UniServe
AUSTRALIA

Putting you in the Picture

Proceedings of Workshop

July 15-16, 1997

The University of Newcastle

UniServe Australia was set up by the Committee for the Advancement of University Teaching (CAUT) in 1994. The Committee established a nationwide network of clearinghouses (modelled on the Computers in Teaching Initiative [CTI] project in Britain) for the collection and dissemination of teaching materials throughout the whole Australian university system. The members of the network are:

- Engineering at the University of Wollongong;
- Science at The University of Sydney;
- Health at the University of Newcastle;
- Law at the Australian National University;
- Humanities & Social Sciences at the Royal Melbourne Institute of Technology; and the
- Coordinating Centre at the Australian National University.

The role of the **Coordinating Centre** is to:

- support and promote the activities of the clearinghouses;
- develop and coordinate standards for the clearinghouses;
- disseminate information about professional development and innovation in university teaching;
- maintain information about the clearinghouse network;
- publish teaching and research materials not covered by the discipline specific clearinghouses; and
- organise workshops and seminars on integrating networked information into teaching.

UniServe Science aims to enhance the quality of university science teaching in Australia by collecting, maintaining and disseminating information on up-to-date and innovative teaching materials. UniServe Science publishes regular newsletters which include product reviews and articles on developments related to teaching and learning materials in the earth, life and physical sciences. A database of software packages used in teaching ismaintained and is accessible via the UniServe Science web site. Along with software details, the database includes UniServe Science solicited product reviews, usually done by Australian academics. Other activities include: the maintenance of electronic mailing lists for each of the seven disciplines covered; conducting workshops for teaching development; producing software guides and maintaining Australian mirrors for frequently downloaded overseas software.

UniServe Health aims to enrich undergraduate education in the fields of medicine, nursing and allied health professions by assisting teachers and students to identify, access and use appropriate high quality educational materials, particularly those in electronic format. Its main activities include: identifying and accessing educational materials available in electronic format, both nationally and internationally; and evaluating these materials on criteria which include user friendliness, interactivity and educational value. This information is disseminated via the UniServe Health web pages and regular newsletters.

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Summary

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Background

The planning for this workshop began over coffee during the National Teaching Workshop held at UTS in July 1996, following a presentation in which the visual aids were all but unreadable. A group of UniServe staff from the UniServe Coordinating Centre, UniServe Science and UniServe Health discussed holding a workshop on how to handle images and this grew into how to use computer packages to archive and present images.

After several planning meetings, UniServe Health volunteered to be the host organisation led by Wendy Swinkels, and the Coordinating Centre managed the program development, advertising and the financial side. Cathy Clegg and particularly Aileen McCulloch from the UniServe Coordinating Centre put in considerable effort behind the scenes to make things happen. We decided to make the program a single strand rather than having parallel sessions so that we could adopt the strategy of demonstrating the sorts of activities using images used across a wide range of disciplines. The aim was to show what could be done without necessarily getting to grips with the details of how to do it.

Outcomes of the Workshop

We were approached very early on by Dr Ric Lowe with an offer to give a keynote address on his work on teaching with images and this led us to develop a more formal theme on pedagogical issues, to make us more aware about what we were attempting to teach. We sought to complement this with specific examples from a range of disciplines, and to devote some time to practical exercises with some of the IT tools available. It turned out that many of the participants had tried or used PowerPoint on some previous occasion, but there was a great interest in developing skills in PhotoShop which is an inherently more difficult program to master. Participants recognised the power of PhotoShop to improve their use of images in teaching, even if some were overwhelmed by its complexity.

Conclusions from the Workshop

I believe we provided a more theoretical discussion than participants were looking for, and did not provide enough unstructured time for people to try out some of the techniques they encountered. A more integrated program of methods might have been better, but I enjoyed the range and diversity of the practical examples given by the later keynote speakers.

Teaching and the New Technology: A Pedagogical Viewpoint

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In case you missed it, we entered the information age officially in 1991 — the year corporate spending on IT exceeded that of spending on manufacturing technology. In the area of higher education, however, you would hardly know it. The technology supporting teaching is still largely pre-Gutenberg.

Teaching, especially in large first year classes, is still conducted overwhelmingly by students sitting in lecture theatres transcribing notes while they listen to a one-way monologue from the front. Their role, it seems, is to copy down as much as they can, memorise as much as they can and hope that they can recall about half of it accurately a few weeks later in an exam. This is not to suggest that all higher education is conducted in this way, but it is still the way most of our students are expected to learn.

It is not that faculty are strangers to IT. In the mid 1980s we saw the first wave of the IT revolution in the form of microcomputers. Before long we were word processing our manuscripts, producing fancy overheads on our desktop machines and introducing multimedia programs as interesting add-ons to the standard laboratory class. However, most faculty kept teaching in much the same way as before.

Now, in the mid 1990s, we are experiencing the second phase of the IT revolution with a shift of emphasis to the desktop computer as a communication tool and a way of accessing a vast array of data, images and text. It is hard to believe the WWW is only a few years old and its growth in that time has left even the most hardened technophiles bewildered. From the comfort of my home I can now search a library catalogue in New York, check the latest pictures being downloaded from Mars, read this weeks research news in *Nature* and send some data to a colleague in the UK.

All of this must have major implications for how we teach, what we will expect students to do, and indeed how we define learning itself. Yet, till now, the way higher education has been practiced has remained remarkably impervious to technological change and is still defined by classroom hours of instruction. What is not clear, however, is how we should use the new technologies in teaching. That question is currently exercising the minds of academics all over the world. Two strong themes appear to be emerging.

The first is concerned with improving the efficiency of, or access to, higher education. It is hoped that IT will enable the delivery of education to a wider more diverse student population, allowing students to decrease the time they take to complete their courses or allow the same number of students to be taught with fewer resources.

The second theme is concerned with teaching and learning with the hope that IT will allow students to engage more actively, more collaboratively and more meaningfully with the curriculum and achieve enhanced learning outcomes.

These are not alternative or mutually contradictory pathways, but given the pressures to achieve the first goal we must ensure that the second goal is not compromised. In order to ensure this we need to have in place a satisfactory model of student learning and this is what I would like to talk about here. I want to argue that one of the reasons IT has failed to make a major impact on university teaching and learning is that it is being used to perpetuate and potentially entrench an inappropriate model of student learning and that in order to reap the enormous benefits of the new technologies we have to change the way teaching and learning takes place in universities.

Most academic staff in universities have not explicitly developed and articulated a personal view as to how students learn and how they as teachers might best facilitate this learning and in this sense university teaching is remarkably unprofessional. Much of the teaching that goes on in universities is conducted on the basis of what we might call folk pedagogy, that is a set of tacit beliefs that are rarely examined or discussed. I believe that much of the folk pedagogy prevalent in higher education is not in accord with how we know that people learn.

A great deal of the teaching that takes place in universities can be thought of as broadcast teaching, that is, it is conducted by telling people things on the assumption that if somebody hears a new idea then that idea will replace any pre-existing idea. The problem is that learning does not happen this way. What we hear or see is interpreted by our existing ideas and those ideas are very resistant to change.

One of the striking features of the science education literature is how hard it is to get people to change the way they view the world, which is presumably what most of us think higher education is all about. At the same time it is clear that students are able to pass and even do very well in conventional university courses without ever achieving a real understanding of what they have been studying. The research on science education is quite clear about the ineffectiveness of traditional didactic teaching in either changing the way people think or developing in students their ability to analyse, synthesise and evaluate information.

Let us look at some principles that underlie what we understand as how people learn as a first step in examining the implications of IT for teaching.

1. Learning is not necessarily an outcome of teaching.
2. Learning involves the construction of meaning from experiences.
3. The construction of meaning is influenced to a large extent by the learner's pre-existing knowledge, experiences and beliefs.
4. Knowledge construction involves relating new information to prior knowledge in order to build new more elaborate knowledge structures.
5. The meanings constructed by the learner may not be those intended by the instructor.
6. The construction of meaning is negotiated socially.

Most university teaching is conducted according to an entirely different set of principles which embody the notion that learning can take place by ideas being transferred directly from one individual to another and learners play an essentially passive role in the process.

Failure to embody these principles in teaching can result in students being forced into taking what is called a surface approach to their learning where they simply focus on memorising the information as given without attempting to understand it. A great deal of research has shown that many university students do indeed adopt a surface approach to their learning and much of what they memorise is quickly forgotten even though they might retain enough to pass a test.

We now know a great deal about the conditions under which students will engage in meaningful learning. People learn when:

1. they are motivated to ask questions that they perceive are of value and relevant to their goals;
2. new information is presented in the context of the questions they are asking;

3. knowledge is constructed while they engage in authentic tasks;
4. their learning acknowledges, builds on and extends what they already know;
5. specifics precede generalisations;
6. they have opportunities to discuss, explain, write and reflect on the new ideas they are learning;
7. they have some control over what they are learning;
8. they are practicing rather than studying;
9. they are allowed to fail in their initial attempts at learning something new;
10. they receive frequent feedback on their learning; and
11. they are able to self-assess the extent to which they are achieving their goals.

This type of learning is very different from the way in which most students learn in our universities and the exciting thing about IT is that it is potentially able to support this type of learning in a way that the traditional lecture format is not. We can think of it as a change from a teacher centred model of instruction to a learner centred one.

So in what ways can IT be used in this transformation? Robert Kozma and Jerome Johnston (*Change* January/February 1991) suggest seven ways:

From reception to engagement — The traditional model of learning in higher education has involved students taking a passive role, listening to a one way flow of information from the lecturer. IT can facilitate students actively seeking information and constructing knowledge.

From the classroom to the real world — IT, through the Internet, can allow for bridges to be built from the classroom to the world outside.

From text to multiple representation — Traditional teaching in higher education has been dominated by text. IT potentially allows for other forms of symbolic representation, in particular visual representation, which will be more suited to the learning styles of many students.

From coverage to mastery — One of the things computers do best is to allow students immediate feedback and multiple opportunities to learn procedures.

From isolation to interconnection — IT potentially facilitates greater collaboration among learners — an essential feature of learning.

From products to process — IT allows students to actively search for and manipulate information rather than being presented with packages of pre-processed information typical of textbooks.

From mechanics to understanding in the laboratory — IT has enormous potential in enriching laboratory experiences, allowing students to explore alternative hypotheses.

IT in teaching is not new, of course, and many people have been supporting their teaching with multimedia programs. My criticism with the way IT is used in teaching is that it is often too over-prescriptive and in a sense attempts to do the thinking for students. Computers are being used as the machine analogues of the traditional teacher centred model of instruction.

If we are to achieve learner centred instruction with IT, planning, decision-making and self-regulation should remain firmly in the hand of the learner. What we should do is use computers for what they are very good at:

- providing access to vast amounts of information — text, sound, images which students can explore;
- providing tools to learners for them to organise and analyse their knowledge and construct representations of it through text and images; and
- providing a means of communication.

The exciting thing about using computers in this way is that it forces us to think about those things that computers do best, like store information, and those things, like analysis, evaluation and synthesis which are uniquely human.

What IT can do is to provide powerful tools to facilitate learning rather than doing the thinking for students. The criteria for the appropriate use of IT should be that it promotes discussion, reflection and problem solving and that users have a large degree of control over the activities and options. By allowing students to construct and represent their own developing knowledge computers can empower learners to assume ownership of their own knowledge rather than simply reproducing the teachers'.

Using IT in this way could facilitate a shift in thinking to lifelong learning as an outcome of an undergraduate education. Of the different dimensions of higher education:

- mastery of a body of knowledge
- critical thinking ability
- communication skills
- ability to find information
- ability to interact with others

current undergraduate education emphasises the mastery of a body of knowledge above all others. Yet, ironically, this probably rates lower than any of the other factors in determining subsequent success in life and the work force.

Our challenge is to think of ways to exploit the incredible potential of the new technologies in order to allow learners to build meaningful personal interpretations of the world.

How should we proceed? One way is to recognise the three contexts within which IT can be used in learning:

- face-to-face teaching — lectures, tutorials, laboratories;
- telecommunication — phone, email, video link; and
- independent study.

For each of these settings we should ask not what do we want students to know but what do we want our students to be doing — what activities do we want them to be engaged in? Only then can we ask ourselves how IT can facilitate these activities.

What is certain is that if we are to achieve the benefits of the new technologies we will have to rethink how we structure teaching and learning.

First, the very concepts of having students spending a high proportion of their class time doing nothing more than transcribing notes is clearly an inappropriate use of their time and resources and yours. Different models of teaching, such as the successful workshop and studio models of science teaching, need to be explored.

Second, access to intellectual resources via the Internet means that we have to rethink the very goals of the undergraduate experience and what learning outcomes we should be trying to achieve. Our graduates now need to know how to find information, manipulate data, draw independent conclusions and communicate findings. There needs to be a greater emphasis on problem solving and design making skills.

Third, and as a direct consequence of this, we will have to find new ways of assessing student learning that involve knowledge construction rather than simple recall. If we continue to assess and reward memorisation and recall of information supplied by the instructor then we might as well continue with the traditional didactic lecture.

Seeing computers as tools for thinking and communication raises the interesting question of whether human thinking should be judged in isolation. Assessing learning in the absence of our books and computers could be considered a bit like assessing a pianist without a piano. The fact that this idea might strike us as strange is probably a reflection of the extent to which our assessment in higher education is focussed on factual recall — the lowest level of cognitive function.

I believe that universities will have to change and adapt to the changing technologies in the way that business has. If we do not, then other non-traditional providers will move in and we have seen the beginning of that already where universities' traditional monopoly in credentialising students is being threatened. Widespread access to information will make us rethink the role of universities as guardians and gatekeepers of access to knowledge and learned communities.

What is becoming clear is that in order to realise the benefits of the new developments in IT universities will have to change in ways that we have yet to fully explore.

At a time when resources in our universities are so stretched the pressure to look at some of these technologies as ways of improving productivity seems almost overwhelming. At a minimum I hope that we will at least maintain levels of student learning in the face of greatly reduced funding. However, the speed of change is so great and the costs, and hence the associated risk, so high that I think we must be very cautious how we introduce IT to ensure we do not entrench current, and I believe, inappropriate teaching practices.

Teaching and the New Technology: Managing the Transition

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It looks as though the future will be more public, more private, and more technology.
Roderick West, Campus Review July 2-8 1997, p.3

Introduction

Within every university we are witnessing a ground swell of interest in applying 'new' technology to teaching. By 'new' technology I am referring to the linking of the power of a PC with networks to achieve new ways to apply technology. Most universities now have staff using technology in their teaching, whether through a successful teaching grant application or simply through their own initiatives. They may be giving PowerPoint presentations or using video clips in lectures, placing their lecture notes on the web or generating student discussion through email listservs. This conference will assist you, as participants, to find and incorporate graphical images in your teaching using technology and undoubtedly you have been attracted here because you believe it is time for you to enhance your use of technology in your teaching. But several questions must be answered before you can successfully take the ideas from this conference and apply them in your teaching.

- How will you find the resources to do this? the time? the money?
- What facilities will you need access to? equipment? software? information? professional help?
- What facilities will your students need access to?
- What skills do you need? Do your students need?

And before successfully applying these ideas some more fundamental questions must be answered.

- How will your students benefit from this?
- How will you benefit from this?
- How will the University benefit from this?

Broad-based integration of new technologies into university teaching is inevitable. This paper explores the reasons why this is so by examining the changing context and new paradigms for higher education, the potential of the new technologies and the subsequent shifts and tensions within the higher education sector. It closes by explaining that successful integration of new technologies into teaching and learning cannot be done in isolation from the University's broader planning, policy and budget processes.

The Environment: Changing Context and New Paradigms

The characteristics of the environment in which higher education institutions must now operate may be summarised as follows.

- Australian universities now operate in a global knowledge economy[1].

[1] IDP believes Australia can expect to attract 5% of the world's international students by the year 2000 and 7.5% by the year 2010 which would make them 26% of our student population. Between 1996 and 1997 we saw a 17% increase in our numbers of international students. (Yetton, 1997, p.32)

- Government funding and government regulation is reducing[2].
- There is an increasing emphasis on learning rather than teaching and recognition of students as customers.
- Universities must acknowledge the pervasiveness of information and communication technologies and view information technology as a strategic resource and market differentiator.
- Universities must plan and seek continuous improvement.

Within such an environment we are seeing the emergence of a new paradigm for higher education. The table below[3] shows the two boundaries of this paradigm shift though it should be acknowledged that in many senses this is a continuum.

Old Paradigm	**New Paradigm**
University as a city	University as an idea
Terminal degree	Lifelong learning
Student as a 'pain'	Student as a customer
Delivery in classroom during semester	Delivery anywhere and anytime
Government funded	Market funded
Competition is other universities	Competition is everyone
Technology as a cost	Technology as a differentiator

The Potential of New Technologies

'New' technologies are those technologies that are now possible through the advent of cheaper and more powerful personal computers and the spread of networking — desktop video conferencing, networked audio, video and graphics applications, computer mediated communication, and the Web. The development of these new technologies provides the potential for technology to be applied to teaching and learning in new ways which enhance the quality of learning rather than simply providing an alternate method for teaching. The technologies provide opportunities for innovation which go well beyond the automation of existing teaching processes. Technology can be used to 're-invent' the learning process, to enhance learning in ways which were not before possible rather than simply automating the existing teaching paradigm. For example rather than replicating lecture notes on the Web or providing a video tape of a lecture an academic can create a rich resource-based learning environment, linking in other information sources, integrating video, graphics and sound. They can also provide problem-based learning opportunities through simulations, interactive activities, discussion forums and group work.

The learning potential which can be achieved through effective use of new technology may be summarised as follows:

2 Watts, 1996 noted that between 1981 and 1993 government grants to universities in Australia went from 90% to 60% of their total income.

3 Adapted from Exploiting information technology in higher education, 1996, p.10

- it enables self paced learning and the potential to increase learning productivity;
- it enables interaction, discussion and collaborative learning;
- it empowers students to have greater control of their learning;
- it provides solutions for learners with disabilities; and
- it provides access to large amounts of information.

The new technologies also have the potential to provide solutions to meet the challenges of the global knowledge economy and reduced government funding by:

- opening up new markets;
- easing pressures on time and space;
- enhancing academic productivity; and
- providing economies of scale and mass customisation.

These two areas of potential can be integrated as there is no simple relationship between cost and value to a student (Open University, 1996, p.5). It is possible to create effective learning experiences of value to a student whilst minimising cost. To give an indicator of the potential savings from more flexible delivery of teaching and learning the Open University currently graduates a student at less than half the cost of a regular UK university (Rumble in Lockwood, 1997). Moran (in Lockwood, 1997) concisely sums up the challenge for universities:

The question is becoming, not whether flexible learning can enhance the cost effectiveness of traditional teaching (important though that question is), but whether a university will survive and prosper in the next century without rapidly integrating the various dimensions of flexible learning into its process, culture and value.

Shifts and tensions

The environment in which universities operate and the paradigm shifts which are required are causing many tensions and shifts as each university grapples with the challenges ahead. Course design and delivery has traditionally been a serial process largely controlled by an individual academic. Now if we require the development of media to support a subject or course we require different sets of skills, a project management approach to subject/course development and a different budget framework. Previously curriculum development was largely a hidden cost (Laurillard, 1996) which now will need to be explicitly recognised. We are seeing tensions not only within universities but between them as they seek to determine a balance between collaboration and competition. The shifts and tensions which must be managed may be summarised as follows:

• knowledge driven	• customer driven
• collaboration	• competition
• quality	• economies of scale
• autonomous academic process	• planned production process
• academic as 'sage on the stage'	• academic as 'guide on the side'
• academic freedom	• rise of the 'para-academic'
• educational culture	• corporate university model
• delivery costs	• development costs

Critical Success Factors for integrating new technologies into teaching

The limitation will be the time it takes universities and staff to develop the skills needed to effectively exploit the medium, and how universities handle the associated cultural change. Those that have effective staff development and technology diffusion policies and structures in place, and who view *information technology as a strategic tool in attracting new students, will be at the forefront.* (Boalch, 1996 in Yetton, 1997, p.49)

There are a number of factors which will determine the success of integration of new technologies into teaching. These include:

- the university's planning and policy framework;
- the strategies in place;
- the quality and extent of infrastructure; and
- the culture within the university.

Planning and policy framework

Yetton (1997, p.9), in examining the management of technology in Australian higher education, points out the different approaches taken by economists and strategists: the economist's view of market outcomes assumes all firms are similar and success is dependant upon the bottom line whereas the strategists argue that organisations are successful because they are unique and differentiate themselves from their competitors. Given that universities exist for greater aims than 'the bottom line' we must therefore think how we will be successful through differentiation. How will we be unique and what will differentiate us from our competitors? What does this mean for our approach to integration of technology into our teaching? The University of Wollongong (Yetton, 1997, p.24-25), for example, plans to grow its fee-paying post graduate students to 23% of their EFTSU by 2000 with delivery via distance through PAGE, SBS TV or Wollongong Online.

For true success each university should have a commitment to the level of application of new technologies in teaching with agreed shared plans and goals and appropriate policies at an institutional level. For example the university must have:

- course planning, development and approval processes which allow for flexibility and responsiveness;
- university-wide plans to develop the required infrastructure;
- teaching release and promotion policies which recognise the importance of academic involvement in the development of subjects and courses using new technologies. Most current university promotion policies don't recognise teamwork, a necessary prerequisite for effective use of technology in teaching, nor do they reward academics for advanced curriculum design or effective use of technology in teaching;
- appropriate copyright and intellectual property policies and procedures in place which protect both the university and the creator of the materials; and
- a sustainable budget model which recognises the change in cost structures necessary to facilitate effective use of technology in teaching.

Edith Cowan (Yetton, 1997, p.31), for example, has moved to resource based learning and flexible delivery and to achieve this shift has changed the University's policies regarding resource allocation and course validation and review.

Strategies

A university's overall strategic plans and policies are one very important element in the extent to which technology can be successfully integrated into teaching. But underpinning this must be appropriate strategies to achieve a successful outcome. To effectively integrate new technologies into teaching may require skills and knowledge in knowledge presentation, instructional design, technical knowledge, project management skills, resource design and production skills, systems analysis, programming, graphics, sound and video skills.

Academic staff cannot be experts in all areas required and Tinkler, Lepani and Mitchell (in NBEET report on education and technology convergence, 1996) suggest the need for the emergence of 'co-professionals' (other authors have referred to 'para-academics' (Fowell and Levy, 1995)) and to break down the barriers between academics and professional staff. Collaborative partnerships with instructional designers, information professionals, web designers and IT professionals will be critical to success.

The staff and students must have the necessary awareness and skills required to use the new technologies through appropriate training and development. The university as a whole must be aware of the potential of the technology and be able to learn from its successes and failures through quality assurance mechanisms. Denise Bradley, Vice-Chancellor at the University of South Australia, (Yetton, 1997, p.67) believes the development of curriculum materials for distance-mode delivery is a powerful form of staff development for academics as it changes their focus from a transmission model of teaching to a learning model — instead of thinking of delivering content they must think about what type of learning they expect their students to gain from the material.

Infrastructure

To successfully integrate technology into teaching there must be an appropriate infrastructure in place. The technical infrastructure, both internal and external to the university, must be adequate. There must be sufficient network capability and network access to deliver media using networks. For example standard phone line connections to the campus are not yet multimedia 'friendly' in that the slow speed of the line works against use of high bandwidth applications. Nor can it necessarily be assumed that the student has a suitably configured PC. Such considerations must be taken into account before developing materials which cannot then be accessed. There must also be appropriate technology available in the classrooms to present material. The software systems available must meet academics' needs.

The student administration processes and systems must have the required flexibility to cope with more flexible delivery of programs and there must be the necessary human infrastructure in place for the required administrative support.

Culture

However, it is apparent that, in the global environment described above with increasing accountability, market competition, changing roles and a more corporate strategic approach to the provision of higher education, a shared or negotiated vision of the enterprise is essential at all levels of the organisation. (Hughes in Yetton, 1997, p.73)

The university must have a shared vision of where it is going and how it plans to differentiate itself from its competitors. Hesketh (in Yetton, 1997, p.38) suggests that the scale is such that the cultural change required within universities to move to IT-mediated learning will take a minimum of three to five years to embed. Working against such a cultural change is the academic perception of corporate planning and policy as anathema and the resistance to any change which appears to control or interfere with scholarly autonomy. Changing a university's culture to support innovation in teaching and learning through the application of new technologies is perhaps the greatest challenge of all.

Conclusion

Integration of new technologies into teaching is inevitable. It will be driven by a number of factors including:

- a genuine desire on the part of academics to improve the quality of student learning;
- attempts by universities to expand their markets and achieve savings; and
- the need to be competitive in the marketplace and meet 'customer' needs for flexibility.

Within such an environment universities must seek to successfully integrate technology into their teaching and learning. This cannot be done in isolation by individual academics. Whilst such 'trail-blazers' can play a key role in demonstrating what is possible true success lies in the development of an appropriate university-wide planning, policy and strategies to make it happen and the development of a culture which supports innovation.

References

Australian Vice-Chancellors' Committee. Exploiting Information Technology in Higher Education: an Issues paper. AVCC, October 1996. http://www.avcc.edu.au/avcc/pubs/eithe.htm

Fowell, S. & Levy, P. Developing a new professional practice: a model for networked learner support in higher education, *Journal of documentation* 51(3), September 1995, pp.271-280

Laurillard, D. & Margetson, D. Introducing a Flexible Learning Methodology: Discussion Paper. Occasional Paper (Griffith Institute of Higher Education) no. 7, 1996

Lockwood, F. An overview of flexible learning: International scene and current trends. A paper presented at Southern Cross University, 1997 http://www.scu.edu.au/services/tl/lockwood.html

NBEET report on education and technology convergence, 1996

Open University Senate. Technology Strategy for Academic Advantage: Discussion paper. Office for Technology Development, March 1996

Watts, R. The 21st century university. Talk presented to the Higher Education Round Table 22nd October 1996

Yetton, P & Assoc. *Managing the introduction of technology in the delivery and administration of higher education*, Canberra: DEETYA, 1997

Video in the Classroom: Problems and Promises

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Introduction

We are repeatedly reminded how important the new media technologies are in our discipline of teaching. Those who are computer literate have embraced these possibilities but for many others, the hype has become hollow and the promises invite scepticism. In the demanding, unforgiving environment of the classroom, we too often discover that:

i) many "multimedia" products are aesthetically and pedagogically unattractive, and their intellectual content small;
ii) the promise of interactive multimedia has been vastly oversold — hurriedly marketed products do not meet our expectations;
iii) many products are **not** interactive, but merely use CD-ROM technology for clever (and useful) cross-referencing;
iv) there are too many platforms which often do not work with too many software products;
v) the technology is often unreliable, as, for example, when computers crash — this is an unacceptable problem particularly with large classes; and
vi) the hardware is not as portable and convenient as, say, a text book.

As a result, teachers are now demanding from these new technologies:

i) quality;
ii) stability and reliability of software and hardware; and
iii) simplicity of set-up and operation.

My discussion specifically concerns the reproduction of live, dynamic events in the classroom. Showing dynamic images of processes, particularly those in biology, is often essential if students (and indeed, teachers) are to gain deep understanding of dynamic events. To illustrate this point, imagine how difficult it is to describe to another person what a sport like football might entail, using only static images such as photographs and diagrams. Image manipulation has also become extraordinarily evocative and useful: consider for example, how educated we have become about the weather because of time-lapse images that show the dynamics of the atmosphere.

The technologies currently available confront both the producer and user of dynamic images with difficult choices and unresolved issues. In particular, the storing and reproduction of dynamic images within multimedia productions often provide vivid illustrations of the problems listed above.

Essence of the Problems

We live in an analog world and our senses, particularly vision and hearing, respond to analog signals. Most early recording platforms (e.g. video and audio tapes, vinyl records etc.) are analog in principle, whatever the actual physical medium used. Computers operate in a digital world because of benefits in handling information digitally in accuracy and ease of transmission. The interconversion of analog and digital signals requires **compromises** and subjects the signals to losses in informational content each time they are thus treated.

Movie films and video display discrete images 24-30 times a second, thereby satisfactorily mimicking continuous events. Loss of information (effectively, loss of quality) starts with the initial recording which requires processing the moving images into digital-like steps. Each image is also recorded via discrete silver grains or video scan lines whose signal varies in colour and intensity along each line. Once these steps are made, some informational content is permanently lost. Analysing motion using frame-by-frame viewing reveals this loss of information, in time (when images are blurred) or in space (when resolution is limited by film grain size or the scan lines). The original recording requires choices and compromises (e.g., film speed/grain; TV format, number of scan lines/resolution etc.). Understanding these choices is important in reproducing high quality dynamic images.

However, these media can also offer significant benefits derived from **Image Processing** and image manipulation. The remarkable potential of digital processing of very weak, noisy signals is shown particularly in space research and medical imaging. We have benefited enormously from images that would not be possible to obtain even a few years ago.

Classroom Media Choices

I will briefly outline the advantages and disadvantages in the choices of media appropriate for use in the classroom. We have three analog technologies: **movie film**, VHS **video tape** and **laser disc**.

Film

Currently, educational films have almost vanished from the classroom. However, they are familiar and worth mentioning because their use graphically demonstrates important practical considerations.

Advantage:

- Superior image quality — when highest quality is required, images are still mostly shot on film even for TV programs

Disadvantages:

- Cumbersome medium, very fragile (e.g., susceptible to dirt, scratches, breakage etc.)
- Non-copyable images, impossible to include in other classroom presentations (e.g. class and lecture notes)
- Expensive medium (film), players (projectors)
- Very linear format that allows no random access

Note that the last is particularly limiting. It is usually impractical or impossible to show a class different selected segments of a film.

VHS Video Tape

Advantages:

- Universal and familiar
- Easy to record, copy, edit
- Very cheap

Disadvantages:

- No accurate random access
- Mediocre image quality
- Serious loss of quality on copying, editing
- Poor control over image play rates (freeze, slow and reverse motion)

Laser Disc

Laser disc technology has been around for 20 years, but has hardly appeared in Australia and is still uncommon elsewhere. This is unfortunate since in practical terms, it offers many advantages in the classroom.

Advantages:

- Controls similar to domestic VCR
- Superior image quality
- Superb freeze framing capability (allowing inclusion of diagrams, photographs, text etc.)
- Accurate, rapid random access to any frame (above), including those within video sequences
- Bar code remote control capability that allows teachers to label lecture/classroom notes for immediate access to selected images
- Extremely reliable, safe for student usage
- Easy interaction with and control by computer
- Multiple (multilingual) sound tracks available

Disadvantages:

- Players not common, perceived to be expensive, actually cost little more than domestic VCRs
- Lack of published material available
- Not recordable
- Medium moderately expensive (discs cost $25-400)

CD-ROM

This technology was designed for storing music, still images and text, for which it is still superb. Its success has prompted developments to extend its capabilities into reproduction of video signals, for which it is basically inadequate (see later). I outline here its main deficiencies **in the context of video reproduction**.

Advantages:

- Players fairly common
- Excellent random access
- Cheap medium
- Easily integrated with other media via computer

Disadvantages:

- Generally poor to unacceptable image quality
- Unstable platform (ever changing: 2X/4X/8X etc. drives)
- Software/hardware compatibility problems

The limitations of CD-ROM (again, I emphasise, in the context of video reproduction) appear to be insurmountable and have led to the development of DVD technology. Before discussing DVDs (below), we will briefly review why these limitations exist.

The Problems of Storing Digital Images

Video consists of 25 (PAL format) or 30 (NTSC format) images or "frames" played back per second. Each of these frames is split into discrete "scan lines", not all of which form the image. PAL images have 625 lines, NTSC have 525 lines. (A complication is that each frame is generated by interlaced "fields" which each effectively contain half the image; "odd-" and "even-" fields play alternately.) The quality of the image is partly determined by its resolution along each scan line. Numerically, "broadcast quality" images are quoted as having a resolution of about 750 lines/inch whereas a typical image recorded on to a VHS tape can be played back at about 200-300 lines/inch.

In creating digital versions of these analog images, each point in the analog scan line is converted to a pixel whose numerical value is related to colour, brightness etc. The number of pixels along each line is an arbitrary choice which controls resolution, now expressed as the number of pixels along the line.

Consider the typical analog-digital conversion of a single full frame of an NTSC colour image. The frame now typically measures 640 X 480 pixels, and so the total number of pixels per image is 307,200. (A PAL frame is more).

Playing these back at 30 frames/sec. requires the handling of 9,216,000 pixels/sec.

If each pixel is allocated 24 bits of colour information, the total delivery of digitised information required is around **27.6 MB/sec**. Add a sound track, and the figure is even higher.

No consumer-level CPU or hard disk today can handle this volume of data! Furthermore, storing even a short video clip requires a tremendous amount of digital storage. The CD-ROM was originally designed to hold 650 MB, which would total about 20 of these images. Accordingly, computer software and hardware designers have utilised various compromises that are vital if CD-ROMs are to store dynamic images. For example, one can:

i) make image size small;
ii) cut the number of frames displayed per second; and
iii) keep colours simple.

In addition, constant improvements in the hard drive mechanisms and reading heads have considerably increased the rate of information transfer: hence the increasing speed of CD-ROM drives (2X-12X). The resultant dynamic images have improved from the original early QuickTime technology (which I consider very poor) to being at best acceptable. However, the limitations inherent in the CD-ROM format have obliged manufacturers to develop a completely redesigned system.

The "DVD"

The acronym DVD was originally used to describe the newly developed "Digital Video Disc" which is the same size and appearance as a standard CD-ROM. The name has since been changed to "Digital Versatile Disc", to better reflect its interactive and creative possibilities.

The current DVD format makes use of several technological advances, notably:

i) shorter wavelength lasers for scanning the disc;
ii) better optics for imaging the information recorded on the disc (higher numerical aperture of lens, more accurate focussing);
iii) more scan lines in disc, closer together; and
iv) better modulation characteristics, error correction in the signal being read.

In addition, DVDs can be double layered; the imaging system can scan either of two superimposed layers (one semi-transparent), and thus, the capacity of the disc is doubled. Furthermore, the two sides of the disc can be used in this fashion, creating a relatively immense storage capacity.

For technical comparison - in DVDs:

Track spacing:	0.74mM	*v*.	1.6mM in CD-ROM
Min. length for a pit:	0.4mM	*v*.	0.83mM in CD-ROM
Laser wavelength:	635-650nM	*v*.	780nM in CD-ROM

Disc rotation speed (1X): constant linear 3.49 m/sec. (similar to that of CD-ROMs)
Data transfer rate is around 11.08Mb/sec.
Data Capacity (12 cm. disc, CD-ROM size):
4.7 Gb, single layered disc; **8.5 Gb** on double-layered;
Up to **17Gb** on double-sided, double-layered disc.

The increased storage capacity of the medium has been coupled with **Image Compression**. This technology is based on the premise that in any series of moving images, much of the information remains constant and so is redundant. The algorithms concentrate upon managing the changing information while retaining the shared information.

The image compression system used in DVDs is called "**MPEG-2**"; the process is very complex and involves transforming sequences of images into blocks of eight, reducing their information content and then recreating the images during playback. A new feature is that it allows continuously variable (i.e., user-controlled) levels of compression, dependent upon type of image being portrayed, moment to moment. This advanced feature is called "**variable bit rate encoding**" and reportedly can eliminate up to 97% of image data without affecting image quality. In practice, the technique is heavily dependant upon human assessment and control during the initial compression (i.e. immediately before creating master discs). When compression is carried out well, the images are, by subjective and anecdotal account, remarkably good, very close to broadcast quality. However, some demonstration discs (not viewed by this author) are also reputedly quite poor and display serious artefacts.

The **end result** of all these advances means that at an average data transfer rate of about 3.5Mb/sec., the single sided disc will hold **2hr. 13 mins**. of **video**, plus MPEG **digital sound in three languages**, plus the ability to carry up to four channels of captions. Double-sided, double-layered discs should hold up to 9 hours of studio-quality video.

DVDs for Teaching?

I now subjectively comment on the potential of this technology for teaching purposes, based partly upon my experience with laser discs which (see earlier) demonstrate various useful capabilities in the classroom.

According to many commentators, **random access** of images should be easy but I have not seen this capability demonstrated and theoretically, if images *per se* do not exist on the disc, it is difficult to imagine how specific frames (e.g. diagrams etc.) can be precisely recalled upon demand. Likewise, inclusion of **stills** is "easy" but how this is organised within the mastering of motion picture images is not clear to me. Freezing of single frames should be easy; **variable speed forward play** is reported to be easy but **reverse play** is not possible.

A possible alternative to true random access is provided by author-defined **program sequences** displayed on a menu at the start of the disc. Thus, the author of the disc decides which various combinations of sequences (equivalent to the "chapters" on a laser disc) might be appropriately grouped together and in what order, and can then program these options into the menu. As far as I can tell, however, these choices are fixed immutably by the author, and the user cannot otherwise tailor the sequences to his/her own lectures.

The caption channels offer the possibility of making available user-controlled **overlays** (e.g., superimposed labelling, diagrams etc., where appropriate). The medium is also apparently flexible enough to offer the viewer choice of viewpoints in movies or sports events, for example, so that a scene can be viewed from one of several possible angles (recorded synchronously on separate tracks). Obviously, such options will greatly inflate the production costs.

So, in summary:

Advantages (to be treated with scepticism!):

- excellent (broadcast) quality
- 2+/4+ hrs. capacity
- versatility, interactivity
- multiple (multilingual) sound tracks
- medium very cheap (like CDs)
- complete computer compatibility (with appropriate video card)
- players competitive with VCRs (e.g. $A600-800)
- some user controllable features such as overlays
- robust medium; DVDs should not age like tapes
- excellent sound
- high quality (e.g. S-VHS output) options
- backwardly compatible with CD-ROMs

Disadvantages:

- no true random access
- not (yet) recordable
- promised release of movies etc. have not eventuated
- NTSC and PAL still are different formats

When is this technology going to happen?

The technology is already here. For example, here are some estimates of the sales of DVD players:

Toshiba: 1 mill. in Japan by 1997
Pioneer: 11 mill. by 2000
Time-Warner: 10 mill. players in the U.S. by 2002

The major companies have already made major investment in the technology. The most significant stumbling block has come from Hollywood whose major studios have not permitted release of first-run movies on DVDs for two main reasons. First, they have serious copyright and intellectual property concerns: DVD images are so good that they can be copied very well on to VHS tapes and thus pirated. Secondly, studios insist on control over release dates of new films in different geographical areas of the world. Thus, studios insist that DVDs of first release films bought in the U.S., must be unplayable for example, in Australia until a predetermined date has been passed.

The importance of these considerations for teachers is that until DVD technology becomes part of the consumer electronics market and thus widely available, familiar and cheap, authors will not commit resources and time to the authoring and production of DVDs for teaching. I think this technology has wonderful potential, but like many areas of the multimedia industry, the companies that have repeatedly promised to deliver this technology to us, have not yet done so.

DVD Web Site

A useful place to start exploring this technology is:

http://www.unik.no/~robert/hifi/dvd/

How much are pictures worth?

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Introduction

There are convincing arguments for using visually-oriented instructional design as a means of making content easier to understand and more memorable. However, it is too simplistic to base instructional actions on the folk-wisdom that 'a picture is worth a thousand words'. One problem with this statement is that it implies all pictures are the same (and equally accessible). Another problem is the implication that pictures in general have some *intrinsic* value that makes them more effective than other ways of presenting information (such as words).

In order to use pictorial materials effectively as instructional resources, we need to do some careful thinking about how learners interact with pictures. There are a number of questions we need to ask such as:

- Which pictures are valuable?
- What characteristics give pictures their value?
- Is a given picture equally valuable to all viewers?

Students can encounter many different types of pictures during instruction. They range from highly realistic depictions such as coloured photographs to extremely abstract representations such as flow diagrams.

Are these pictorial genres equally accessible to the learner? Is one type of picture better at representing information than another, and if so, why? Which of the types of pictures mentioned above would be most readily understood by humanities students versus science students?

Some types of pictures, such as photographs, are relatively 'faithful' representations of their subject matter in that they involve little manipulation of the material. Others, like diagrams, bear very little superficial resemblance to their subject matter because of the extensive manipulations that have been done in order to produce the depiction.

It can be argued that the more realistic a picture is (that is, the more faithfully it represents its referents), the more valuable it will be as a learning resource. However, a counter argument is that, compared with diagrams, realistic depictions are cluttered with irrelevant detail and show only the superficial natural organisation of their contents rather than any deeper levels of content organisation.

These examples show that using pictures effectively as an instructional resource is rather more complex than it first appears. We need to consider carefully not only the type of picture to be used, but also the way in which we use it. Until recently, there was little questioning of the utility of pictures in learning. However, there is now a growing body of very interesting research showing how teachers can help to ensure that pictures realise their potential as learning resources.

Visuals or text?

Our goal in this section is to compare the task of 'reading' a picture document with that of reading a text document. Understanding some of the key differences between these two types of document can help us to design pictorial teaching materials that are more likely to be instructionally effective.

This idea of designing instructionally effective pictorial materials definitely does *not* require you to be an artist. The focus is upon the instructional aspects, not on the aesthetics. In fact, most of what we will consider deals with *existing* pictures and how they can be modified to increase their instructional value. Many of the pictures that we will encounter in learning materials ranging from textbooks to multimedia are of very questionable instructional value because of the limited attention paid to instructional design issues.

Knowing where to look

Competent readers of text have expectations and habits that almost unconsciously guide them through a text document. These expectations and habits come about as a result of being taught to read in a certain pattern (left-to-right, top-to-bottom with English) and from years of practice in using these reading patterns across a variety of document types. Even the scanning of text (as opposed to careful reading) involves well rehearsed and relatively standardised actions. The careful sequencing of written text and its highly conventionalised linear structure allows us to invoke the same general reading strategy no matter what type of text document we encounter and be reasonably confident that this strategy will be effective.

However, there are no corresponding general guidelines for reading a picture. The arrangement of information within a picture is not standardised (as it is for text) and so we have no automatic reading routines that we can call on to help us follow a productive path through its contents. With some types of picture, this may not be a problem because the content is very familiar to us and is arranged in a way that matches the organisation of our everyday surroundings. Our strategy can then be based upon how we would normally read those surroundings.

A more challenging situation occurs when the content is unfamiliar or when familiar content is presented in unusual ways. For example, a photograph of the inside of a computer would present material that is unfamiliar to many people and hence they would have little idea of which parts of the photograph contained important information. In contrast, a highly abstract diagram of a very familiar object or situation can be quite unrecognisable to the non-specialist viewer who will therefore not know which areas need to be inspected.

Knowing what the elements are

One of the things that we are taught to do very early when learning to read is to recognise letters, the groups of letters that form words and the arrangement of words into continuous text. Different spacings mark the distinction between these smaller units of meaning (letters, words and lines of text) while capital letters, full stops and inter-sentence spacing signal larger units of meaning. Because these arrangements embody quite strict conventions, they are applicable to virtually any text document we read. During normal reading, we perform the process of breaking up a text document into its components with little awareness of what we are doing because this fundamental activity has become so automatic.

Conventionalised marking off of elements at different levels in this way allows a capable reader readily to identify the various units of information that comprise the text. However, there are no similar 'universal' rules for identifying the boundaries of elements that make up a picture. Each picture must be divided into individual information units according to a limited number of graphic cues (such as a sudden change in colour, intensity or line) and the viewer's background knowledge of the objects depicted.

In contrast with text documents, the basis upon which any given picture document is divided up into its components is not necessarily applicable to some other picture document. In this respect, pictures can be more challenging than text.

Following an appropriate sequence

Well-written instructional text obeys grammatical rules and typically sequences ideas carefully so that they form a clearly connected linear chain. There are only a few possible ways of legitimately arranging word elements that function as nouns, verbs, adjectives, adverbs and the like. This means that if readers follow the left-to-right, top-to-bottom sequence through the text, they will be working through the elements and ideas in the order the author intended.

However, there are no similar sequencing constraints that apply to the exploration of pictures. Because the structure of a picture reflects the structure of the content it represents (rather than some arbitrary conventional structure), there can be no universally applicable reading sequence as there essentially is for text. In principle, the reader of a picture can start at any point in the display, follow any sequence through its elements and distribute attention amongst those elements quite unevenly during the reading process. Contrast this with typical text reading behaviour.

Unfortunately, this freedom to explore a picture in a highly individualistic manner is not necessarily beneficial for learning. Whether a learner takes a productive or an unproductive path through a picture depends on the design of the picture itself and on the learner's existing background knowledge and interpretative skills. If the learners are new to the subject matter being depicted (which is often the case) and so lack relevant knowledge and skills, they can be forced to rely heavily on the picture's instructional design to guide them in productive reading paths. However, all too often no such guidance is given because pictures are assumed by authors to be self-explanatory.

Knowing how to connect the elements

Like text documents, picture documents typically represent information at a number of levels. At the broadest level, the whole of a text document has an overall theme. Individual sections that make up the document contribute to the theme in various ways. Within these sections, sub-sections made up of a number of paragraphs develop these contributions in some detail.

In a formatted text document, this hierarchical structure is signalled by different levels of headings and subheadings. Variations in spatial layout (vertical and horizontal) are further used to indicate the pattern of interconnections between ideas in the document. In a well-designed document, these visual and spatial cues allow the content structure of a text passage to be appreciated at a glance. However, with pictures there is no strictly comparable set of conventions. The overarching ideas or aspects of a picture are presented simultaneously with the minutest details and it can be very difficult for a novice in the subject area to appreciate the different levels (a problem of not being able to see the forest for the trees).

Even at the level of details, it can be challenging for a learner to interpret appropriately the relationships amongst the various elements comprising a picture. A key challenge for the learner is to determine what aspects of a picture indicate how its different elements are related to each other. For example, the fact that some elements are physically close in the picture while others are far apart does not necessarily indicate anything about the extent of their functional or conceptual relatedness. Further, even when there seems to be compelling evidence from the graphic treatment that a number of elements are closely related, this does not mean that the learner necessarily knows the nature of the relation involved.

Pictures that instruct

There is a big difference between a picture that merely presents information and a picture that has been specially designed to make it instructionally effective. The 'take it or leave it' presentational picture that makes no attempt to help the learner understand the information it offers is too often of limited educational value. In order to re-design a picture so that it is more instructionally effective, it is important to address the sorts of differences between text and pictures discussed above.

This re-design task involves providing the learner with explicit support for picture processing. The guidance that conventions and structure provide to support effective reading of a *text* document need to be parallelled by graphic and other helpers that do much the same job for a *picture* document. These can either be added to the picture itself or accompany the picture as external reading aids. In some cases, extensive manipulation of the original picture or complete re-design will be necessary.

The following instructional design suggestions address various limitations of pictorial representations that are often ignored in current instructional materials. They are given here in quite general form rather than as specific techniques because there are many ways of implementing the principles they embody. Different educational technologies provide different opportunities for dealing with these limitations and each design case should be considered on its merits.

Show macro structure
If a picture is rich with detail, it may be difficult for learners to appreciate its macro structure at a glance (compared with the way they would be able to pick up the macro structure from a well-designed and formatted text document). This is especially likely if all the information in the picture has the same visual status, as in a photograph. Learners need to know how to group the detail in a picture into the main informational chunks that make up the display.

Define key elements
The learner must be able to find all of the key elements that make up a picture easily and accurately. This means that each of these elements needs to be clearly defined in terms of its graphic characteristics (shape, size, surface treatment, outline, etc.) and have a set of characteristics that is readily distinguishable from those of the other elements. Relative positioning of the elements within the display area is another important consideration here. The instructional designer's aim should be to make the key pictorial elements as well-defined as are the individual components that make up a text document.

Indicate relative importance
Learners may need help in distinguishing between (a) information in the picture that is central to the ideas being presented and (b) the rest of the picture that constitutes its context. In addition, not all of the 'central information' will be of the same type so that the themes and sub-themes within that information may need to be clarified. Visual manipulation of the picture can make these different aspects more apparent to learners and so favour appropriate interpretation. For example, the contextual material can be suppressed and the main informational chunks highlighted. Further, different types of information can be explicitly indicated using different graphic treatments.

Direct attention
When learners are viewing an instructional picture, there are typically certain parts that they must attend to if they are to have any chance of developing an appropriate interpretation. Compared with text, pictures give learners much more freedom in where they direct their attention because there is no standardised reading procedure. This means there is a much greater danger that they will gloss over important information or even miss it completely. For this reason, a picture to be used for instructional purposes should incorporate design features that deliberately draw attention to its critical features by making them more conspicuous.

Guide the reading sequence
Although it is essential that a well-designed instructional picture directs learners to its critical features, it is also usually important that learners work through these features in a particular order. With some topics, this can be encouraged by arranging the pictorial elements in a conventional

sequence across the display (such as left to right to indicate the passage of time). However, with other topics this would distort aspects of the picture and so different approaches (such as arrows or numbers) must be used to indicate the suggested reading order. Such sequencing issues do not arise with conventional text documents because the order in which a particular idea is encountered during reading is determined by its position on the page.

Signal the relations

Items of information in a picture that are related in some way are often positioned near each other. However, this relation of 'physical proximity' can be misleading as an indicator of other types of relatedness (such as functional or conceptual relations). If items are widely separated within a picture and yet are closely related, learners need to be given help to make the appropriate connections. These perceptually counter-intuitive relations can be exposed by the use of various visual signals such as colour, texture or connecting lines.

Expose different levels

Because pictures are multi-layered representations, learners need to be aware of the different levels at which they can be read (from the global level right down to the details). Effective reading of a picture typically requires a learner to move flexibly between its various levels and to appreciate how they are interrelated. These levels can be explicitly indicated by providing several versions of the picture with each one emphasising a different level and how to connect these levels. Our purpose should be to help the learner take different perspectives on the picture's content and so develop a richer and more sophisticated interpretation.

Avoiding a mess

Although it is important to give adequate support to learners in how to read a picture, there are also some dangers in adding design features that are intended to make implicit information in a picture more explicit. Perhaps the most serious is that the picture becomes so overloaded with additions or so distorted by various manipulations that it becomes more difficult for the learner to deal with than the original. One way to circumvent such problems is to use multiple versions of the same picture, each with different instructional intentions. However, this approach must be treated with caution so that it does not produce an explosion in the total number of pictures.

Selected Readings

Lowe, R.K. (1993). *Successful instructional diagrams*. London: Kogan Page.

Lowe, R.K. (1993). Constructing a mental representation from an abstract technical diagram. *Learning and Instruction, 3*(3), 157-179.

Lowe, R.K. (1994). Selectivity in diagrams: Reading beyond the lines. *Educational Psychology*, *14*, 467-491.

Lowe, R.K. (1995, July). *Developing basic chart reading skills: using interactive animation for building effective mental models*. Paper presented at the 2éme Conférence Internationale sur l'Enseignement Assisté par Ordinateur et l'Enseignement á Distance en Météorologie, Toulouse, France.

Lowe, R.K. (1995, August). *Supporting conceptual change in the interpretation of meteorological diagrams*. Paper presented at the 6th Conference of the European Association for Research on Learning and Instruction, Nijmegen, Netherlands.

Lowe, R.K. (1996). Background knowledge and the construction of a situational representation from a diagram. *European Journal of Psychology of Education*, *11*, 377-397.

MedCAT: An Internet / Intranet solution for the archival and distribution of media resources

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The last decade has seen radical improvements in communications technologies, brought about by advances in optical fibres and transmission systems. Such advances, together with changes in computer hardware and software technologies have stimulated the growth of large scale computer networks. However, the most significant growth has been in the expansion and accessibility of the Internet primarily due to the development of the World Wide Web (WWW). This growth has spawned entirely new industries in electronic publication and media distribution and management.

These changes, together with the increasing emphasis on quality of education and efficient university teaching have paved the way for the development of sophisticated electronic communication systems for the administration, management and delivery of education into the 21st century. Many institutions have already invested significant resources into the infrastructure to support this environment. Academics are also changing the way information is communicated and are increasingly focusing on the electronic delivery using Computer Aided Instruction via CD-ROM and the Internet. This increasing move to electronic communication has highlighted several problems in the distribution and management of information. A significant problem we have faced at the University of Melbourne is the gradual attrition of valuable slide collections from retiring staff. In order to protect the intellectual property and archives within the University we have built an electronic repository of media resources which can be shared across the University. This archive facilitates the sharing and management of electronic resources across the University. Specifically developed for the Faculty of Medicine this system consists of several thousand images from all aspects of medicine. This rapidly growing resource facilitates the interaction of University departments and maximises the value of this ever expanding resource.

Use of Imagery in Teaching *via* Video conferencing

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Introduction

Network regional universities often have small classes on each of several campuses. Hence either students at some campuses were disenfranchised by having fewer unit offerings, or classes repeated, at great inefficiency, on each of many campuses. Video conferencing has provided one possible method of teaching classes to several campuses more efficiently. The School of Biological and Chemical Sciences at Deakin University has used both room-based and desk-top video conferencing. This paper outlines how we have used video conference lectures in two of our third-year organic chemistry units.

The teaching of chemistry requires the use of detailed chemical and technical imagery to depict the 3-dimensional structure of molecules, reaction schemes, and other chemical concepts. Normal (room-based) video conferencing provides a low-resolution visual link that is unsuitable for the transmission of such imagery [1, 2].

The Deakin University BCS Model

There are many possible solutions for overcoming the deficiencies of video conferencing. At Deakin University, the School of Biological and Chemical Sciences is using video conferencing links to provide real-time teacher-student and student-student audio-visual interactions. We have chosen to supplement the video conferencing link by high-resolution computer-assisted presentation of visual images.

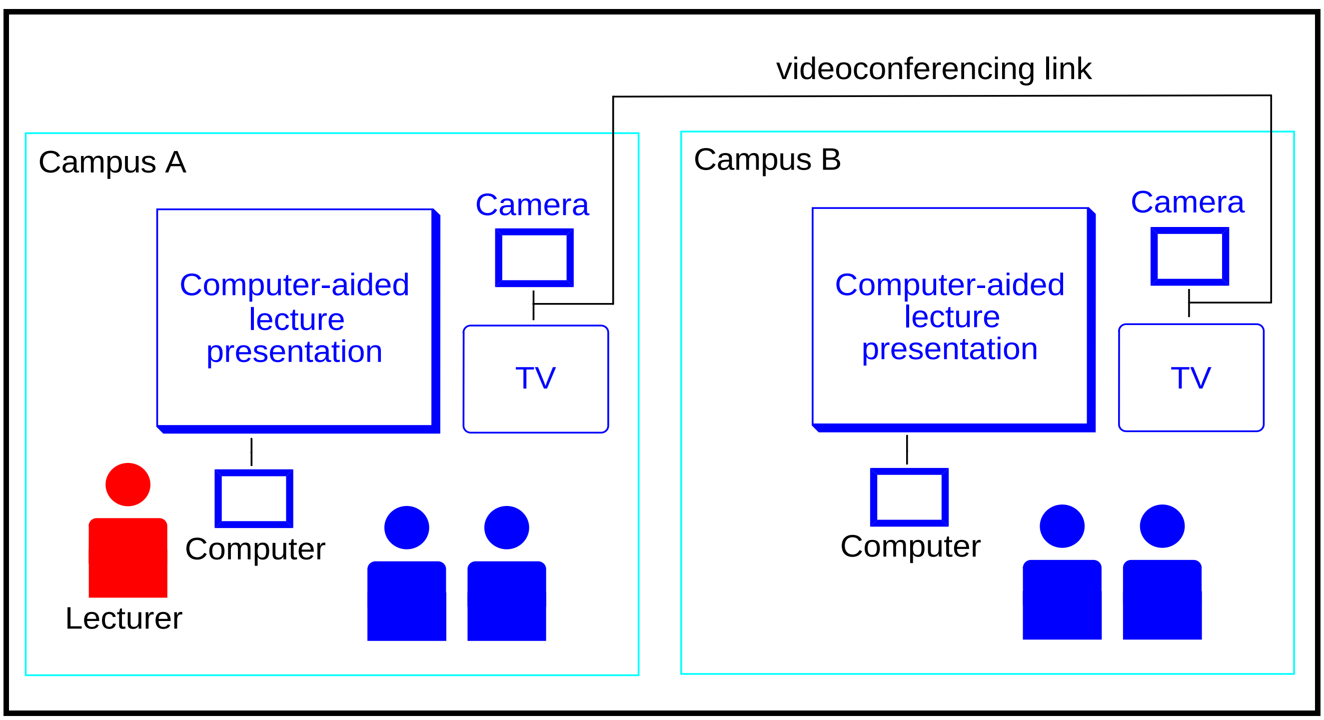


Figure 1. *Schematic diagram showing how computer-aided lecture presentations are used to supplement the video conferencing link.*

Figure 1 is a schematic diagram showing the use of video conferencing in the teaching of third-year chemistry units.

- The **video conferencing link** provides **visual and audio interaction** between lecturer and students on one campus (e.g. Geelong) with students on a second campus (e.g. Rusden). In practise, half the lectures are taught from Geelong while the remaining lectures are taught from the Rusden campus.
- High-resolution imagery (chemical structures, equations, etc.: e.g. see Figures 2 and 3) are presented on a second screen in a computer-aided presentation. Students are either given or purchase black-and-white hardcopies of the computer-aided presentation, but can view and download colour copies (in non-editable PDF format [3]) of the computer-aided presentation from a password-protected WWW site.
- The lecturer elaborates on any point by writing on a piece of paper which is viewed by students at all sites by the use of a document camera via the link. Students also use the document camera either to clarify a question they wish to pose to the lecturer, or to answer a question posed by the lecturer. However, one unsatisfactory aspect is that use of the document camera results in loss of the face-to-face visual link.

Images

All images for the third-year units taught by video conferencing were prepared to maximise legibility and clarity. These are the same principles that should apply to the generation/production of any diagram used in teaching. Specifically,

1. All diagrams were prepared using:

   - **mathematical equation typesetting software** (Expressionist [4]);
   - **graphical software packages** (DeltaGraph Pro [5] and Excel [6]); or
   - **chemical structure drawing software** (ChemDraw Pro and Chem3D Pro [7]).

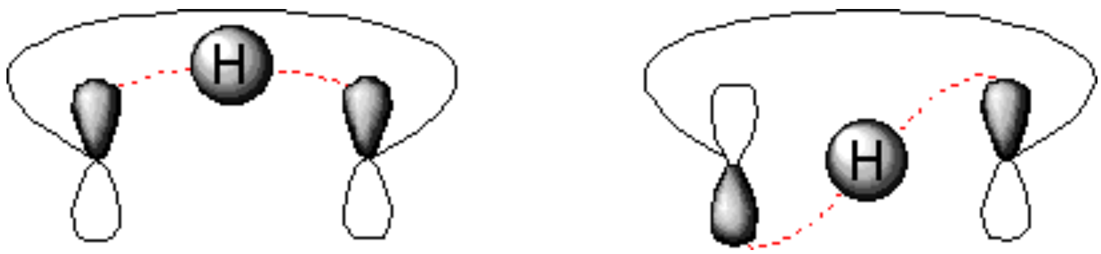
   A minimum font size of 18 point was used for all diagrams.
2. **Optical chemical-structure recognition software** (Kekulé [8]) was used to convert scanned (TIFF) chemical structures into ChemDraw files [6; also see Figure 3]
3. **Presentation software package** (PowerPoint [6]) was used to give a consistent "look-and-feel" for all layouts, images and text. Helvetica font [9] (with minimum size 24 point) was used for maximum legibility and clarity. Colours were used to highlight important points, but the number of colours kept to a minimum [9]: see Figures 2 and 3. (*Editor's note: slides slightly distorted due to adjustment for publishing*).

The Future of video conferencing at Deakin University

Deakin University intends installing computer-network ports in all video conferencing classrooms. Simultaneous video conferencing and computer-network links will provide multiple-media presentation and transmission of high-resolution imagery, combined with real-time teacher-student and student-student interactions. The use of graphics tablets [10] as computer-input devices, coupled with the network program Timbuktu Pro [11] will use the computer network as an **interactive electronic whiteboard** facility **without** the loss of the face-to-face visual link. Furthermore, the lecturer, on one campus, will have real-time, interactive control of the computer-aided teaching **on all campuses**. We call this **simultaneous multiple** (telecommunication) **media** teaching.

Transition state

- ignore details of π system
  - hydrogen s orbital
  - carbon p_z orbitals
- symmetry of π system
  - determines suprafacial or antarafacial



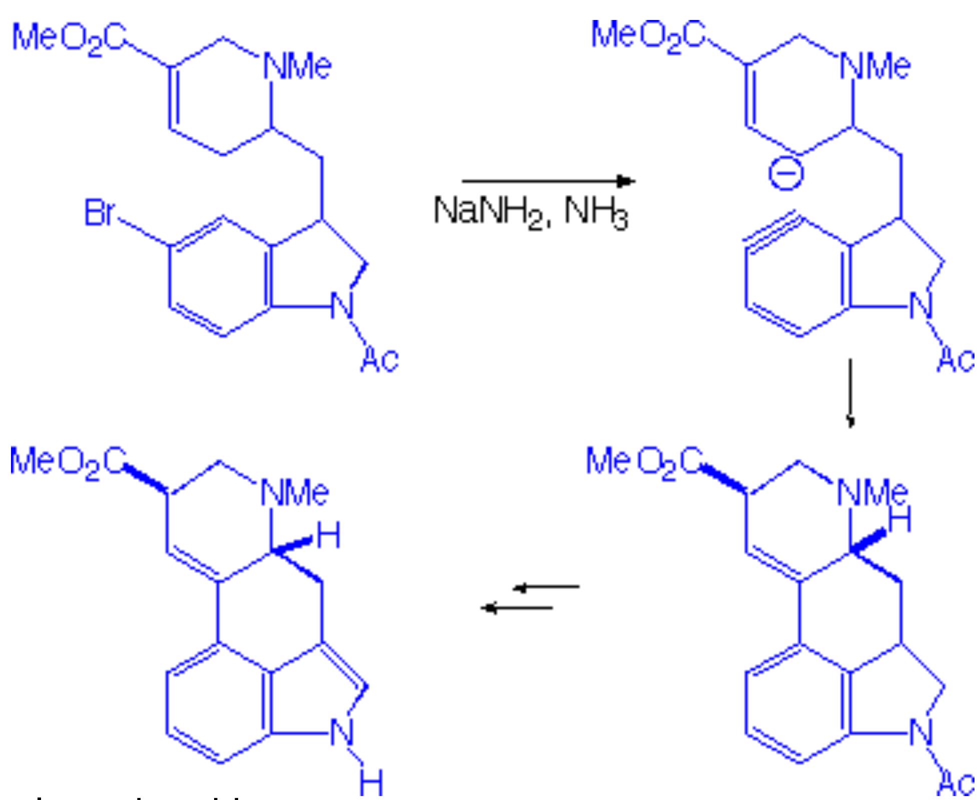
suprafacial

antarafacial

difficult for [1,3] or [1,5] shift

Figure 2. *Pericyclic Reactions: Sigmatrophic*

- ... synthesis of lysergic acid ester



lysergic acid ester

Figure 3. *Arynes - ... organic synthesis*

Other initiatives within the Deakin University, School of Biological and Chemical Sciences include:

1. Use of **desktop-based video conferencing** for tutorials on the use of computational chemistry software;
2. Use of **cable- and satellite-television** (Optus Vision) for delivery of teaching from one campus to several locations [12]; and
3. Video conferencing lectures involving multiple campuses within Deakin University and other interstate universities.

In an ideal world, there would be sufficient resources for all students to be taught by a "live" lecturer, but this is not always possible. Video conferencing can be used to bring together students on one campus with a lecturer on another campus in a "live", interactive lecture. Computer-aided instruction can be used with video conferencing in a simultaneous multiple-telecommunication-media environment where each technology is used in a synergistic manner.

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References

[1] *Eg* C. Driver, paper presented at IUPAC Conference on Chemical Education (July, 1996).
[2] K. MacIver, *Information Age*, pp 28–33 (August 1996).
[3] Acrobat is produced by Adobe [URL: www.adobe.com].
[4] Expressionist is produced by Waterloo Maple Software, Canada.
[5] DeltaGraph Pro is produced by DeltaPoint, Monterey, CA, USA.
[6] Excel and PowerPoint are produced by Microsoft Corporation [URL: www.microsoft.com].
[7] ChemDraw Pro and Chem3D Pro are produced by Cambridge Soft Corporation [URL: www.camsoft.com].
[8] A. Rogers, *J. Chem. Info. Comput. Sci*, **34**, 1225 (1994); Kekulé is produced by Oxford Molecular Group (PSI International Inc.).
[9] R. Vetter, C. Ward, and S. Shapiro, *IEEE Multimedia*, **2** (4), 46 (Winter, 1995).
[10] Artz-II graphics tablets are produced by Wacom Co Ltd.[URL: www.wacom.com].
[11] Timbuktu Pro is produced by Farallon Communication [URL: www.farallon.com].
[12] D. Clift, paper presented at the UniServe Workshop on the Use of Imagery "Putting You in the Picture", University of Newcastle, July 1997.

Using the Cable Television Network for Cross Campus delivery of First Year Chemistry

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Faced with the necessity of delivering a beginners chemistry programme on two campuses this year and lacking sufficient bandwidth in the university's internal network, I enlisted the assistance of the Optus Education channel to deliver lectures, in real time, from the Rusden to the Burwood campus. Although the initial intent was to have full two way interactivity, the limitations imposed by the use of an external carrier meant that this was not possible in the first instance.

Demonstrations of chemical phenomena form a very important part of the lecture content which also involves exposition by the lecturer and the use of PowerPoint to display computer generated images. The computer display was closely linked to the chemical phenomena being demonstrated on the lecture bench. The consequent need for high quality visual images and the numbers of students involved on each campus made the use of the existing video conference facilities impracticable. Lectures were recorded on videotape and made available in the libraries on both campuses. Some students who had access to the Optus Education channel at home found it more convenient to watch the lectures there or to record them for subsequent viewing.

A comprehensive printed summary of the lectures was provided and the lecturer himself conducted all of the tutorials on both campuses in order to ensure that all students had the opportunity to interact with him personally. Although this involved considerable effort, it was based upon the premise that students would be more likely to accept the technology if they saw the lecturer as someone who knew them and had a real concern for their welfare. Subsequent evaluation of the unit based upon verbal and written feedback from students on both campuses appears to validate this belief. Laboratory classes were also conducted on both campuses so that it was not necessary for any student to commute between campuses though some elected to do so.

Towards the end of the semester students were interviewed by an independent evaluator and also completed a written questionnaire which aimed to determine their educational background, where and when they attended or viewed the lectures, their perceptions of the advantages and disadvantages of the method of presentation and their suggestions as to how the programme might be improved. In general, those students who only attended the live lectures on the Rusden campus and had no experience of the video link believed that the latter represented an unsatisfactory alternative with very few advantages. They tended to see video delivery as a downgrading of teaching and a cost cutting exercise rather than a means of increasing flexibility. The Burwood students, on the other hand, were almost universally enthusiastic about the approach, with 42 % actually expressing a preference for the video presentation over the live lecture and a further 30 % indicating that the two forms of delivery are equally acceptable. All of the Burwood students were able to cite a variety of advantages for the video link, particularly in regard to the flexibility of access that it permitted and the fact that it eliminated the necessity to travel between campuses, a distance of some 8 km. Interestingly, however, Burwood students expressed a greater willingness than their Rusden counterparts to travel between campuses should it be necessary. Students on both campuses commented on the fact that having each lecture available on videotape permitted them to replay all or part of it to clarify points that they had not grasped on the first viewing or to catch up on lectures missed because of timetable clashes or for other reasons.

The lessons learned from this trial are at present being applied to the delivery of a second semester chemistry unit to a much larger group of students which includes many of those involved in the Foundations unit together with their peers who took the standard first semester unit which assumed a knowledge of secondary school chemistry and was conducted entirely on the Rusden campus. Technical difficulties encountered as a result of using improvised hardware are gradually being overcome and it is anticipated that the video link will be extended in 1998 to include the delivery of first and second year units in biochemistry, chemistry, computing, earth science, physiology and mathematics.

Multimedia in the Teaching of First Year Biology: The Use of Graphics and Animations

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First year biology introduced computers to the learning environment to help students understand topics which are difficult to conceptualise and are often difficult to demonstrate in the laboratory, to encourage students to take responsibility for their own learning and to enhance group learning skills. We deliver computer-based assessment (formative and summative), computer-based teaching modules and web-based materials.

Biology is a very visual subject, thus high quality images and animations are essential, enabling biological processes to be illustrated in an animated and interactive manner. Pictures have a direct route to long term memory with each image being stored as a coherent "chunk" or concept (Paivio et al, 1968), and without useful meaning the pictures are not easily committed to memory (Freedman and Haber, 1974). Guidelines summarised by Levie and Lentz (1982) in an extensive review of the effects of illustrated text against text alone suggest:

- the presence of pictures relevant to the text will assist learning;
- pictures not covered by the information in the text will not enhance the learning of the text;
- the presence of pictures in the text will not aid the learning of the text which is not illustrated;
- pictures can help learners to understand what they read and also to remember it;
- pictures can sometimes be used as substitutes for words or as producers of nonverbal information;
- learners may fail to make full use of complex illustrations; and
- pictures may assist learners with poor verbal skills more than those with good verbal skills.

The use of graphics and animations in our computer-based teaching modules and web-based materials is designed to stimulate understanding and help in remembering the detail. Graphics are chosen for their meaningful input in portraying or understanding biological content.

Graphics have been generated from original art work, both computer and paper based, and sources such as clipart, textbooks, magazines, video camera microscopy etc. These images have been generated using Adobe Photoshop, Aldus SuperPaint and Avid VideoShop. Some images have been manipulated to create animations using Elastic Reality (ASDG), ADDmotion (Motion Works), Director (Macromedia) and Authorware (Macromedia), and incorporated into our computer-based materials.

References
Freedman J and Haber R N (1974). *One reason why we rarely forget a face*. Bulletin of the Psychonomic Society 3: 107-109.
Levie W H and Lentz R (1982). *Effects of text illustrations: a review of Research*. Educational Communication and Technology Journal, 30: 195-232.
Paivio A, Rogers T B and Smythe P C (1968). *Why are pictures easier to recall than words?* Psychonomic Science 11: 137-8.

UniServe Science narrows the field

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The value of computer-based images in teaching and learning

With the increased use of computers in education it is essential that educators use this technology to enhance student learning. To do this effectively the technology must cater for different learning styles and support the processes students use when they learn. In order to assimilate the new information correctly and gain a broad understanding of it the student needs repeated exposure to variations of the concept and must be actively involved in the learning process. Computer-based images, both still and moving, can be used to provide an environment in which this can occur. For example, interfacing equipment in the laboratory allows the students to conduct 'what if' scenarios with lab exercises; plotting software allows students to plot several variations of a function; and science microworlds (or simulations) enable students to explore a particular problem area by inventing their own activities and experimenting, testing and revising hypotheses.

Need for caution

Computer-based images can expose students to variations of a concept and they can stimulate students to become actively involved in their learning. However, this is not always the case. Some pictures aid learning. Some do not aid learning but do no harm. Others do not aid learning and are distracting or even misleading. Many multimedia programs are still based on behavioural models of learning that emphasise only individual learning and feedback. Morgan (1996) reminds us that we must always evaluate whether our use of technology in education really does support student learning.

Ring (1996) notes that although interactive multimedia has provided richer human-computer interaction much of it is quite complex and difficult to use. Care must be taken to avoid student confusion or information overload through complex or poorly designed images. It is also becoming apparent how easily designers can distort reality using new video and imaging technologies. This is particularly dangerous in an educational setting as the student is left with incorrect knowledge.

In addition, the added emphasis on the use of graphics and the availability of tools which make adding graphics to software applications very easy, increases the likelihood that instructional designers will lose sight of their original goals. Rieber (1994) reminds us that, with graphics in particular, there is a strong tendency to let technology, rather than teaching and learning objectives, dictate decision making. Often designers and consumers of educational software unconsciously fall into this trap. They encourage the use of all special features, instead of questioning whether such features are relevant to the lesson goals and hold the learner's attention. Often a combination of text and graphics is most effective. Levin (1989) pointed out that "pictures interact with text to produce levels of comprehension and memory that can exceed what is produced by text alone". This was borne out by Bernard (1990) who found that when text captions were used to support pictures the illustrations were more effective than when the illustration alone was used. It is always important to consider the learning objective of illustrations.

UniServe Science reviews

While multimedia has the potential to enhance education, there has been little opportunity for educators to gain experience in how to effectively use and critically evaluate this new media. With the huge volume of products on the market today there is no way educators have the time to seek out and compare different offerings. One of UniServe Science's key activities is to acquire currently available software packages for use in teaching tertiary science, commission independent reviews of this software by teachers in the field and make the findings available to all interested academics. Reviewers are provided with guidelines and an evaluation checklist to ensure they consider all relevant aspects and are encouraged to trial the product with students to judge its effectiveness. Reviews are entered in an online searchable database, emailed to discipline specific mailing lists and may be published in the UniServe Science newsletter.

These reviews highlight important educational aspects of the products and help narrow the field for busy teachers. For example, two recent reviews included the following statements.

1. *The animations are the most disappointing part of this teaching resource. There are serious misrepresentations of the molecular world, examples being ... at best a poor quality teaching/learning resource, at worst a potential generator of serious misconceptions ...*
2. *...cleverly constructed piece of software which is easy and fun to use and very instructive ...*

The UniServe Science reviews are a valuable resource for science academics who wish to integrate the use of computers into their teaching but do not have the time to carry out evaluations on the possible alternatives. The reviews are available in the searchable database at **http://science.uniserve.edu.au/**

References

Bernard, R.M. (1990). Using extended captions to improve learning from instructional text. *British Journal of Educational Technology*, 21(3), 215-225.

Levin, J.R. (1989). A transfer of appropriate processing perspective of pictures in prose. In: Knowledge acquisition from text and prose. Eds Mandl, H. and Levin, J.R. Elsevier Science Publishers, Amsterdam.

Morgan, T. (1996). Using technology to enhance learning: Changing the chunks. *Learning and Leading with Technology*, 23(5), 49-51.

Rieber, L.P. (1994). *Computers, graphics & learning*. Brown & Benchmark, Madison, Wisconsin.

Ring, G. (1996). The role of graphics in user interfaces. *Australian Educational Computing*, 11(1), 4-7.

Weller, H.G. (1996). Assessing the impact of computer-based learning in science. *Journal of Research on Computing in Education*, 28(4), 461-485.

Wiburg, K. (1995). Becoming critical users of multimedia. *The Computing Teacher*, 22(7), 59-61.

Williams, J. (1994). *The use and capture of images for computer-based learning*. Educational Technology Service, University of Bristol.

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