



Learning tool or potplant stand? Students' opinions of learning from a CAL program in a distance education context

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Although teaching institutions are continually moving towards electronic forms of delivering learning material, a study of first year adult distance chemistry students found that they had developed a successful learning profile based on their present printed learning material and were reluctant to consider the use of alternative methods of delivery. The reasons for this reluctance were explored by developing a Computer Aided Learning program, based on the students existing learning strategies, and offering it as an alternative to printed material. Although many volunteered to use the program only a third of these persevered with its use. Reasons for abandoning the program were generally associated with a fear that they may be wasting their time in having to learn a new method of study. However those that did use the computer program considered it to be a more efficient way of learning than from printed material.

Introduction

Technology poses a serious challenge to schools and universities. In a world increasingly focused on globalisation, educational institutions are turning to computer driven technologies to reach a wider clientele for their products and in the process are being forced to review and probably change their methods of teaching (Bryant, 1998).

This paper discusses two studies carried out over several years on first year distance chemistry students. These studies explored:

- the students' priorities when studying, and
- their acceptance of computer technology.

It was found that most of the students did not share institutional management's view of the computer as a learning tool (Lyll, 1998). In fact one student was led to declare "if I had a computer at home the best use I could see for it is as a potplant stand".

Background

In the technology-driven system of distance education in United States of America the majority of universities and senior colleges now offer off-site courses using electronic communications (Gubernick & Eberling, 1997). The predominant contemporary systems, such as those at Pennsylvania State University (Eddy et al, 1997) and Northern Arizona University, use CD-ROM and the World Wide Web (WWW) (Connell, 1997) to deliver their programs both on-shore and off-shore. Similar trends towards computer aided learning (CAL) can also be found in other countries including Australia (Monash University, 1997).

There is, therefore, considerable pressure on educators to utilise modern technology to provide more flexible ways of delivering educational programs (McNamara & Strain, 1997). To assist in this there are numerous books and articles of a general nature in the literature proposing different pedagogy and models of CAL programs. It is important, however, that any change in teaching style take into account the viewpoint of the student since, as Volet (1991, p322) points out, a teaching approach that suits the learner is more likely to be successful than one about which they have doubts. Furthermore, as Hore (1993) has pointed out this may be discipline specific, what suits the chemistry (or perhaps science) student may not suit others and vice versa, and there are few articles written specifically for chemistry.

Burden (1993) has suggested that CAL is a useful medium for teaching chemistry because of its graphics capabilities since chemistry makes great use of symbols and diagrams. He believes that students find it exciting because they can move around in the program just by clicking on a "button" and less judgemental than lecturers when giving feedback. In an investigation of learners' perceptions of a CAL course in a first year distance education chemistry in South Africa, De V Steyn et al (1996) reported that the students responded favourably to the tutorials, examples and the feedback from problems. Grades were not significantly different between those who used the printed material and those who used the CAL but nearly all the latter claimed they learned quicker and better and would prefer this method.

In separate studies, Gregory & Stewart (1997) and Calverley et al. (1998) found that CAL programs in basic physics encouraged student centred learning, allowed the students to self pace themselves and was particularly useful in assisting students of differing abilities and academic backgrounds.

Although many institutional programs are delivered through the WWW, Gooley et al (1994) believe that CAL delivered through a CD-ROM is useful for isolated communities which do not have access to appropriate educational institutions because it is easily transportable, does not require an expensive network connection, and has sufficient storage capacity to present a flexible learning package using graphics, motion and sound. This would appear to be particularly suitable for the delivery of distance education chemistry courses in Australia. However, whether a program is delivered through the Web, by CD-ROM or by floppy disk is not relevant to this study since it was the use made and interaction between a student and a computer program which was being investigated.

Students' priorities for studying

The first study was carried out on three groups of adult students studying first year chemistry by distance education at two Australian universities. The students' priorities were determined by both quantitative (questionnaires) and qualitative (in-depth interviews) methods using a grounded theory approach.

The study identified that the students had developed what appeared to be a successful learning profile. They regarded themselves as independent learners, taking responsibility for their own learning. They considered that they were able to learn on their own without the immediate supervision of teachers or interaction with other students. The latter was clearly regarded as being unimportant.

The students employed both surface and deep learning strategies for studying, whichever they deemed to be most suitable for their immediate goal learning strategies. Biggs (1993) and Entwistle & Tait (1990) describe this as a "strategic" approach to study, that is, the learners are most concerned with the efficiency of their learning. For these adult distance learners, the major reason for adopting such an approach was the lack of time for studying, this having to be organised around employment, family and home commitments.

The learning strategies used by the students were based on preparing their own written notes from their study material (Lyall, 1998) which was predominantly printed material, consisting of the study guides produced by the university textbooks. The few computer programs available to the students were not regarded as being important components of their learning schedule.

Although they were developed from printed materials it was suggested that a computer-aided learning program (CAL) would also support these learning strategies. However the students were not enthusiastic about receiving study material using only computer generated study material. The main reason for this was the reluctance of the students to change their study habits. That is, they had developed a comfort zone and it seemed that it would be difficult to convince them to move out of it. This reluctance to change originated from their perception that they did not have time to learn a new method of studying and were unconvinced that a new method offered by CAL would be advantageous to them.

In essence the study identified that the priorities of students had little to do with the technology as a means of delivery or as a learning tool in its own right.

Students' acceptance of technology

In the light of the findings from the first study a further study was carried out to explore the factors influencing the students acceptance or rejection of an electronic interactive version of their study material. This was achieved by developing and piloting a computer-aided learning program prototype, incorporating features suggested by the results from the previous study, and offering it to distance education students studying organic chemistry as an alternative to their present printed study material.

Criteria for the development of the CAL program

The software used for the CAL program was HyperWriter, chosen because:

- it was readily available,
- a runtime version of the final program could be distributed to the students without copyright problems or costs,

- the software supported most of the functions identified by the students as being important.

As in the first study, the target population for this study was three (different) groups of adult students studying first year chemistry by distance education at two Australian universities. Although the text for each group was slightly different the curriculum was similar and therefore the principles involved in developing the programs were also similar.

The first program attempted took an estimated 600 hours of work to develop but the other programs took significantly less time (between 300 and 400 hours) to write.

There were two components to the design of the CAL program, the general framework of the program and the design of the learning materials.

Selection criteria for the general design

One of the important criteria was to make the program as quick and easy for the end user to set up and use as possible. This was considered essential because of the limited amount of time that distance education students have for studying and their limited computer expertise (Lyll, 1998).

The program and files were distributed to the participants in the study on several floppy disks and installation consisted of simply copying all the files to a single directory on a hard drive. Two sets of instructions were given for this, a step by step procedure for those new to computers and a briefer one to those who were more expert users. To access the program participants had only to type in a single command from the DOS prompt.

After the first screen, which was similar to the cover of a book, the students were presented with an index to the complete CAL program as shown in Figure 1 below. It should be noted that diagrams of the screens are produced here in monochrome to make them easier to read. As can be seen this screen contained the navigation and instructional buttons, and access to a "Glossary of (Chemical) Terms".

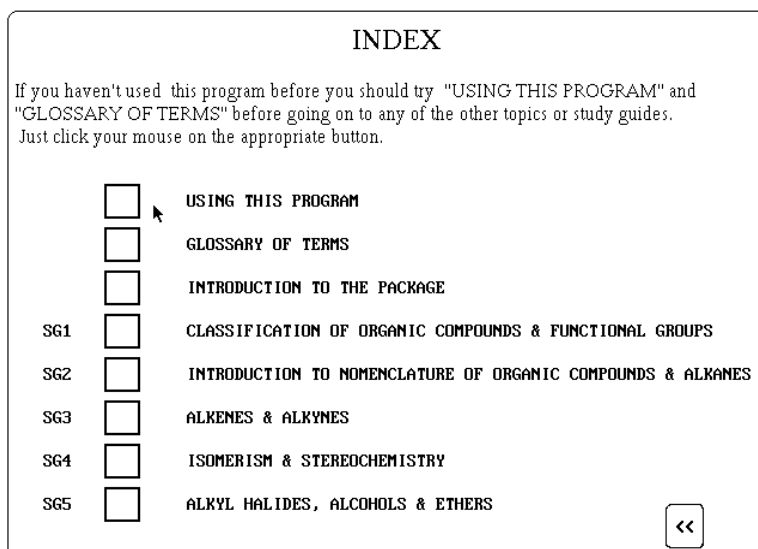


Figure 1: The main index to the computer program

Basic design criteria used in the learning program

The metaphor used throughout the learning program was that of a book, which was the framework with which the students were most familiar. Therefore, wherever possible scrolling screens were avoided, particularly in the study guides.

The learning materials were divided into several modules, each dealing with a specific set of topics. These modules were labelled as Study Guide 1: Classification; Study Guide 2: Nomenclature; etc, similar to the printed study guides traditionally used by the students.

At the beginning of each module there was a main menu from which the students could choose one of five pathways depending on where they were in their studies. The way in which these pathways relate to each other is shown in Figure 2.

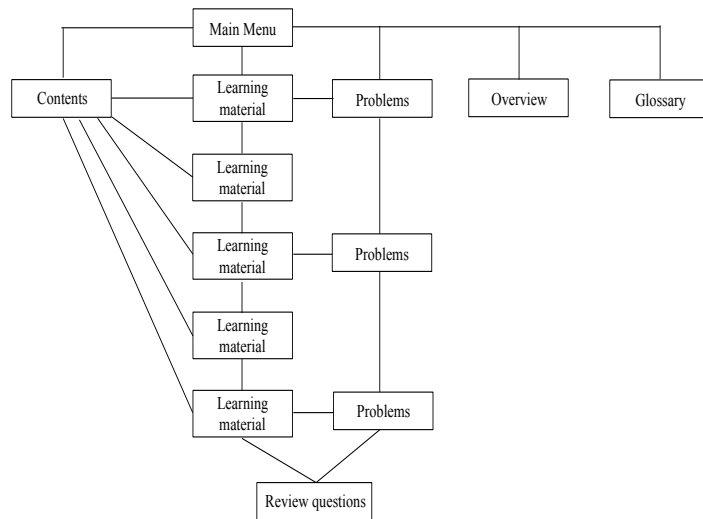


Figure 2: Navigation through a study guide

The “contents” screen was an index of the topics within the particular study guide. In many ways this should have been redundant in a hypertext computer program. It would normally be used when students needed to refer back in their learning material, which, in a CAL program like this, can be more easily done by providing a hypertext link between the problem and the specific revision topics. However it was included for several reasons:

- It was the usual way learners had learned to access revision material in printed form
- In case the designer had neglected to anticipate that a problem may occur and not put a direct link into the text
- In case the student wanted to revise only a select part of the content.

“Problems” was a direct access to all the exercises in the study guide. These exercises were integrated into the learning material and would normally be accessed from the learning materials. However a direct access from the main menu was provided so that the students could try the problems themselves without first viewing the content. This was in response to the students wanting to regularly “test” their knowledge.

The “overview” was a brief description of the content and “Glossary” is self evident.

Design of the individual study guides

The electronic study guides were each designed in a similar way. For the purposes of the study, the wording of the learning material was identical to that in the printed study guides for two reasons. First was to eliminate any variability due to different instructional material, since the aim was to examine the form of delivery and not the content. The second reason was to ensure that participants of the CAL study would not be disadvantaged should they decide to withdraw from the project and continue to study from their printed study guides.

From the learning material screens learners could access several study aids through a series of hypertext links. These links are shown diagrammatically in Figure 3 and their purposes are described below. It should be noted that not all screens contained all links.

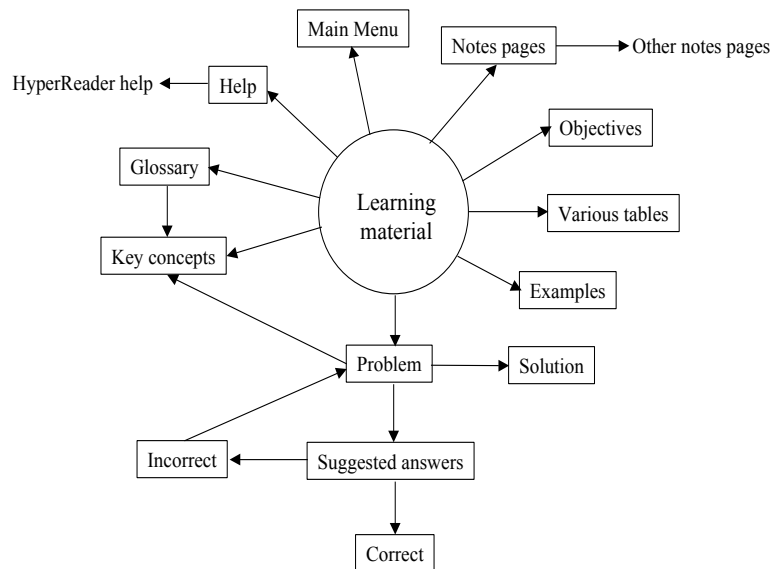


Figure 3: The possible hypertext links from a learning material screen

A hypertext link was formed for all terms contained in the glossary. This meant that the meanings of any of these key terms could be obtained by merely clicking the mouse on the word in the text.

More detailed information on some important concepts could be accessed in a similar way provided they had been defined somewhere in the study

guides. For instance, clicking on the words "molecular formula" took the student to a description of this key concept, which had been explained in detail elsewhere in the study guides. For instance, clicking on the words "molecular formula" took the student to a description of this key concept, which had been explained in detail elsewhere in the study guides.

Each screen had a series of buttons down the right hand side that activated hypertext links to information and features that may be useful to the students. These varied depending on the nature of the text but always included links labelled "Help", "Main Menu", "Notes" and "Ob" (Objectives). Other buttons that were used as appropriate were "Examples", "Problems", "PT" (Periodic Table) and various lists from the text (such as "FG" for Functional Groups). The functions of these will be described below. A typical screen from the learning material is shown in Figure 4.

As the number of carbon atoms in a chain increases, so too does the number of ways in which they can be arranged. Therefore, it is possible to form compounds which have the same chemical composition (i.e. the same numbers of atoms of each element) but with different arrangements or structures, and therefore different physical & chemical properties.

Such compounds are called isomers. All isomers have the same molecular formula but have different structural formulas.

All the compounds in the diagram below have the molecular formula C_5H_{12} (pentane) but different structural formulas. (The large green circles represent carbon atoms and the small blue ones hydrogen atoms).

Isomers of pentane

Help
Main Menu
Notes
Examples
Problems
Ob PT
<< >>

Figure 4: A typical screen from the learning material

An important feature of the program was the facility for students to make their own notes. Writing their own notes had been identified in the first study as an important part of the learning style of students (Lyall, 1998). In the CAL program the "Notes" button provided this by bringing up a pop-up screen as shown in Figure 5. The student could then type in any notes or comments and save them. The screen could be accessed (and modified) from the learning material as required.

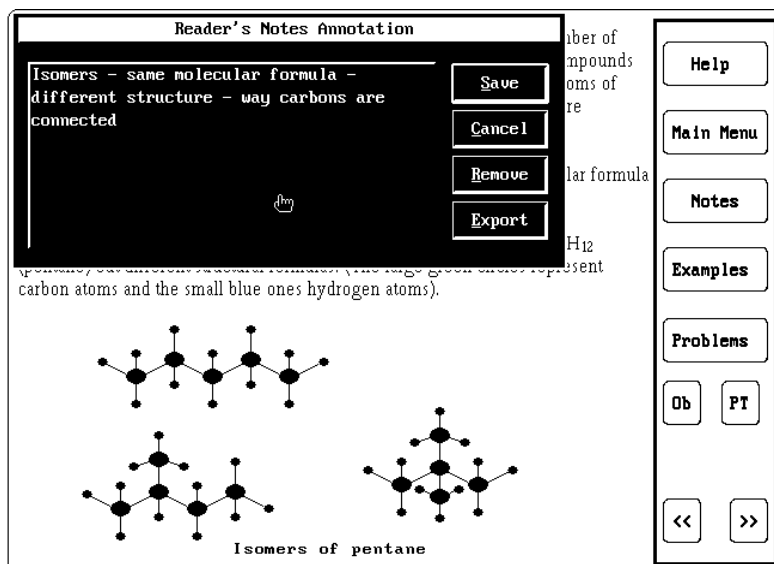


Figure 5: A typical "Notes" pop-up screen

The "Objectives" (Ob) button and, if included, the "Periodic Table" (PT, as in figure 5) and "Functional Group" (FG) button, also brought up a pop-up screen containing the appropriate information, to which the student could then refer. Also included throughout the learning materials were links to various tables and lists whenever it was considered that the students may need to refer to these while studying. For example, a table listing the meanings of the organic prefixes meth-, eth-, prop-, etc was provided on some of the screens explaining the rules for naming organic compounds.

The "Examples" button brought up a screen on which several examples, which demonstrated the content of the instructional text, were given. This was one of the few cases where a scrollable screen was used but it was designed so that each example fitted exactly on only one screen and they could be accessed one after the other by using the "PageDown" or "PageUp" keys on the computer keyboard.

For instance Figure 6 shows the first of three worked examples of how to name branched hydrocarbons by the IUPAC method.

We can apply the four rules of nomenclature to the following hydrocarbons.

E1.

$$\begin{array}{c}
 \text{CH}_3 \\
 | \\
 \text{CH}_3-\text{CH}-\text{CH}-\text{CH}_2-\text{CH}_3 \\
 | \\
 \text{CH}_2 \\
 | \\
 \text{CH}_3
 \end{array}
 \qquad
 \begin{array}{c}
 \text{CH}_3 \\
 | \\
 \overset{1}{\text{CH}_3}-\overset{2}{\text{CH}}-\overset{3}{\text{CH}}-\overset{4}{\text{CH}_2}-\overset{5}{\text{CH}_3} \\
 | \\
 \text{CH}_2 \\
 | \\
 \text{CH}_3
 \end{array}$$

This compound contains only carbon and hydrogen atoms joined by single bonds, therefore it is an alkane, and the longest chain contains 5 C's so it is a pentane.

The chain would be numbered from the end nearest a branch, which in this case is from the LH end.

There are two substituents, an ethyl group on C-3 and a methyl on C-2. The substituents are named in alphabetical order, so the ethyl comes before the methyl, regardless of their size or the numbers associated with them.

The correct name is 3-ethyl-2-methylpentane.

Page down for another example.

Help
Main Menu
Notes
To the SG

Figure 6: A typical "examples" screen

Correctly name the three di-substituted hydrocarbons below:

P1

$$\begin{array}{c}
 \text{CH}_3-\text{CH}_2-\text{CH}-\text{CH}_3 \\
 | \\
 \text{CH}_3-\text{CH}_2-\text{CH} \\
 | \\
 \text{CH}_2 \\
 | \\
 \text{CH}_3
 \end{array}
 \qquad
 \begin{array}{l}
 \text{ANSWER} \\
 \text{SOLUTION}
 \end{array}$$

P2

$$\begin{array}{c}
 \text{CH}_3 \\
 | \\
 \text{CH}_3-\text{CH}_2-\text{C}-\text{CH}_2-\text{CH}_3 \\
 | \\
 \text{CH}_3-\text{CH}_2-\text{CH}
 \end{array}
 \qquad
 \begin{array}{l}
 \text{ANSWER} \\
 \text{SOLUTION}
 \end{array}$$

P3

$$\begin{array}{c}
 \text{CH}_3-\text{CH}_2-\text{CH}-\text{CH}_2-\text{CH}_2-\text{CH}_3 \\
 | \\
 \text{CH}_3-\text{CH}-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_3
 \end{array}
 \qquad
 \begin{array}{l}
 \text{ANSWER} \\
 \text{SOLUTION}
 \end{array}$$

Help
Main Menu
Notes
Prev Prob
Next Prob
Alkanes
To the SG

Figure 7: The first screen of a typical "problems" sequence

It was pointed out by one of the students using the program that the use of the PageDown and PageUp keys was a fault in the design because it changed the navigation protocol from the mouse to the keyboard.

The "Problems" button took the student to a sequence of screens where a problem exercise was presented and the answers or worked solutions could be accessed as required.

The exact design of the screens and links varied depending on the nature of the exercise but a typical sequence (to name a hydrocarbon) is shown in Figure 7. As can be seen from this figure, students were required to solve the problem outside the computer, that is, using pen and paper or mentally. Once this was done they had the option of checking whether their answer was correct (which would be the usual pathway) or to go directly to the solution (for instance if they did not know how to begin solving the problem).

Assuming they would choose the expected pathway of checking whether their answer was right or wrong, they would activate the "ANSWER" link, but instead of the answer being given directly some alternative names were shown as in Figure 8. This gives students an opportunity to revising their answer if it did not correspond with any of those shown.

Correctly name the three di-substituted hydrocarbons below:

P1

$$\begin{array}{c} \text{CH}_3-\text{CH}_2-\text{CH}-\text{CH}_3 \\ | \\ \text{CH}_3-\text{CH}_2-\text{CH} \\ | \\ \text{CH}_2 \\ | \\ \text{CH}_3 \end{array}$$

P2

$$\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_3-\text{CH}_2-\text{C}-\text{CH}_2-\text{CH}_3 \\ | \\ \text{CH}_3-\text{CH}_2-\text{CH} \end{array}$$

P3

$$\begin{array}{c} \text{CH}_3-\text{CH}_2-\text{CH}-\text{CH}_2-\text{CH}_2-\text{CH}_3 \\ | \\ \text{CH}_3-\text{CH}-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_3 \end{array}$$

P1

Is the correct name

3-ethyl-4-methylhexane

or

4-methyl-3-ethylhexane

or

2-sec-butylpentane ?

Figure 8: The first screen in the "answer" sequence

They then selected the name which they thought was correct. If it was correct then a pop-up screen informing them of this was activated. If they were wrong another pop-up screen was activated telling them exactly what was wrong with that answer, as, for example, in Figure 9.

Correctly name the three di-substituted hydrocarbons below:

P1

$$\begin{array}{c} \text{CH}_3-\text{CH}_2-\text{CH}-\text{CH}_3 \\ | \\ \text{CH}_3-\text{CH}_2-\text{CH} \\ | \\ \text{CH}_2 \\ | \\ \text{CH}_3 \end{array}$$

P2

$$\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_3-\text{CH}_2-\text{C}-\text{CH}_2-\text{CH}_3 \\ | \\ \text{CH}_3-\text{CH}_2-\text{CH} \end{array}$$

P3

$$\begin{array}{c} \text{CH}_3-\text{CH}_2-\text{CH}-\text{CH}_2-\text{CH}_2-\text{CH}_3 \\ | \\ \text{CH}_3-\text{CH}-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_3 \end{array}$$

P1

No, you have found the longest chain and numbered it correctly but have listed the substituents in the wrong order.

They should be in alphabetical order.

Click the RIGHT mouse button to return.

Help

Main Menu

Notes

Prev Prob

Next Prob

Alkanes

To the SG

Figure 9: A typical pop-up screen when an incorrect answer was given

From here they could go directly to the learning material for revision or go back to the original screen as shown in Figure 7 and look at the worked solution by clicking on the word "SOLUTION". The format of the worked solution screen was similar to the Example screen in Figure 6.

At the end of the module there was a section with several more problems presented in a similar way to those in the study guide.

Methodology

To determine the students use of, and attitudes to, the program, disks containing the CAL program, instructions for installing the program and a logbook were sent to the participants by postal delivery at or near the beginning of the semester in which they were due to study the organic chemistry unit. The logbook consisted of a series of sheets with a few specific questions listed, particularly as to whether the users found the computer program a more (or less) effective way to study than the printed

material and what features (if any) of the program helped them to learn. The users were also encouraged to write down any thoughts or comments they may have as they used the CAL program.

Participants were then interviewed by telephone after they had returned the logbooks at the end of the semester. These interviews were used to ascertain the participant's opinions and to expand on the information from the logbooks.

At the end of the study participants were asked to return the disks after first copying the files they had used back over the original files. This was to review any Notes they may have added.

Results

The number of students who ultimately completed the computer study was low (commencement N=34, completion N=11), hence definitive results on the students' use and opinions of the CAL program could not be obtained. However there were a number of indicators which are worth noting, including the reasons for the participants withdrawing from the study.

Therefore interviews were conducted with all the students (as far as was possible) and the logbooks were examined for generalities and to discover whether there were any common features which could form the basis for future research studies.

The number of students from each group who volunteered and those who actually participated by using and returning the logbooks are shown in Table 1.

Table 1: Number of students participating in the computer study

Group	Volunteers for CAL program	Actual participants
1	9	3
2	11	3
3	14	5
Total	34	11

Most of the volunteers for the computer program had an expectation that the program may be of some benefit to them. This was indicated by

comments from several students when indicating their willingness to participate. Some typical comments were:

"If I could have access to a good program for studying chemistry then I would consider using it as my main study method"

"I would prefer to use a computer than printed material"

"I own a computer and would be eager to use it or any other technology that would assist me in studying chemistry".

From the table it can also be seen that nearly two-thirds (23) of the volunteers withdrew from the study without completing the logbook. Five students had withdrawn from the subject or could not be contacted. The others were interviewed, generally by telephone.

Some of their reasons for not continuing in the study were very interesting:

- There were a few who did not even attempt to install the program deciding that they could not risk trying a new learning method.
- Several (including a few who did participate fully) had problems in installing the program on their hard drives. In some cases this was due to the inexperience of the students in installing software and in others it was due to the setup of their computer. In most cases these problems could be quickly solved by telephone or by the students themselves (or their friends), if they were experienced users of computers. But for many of the inexperienced, and often isolated, students the fact that they could not immediately start using the computer program for studying was a strong disincentive and they returned to their more familiar study methods.
- Some volunteers successfully installed the program but after using it for a short time reverted to studying from the printed notes. In a few cases this was due to problems in the program. For instance, two volunteers reported that some of the screens would not properly scroll and another found that some of the graphics overlapped. These, and other, problems resulted in the students abandoning the use of the program without attempting to contact the author. This was invariably because they felt that they could not afford to spend time on trying to fix a problem with the program. For instance two typical comments were:

"Being a rather inexperienced computer user, initially I had a rather stressful time in getting the program going. I then went through the whole program quickly to see what it could do. Following this session I decided that since it was week four of the semester, I had to get going and went to the familiar study guides"

"I did not take part in your trial due to time constraints, although I did skim through the program a couple of times for revision. I also had trouble in setting up the program and if left to my own devices I would not have been able to do it".

- In most cases however the students decided that they just could not study properly from the computer. There appeared to be two major problems, that they found it difficult to learn directly from a computer screen and they found the note-taking facility difficult to use. Some typical comments were:

"I find I can't study straight from a screen I have to see it in print" (this was from a student who was an experienced user of computers and was skilled in computer programming),

"I felt that I needed to have all my books open around me rather than being just limited to one screen of information"

"I find it much easier to make notes from a book rather than from a screen"

"I didn't have much use for the Notes facility as I found it easier to write them"

"I felt a frustration that I couldn't write notes by hand on what I was reading on the screen".

Logbooks of those who completed in the study were examined individually to determine whether any common opinions on the computer program could be identified.

All eleven participants reported that they liked using the CAL program for studying. Two admitted they were a bit reticent at first but after they became familiar with the program found it easy to use. Most thought the use of colour made the program more interesting. On only a few occasions did they find it necessary to consult other (printed) material. Several thought that the CAL program improved their motivation.

One wrote "it is easier to concentrate on the work, harder to be distracted and easier to get back to work after an interruption" and another believed it was "fun to use" although he found he became sidetracked some times in the examples and glossary (looking at material not relevant to the task

at hand) but this was not a great hindrance. A third thought that the different format "made it a novelty and enthusiasm was increased" so it kept her more interested and motivated, which she believed helped her learn more.

Only three used the notes facility, some preferring to make written notes as they normally would and others reporting that they did not need to make notes, that they could learn directly from the program. One problem that may have made the notes facility less useful, and so less likely to be used, was that it did not support graphics, therefore structural formulas (important in organic chemistry) could not be drawn. Several students mentioned this as a problem. One participant used a word processing package, instead, to make his notes.

There were two features which, according to the participants, made studying easier and quicker from the CAL program. The first was the ability to access reference material without leaving the learning material. All used the glossary at some time and reported that they thought it helped their concentration since they did not lose their place in the learning material. Others liked the facility for accessing lists such as functional groups.

One believed that being able to look up the meanings of words instantly made for a deeper understanding of the content since she was less likely to go on not really knowing what a word really meant. Another believed it was a great help to have the information/references required "just a click away, instead of rifling through textbooks".

The other preferred facility was the way the examples and problems were presented. Nearly all participants commented on this facility and claimed that it encouraged them to do more problems which in turn helped their understanding of the material.

One wrote, "being able to go to the problems, check the answers and then return to the screen that you started from with a few mouse clicks, saves a lot of time and permits a more intensive, flowing session than is possible otherwise". Another used the examples as self-tests and believed this was very useful (gave him a better understanding) and a third found the solutions to be useful "to clear up minor technical points".

All of the participants thought that they learned better, or at least as well, from the CAL program than from the printed material and six believed that they learned the material faster from the CAL program than from the printed material. They attributed this to several factors:

- One believed that computer learning was superior to that from print because of the degree of interaction.
- Another believed that he learned much faster and the examples, particularly, saved a lot of time.
- A third felt that the CAL program provided the material in a more cohesive flow, which was beneficial to his understanding.
- A fourth felt that she understood the study guides on the computer program better than the printed study guides. But she was not convinced that this was due to the information “sinking in” better via the computer, it may also have been because the content in the computer study guide was easier or because she spent more time studying it.

When asked what improvements they would like to see in the program, the majority did not think there were any serious deficiencies apart from not being able to draw chemical structures in the notes screens. Some said that they would like even more exercises and three would have liked to be able to print out the problems (the program would allow the printing of text but not graphics). Other improvements suggested by individual students was automatic installation of the files (typing one command, usually *install*, loads all the files on the hard drive), more links to previous notes and more lists or summaries. The latter comment also applied to the printed notes.

By the time they had finished the study several of the participants had become very proficient at using the software menus for moving around the program, rather than the buttons built in by the author, and found that this was beneficial to them as they could access material in their own way.

Summary

The data supports the suggestion made initially that the students operated within a “zone of comfort” in which they had established a well defined and apparently successful way of studying, using the printed study guides provided by the university and printed textbooks. Any attempt to move the students out of this comfort zone will need to overcome their

reluctance to change. In particular, they will need to be convinced that there was some immediate benefit, measured by their learning outcomes, in adopting an alternative study method and also that they did not have to go through a period of re-learning how to study.

As shown by the original interest in the CAL program many of the students were, at first, eager to use it. The prime motive for these students appeared to be the expectation that CAL would provide them with a more efficient way of studying. That is, they could learn more in a shorter time. If this expectation was not met, or if there appeared to be a chance that it may not be met, then the students were reluctant to use, or even try out, the program.

This can be seen in the notion that, for the great majority, the slightest problem resulted in them abandoning the CAL program and returning to their more familiar, and proven, study methods. The main reason for this was that they were reluctant to move outside their comfort zone and take a risk that an alternative study method may be better. The fear was that, if it wasn't, then they would have wasted their precious time, which may result in their failing the subject. In particular the students felt that did not have time to "learn how to learn" from the program and that they did not have time to learn how to *use* the program.

On the other hand, those students who persevered with the CAL program believed that it provided a more efficient method of study than printed material and was more motivating.

It would appear from these admittedly few results, that a CAL program may ultimately be an alternative way of learning which could benefit some students, that is, those whose learning profiles were compatible with the program. The main problem will probably be in introducing it to these students.

Implications of the findings from the study

Some suggestions can be made. First, the computer program must be free of faults and easy to install. Although this would seem to be applicable to all computer (and other) programs it is particularly so in the case of the distance student. The participants would not tolerate any problems in the running of the CAL program. This did not apply to mistakes in the text since all students were reasonably tolerant of typographical errors in their learning materials, but applied to anything which made the program difficult to use.

Second, the program should, in the first instance, follow the metaphor that adult students are used to. That is, sequential learning as in a book, page by page. In this way adult students can utilise their already established learning strategies and are more likely, once they are comfortable with the computer, to make further use of its capabilities. However as the new generation of learners becomes more familiar with CAL then this is a restriction which may well not apply.

Perhaps even more importantly, to make the CAL program more acceptable, it should be offered as an alternative to, rather than a substitute for, printed notes so that the student can revert to more familiar ways of learning if he or she considers it necessary. It is likely that many distance education students will, at first, use the program as a support to their traditional printed material. For instance, one of the perceived advantages of the CAL program over print was in the presentation of problems and exercises. Once the students can see an advantage such as this in using the program then they will be more likely to use it as their main learning material.

The suggestions made are based on a very small population. However they do provide some indicators for those beginning to consider the use of CAL in their distance learning programs.

References

- Biggs, J. B. (1993). What do inventories of student's learning processes really measure? A theoretical review and clarification. *British Journal of Educational Psychology*, 63, 3-19.
- Bryant, A. (1998). Re-engineering higher education: Reconciling profitability with the common good. In C. McBeath, C. McLoughlin and R. Atkinson (eds), *Planning for Progress, Partnership and Profit*. Proceedings EdTech'98. Perth: Australian Society for Educational Technology.
<http://cleo.murdoch.edu.au/aset/confs/edtech98/pubs/articles/abcd/bryant.html>
- Burden, F. R. (1993). Computer aided instruction: Authoring tools for chemistry teaching. *Chemistry in Australia*, February, 72-3.
- Calverley, G., Fincham, D. & Bacon, D. (1998). Modernisation of a traditional Physics course. *Computers & Education*, 31(2), 151-169.
- Connell, C. (1996). The Northern Arizona University paradigm for distance learning where student interaction is paramount. *Education*, 117(2), 162-6.
- De V Steyn, M. M., Alexander, P. M. & Rohm, D. (1996). CAL for first year analytical chemistry by distance education. *Computers and Education*, 27(2), 95-101.

- Eddy, J., Burnett, J., Spaulding, D. & Murphy, S. (1997). Technology assisted education. *Education*, 117(3), 478-80.
- Entwistle, N. & Tait, H. (1990). Approaches to learning, evaluation of teaching and preferences for contrasting academic environments. *Higher Education*, 19, 169-94.
- Gooley, A., Towers, S. & Dekkers, J. (1994). CD-ROM for education and training in rural and remote areas. In T. Evans & D. Murphy (Eds), *Research in Distance Education*, 4, 127-36. Geelong: Deakin University Press.
- Gregory, J. R. & Stewart, M. F. (1997). Production of a multimedia CAL package in basic physics. *Physics Education*, 32(5), 332-339.
- Gubernick, L. & Eberling, A. (1997). I got my degree through e-mail. *Forbes*, 159(12), 84-9.
- Hore, T. (1993). Learning theories in practice. *Higher Education Research and Development*, 12(1), 1-3.
- Lyall, R. (1998). *The interactive technologies in distance education chemistry*. Monash University: PhD thesis.
- McNamara, S. & Strain, J. (1997). All you need is...? Assumptions and realities in building multi-media learning environments and resources. *Proceedings ASCILITE'97*, Perth: Curtin University of Technology. [verified 12 Jul 2000] <http://www.ascilite.org.au/conferences/perth97/papers/Mcnamara/Mcnamara.html>
- Monash University (1997). *Leading the Way: The Monash Plan 1998-2002*. Melbourne: Monash University. <http://www.monash.edu.au/monashplan/> [verified 12 Jul 2000]
- Volet, S. E. (1991). Modelling and coaching of relevant metacognitive strategies for enhancing university students' learning. *Learning and Instruction*, 1, 309-336.

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