Psychology Practicals: Delivering by Use of an Interactive CD-ROM

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Abstract

A project is described in which a CD-Rom package was developed for use in delivering psychology practicals to students studying psychology at a distance at the introductory level (stage one) of a degree programme with The Open Polytechnic of New Zealand. Development occurred in two phases: investigation of the concept, and design/development of the package. Design factors such as disk capacity, text versus visual components, interactivity, and navigation problems are discussed. Seven experiments were chosen, covering a variety of domains in the field of experimental psychology and based on the key experiments in these domains. Included in this paper are synopses of the literature reviewed as a part of the investigation phase.
# Contents

Acknowledgements vi

Introduction 1

The CD-Rom project 3
  Phase I: Investigating the concept 3
  Phase II: Designing the package 9

Results of the literature search 13
  Open and distance learning and computer-assisted learning 13
  Learning science subjects 14
  Learning psychology 14
  Using computer technology to deliver psychology practicals 14
  Web pages 15
  Concluding comments 15

Bibliography 16

Appendix: An analysis of the bibliographic sources 22
  Open and distance learning and computer-assisted learning 22
  Learning science subjects 35
  Learning psychology 40
  Using computer technology to deliver psychology practicals 46
  Web pages 51
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Introduction

The Open Polytechnic of New Zealand delivers its training and educational packages at a distance, primarily by the use of print-based materials, but to a lesser extent by electronic means. This mode of delivery presents a challenge in the delivery of degree-level courses in psychology, because the traditional approach at non-distance (class contact) institutions requires students to attend supervised laboratory sessions to cover the practical component of any given course. This is not a feasible option for The Open Polytechnic, because students are spread over the entire country, with some overseas. It is possible for students to attend on-campus courses, but such a requirement cuts across the notion of openness that this polytechnic values highly. Thus, mandatory attendance at supervised laboratory sessions was never a viable option.

When the first psychology course was designed after receiving accreditation for the Bachelor of Applied Science (B App Sci) degree programme, consideration was given to the delivery of the practicals for the introductory courses. It is in the two introductory courses (73 196 Social & Individual Psychology, and 73 195 General & Applied Psychology) that the student is introduced to experimental work, and is required to conduct a number of simple experiments. Informed by the reasoning introduced above, it was felt that delivery of these practicals could be done at a distance, using print-based materials sent by mail, and the courses were designed with this in mind. However, after a year of running the courses it was accepted that a number of students encountered some difficulties. Thus, the concept arose of running voluntary face-to-face practicals at Open Polytechnic Resource Centres in Wellington, Auckland and Christchurch. In these 2-to-3-day class-based practicals, the students were introduced to the methodology of psychology and assisted up a fairly steep learning curve. The benefits were obvious to those who attended, and to us in terms of their performance in their submitted practicals.

The class-based practicals continued from early 1995 through to mid-1997. However, despite their academic value, an analysis of cost showed they were not cost-effective and, in the latter half of 1997, the classes were abandoned. In
addition to the cost-effectiveness issue, there had been some criticism (or at least concerns) expressed by certain psychologist members of the degree monitoring panels that were appointed by government to evaluate progress with the degree programmes. In particular, these panellists were concerned about the way in which we were dealing with the experimental aspects of our psychology courses. The writer and others strongly voiced the view to successive monitors that one could successfully deliver psychology practicals at a distance, but conceded that this required a different approach to that taken within university psychology departments, who taught in face-to-face mode. After several visits by the monitoring panels a compromise was struck in which The Open Polytechnic (the writer specifically) would investigate the use of CD-Rom technology as a means of supplementing the delivery of psychology practicals to our first-year psychology students. The panellists accepted that this would provide a solution to the problem.
The CD-Rom project

In August 1997 the writer successfully applied to The Open Polytechnic Research, Ethics and Scholarship Committee for a research grant to ‘Pilot and Evaluate Alternative Methods of Delivery of Psychology Course Practicals’. Despite the open-endedness of the title, the research was directed at the specific use of CD-Rom technology. The project had a budget of $38 000, and was divided into two distinct phases.

Phase I: Investigating the concept

Phase I had two major aims. The first was an analysis of the literature that deals with the use of computer-based technology in delivering courses in general, and psychology in particular. The second aim was to conduct a survey of Open Polytechnic psychology students — exploring a range of issues relating to the use of computer technology in their studies, with a particular focus on CD-Rom technology.

Literature search

The writer employed a graduate student from Victoria University of Wellington to conduct an extensive literature search and critique, covering the range of literature that deals with all aspects of delivering learning opportunities through the use of computer-based technologies. This student did an excellent job, and her report identified several categories of usage of this technology:

- General articles about open and distance learning and computer-assisted learning, with no specific focus on a given discipline.
- General articles on the use of computer technology in the learning of science subjects.
- General articles about learning psychology without any specific reference to experimental work.
- Specific articles about using computer technology to deliver psychology practicals.
- Web sites on the Internet that delivered training in psychology at the introductory level.
In summary, although some of the articles reviewed raised negative aspects of the use of computer-based technology as a learning aid (primarily due to a techno-phobic element among some potential users), the general consensus was positive. Especially emphasised was the value of an active and interactive experience as opposed to the somewhat passive experiences associated with print-based materials. In particular (and relevant to this project), the CD-Rom package is seen as a very cost-effective medium that facilitates learning at a distance. Computers are suited to teaching practicals in science-type disciplines in general, and to psychology in particular. Psychology students are more receptive to computer-based approaches than they are to textbooks. There are valuable lessons to be learned from comments in some of these articles, and these were taken on board in developing the CD-Rom package discussed here.

A more detailed discussion of the literature search and its findings are included at the end of this paper.

**Student survey**

It was decided to gauge student views on a range of issues relating to the use of computer-based technology in regard to the delivery of psychology practicals. To do this a telephone conference was set up. These direct responses then formed the basis of the questions in the survey.

The key question areas for this telephone conference were:

- views on the use of computer-based technology in delivering psychology courses
- views on the use of psychology practicals
- a discussion about the use of CD-Rom technology (access, fears about its use, economic factors and so on).

There was general support for the use of a CD-Rom to deliver psychology practicals. In addition, valuable views were obtained on aspects such as access, equity, fear of the technology, and the advantage of the medium (e.g. interactivity and fun).

The survey itself was undertaken to elicit information on a whole range of topics in relation to the use of computer-based technology in the delivery of psychology practicals. The participants in this survey were selected from Open
Polytechnic students who were currently active in either 73 195 General & Applied Psychology or 73196 Social & Individual Psychology. A total of 239 students were selected. The materials consisted of a survey instrument (questionnaire). This contained six parts. In Part A, information of a demographic nature was elicited (e.g. gender and age range). Part B explored the use of practicals as a part of a psychology course; Part C, computer-based technology usage issues (e.g. skill level); Part D, the usefulness of computer-based technologies in relation to psychology practicals; Part E, issues relating to supervised practicals. Part F provided the respondent with an opportunity to give open-ended comment.

A questionnaire was sent to the participants. They also received an honesty declaration relating to prize entry. In order to increase the response rate, a $50 book voucher was offered as a prize, the conditions of entry being simply the return of a completed questionnaire. To preserve anonymity, two reply-paid envelopes were enclosed with the mailed-out questionnaire; one for returning the questionnaire, the other for returning the honesty declaration. The declaration contained the student’s name and address.

A response rate of 44.4% was obtained for this survey, with 17 males and 89 females responding. Respondents ranged in age from 19 to 64 years, but were mainly clustered in the 25 to 49 age range. Respondents were located all over New Zealand, many in rural regions. For the four main centres of Auckland, Wellington, Christchurch and Dunedin, the distributions closely followed the national demographic spread of populations in those regions. Nearly 52% had constant access to a computer and only 16% had no access at all. Seventy-one per cent had access to IBM-compatible hardware, with the balance having access to other systems (mainly Apple Mac). In terms of the percentage of their computer use, the distribution was 80% wordprocessing, 72% spreadsheet work, 44% for both email and general Internet use, and 69% CD-Rom use. In terms of location of computer access, 65% was home use, 14% at work and 21% other locations (e.g. in a school, cyber café or library). The responses to parts B through E of the survey instruments yielded the following:

- strong support for the use of psychology practicals in Open Polytechnic courses
- strong support for the belief that a skill transfer occurs from practicals
- strong support for essential acquisition of practical skills
- a variety of computer-skill levels
• mixed response to
  – the issue of comfort with Internet use
  – the issue of comfort with email use
• strong support for comfort in using CD-Rom technology
• good support for CD-Roms in providing psychology practicals
• strong support for CD-Rom-delivered practicals being interesting and educational
• strong support for CD-Rom interactivity facilitating learning
• mixed support for CD-Rom as a replacement for face-to-face, supervised practicals
• sharply divided views on requiring computer access to complete a course in psychology
• strong support for the view that computer-based technologies enhance the learning of psychology
• mixed response to the notion of travelling to a resource centre to use a CD-Rom package.

Part E, Question 14, required an open-ended response in relation to Question 13 (which asks about the enhancement offered by computer-based learning technologies) where the response to Q13 was in the negative. As few respondents answered in the negative to Q13, there were equally few responses to Q14. Some typical responses were

• lack of dependency of learning on the technology
• help from other sources obviates the need
• doesn’t seem to add anything that is not provided by the print-based materials
• seen as simply an alternative — no better, no worse
• books are better from access point of view (e.g. use on the train, bus, plane).
Part F provided the respondent with an opportunity to comment on any aspect of the survey. Just over half of the respondents supplied comments, and the following summary captures the ideas expressed.

Restrictions on time and place offset the advantages.

Unable to use CD-Rom on bus, train, plane, unless you own a laptop.

Visual impact aids study.

The CD-Rom facilitates learning.

Would be prepared to travel to Resource Centre to use computer equipment there.

Choice required between CD-Rom and print-based delivery (lack of choice would be unfair).

The use of a CD-Rom is a great idea. Well done to The Open Polytechnic for the initiative.

Great idea, but unable to afford a computer.

It is reasonable to expect students to have access to computer equipment (most workplaces/schools have computer hardware).

A CD-Rom doesn’t enhance learning any more than does print-based material.

Cost/access makes it difficult for some students.

CD-Rom access should be on student’s own PC, in own setting, otherwise learning is hindered.

Don’t have time to travel to a resource centre (student allowance doesn’t cover travel costs).

Conducting experimental activities is quite important in a psychology course. I feel it is important to integrate computer technology into the learning, as that is, for the most part, real life these days.

The psychology labs must be culturally adjusted to New Zealand conditions (too much dependence on North American sources).

Computers are today’s technology and are used in most avenues of life, thus owning a computer is a high priority, and students are prepared to make sacrifices to benefit themselves and their families in the long run.
Psychology needs to maintain the human element (too much machine intrusion is negative).

The idea is OK, but you would need to provide training for computer use.

A CD-Rom is a strong way of learning, giving more, and instant, feedback, and is much more fun to learn with.

CD-Roms suit some learning styles and those people with a strong kinaesthetic sense.

CD-Roms would never be a substitute for face-to-face instruction.

Computing ability is a prerequisite for some jobs (e.g. in psychiatric nursing).

Some of the results are not surprising. For example, that 84% of the respondents were female is no surprise in view of the fact that more than 70% of all Open Polytechnic psychology students are female. Similarly, the graph showing regions seems to follow an expected pattern, with most students living in the Auckland region and few living in the Dunedin region. What is surprising, is the very large numbers of respondents who live outside the four main centres.

Of interest is the higher-than-expected access to a computer (over half of the sample have constant access). Only 16% have no access at all. As expected, most have access to IBM-compatible equipment, corroborating the trends reported in the computer magazines (such as *Computer World*) in which Apple is losing out. Access to software follows the expected trend except in the case of CD-Rom. It is surprising that nearly 69% of the sample have such access. However, it is reasonable to assume that most of the computers used by these students are recent machines, in which the CD-Rom player tends to be standard. Conversely, access to the Internet or an email facility requires additional software and an agreement with a service provider (e.g. Telecom’s Xtra), so one would expect lower numbers in these cases. It is encouraging to see that 65% of the sample have computer access in their own homes.

The responses in Part B through E overall show strong support for a range of issues, including the use of psychology practicals, skill transfer, the acquisition of practical skills, and the use of CD-Rom technology. However, it is clear that students expect choice in regard to delivery technology — they don’t want to be forced into using a computer to complete their courses. There was a mixed response to issues such as the use of the Internet and email, and to CD-Rom as a replacement for face-to-face practicals.
The results of this survey gave general support to the development of a CD-Rom package for delivering psychology practicals. Overall, the respondents were enthusiastic about the concept even though quite a few did not have access to a means of playing a CD-Rom. However, there was also a strong message about choice. Most respondents expect to be given a choice between print-based material and CD-Rom, and not to be forced into a situation where course completion is dependent on access to a CD-Rom player. The CD-Rom technology was seen as enhancing the learning process in that it is interactive (rather than passive) and is fun to use.

**Phase II: Designing the package**

In designing a CD-Rom for use in delivering psychology practicals, a number of key factors had to be taken into account:

- the capacity of the disk
- the relationship between textual and audio-visual modes of presentation
- the degree of interactivity that was encouraged and permitted
- navigation problems as the user moves around a screen and from screen to screen.

**Disk capacity**

A standard CD-Rom has a capacity of around 600 megabytes. For purely textual presentation, this is vast. The average psychology course learning guide uses around 100 kilobytes. So we could get some 6000 learning guides on a CD-Rom! However, as soon as you start to use interaction, audio, graphics and video clips, the bytes are used much more quickly. As a guide, a good resolution, quarter-screen-size still photograph requires around 50 kilobytes (a very long article!) Video consumes the bytes even faster. At second glance, therefore, 600 megabytes begins to look a bit smaller.
**Text versus audio-visual**

The CD-Rom lends itself to either mode of presentation, and one can combine modes. Some experiments are textually oriented (e.g. exploring memory using nonsense syllables), some are visually oriented (e.g. mapping the colour sensitivity of the retina), and some are aurally oriented (pitch discrimination). Capacity becomes a key issue if sophisticated visual presentation is to be used.

The question of using background music (as well as audio in the experiments) also had to be resolved. The CD-Rom project team sought advice and musical input from a musician with extensive knowledge of music computer technology. In general, his advice was to use music sparingly and appropriately and, for the most part, to keep it in the background. The writer can only agree with this advice because, from personal experience of CD-Roms for psychology practicals, music can dominate or even distract from the intent of a given experiment. Thus, in the CD-Rom package discussed here, music was used only on the opening introductory screen, and on the closing screen with the credits. The music was generally baroque, in this case alluding to JS Bach, and was produced using a guitar synthesiser and a midi computer system. The music was recorded directly into the computer. The issue of the fidelity of the audio is not a major concern. The quality of the sound signal from the guitar synthesiser was far higher than could be reproduced by the standard computer’s speaker system.

**Interactivity**

One of the great strengths of this medium over traditional print-based modes of delivery, is the way in which students can interact with the information that is presented. For example, the student can supply answers to questions, can select options and make hypertextual leaps. This feature makes the CD-Rom both fun to use and a powerful tool for learning.

**Navigation problems**

Great care has to be taken in designing the package to avoid navigation errors or flaws in the design which make it difficult for the user to get from one part of the package to another. For example, the student might begin a sequence, end up down a *cul de sac* and not be able to get back to the main menu.
**The experiments used in this package**

The writer generated a range of experiments that are suited to 100-level psychology students and appropriate for CD-Rom technology. The project team, comprising the writer, the multimedia designer and the software designer, met regularly to evaluate the experiments in terms of their feasibility. Some experiments are easy to implement in this medium (e.g. exploring the concept of the learning curve using nonsense syllables). Others proved to be very challenging (e.g. exploring shaping by using reinforcers to train a virtual dog to sit up and beg). On the basis of budgetary and technology constraints, the following list of experiments emerged:

- the Stroop effect (perceptual domain)
- the learning curve (learning domain)
- retention under different conditions of learning (memory domain)
- chance and probability (statistics)
- facial and bodily expressions of emotion (emotion domain)
- trait approach to personality (personality domain)
- problem solving (cognition domain).

The overall design used a screen showing a menu of items for each experiment, where the items were

- **Introduction**: introduces the student to the topic of the experiment.
- **Experiment**: describes the experiment that is to be conducted by the student using the CD-Rom, gives instructions on how to proceed and, if appropriate, the origin of the research that led to the experiment.
- **Results**: discusses the student’s findings in relation to the findings of research.
- **Application**: discusses the relationship between the experiment and real-life applications.
- **References**: lists the full reference details of the sources that are cited in the textual information.
- **Bibliography**: lists full reference details for readings that the student may follow up.
Each textual screen has a hypertext link to a glossary of terms. Where a less commonly used word or term appears in the text, it is underlined and the student can click on it to bring up an inset panel with a definition of that term.

**Trialling the design**

It was vital that the product was trialled before production quantities are printed. The first stage of this process consisted of printing several copies of the completed software onto a writable CD-Rom. The software design team, a dummy student, and the author ran the package independently, looking for a variety of flaws such as navigation and textual errors. No matter how well the software has been designed nor how carefully checked, such errors always occur. In the case of this package, a variety of errors were identified, ranging from simple typographical errors through to major navigational problems. For example, a major glitch occurred in the Stroop test, where the user was asked to start the experimental trial. In this case, when the user had conducted the initial test trial (designed to familiarise the user with the actual experiment), and attempted to move onto the experiment proper, the programme simply quit, throwing the user back to the execute command for the package.

Once the errors were corrected, twenty disks were produced and sent out to students currently studying Open Polytechnic introductory psychology courses. The students were supplied with a disk and a question sheet for use in evaluating the product. A variety of answers were sought, some dealing with the behaviour of the CD-Rom in terms of ease of navigation and presentation, and some to do with the usefulness of the disk to current study. The feedback received was valuable and positive, and was used to finalise the design.

**Uses for the package**

With the completion of the trialling stage, production quantities have been printed, initially for dispatch to all Open Polytechnic students studying psychology at the introductory level. Beyond this, the CD-Rom package will be promoted for sale to organisations that have an interest in such a product: for example, book stores, libraries and textbook publishers.
Results of the literature search

As mentioned earlier, as a part of the CD-Rom project, a survey of the relevant literature was conducted, and the results of the literature surveyed were grouped into the following headings:

- General articles about open and distance learning, and computer-assisted learning, with no specific focus on a given discipline.
- General articles on the use of computer technology in the learning of science subjects.
- General articles about learning psychology without any specific reference to experimental work.
- Specific articles about using computer technology to deliver psychology practicals.
- Web sites that deliver training in psychology at the introductory level.

The following results are a synopsis of the findings under each heading.

Open and distance learning and computer-assisted learning

Thirty articles were reviewed under this heading. In summary, these articles show that computer-assisted learning is effective across many learning situations (although support is not universal). The educational emphasis is now on ‘active learning’ (through exploration and discovery), rather than ‘passive learning’ (being told something). Computers seem to promote active learning, but further research needs to be done to see if the active learning is, in fact, due to the computers, or due to the instructional methods they use, or to ‘interactivity’.

CD-Roms are good storage devices. They have a large capacity, fast access, are cheap and can be re-used. When designing a package, it is important to take into account that different people learn differently. Computer-learning-strategy instructions should be included in the package. It is also important to include a feedback function, as students like to immediately know how they did. The most popular computer packages are simulations, as they enable students to work on experiments that would otherwise be dangerous, difficult or expensive. Computer packages also allow students to work anywhere, anytime. The disadvantage of computer learning is that some people are ‘computer
phobic’. Printed leaflets, Internet or CD-Rom packages may help these people. Finally, it is important to develop a computer package so that it can easily be updated, and to keep in mind that a thing should not be done just because technology allows it. A computer package should be designed to meet the needs and wants of the students.

**Learning science subjects**

Eight articles were reviewed under this heading. In summary, these articles show that science is a difficult subject. The use of simulations in science practicals is good, as it lets students access otherwise inaccessible environments. But simulations are limited, in that they cannot go beyond what has already been done. Students have generally received simulations positively, but feel that practical ‘hands-on’ experience is also important.

**Learning psychology**

Ten articles were reviewed under this heading. In summary, these show that psychological software can address students’ specific learning needs and problems if the design is based on behavioural principles. One problem that arises when trying to work out a psychology curriculum, is breadth versus depth. Should more material be introduced, or should you use less material, but cover it more thoroughly? So far, there is no answer to this.

Computers have been shown to be more helpful in experimental psychology than in other disciplines. This may be because experimental psychology is easily ‘computerisable’.

**Using computer technology to deliver psychology practicals**

Seven articles were reviewed under this heading. In summary, these show that psychology students have received computer labs and tutorials very favourably. Computer tutorials are better at helping students revise for tests than textbooks are. Simulations allow for ‘clean’ and meaningful data. This data is collected quickly, leaving more time for analysis and discussion. Computers can also be adapted to act as experimental equipment (which is often more versatile than conventional equipment). Research methods are taught more easily and are made more interesting with the help of computers. More complex experiments can be understood and implemented in this way. On the other
hand, in some situations (such as operant learning), students prefer to use a real, live rat than a computer simulation. Some people do not regard simulations as important and consider them inferior to hands-on practical experience. Ideally, both computer simulations and some practicals should be used. Some areas of psychology (personality, social, abnormal, developmental) are hard to represent with a computer model.

**Web pages**

Six web pages were identified as relevant to the issue of teaching psychology courses by means of computer-based technology. This is true at the general level and at the specific discipline level.

**Concluding comments**

While a small section of the surveyed literature expresses negative views about the use of the CD-Rom, most of it is very supportive, describing it as a valuable medium for delivering psychology practicals. Our own research has backed this positive view, and we are convinced that our introductory-level psychology students will benefit from the use of their CD-Rom package. At this point, it is not possible to provide empirical support for this conviction, but it is our intention to survey students in regard to their use of the package.
Bibliography

Note: An analysis of these bibliographic sources is appended as an appendix.


Crofter Publishing.


Directory of Psychology Software.
<http://www.york.ac.uk/inst/ctipsych/dir/contents.html> (15 July 200)


Internet Psychology Lab.
<http://kahuna.psych.uiuc.edu/ipl/> (15 July 2000)


*Psycho Mega CD.*


Appendix: An analysis of the bibliographic sources

The following is an analysis of the sources in the literature review. A synoptic comment is made against each item. The sources are grouped under the same heading as given in the article.

General articles about open and distance learning and computer-assisted learning

Defining software for the curriculum


Software is only useful if it is

• comprehensive (student must be able to use it, instructions should be given, and so on)
• appealing and interesting
• broad in its coverage.

Evaluating computer-assisted learning at the British OU


Support for CAL:

• experiments that are dangerous or difficult (e.g. nuclear reactions) can be simulated
• communication and database capability enables students to have quick access to information
• input and output devices make learning easier for students with disabilities.
Problems with CAL:

- access to the technology is still not ideal
- some people who have had bad experiences with computers are reluctant to use them again.

*A meta-analysis of the effects of feedback in computer-based instruction*


Feedback is one of the most critical components of computer-based instruction, as it lets students know how they are going and helps them work on their learning difficulties. Ideally, feedback messages should simulate cognitive processes, so that students can understand them and follow them.

As adaptive systems give students increasingly better feedback, students’ achievement levels should rise. More research needs to be done on the programming of feedback.

*Understanding learners in open and distance education*


People come from different social and educational backgrounds. For example, older people (who constitute a large percentage of open learners) may be afraid of new technology. Different people have different learning styles, and these must be accounted for in the design of a course.

*Personal computers for distance education: The study of an educational innovation*

Learners come from a wide variety of backgrounds. Courses must be structured to meet their individual needs. When developing a new programme it is essential to study the students to find out if the new development will be useful, worthwhile, economically viable, and so on.

Non-sequential organisation of a programme helps to individualise it.

The CD-Rom is a powerful storage device. It is economically viable.

**Remote education with online communications and laboratories**


Online computer-assisted learning is successful because: it involves graphic presentations and animations, where ‘learning by reading’ is complemented by ‘learning by intuition’; interaction and electronic laboratories allow students to deepen their knowledge by ‘testing’, and ‘trying-out’, and ‘learning by doing’. Online learning also provides the benefit of communication. It enables students to obtain immediate feedback because they rate their own work. This may lead to poorer results in some students. This could be compensated for by a few ‘realtime’ tests, set and marked by a tutor over the course of the learning programme. The same principle would apply to learning via CD-Rom.

**Knowledge-based systems in teleteaching**


Artificial Intelligence could help distance students learn by answering questions immediately. It could generate problems and evaluate and correct the solutions proposed by the student. An intelligent program could deal with students’ different types of learning and their different ways of interacting with the program.

Artificial Intelligence could help with effective feedback.
CD-Rom as a storage medium for computer aided instruction


A CD-Rom is capable of storing graphics, animated graphics, digitised pictures, simulation programs and audio sequences. It has a large capacity and short access times.

A CD-Rom is easy and efficient to use. It is not easily damaged and is resistant to wear (so it could be re-used). It is reliable (won’t crash and so on, as online programs can).

CD-Roms are now cheap and easy to obtain.

Meta-analytic studies of findings on computer-based instruction


Many studies have shown that computer-based instruction has a positive effect on learning.

Assessing technology in assessment


When developing educational technology, it is essential that the technology be shaped by the needs of the programme and the students, and not purely by the potential of the technology.

Simulations can be used for both training and assessment, but these two types need to be distinguished.

Technology can aid the assessment of a course.
Cyberlearning: New Possibilities for HRD


Technology allows people to ‘talk’ anytime, anywhere. Time and location are no longer a constraint.

The Internet offers ways of learning through email, bulletin boards, interactive tutorials, real-time conferencing in a virtual classroom. Tutorials and software can be downloaded.

Intranets are internal electronic networks that can support the delivery of CD-Rom based training. There are many types of learning programs available on CD-Rom and these are improving all the time.

This type of technology is very good for distance learning. For people who are unsure about how to use this new technology, many helpful tutorials, Web sites and CD-Roms are available.

Towards a strategy for supporting distance-learning students through networked access to information: Issues and challenges in preparing to support the Doctorate in Education


When trying to provide networked access to information within a multi-layered organisation, there are many issues to be considered.

- Students’ skills: Computing knowledge varies greatly among students. Not all students have access to a computer and access to a computer does not necessarily equate with computer literacy.

- Instructional materials: Keeping the information up to date is important, so the information needs to be stored in a way that is updatable.
**Integrative evaluation: An emerging role for classroom studies of CAL**


The authors performed many studies and found that the use of teaching software is applicable to a wide range of subjects.

When developing software, it is important to determine the level of knowledge students should have before they can use it.

**Computer-assisted learning in the Netherlands: A review of findings**


CAL is most popular in maths and science subjects. The most popular forms of CAL are simulations.

CAL is usually divided into three parts: drill and practice (exercise programs), tutorial (instruction programs) and simulation.

Simulations are popular because they are the only CALs in which the program adds, to the curriculum, something that a teacher or tutor cannot offer. Simulations offer a safe environment for practice; time scales of real-life processes can be changed and hypothetical realities can be designed.

This view sees learners not as persons into whom knowledge can be poured, but as active constructors of knowledge. Simulation lets them do this.

At the time of writing this article, many institutions did not yet have access to such technology as CD-Rom.

**Evaluating CAL at the Open University: 15 years on**


CAL was first integrated into the learning system in 1979. Few people used it.
Reasons for this were: people were afraid that they were going to look stupid, they were afraid that they might ‘break’ the software or that they might be spied on. ‘Bad computer experiences’ had generated these fears. At this time, access to computers was limited.

By 1989, many students used CAL and they viewed it very positively (as a most useful and efficient form of revision).

Today, CAL is not used for primary teaching. It is designed to reinforce the students’ understanding of the printed course materials. Most of CAL’s use is described as ‘interactive tutorial dialogues’. The tutorial tests the student and enhances their knowledge of the course materials. Simulations are often used with science courses.

**The effects of computer-assisted learning-strategy training on the achievement of learning objectives**


Teaching someone learning strategies is, in effect, teaching them how to learn. Learning tactics can be either memory-directed (e.g. mnemonics, summarising, outlining, underlining) or comprehension-directed (e.g. questioning ideas, understanding ideas and their interrelationships, rather than simply recalling them).

In this study, the authors hypothesised that students learning with a comprehension-directed approach would learn better (using CAL) than students using a memory-directed approach. There were no significant differences.

They found that students may not transfer their normal learning tactics to a CAL environment. Based on their recreational experience with computers, some students may simply scroll or click through the program. Computer-based learning-strategy training should come with the package.
Individualization of teaching and learning: Where have we been; where are we going?


Programmed instruction boomed in the 1970s when ‘individualisation’ was the self-paced study of set material. This progressed from practice and drill programs to tutorials and then to the simulations used today.

Today’s approach to teaching is facilitating access to information, rather than causing learning to occur. The new generation of learning materials has an emphasis on learner control over aspects such as content, presentation, learning rate and study method. Multimedia helps to make these materials possible. The thing that is lacking from most multimedia productions is attention to interaction (feedback).

An alternative approach (that the author is working on) is integrating computer-based learning materials with network access to a distant tutor. The learner can work at their own pace and place, but whenever they want to engage in a deeper discussion, they can link to the tutor.

Computer-based instruction has many advantages:

- It provides interactive, learner-paced learning that can take place anytime.
- Units can be repeated any number of times.
- Students become more computer-literate through this approach.

Motivational analyses on the effects of type of instructional control on learning from computer-based instruction


Students under program-control (program tells student where to go next) performed better on a subsequent test than students under learner-control (student controls where to go next). This was not what the hypothesis predicted. There was no difference in motivation between them (probably because the computer itself motivates students to learn). Regardless of the type of instructional control, the level of satisfaction was higher than the confidence
in instruction. Further research should be conducted before definite conclusions about the motivation of computers, or the effect of instructional control, are be drawn.

**Student perceptions of the tutor’s role in distance learning**


Students feel that a tutorial should use course materials (and not introduce outside content). They feel that it should have clear aims and objectives and that they should know what these are (giving information about the course programme in advance is a good idea).

Students think that the tutor should know the course intimately and be able to explain it. They want to know how their assignments can be improved and what was good (as well as what was bad) about them. The more useful a tutorial will be to them, the more likely students are to pay attention to it.

**Distance learning in the future**


In the future, distance learning will call for major investments in large-scale computer-based programs that use multimedia for instruction, rather than just information distribution. Experiments need to be done to develop this.

The fact that all people are very different must be taken into account when designing distance learning programs.

Learning is achieved a lot better through interactive material. It is cheaper this way and people pay more attention to it. Lectures and books are very passive ways of learning. Active learning is better.
**Delivering distance learning in a profit centered environment**


The CAL grading system cuts times for the receipt, grading and return of students’ answers. Students like prompt feedback.

**Interactive multimedia for engineering education**


Technology is good as a teaching tool as it enables students to have as many attempts at solving a problem as they want, take as long as they want, and so on. They can learn by exploring, rather than by simply being told. The learning does not become routine and boring.

Today, significantly more information and knowledge can be communicated in a shorter time than ever before. A CD-Rom package is self-contained, making it easy to use and reducing cost. Materials such as CD-Rom can also be re-used.

**IMM: An overview**


Interactive multimedia software is economically viable. It is cheaper than printed text. The only problem is hardware costs, but with time, these will go down too.

**Research support for interactive multimedia: Existing foundations and new directions**

Learning by IMM is very different to the traditional mode of learning. Although it has been shown that students work better by actively exploring a field, this does not automatically happen just because the information is presented via IMM.

**Mega-universities and knowledge media: Technology strategies for higher education**


As population is increasing, distance learning is beginning to play a more and more important part in higher education. Distance education relies on many technologies. A technology strategy can give a competitive advantage to a university.

**Exploring hypermedia**


When designing educational software, the style of learning and the type of learner must be accounted for. Hypermedia can be used as an effective teaching tool in many situations.

**Research and theory on multi-media learning effects**


Some of the benefits in learning that are found in multimedia learning environments are not necessarily due to the multimedia itself. It is possible that they are due to interactivity or other instructional methods. This needs to be investigated.
An evaluation of computer assisted study in controlled and free access settings


An effective study environment should encourage active cognitive processing of the material being studied. Students should also be able to monitor the success/quality of their study efforts and make the necessary adjustments to correct deficiencies. Many studies have shown that a significant number of students are unable to do this.

The experiments in the study by Grabe et al. showed that students who used computer-assisted learning performed better in tests (hence learning with computers achieves the above-mentioned objectives).

But there were also some discouraging findings, such as the number of students using computers declined throughout the semester. Also, the less able students seemed to use the computers less.

Further research needs to be done, with student perceptions about various aspects of computer-assisted learning being the most important variables.

Computer-assisted instruction, students’ off-task behavior and their achievement


Tenth-graders doing a business education course were observed during computer-assisted instruction (CAI) and seatwork. Their off-task behaviours (such as non-learning related talking, out-of-seat talking, sitting and not working, moving around, sleeping) were measured.

It was found that students engaged in less inappropriate behaviour during CAI than during seatwork. That is, the percentage of time spent on off-task behaviours was lower during CAI. Test scores on CAI were significantly higher than test results for seatwork (*but this could be due to the nature of the topic being tested*). During CAI, students interacted more with teachers and other students and these interactions were mostly learning-related.
These results may be due to students being more interested or motivated to learn during CAI. But there was no correlation between off-task behaviour and CAI, so it cannot be said that the lack of disruptive behaviour is a causal effect of CAI.

CAI with a practice and drill focus (along with controlled instruction) has been shown to be an effective way of helping students improve their academic performance as well as minimising off-task behaviour. Therefore, computers may be beneficial to both students and teachers.

**A computer-aided self-testing system for biological psychology**


Students in a first-year course in biological psychology were able to use a self-testing system to help them revise for exams. This system was either computer-aided (run on IBM compatibles) or printed. The self-tests were based on textbook materials and instructor notes.

Most students took advantage of this system. The majority used the printed version (only those with their own computers seemed to use the computer version). Very few students took advantage of the university’s open computer facilities. This could be because first-year students were not well acquainted with the facilities or may be due to computer angst.

Both revision methods significantly improved the students’ performance. There were no exam score differences between the two revision methods and neither method took longer or was more difficult to use.

Hence, improved learning is not necessarily due to computers; it could be due to material format, instructions, being able to use materials anywhere, anytime, and so on.
General articles about learning science subjects

Open science: Distance teaching and open learning of science subjects


Science is a difficult subject to teach and learn. Because of this, it is impossible to design a text that is universally effective in teaching it. Multimedia methods may be better than traditional textbooks.

Unlike human tutors, computers can repeat an answer many times, they do not lose patience and can devote full attention to the student.

The possibility for individualised instruction using computers and multimedia is still fairly limited.

Access for all students to computers is still a problem. Possibilities to solve this are: the institution can loan the computers to students (this would be very expensive), the institution can hire computers out (cheaper) or it could request that the student have access to a computer in order to do the course (which would discriminate against some people).

Simulations are effective in teaching about things that happen very quickly, are difficult to see, and so on. They give student’s access to otherwise inaccessible environments. But, in a simulation, the model has already been created by the developer and there are few opportunities to change the basis of this model. Therefore, simulation can be limited.

CD-Rom: digital technology facilitates data integration, and has a high storage capacity. CD-Rom allows high-quality images, which are very useful in teaching.

Since practical work is very important in science subjects, the simulations and demonstrations that multimedia technology allows are very useful.
Educational computing: Learning with tomorrow’s technologies


Simulations are dynamic models or descriptions of events. They are useful for teaching as, in a simulation, students need to be active (not passive observers) — they learn by doing. Simulations are like play, therefore students don’t get bored easily.

Simulations have several advantages over real-life experiments, in that they are less expensive and are completely safe.

Developing computer-assisted learning for physics instruction


Computer software designed to help students who are learning physics (during Summer School at the OU) was enjoyable to use. The main programs were physics simulations. The university supplied the equipment for this course (as it all took place at the same time and at the same location).

An evaluation of the student response to electronics teaching using a CAL package


Computer simulation allows the student to learn at their own pace. The system can be used out of hours. Students are not inhibited by a fear of damaging equipment or components, and the package encourages experimentation in a form that does not take place in the lab when real components are used.

One of the concerns in the study was that the value of practical experience would be lost in the use of a simulation. Another concern was that the bridge between theory and reality might be lost.
If the students did not understand their notes at the beginning, a real lab or a computer lab were equally helpful. There was no correlation between liking computers and wanting the lab to be entirely replaced by a computer package. Those who used the computer package were more in favour of it than those who did a real lab. The computer laboratory was markedly quicker and the students who did it found it easier. Opinion was mixed about whether the real lab should be entirely replaced by the computer lab. Some students (almost three quarters) expressed concern about the loss of hands-on experience. Students liked the computer lab, as it was safer, quicker, more convenient.

**Pharmacology experimental benefits from the use of computer-assisted learning**


Students found many benefits from using CAL to supplement practical laboratory classes. These students showed a noticeable increase in understanding theoretical concepts in the applied setting of a real experiment.

Previous studies have found that CAL is popular with undergraduate students. This popularity is not dependent on their previous computer experience.

Real practicals run by a beginner can produce disappointing results. Because of this, practicals can be viewed as unsuccessful, which is bad for motivation. Therefore, CAL is better for motivation. CAL is also cost-effective, especially when time is limited and equipment is in short supply.

**Project BioQuest**


BioQuest is a CD-Rom package for learning biology. The program includes three elements that are important to the teaching of science: problem-posing, problem-solving and persuasion.
With this software, students must define a problem (the software doesn’t state one). The program emphasises that real scientific problems don’t have right answers that are known by the authorities. It also stresses the importance of record-keeping and the development of a persuasive scientific report.

As this package is published on CD-Rom, the cost to the publisher is constant, so the project can grow without significantly increasing costs.

Simulation software in a life sciences practical laboratory


There are several reasons for using simulations in a teaching context:

• They provide a safe environment for testing hypotheses and studying outcomes.

• There are no set times when students have to do the labs; therefore, they can use the materials for reinforcement, revision and self-testing out of scheduled class times.

• Teacher or demonstrator time can be diverted to other tasks.

In teaching science (in this case, physiology), there are further reasons for using simulations in labs:

• There is no need for specialised or expensive equipment.

• Students can concentrate on biological principles rather than techniques.

• Students can perform experiments that would otherwise require high levels of physical or technical skill.

• The use of live creatures is avoided.

There are also some arguments for using physical, practical labs, the most important of these being the need for ‘hands-on’ experience.

The authors observed students doing various lab experiments (simulated and practical) and found that the simulation was treated very much like one of the labs, rather than just a computer-assisted learning exercise.
The emphasis on learning and understanding the subject material is stronger when working with a simulation than when doing a practical lab. There is very little time spent on learning how to use the computer for a simulation. In a practical lab, there is a lot of time spent on learning how to use the equipment.

The good thing about simulated experiments is that students can get the results clearly and quickly. The bad thing is that there is sometimes too much information, which can be confusing, and a student cannot ask the computer to rephrase what it just said.

Ninety per cent of students reported that it was useful incorporating simulations into the lab programme. The reasons given were:

- Quick and easy experiments can be set up and results obtained.
- Things are explained clearly and you can’t get bad results the way you can with practicals.
- Difficult experiments and techniques can be used, from which good results are obtained and conclusions can be drawn.
- They introduce how things will be run in the future.
- They cut down on animal experimentation.

But students reported that they would feel cheated if all practicals were replaced by simulations. Students felt that they need the hands-on experience, as that is the way to connect what they are learning with the real world. It is important to have hands-on experience in running experiments.

The authors feel that incorporating simulations into the programme, and not just making them optional, works well. Another bonus of this is that students learn how to use computers and computer simulations which are being used more and more in the research field.

**Assessing the impact of computer-based learning in science**


Computer-based learning still falls short of providing students with many rich opportunities to carry out science in the context of discovery: the origin and evolution of ideas, the gathering of evidence, the establishing of the validity and reliability of that evidence, and so on.
But simulations do have some advantages. They allow the omission of distracting features. They force the students to search their memories for knowledge that relates to the problem being solved, to assimilate that knowledge into a solution and evaluate the result.

The weakness of simulations is that they only indirectly indicate whether the student understands the material, and they provide no new knowledge beyond that which the student already possesses or can create.

**General articles about learning psychology**

**Technologically assisted instruction and student mastery, motivation and matriculation**


There is support for the idea that high-tech teaching tools enhance learning and motivation (in psychology as well as other subjects). However, this finding is not universal. The contrary findings may be due to the type of technology being used, for example, a text-based tutorial could be seen as dull, whereas a graphics-based tutorial may not be.

This study was designed to see if students who used technology (simulations about hemispheric specialisation, visual illusions and statistical correlations) would perform better on a subsequent test.

In general, students perceived the technology in a positive way. The data is inconclusive, but it does not show that students using the technology did better. The poorest students who used the technology showed the greatest gains. Feedback is important to students.
**Ideas in practice: a developmental education approach to computer-assisted content instruction**


Students learn best when they work actively in groups and when teaching staff are perceived to be resources for students rather than dispensers of information.

Before instructors implement computer-assisted instruction, they must clarify their educational objectives to

- teach the content of introductory psychology
- develop students’ academic skills
- break down avoidance behaviours that interfere with students’ academic success.

If exercises are game-like, they are more likely to hold students’ attention and to motivate them to study.

Students have many problems with studying (such as not distributing study time well). Software could be designed to address these types of problems. Students’ different learning styles can be examined.

**Curriculum**


The main goal of psychology is to teach students how to scientifically think about behaviour. No one curriculum is suitable for all, but all should

- teach students to distinguish between facts and inferences from facts
- teach students that naming is not explaining
- pay attention to human diversity
- be broad enough to represent the diversity of the field
- teach statistics, research design and psychometric methods
• teach students to generalise what they learn and apply it to real life
• enable students to understand the literature and journals and to communicate their knowledge
• teach about the ethical standards of psychologists.

An introductory psychology course should provide a survey of psychological topics and methodological approaches that reflect the breadth of the field.

**Promoting active learning in psychology courses**


In active learning, students enjoy a hands-on or a minds-on experience. Active learning involves feedback that is not necessarily graded. It increases student involvement and so it is beneficial for both students and faculty.

For active learning to be truly effective, tutors should tell students about it. Students should be told what is required of them in advance. Instructions should be given in such a way that students are motivated and challenged to study.

It is important to establish rapport and climate in a learning place.

Active learning is not do-it-yourself learning. The course should be planned thoroughly by the instructor. Exercises must be relevant to the material being discussed.

A primary method for active learning is through demonstrations and exercises.
Transforming undergraduate psychology for the next century


The main problem in trying to develop new psychology curricula is the depth versus breadth debate. Should more material be covered, or should less be covered but more thoroughly?

Using HyperCard to administer a figural test on the Apple Macintosh


This article describes a HyperCard application for administering an objective personality test with visual stimuli.

Before the development of this application, computer applications in psychological assessment included pictorial stimuli only to a limited extent.

The strength of the present application is that it involves a script that can easily be adapted to other situations: for example, other types of personality tests. Simulations are likely to represent the future dimension in psychological assessment. Work of this type has already been done on skills assessment and training packages. The stimuli in these applications consist of moving video scenarios stored on CD-Rom devices.

The present application demonstrates that the HyperTalk script language is powerful enough to fulfil several functions in psychological assessment. HyperCard’s particular strengths lie in its provisions for presenting a variety of forms of information to the subject (including text, figural and even animated stimuli) as well as in its flexible capability for providing control over the presentation of stimuli.

This article is an example of a practical application of technology in psychology-related matters. The same type of strategy can be applied in an educational package for psychology.
Computer use in psychology instruction: A survey of individual and institutional characteristics


There is considerable variation in the use of computers for teaching psychology across different tutors and different institutions. Most institutions value computer support in psychology instruction. Computers are least likely to be used to teach personality, developmental or educational courses. They are most likely to be used in teaching statistics, research methods, and in the experimental area.

Internet and the support of psychology education


The Internet can revolutionise the way psychology is taught. Information can easily be modified and updated, information about psychological resources is available. Support is also readily available.

The same principles could apply to CD-Rom, although support would not be as readily available.

Teaching of physiological psychology in a multimedia classroom


In a multimedia classroom, lectures are illustrated with computer-generated text, graphics, animations and video clips. Keypads mounted on student desks tabulate individual responses to questions posed in the class. The use of keypads promotes active learning in a large lecture class, because each student formulates an individual answer to every question. Experiments, with students as active participants, can be run during a lecture.

Exam results are the same in a multimedia class as in a conventional class (although this could be due to ceiling effects). The multimedia class is more conducive to work.
Because more time is spent on activities, less time is spent on factual knowledge, which means that students have to rely more on the textbook. In the absence of facts given in lectures, some students may find material hard to understand (but their exam results are good, so this may not be the case).

This was the first course on physiological psychology to be run in a multimedia classroom. Over time, as lecturers and students become more used to this method, its effectiveness may improve.

It is important not to concentrate solely on practicals, but to teach factual knowledge as well.

**Using computers to teach behavior analysis**


Experimental analyses of the differences between contingency-shaped and rule-governed behaviour suggest that it is important to do experiments, rather than just read about them, in order to learn. Courses in behaviour analysis should include laboratory experience. When this is impractical, computer experiments and simulations can add a lot to the course programme.

Effective software reflects behavioural principles and incorporates appropriate contingencies to maintain the behaviour of both the student and the instructor. The way to develop effective software is through experimentation: that is, start with a preliminary version, see what problems students have with it, revise and retest.

The authors developed a computerised lab for teaching about reinforcement contingencies. As this is a difficult topic, a computer program to teach it needs to be carefully designed.

An advantage of computer-based instruction programs is that every student can master a certain level before moving on to the next part. This is not possible in a normal classroom situation, where a weak student who does not understand one module falls further and further behind as more advanced work is done.
Specific articles about learning psychology and psychology practicals

A computer tutorial on consequences in operant learning


This article talks about a computer tutorial that teaches the fundamentals of consequences and contingencies in operant learning. Students view this program positively and regard it as more useful in preparing for a test than a text or study guide. Many of them desired more course material to be presented in the form of computer tutorials.

Design and use of a U.S. census data computer laboratory for teaching undergraduate research methods


The U.S. Census of the Population, a database commonly used in all of the social sciences, is used to give students research experience and to avoid ethical problems involved in working with animal and human subjects in an undergraduate course.

Recent examinations of undergraduate education in psychology have pointed out the need to address diversity in learning styles and educational background and have recommended restructuring the learning environment to stimulate active learning. Historically, the social sciences have had a strong tradition of hands-on learning. Unfortunately, today, the costs of this may be too large, the number of students too great and so on, for such a method to work.

This paper describes the development of a networked computer classroom designed for teaching research methods, using the U.S. Census of the Population as a database. The programme is designed to include both practical and theoretical research components. The data sets provide the students with various types of information.
Student responses to this program are positive. The students have demonstrated, through their work, that computerised education is an important tool in their achievement.

Problems with this approach include:

- The demand for computer facilities is far greater than anticipated (not all people may have access).
- Some students and faculty are computer phobic.

The use of the U.S. Census data encourages students to become involved in the learning process. The program teaches both statistics and how to write research papers. For this type of programme to work, instructors must develop structured assignments, and must clearly define what is expected of students.

**Computer-based methodology laboratories: 1: An undergraduate course in experimental psychology**


At West Virginia University, microcomputers are used in the laboratory sections of a conventional undergraduate course on research methods in psychology. The computer systems increase the speed and efficiency of data collection, reduce errors of procedure and measurement, and implement numerous steps to standardise procedures and limit extraneous influences. As a consequence, uncontrolled variability is minimised and the opportunity for meaningful research outcomes is maximised. The laboratory can be expanded with software alone, without the expense of additional hardware.

The lab sessions in the course are designed to give students first-hand experience in research design and methods of data analysis. No simulations are used. All of the projects involve the observation of real behaviour, with the students themselves taking turns being investigators or subjects. Computers assist by taking the place of traditional, but less reliable and more expensive equipment, such as pursuit rotors, mirror tracing stands, and so on.

The design of the software was guided by the objective of reducing the tedium that often accompanies laboratory procedures. Another major objective was to improve the chances of obtaining meaningful research by minimising noise in
the data. With computer-assisted research, errors of measurement can be reduced and errors of procedure virtually eliminated. Various steps can also be taken to control for extraneous variables, even if these would be too complex for manual procedures.

Student evaluations of the course have been positive. The use of computers in the laboratory provides significant benefits. Computers and well-developed software duplicate the functions of a traditional lab at a fraction of the cost. Data are collected quickly and efficiently, leaving more time for analysis and discussion, while increasing the number and complexity of the projects that can be conducted.

By writing more software in high-level languages, the lab can be expanded without the expense of additional hardware. Suitable commercial software could also be incorporated into the lab.

**Computerized laboratories for psychology instruction: How successful are they?**


The psychology laboratories at the University of North Carolina at Charlotte were upgraded to computerised labs to provide students with experience in a broad variety of research situations in psychology. The computers made teaching data analysis easier and more interesting.

The software purchased can be used for

- lab exercises that demonstrate contemporary psychological research
- statistical analysis
- CAI lessons that offer repeated practice with conceptually difficult material.

New programs can be added. In particular, the university wants to purchase open-ended software (that allows the students to design their own experiments).

In evaluating the computerised lab, most students agreed that the computer exercises made the material easier to learn, and that the lab exercises represented an important learning experience. Instructor reactions were also positive. They agreed that teaching in the computer lab was stimulating and
exciting and that the lab provided students with necessary practical experience in research methodology.

The CAI lessons (e.g. on how to write a lab report) have also been shown to be successful.

This lab provides laboratory experiences that are essential for doing more advanced courses in psychology. It has been especially successful in making students more confident about research methodology.

For some topics (e.g. operant learning), students clearly preferred practical, rather than computer-simulated work.

In summary, the computerisation of psychology labs has been a success, not so much as a result of how much the students are learning in the classroom, but because these labs have an effect that reaches beyond the one-credit lab experience that they were designed to improve. There is now work being done on remedial teaching with CAI programs. A CAI program for teaching psychological physiology (judged by most students to be their most difficult subject) has already been developed.

A computer lab for undergraduate psychological research


This article describes the MEL (Micro Experimental Laboratory) in psychology. MEL can be used as the main basis for research in applied psychology courses. Because of MEL, students are exposed to more experiments and are better able to discuss alternative experimental procedures for testing the same, and similar, hypotheses.

MEL experiments can be written in such a way that they can be modified for individual students. Experimental psychology students use MEL. Students studying developmental, cognitive or social psychology use another program, but all psychology departments are encouraged to incorporate computer labs into their courses.

This approach needs a lot of funding in order for maintenance and upgrading to be performed regularly. A solution to this might be to charge students a lab fee.
Every student at Drexel University is required, on admission, to purchase a Macintosh computer. Because of the unique nature of psychology as a discipline, computers could make a good contribution to it. Specifically, software can be provided to convert the Macintosh into real and functional research equipment that permits the student to have a take-home laboratory for psychology. Emphasis is not on simulations or programmed learning, but on direct interactive and creative generation of research data.

One advantage of the Macintosh is that it is more versatile than practical equipment: for example, in a mirror-tracing task, it is possible to reverse not only left and right (as normal mirror-tracing), but up and down, or both together.

The difficulty, as with any model of computerisation, is that many areas of psychology (clinical, social, physiological) are awkward to represent effectively.

There are many advantages to every student having their own computer. Apart from those discussed above, word processing and formatting allows the production of well-presented documents. In addition, students can engage in self-editing, with consequent improvement in academic quality. Graphics can also be improved with computer applications.

The real evaluative criterion though, is not whether a computer lab can be used in an introductory psychology course, but whether this form of the course can achieve the highest standards.
**CD-Rom buyer’s guide**


MacLaboratory for Psychology: Research Version 3.0 is a package (available now) that allows the user to create research-grade experiments in psychology. It displays a ‘virtual lab’. It combines research protocols, tutorials, teaching materials, movie clips and simulations.

Another package, Question Mark Software, creates quizzes. Students have received this package positively, saying that it is effective in helping them to study for exams.

**Web pages**

*Psycho Mega CD.*  

This page shows and allows a user to order software that is available for the teaching of psychology. This software is mostly in the form of quizzes that a tutor can write for students (or that students can write themselves).

*Crofter Publishing.*  

This page shows and allows a user to order software of psychological simulations (e.g. simulated rats running through mazes that teach about learning theory).

*Internet Psychology Lab.*  
<http://kahuna.psych.uiuc.edu/ipl-/> (15 July 2000)

This page shows an Internet Psychology Lab (an interactive multimedia lab of experiments in psychology). The experiments shown are perception experiments. A user can participate in them.

*CalCampus: Social Sciences and General Education Courses.*  
CALCampus (an online teaching centre) offers distance courses online. One of the courses offered is introductory psychology. These courses are developed solely through the Internet. This page provides a description of the course, enrolment details and so on.

Directory of Psychology Software.
<http://www.york.ac.uk/inst/ctipsych/dir/contents.html> (15 July 2000)

This page is a directory for software that teaches (or assists in teaching) various psychology courses. Psychology CD-Roms include databases, multiple-choice questions and electronic versions of textbooks (no virtual labs).


An evaluation of a CAL program used in medical education showed that the use of different media resources facilitates learning. Completing a CAL tutorial before a practical lab was found to be very helpful. This result would also be applicable to a psychology lab.