colleagues

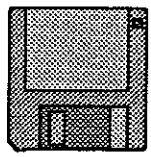
Some colleagues in your department may have previous exposure to CAL and could offer some helpful hints. If no one is knowledgeable about CAL in your department, contact one of the people mentioned in this issue of FOCUS, or the Office of Instructional Development and Technology.

Take a Course

Henson College offers a number of computer-related courses ranging from micro-computer literacy to data management to the design of multimedia programs.

Confer with Academic Computing Services

The Teaching Unit of Academic Computing Services regularly assists faculty by



leading or helping with computer modules in academic courses. This could take any one of the following forms: 1) to lead a seminar; 2) to teach a class; 3) to teach a computer subject over several classes; 4) to provide student assistants in computer-related seminars; 5) to provide student leaders in these seminars; 6) to assist in the design and development of computer-based learning modules. To date, the level of this service has been primarily computer literacy. However, the Unit does have several tools that allow for the development of CAL modules. Faculty interested in developing a project are invited to contact the Unit.

This is a service provided at no charge for the first episode. The spirit of this service is to help faculty become self-sufficient in carrying out the instruction in the future. It has been the practice of the Unit to pass along all the teaching materials and permit duplication by faculty. Repeat episodes are treated as billable work.

The only limitation is the number of people the Unit has available to provide the service. As a general rule, you should meet with the Unit to discuss your needs a full term in advance of your requirement. Resources are assigned to projects on a first request, first serviced basis.

It is the genuine wish of Academic Computing Services to help you open up new doors. Please do not hesitate to call them for information or assistance (494-3472). □

CAL Comments:

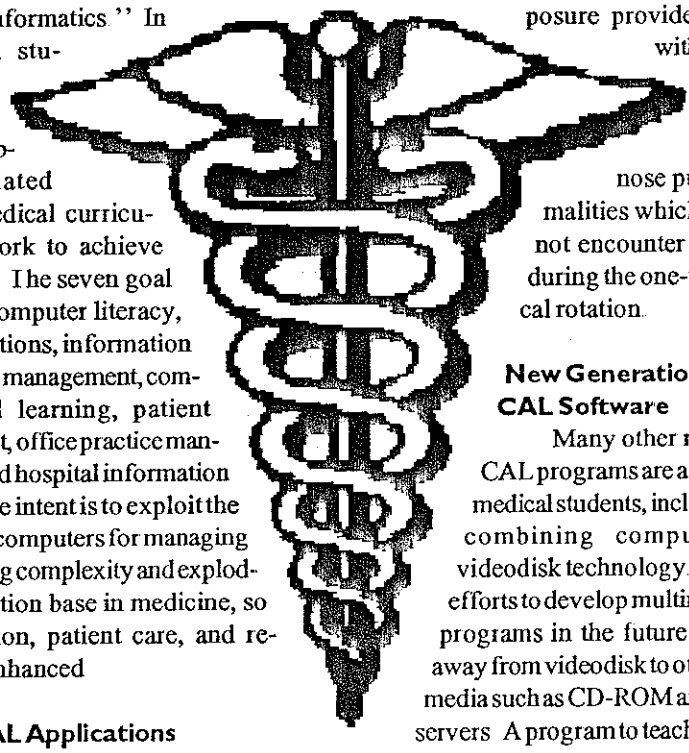
The editors of FOCUS welcome your comments and observations concerning this theme issue and computer assisted learning at Dalhousie. □

tational physics, computer interfacing, and mathematical physics. Computer simulation allows students to better understand abstract concepts and mathematical relationships. A popular computer program, Mathematica, is very effective in the latter case.

Faculty of Medicine

Medical Informatics

Faculty and staff in the Faculty of Medicine have developed a set of seven goals for the use of computers in medicine by students, covering an area referred to as "medical informatics." In the future, students in the new case-oriented, problem-stimulated (COPS) medical curriculum will work to achieve these goals. The seven goal areas are: computer literacy, communications, information retrieval and management, computer-aided learning, patient management, office practice management, and hospital information systems. The intent is to exploit the potential of computers for managing the increasing complexity and exploding information base in medicine, so that education, patient care, and research are enhanced.



Sample CAL Applications

Students have found 'drill and practise' and 'tutorial' packages largely irrelevant and often no more than "electronic page turning." However, the most popular, and useful, packages have been simulations. Most of the CAL software packages are purchased commercially and made available on a local area network. A variety of CAL packages have been purchased for medical students' use, such as Anatomy of the Arm, Cyberlog Series, HeartLab, HyperBrain, HyperCell, HyperHeart, Simulated Dog Lab, MacKinetics, Mical, and Psycal. As well, several CAL simulations have been developed by our faculty, such as Pupil Examination by Ann Hoskin-Mott in Ophthalmology and Charles Maxner in Neurology. Hormone Signalling by Dieter Pelzer, and Blood Pressure Measurement by Korotkoff Sounds by Hermann Wolf, both from Physiology and Biophysics.

The most effective CAL programs in medicine employ a multimedia approach. The Pupil Examination package was developed with the guidance and support of Ms. Shumin Lee, Instructional Design Coordinator, Medical Education Unit. It uses a Macintosh computer connected to a mannequin head equipped with photosensitive cells for its "eyes." This permits students in third year to perform the "swinging flashlight test," a test in which students shine a flashlight in each eye of the mannequin in a particular rhythmic fashion. Such exposure provides students with the opportunity to observe and diagnose pupil abnormalities which they may not encounter in patients during the one-week clinical rotation.

New Generations of CAL Software

Many other multimedia CAL programs are available for medical students, including those combining computers and videodisk technology. However, efforts to develop multimedia CAL programs in the future will move away from videodisk to other storage media such as CD-ROM and network servers. A program to teach histology, proposed by Howard Dickson of Anatomy and Neurobiology, is currently at the design stage. A "team" approach to development is planned, using content, instructional design, graphics, programming and technical expertise as required.

Some CAL simulation programs model an actual clinical situation by allowing patient conditions to change over time, or to be affected by interventions by the "doctor" (the student user). Tim Pollak and Brian O'Brien of the Department of Medicine have been using Iliad and Quick Medical Reference (QMR) programs to introduce clerks and residents to the theory of the diagnostic process. In the future, improved computer communication links between the medical school and local hospitals should lead to an increase in the educational use of CAL in clinical settings.

These examples have only scratched the surface of this complex and fascinating area. With the enthusiasm and talent of faculty and students, there will be continued growth in the use of CAL in the Faculty of Medicine.

School of Business Administration

Computer assisted learning is widely practised in the School. All faculty have a micro-computer on their desk and there is a large micro-computer lab for students. Faculty use various forms of CAL to meet different needs. For example, Tony Schellinck and Neil Maddox have two marketing textbooks that include software exercises, tutorials, and a statistical analysis program. Gus Gassmann has written a very comprehensive CBT approach to the teaching of introductory statistics, and Mary Brooks developed a computer based course on Export Marketing. In other applications, Don Sheridan and Tim Roberts are currently working on ways of using hypertext to teach business cases, and Tim Roberts teamed up with a visiting professor to develop a sophisticated small business simulation which is used in policy, accounting, and finance courses.

Networking

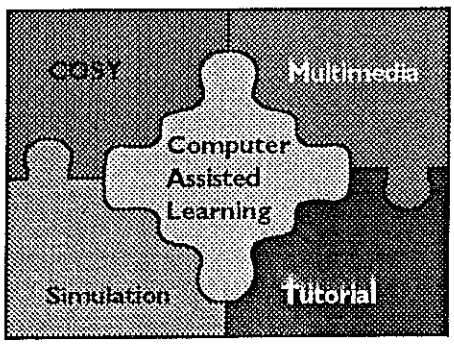
In the use of computers for *networking*, Chuck Dirksen has been a pioneer in the use of conferencing software (VaxNotes) and the generation of student, down-loadable problem sets which incorporate random

required and optional discussion topics. He notes that a number of students, who are uncomfortable speaking in class, find computer communication less intimidating and blossom in electronic discussions. Students also say computer conferencing is a convenient way of getting together outside class without worrying about schedules. They can join a conference or send messages 24 hours a day, seven days a week.

In another networking application, Dr. McNeil has introduced his senior students to a classroom without walls. As part of a research methods course, he shows his students how to use *Internet* to search for information in international databases, such as Oxford University's library holdings list. He also encourages them to participate in computer conferences with scholars from all over the globe using *Bitnet*.

Sociology and Social Anthropology

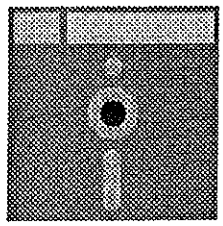
Another user of computers for networking is David Elliott. He comments that his Department is committed to developing student computer literacy, as are several other Departments in the Faculty of Arts and Social Sciences. Along with several of his colleagues, Dr. Elliott uses Dalhousie's VAX Mail to send materials like course outlines,



exercises, and supplementary bibliographies to his students. In return, the students are encouraged to respond electronically. Draft versions of papers from students may be sent for comment over the E-mail system, although hard copy is required for final versions. In some courses, small data sets are mailed out and downloaded to microcomputers for statistical analysis. For courses in which group projects are an option, students engaged in such work are encouraged to use electronic communication. Most students use the computer lab in the Department of Sociology and Social Anthropology, but Dr. Elliott estimates that twenty-five to thirty percent of students have access to personal microcomputers - a figure which is likely to rise in the future. Dr. Elliott and his colleagues encourage their students to experiment with accessing remote databases and libraries; these applications will expand as more data sources are put on-line and as search software improves.

Biology

Daphne Themelis is one of several Biology faculty members who use CAL or CMC in their classes. Simulation and discovery/inquiry are the two types of CAL applications she finds most useful. In her Biology 1001 lab, students use part of a commercially prepared CAL package on enzymes. Due to the processing and graphics capacity of computers, students can easily see the effect of temperature and Ph on enzymes. They then compare these "ideal" results with the findings in their own experiments. In another application, students use a simulation to study how changing body chemistry affects animal growth. Students input data to see the effect on animal growth of having too much "x" or too little "y," and begin to speculate on reasons. Their hypotheses are tested later in the lab.



David Patriquin used computer conferencing (COSY) several years ago in a graduate course to provide increased opportunity for discussion. He recalls that it was very successful and hopes to introduce computer conferencing applications into first year courses with large numbers of students.

Physiotherapy

HyperCard applications (multimedia CAL) are popular in the School of Physiotherapy. For example, in a clinical therapeutics course, Scott MacKinnon developed a HyperCard package, printed material, and a video for a module on Ergonomics. The HyperCard package includes custom mathematical algorithms and allows for the collection, reduction, and intermediate interpretation of various biomechanical, physiological, and anthropometric profiles for a subject performing a task. This application of CAL is used in two ways. It is incorporated into lectures as a demonstration (incorporating the course video) to present examples of typical ergonomic assessments, using a problem based approach. The application allows assessments to be done in a more efficient fashion. Also, the application is available to students to incorporate into their course project on ergonomic assessment.

Physics

Faculty in the Department of Physics, including Barry Paton and Forest Fyfe, speak about making their students not just computer literate in physics but computer intelligent. The Department has invested in two undergraduate Macintosh labs. In the first year, the computers are used to teach conceptual physics through interactive exploratory sessions. In the second year, students apply graphical analysis, spreadsheets, dimensional analysis, and computer simulation to sophomore level physics. The senior lab focuses on subjects including compu-

Why Use CAL?

Depending on the courseware, computer assisted learning can:

- Provide an interactive learning environment
- Allow complex modeling and simulation because numerical calculations are done very rapidly
- Enhance learning of difficult concepts through the use of simulation and computer graphics
- Integrate video and audio information into a lesson
- Give the opportunity to practise on randomly selected problems
- Supply immediate feedback on responses
- Provide remedial help to the learner
- Keep track of student progress
- Offer opportunities for electronic communication and dialogue outside class time
- Allow exploration of international databases or conferences