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From the director

What webs we mortals weave

UniServe Science has just held its third annual national workshop, devoted to the topic of University Science Teaching and the Web. It was attended by 85 academics from every state in the country except the Northern Territory. There were two keynote speakers: Shirley Alexander from UTS and CUTSD, who covered the theoretical and pedagogical issues, and Peter Lee, Dean of Engineering at Murdoch University, who talked about the practical aspects of a comprehensive working system. There were twelve contributed papers and four poster papers, all describing courses or developments which had been in use for some time.

It seemed to us when we were planning this workshop, that now was a singularly appropriate time to examine the use of the web in our teaching. During the three years we have been in operation, we have attempted to keep our finger on the pulse of what is happening at the teaching coalface (to mix a few metaphors). Until quite recently the fraction of teachers using the web was really very small. About a year or so ago, suddenly lots of people were starting to do things. In her keynote address, Shirley Alexander drew attention

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to a classification system for those who use technology in their teaching (originally due to Everett Rogers):

- (1) *innovators*: 5–10% of the population who are keen to try out new things and take risks;
- (2) *early adopters*: opinion leaders who take the role of decreasing the uncertainty of others;
- (3) *early majority*: who want to know if it works before they will use it;
- (4) *late majority*: who are skeptical, and adopt only under extreme pressure; and
- (5) *laggards*: who are not interested in change.

It seems to us that the “innovators” amongst us have been beavering away all this time, and now it is the “early adopters” who are leading the big push for change. How better to help them on their way than to hold a national workshop on the topic.

We were very pleased with the way the workshop ran, and responses from those who took part were overwhelmingly positive. As we have come to expect, the greatest crowd-pleaser was the chance to get together and discuss problems with others who are trying to do the same thing as you. That and the simple feeling of belonging to a community of your peers — something that is often not possible for those interested in teaching in departments dominated by the research ethic. There were downside aspects of course. The equipment played up, as usual. (I wonder if technical hitches are an unavoidable accompaniment to this kind of work, and we should just learn to live with them?)

It was a pity too, that the majority of the attendees were from the Sydney metropolitan area. This is understandable, given the cost of travel and the tightness of travel budgets, especially for matters involved with teaching.

Perhaps the fault was ours. We didn't finally decide on the timing of the workshop until very late last year, and people do need time to organize funding for travel. We won't make that mistake again. We are announcing here and now that the next UniServe Science national workshop will be held at the corresponding time next year:

FRIDAY – SATURDAY, APRIL 9 – 10, 1999.

We've been asking around for what the topic should be. The consensus so far seems to be that we should follow up on web-related matters: distance-based and problem-based learning and assessment. *Do you agree with these topics? Are there more important ones? Please contact us and let us know your ideas.*

Let's return to web-based teaching. In our workshop we gathered reasonably representative information about what is happening in Australia right now. That information will be available in our published proceedings to those who weren't able to attend. These will be, as usual, put up on our website. Keep looking at the *What's New* page. But in order to supplement that coverage with information about what is happening elsewhere, we have reproduced, in this issue of the newsletter, three articles from the newsletter of the Teaching and Learning Technology Programme (TLTP), based in the UK. Actually, as you will note, one of those articles discusses work done in Australia.

We also intend, in future issues, to set up a new section, called *WebBytes*, where people will get the chance to say something brief about projects they are working on that are still far from finished. There is so much happening in this field that we really can't wait to hear about projects only when they have all 'I's dotted and 'T's crossed. So watch this space.

And don't forget to put in your diaries the date of our next national workshop,

FRIDAY – SATURDAY, APRIL 9 – 10, 1999.

UniServe Sites

Information about, and links to, other UniServe sites may be found on the UniServe Australia homepage
<http://uniserive.edu.au/uniserive/>

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Tutoring on the WWW

Nathan Scott and Brian Stone, University of Western Australia

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In 1995 at the University of Western Australia we introduced an “intelligent computer tutoring system” for the teaching of first year engineering dynamics. We have now had three years experience with the system and have seen pass rates rise to 95%.

The computer assessment is fairly rigid in that it requires each problem set to be answered correctly before the student may attempt some assessed problems. There are usually about eight problems on a topic designed to find any misunderstandings. Feedback about detected specific misunderstandings is available while these first problems are attempted. Then there are two assessed problems which are marked. These marked problems count for 20% of the unit, the remainder comes from a mid year exam (30%) and a final exam (50%). There are deadlines for the assessed problems after which no marks may be obtained, however the problems must still be completed before the next set of questions may be commenced. In this way *all* students have to answer *all* problems correctly, which it is hoped will imply a reasonable degree of competence.

The serving computer records most student actions. Each student is given a printed sheet of the problems during a lecture. This sheet has the same *words* for each problem that the student will be given by the computer but the *numbers* are not those the student is given when logged in. Each student has a different set of numerical values for the problem; the server generates these numbers randomly within defined limits. The questions have been designed to “trap” common misconceptions which have been determined by a thorough analysis of past exam scripts. For each question, the software generates the correct answer and several possible erroneous answers that would be expected if the anticipated misconceptions were applied. Any student answer within $\pm 2\%$ of any of the answers is assumed to have been derived by the associated method. Then, as necessary, students are given appropriate feed-back. In dynamics around 200 questions are set over the course.

At any time a student may also send a query on-line to staff. All such queries and staff responses are attached to the problem and may be viewed by all other students. Students may also send personal and confidential queries by a private forum.

Finally, the progress of all students is monitored and displayed so that the lecturer always knows the state of the class:- are they all stuck on a particular problem, is anyone not keeping up, which problems have required the most attempts etc.

The outcome has been an increase in pass rate from around 80% to 95% with exams that have been moderated to ensure that they have not got easier. The same approach has been taken up within UWA for statics and thermodynamics.

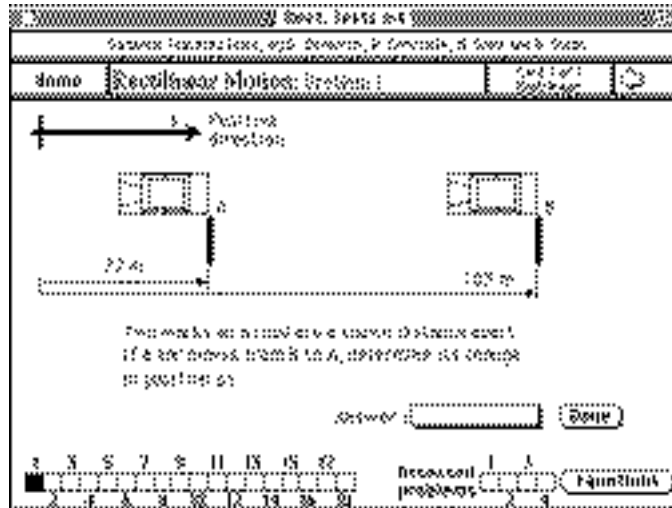


Figure 1. First problem of first set

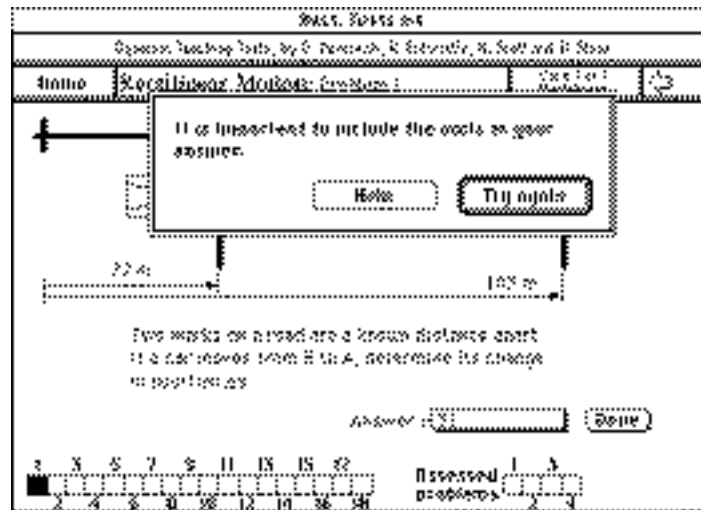


Figure 2. Error message if units omitted

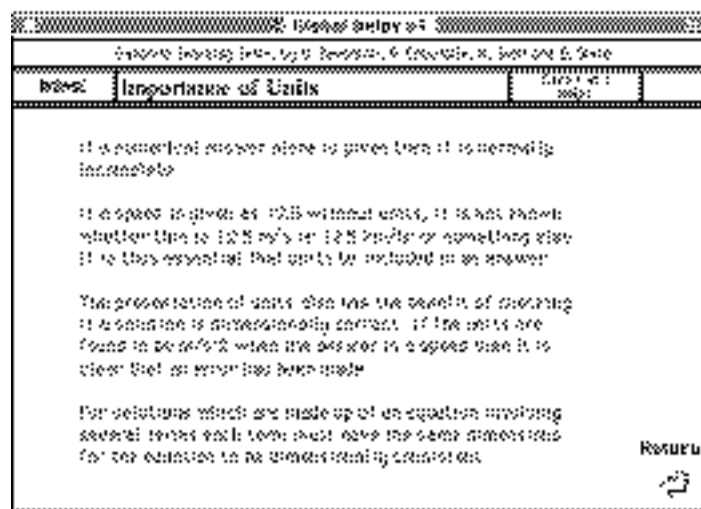


Figure 3. Help card for units

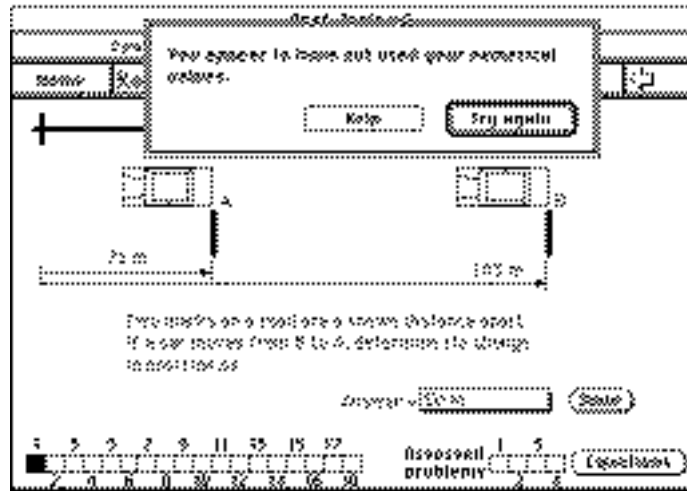


Figure 4. Error message if wrong numbers used

More information about the system can be found at:
<http://www.mech.uwa.edu.au/Dynamics/DynamicsHome.html>
 and
<http://www.mech.uwa.edu.au/Dynamics/Promotion.html>

Within Mathematics, the approach has been extended to calculus and statistics, with equations required as answers and with diagnostic feedback available.

CalMæth: Fast, friendly diagnostics in Statistics and Calculus

Calculus and Statistics are among the most difficult first-year courses, and students need lots of practice and instruction. This places a

great burden of assignment marking on staff — an expensive business.

Dr Kevin Judd (Mathematics, UWA) has invented a very successful computer-based interactive mathematics tutorial system which is an enhancement of the one used by Scott and Stone. It is unique: students are given personalised assignments and enter mathematical expressions as answers. The system immediately diagnoses errors in these answers, even if they appear in combinations, and it gives clear English feedback to the student.

This development has led to a completely new kind of Mathematics classroom. Students work singly, or in small groups, at the computer terminals on their questions, the system catches most of the mundane errors, and the tutors are freed to deal with students individually and at a much higher level. So far nearly 1,000 students have used this enhanced system, totalling about 30,000 hours of instruction.

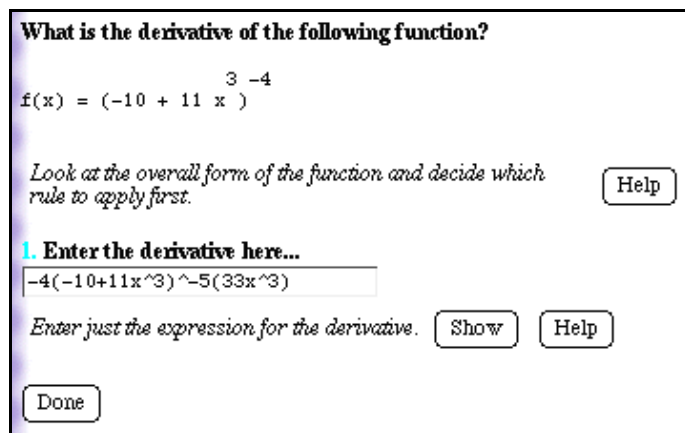


Figure 5. CalMæth poses a simple calculus question

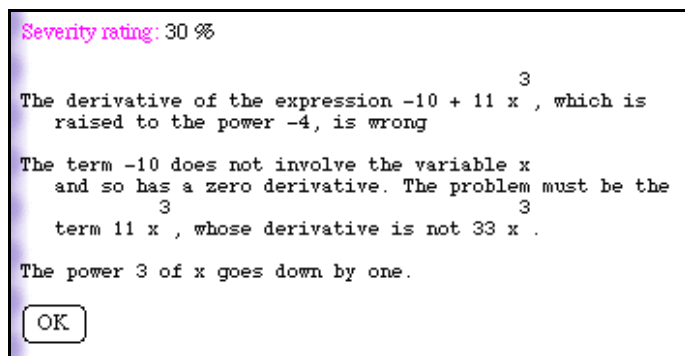


Figure 6. Diagnostic feedback from *CalMaeth* about the attempt in figure 5

The students say they like the system because it “drills” them and “makes them do the work”. Students also like the way the system gives them immediate feedback and is able to diagnose most common errors in the subject.

The *CalMaeth* system also:

- gives the students a clear indication of their achievement in the course;
- greatly reduces the staff marking loads;
- increases the one-to-one interaction between staff and students;

- clearly identifies students having difficulties, and pin-points those difficulties; and
- ensures a guaranteed level of competency.

CalMaeth packages are available for intermediate Calculus and Statistics. You can try them on-line at:

<http://CalMaeth.maths.uwa.edu.au/>

For more information, contact:
calmaeth@maths.uwa.edu.au

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UniServe Science PUBLICATIONS

<http://science.uniserve.edu.au/su/SCH/pubs/>

- **UniServe Science News** is available on-line and in Portable Document Format (PDF)
- **Proceedings of UniServe Science Workshops** are available in PDF (Dry Labs Workshop and Computer Assessment Workshop)
- **UniServe Science QuicKards** summarise the software most commonly used in Australian universities for teaching first year classes and are available on-line
- **CAL-laborate** is a collaborative publication from UniServe Science, the UK CTI centres for Physics, Chemistry and Maths and the Swedish Council for Renewal of Undergraduate Education and is available on-line
- **Proceedings of UniServe Australia Workshop** *Putting you in the picture* is available in PDF

Active Learning with COSE (Creation of Study Environments)

Mark Stiles, Staffordshire University, UK

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COSE is a WWW-based system enabling creation and delivery of active, collaborative learning environments. It is based on a pedagogy which recognises that learning is most effective in the context of some task or problem. However, it also recognises that many undergraduates lack the learning skills required to undertake learning based on real-world problems, particularly as the skills needed to deconstruct such problems into component activities are usually missing.

Therefore, the learner is presented with a hierarchy of “learning opportunities” ranging from simple, bounded, tasks through to “real world” projects, enabling learning skills to be acquired gradually.

The COSE Learner Interface, presents the learner with a list of “learning opportunities” which have been assigned to them (or their collaborative group) by tutors. Each consists of a Pageset describing the task in question. Attached to each of these pages are pages of “theory” (notes, relevant information), “hints” (advice, pointers to approach, procedural guidance) and an index to related learning opportunities in COSE, external WWW sources, and paper sources. A page can contain any WWW compatible content, but can also have attached up to two standalone “media objects”, separately catalogued in the system and displayable via a button.



Figure 1. The COSE Learner Browser

An email button provides links to a learner’s group(s) and tutors managing the learning opportunities assigned. Learners can create work in any desired format, share it with other learners, and label work completed as viewable by a tutor, who is informed of the fact by email. If desired, learners can create work in COSE format, which can subsequently be published (by a tutor) into the system as a resource.



Search facilities allow learners to search the entire system by keyword for resources, and gather them in a “basket” for later use. This cross-discipline searching encourages synthesis in learning.

Additional communications tools and cognitive aids are planned.

Tutors are provided with an interface which facilitates either individual or collaborative creation and management of content, and the publication of finished material for use by

learners. The publication mechanisms can be used as a quality control. Pagesets, pages and media objects are described using keywords on creation, and tutors can search the system for relevant published work, save it in their basket and incorporate it (even an individual page or media object) into their own material. Published material cannot be changed, only re-published in a new edition, ensuring that content remains stable.

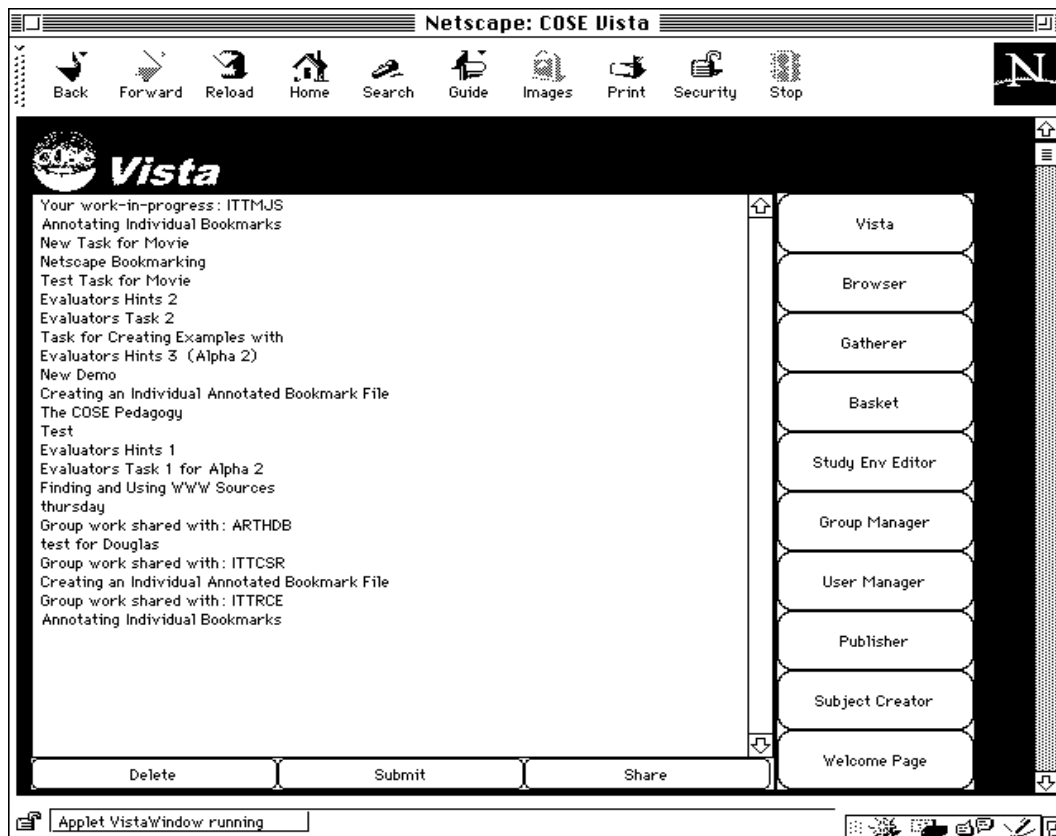


Figure 2. The COSE Tutor Vista

Other facilities provide the creation and management of individual and collaborative groups of tutors and learners, and the assignment of learning opportunities to learners and groups. The system tracks learner behaviour with a view to assisting assessment of the value of particular content, and possibly learner profiling.

COSE, written in Java and CGI, runs on any standard WWW server. It requires *Netscape* or

MIE 3 or 4 on the client, which should be a PC running *Windows 95/NT*, or a Power Macintosh.

The COSE project is funded under the JISC Technology Applications Programme.

The COSE team are seeking colleagues interested in evaluating the system.

The COSE URL is <http://www.staffs.ac.uk/COSE/>

CORRECTION

The article entitled **Production of Video Images to Enhance Teaching in First Year Undergraduate Botany** by Bielig and Bailey (UniServe Science News, Vol. 9, March 1998) contains a diagram entitled the *Sexual Stage - Rhizopus* (Figure 2 on Page 9). The label *zygospores* within that diagram should read *zygospore*.

Learning by Solving Examples through Data Driven Internet Based Intelligent Tutoring Systems

Ashok Patel, De Montfort University, UK

This article is reprinted, with permission, from the Teaching and Learning Technology Programme Newsletter, No. 10, Autumn, 1997.

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The Byzantium project has successfully produced four Management Accounting and one Financial Accounting tutoring applications for introductory level accounting, along with a Marker software. Blackwell Publishers publish the software and accompanying text (ISBN 0-631-20750-3). The tutoring software was designed under a model of Computer Integrated Learning Environments (CILE) that recognises that the level at which a discipline is taught and learnt is a vital context for designing a tutoring software package. In this model, the learning of a subject discipline is divided into three distinct knowledge levels:

- 1 At the *introductory application level*, a student forms mental maps of various conceptual objects, each consisting of a small network of interrelated conceptual atoms, and learns how to use the basic tools of the discipline.
- 2 At the *advanced application level*, the integration of conceptual objects takes place. Vertical integration involves a comparison of the results of multiple use of the same tool whereas horizontal integration employs multiple tools to solve a given problem.
- 3 The *actual application approximation level* attempts to simulate a simplification of the real world problems. Students learn how to account for behavioural and environmental factors.

The research and implementation output to date has focused on the development of the first level packages. However, it is recognised that on-going developments in the Internet and related fields can greatly assist the next stage of development by providing an infrastructure for distributing development efforts and also for linking the outputs of such distributed efforts.

Extension of Intelligent Tutoring to the Internet

Byzantium's experience of developing diverse tutoring applications has provided the information necessary to formulate a methodology to construct an authoring tool. Due to advances in programming languages (e.g. Java) a generic tutoring application builder for use in producing Intelligent Tutoring Applications (ITA) on the Internet, and maintaining an indexing mechanism for all the ITAs so developed, is now conceivable. An ITA builder would interactively facilitate rapid development of the ITAs by subject teachers of any numeric discipline, at minimal investment. Figure 1 shows a possible workbench for the development of such ITAs. The approach also enables teachers to share and build on each other's work, allowing them to incrementally build more extensive Internet Based Intelligent Tutoring Systems (IBITS), using the ITA building blocks. It also enables teachers to structurally tailor any existing ITA and produce a variation to suit the sequence in which they might wish to introduce the concepts.

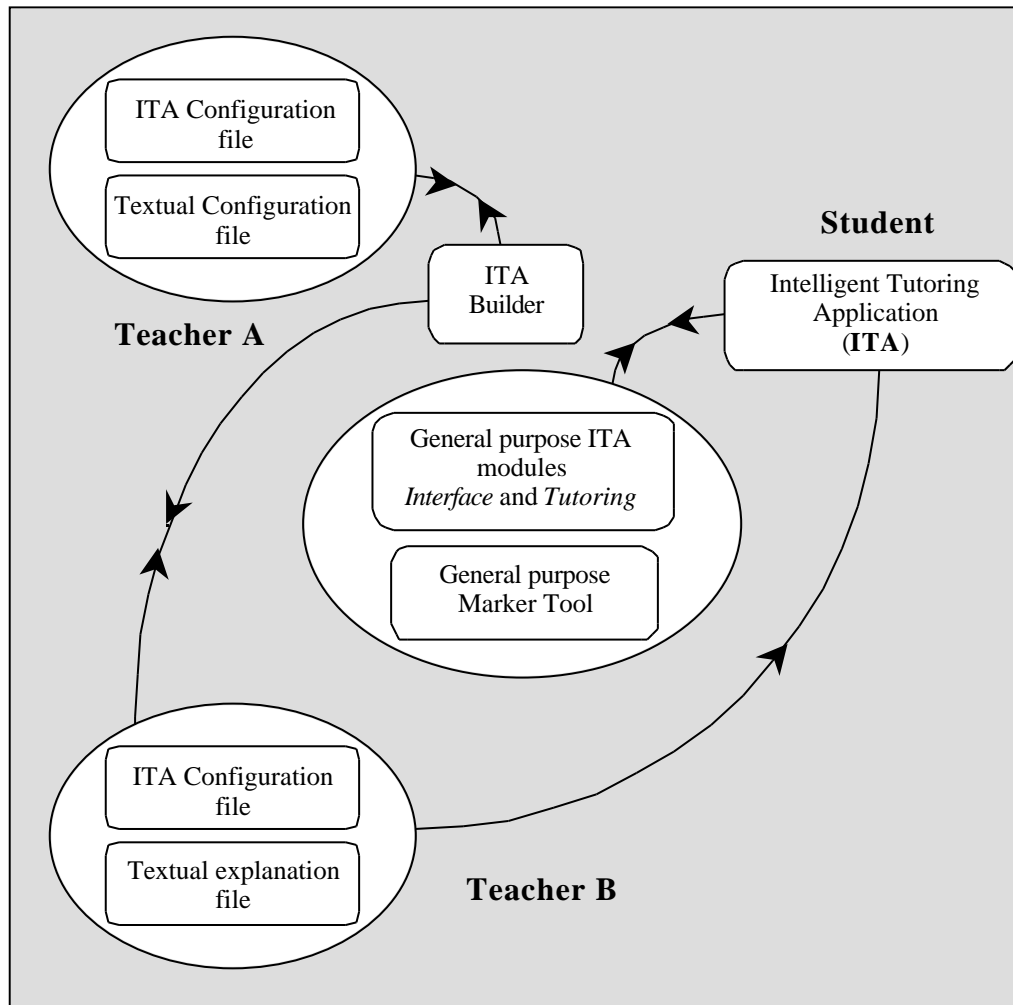


Figure 1. ITA Workbench

There is a vast number of potential applications for numeric topics across a wide range of subject disciplines. With the appropriate design tools the Internet provides a very productive platform for collaborative and co-operative efforts by teachers who can rapidly and cost-effectively build up the diverse range of software tutors necessary to cover the large area of the numeric techniques and their applications. The Internet also provides platform independence and enables sharing of design

tools between, say, the PC users and the Unix or Macintosh users.

An expanded article on this project appears in the CTI Engineering Newsletter Issue 12, Winter 1997/98.

<http://www.ctieng.qmw.ac.uk/cti-eng/publications/newsletters/nl12.pdf>
or link from publications to
<http://zeus.gmd.de/~kinshuk/welcome.html>

Research papers:
<http://byzantium.dmu.ac.uk/publications.html>



WebBytes

What is a WebByte?

It is a *brief report* about an *educational initiative* which uses the *Web* for its delivery. Please send us a progress report on your work and we will include it in our new section **WebBytes**.

(PhySciCH@mail.usyd.edu.au or BioSciCH@mail.usyd.edu.au)

Practical Ways to Improve Student Learning in Lectures

Marjan Zadnik, Department of Applied Physics, Curtin University of Technology

Marjan was awarded one of two CAUT National Teaching Fellowships in 1996 and spent several months in Germany and the USA investigating innovative Physics teaching and learning and research into Physics Education at University level.

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“If students are to learn desired outcomes in a reasonably effective manner, then the teacher’s fundamental task is to get students to engage in learning activities...It is helpful to remember that *what the student does* is actually more important in determining what is learned than what the teacher does” (Shuell, 1986).

Introduction

Within the Physics Education Group at Curtin, we are trialling a number of innovative teaching strategies such as the establishment of the “Physics Studio” (Loss and Thornton, 1997, adapted from Wilson and Redish, 1992; and Wilson, 1994) which utilises student-centred learning workshops to replace the conventional lecture – tutorial – laboratory classes. Dr Robert Loss is developing and evaluating World Wide Web teaching and learning materials within existing units and a new unit on Web literacy (Web Science, Kovler, Loss and Zadnik, 1997). Through the support of a large ARC grant we are also assessing the effectiveness of computer-based multimedia Physics instruction (Yeo, Loss, Zadnik, Harrison, and Treagust, 1998). However, much of the Department’s teaching is still carried out in a traditional format in the form of lectures*.

In spite of research in science education providing support for constructivism, student-centred learning, and the benefits of flexible and interactive delivery mechanisms, universities continue to use and build large lecture theatres. Lectures may be effective for information delivery, but are often no better than other available methods and probably worse than many texts and/or Web based materials. Traditional lectures tend to emphasise voluminous content, surface learning, low levels of student engagement and effective learning (Bligh, 1971; Gibbs and Habeshaw, 1989) and often decreasing student attendance. So, why do universities persist with lectures? Two commonly held views are, **economics** (fewer dollars per student hour) and **tradition** (That was how we were taught, and if it was good enough for us, it is good enough for today’s students!). The former is difficult to refute in times of ever shrinking budgets which suggests that much of our teaching (especially service teaching to large groups of non-major students) will continue to be in the form of lectures. How then can we improve the large lecture learning experience?

Peer or collaborative learning in lectures

One very successful and easily adoptable technique, which I came across as part of my CAUT National Teaching Fellowship Award travels, was at Harvard, where I met Eric Mazur, from the Physics Department, and sat in on one of his first year electricity and magnetism classes. Mazur has developed a technique which he calls “peer learning” or “collaborative learning” for use in large lectures. The technique has now been widely adopted in the USA largely as a result of its demonstrated effectiveness, ease of use and transferability to other disciplines. Several times during an

otherwise standard lecture, the lecturer poses a carefully selected, relevant, conceptual question with a set of possible answers. The questions do not involve formulae or calculations and students are given about a minute to select one of the possible answers which they write down. They then vote on the answers (by a show of hands, or at Harvard, by entering their choice into a network of hand held calculators) so that they and in particular, the lecturer, have immediate feedback on possible misconceptions students have. Given that most people learn best when having to teach others, the students are then asked to turn to one or two neighbours and convince them of their selected answer. After another minute or two, the lecturer asks students to again vote for the alternatives. The new voting pattern almost always leads to an increase in the number of students choosing the correct answer as well as providing more feedback to the lecturer who can then decide whether to spend more time on that concept or move on to new work. Of course, the lecturer gives the correct answer and may further reinforce the concept by having a demonstration available. For example, in the Mazur lecture I attended, the conceptual question dealt with a pendulum with a small sheet of copper at its end, swinging through the poles of a strong electro-magnet. Students were asked to predict its behaviour, via the above method. After voting was completed, Mazur demonstrated the effect on the swing of the pendulum when the magnetic field was switched on. There was a loud gasp of surprise from the student body on seeing the demonstration. Clearly the message had sunk in. Students had their misconceptions challenged both through discussion and through the demonstration.

In my own experience in using this technique, I have found students very attentive to such challenging questions and eager to participate in the discussions. Post-course surveys indicate over 80% of the students prefer this style of lecture to the traditional “stand and deliver” approach. As part of the dissemination phase of my Fellowship, I have discussed and demonstrated peer learning at seminars and workshops to over 800 lecturers and teachers. Many participants have tried this in their own classes and reported positive results. I have used examples of conceptual questions (similar to those found in Paul Hewitt’s book “Next Time Questions: Conceptual Physics, eighth edition”) with groups as large as 200 people and have had over 50% of the group (non-physics teachers) initially choosing the incorrect answer. However after a short discussion with their neighbours, the percentage still with incorrect answers dropped to less than 20%.

An interesting variation is to ask students not only to vote on an answer but also to express, on say a 1 to 3 scale, their confidence in their answers both before and after discussion with their peers. Again my experience, and that of others, indicates that the two minute discussion with peers has improved not only the proportion of students with the correct answer but also their confidence in their answer.

There is of course a cost for this level of interaction in that it reduces the amount of time instructors have to “deliver” content. Anyone concerned about this may need to ask themselves, is it more important for students to understand the difficult concepts in this lecture or to deliver that additional 10% of material. To use this approach, instructors must either reduce the amount of content they deliver in lectures or assign the content for coverage by other means e.g. student reading.

Overall, the procedure is a powerful method of engaging students’ attention and challenging their misconceptions. An important aspect of this technique is that the questions and alternative answers need to be carefully designed such that a reasonable proportion of the class gets the correct answer. This then leads to useful discussion and the result is an inevitable improvement in student learning, since it engages students at a deeper level than normally experienced in traditional lectures. Mazur has extensively documented students responses and has presented evidence of the efficacy of this method in his book “Peer Instruction”. In the book he also provides over 200 pages of class-tested, conceptual questions (also available electronically on the accompanying disk). Further resources are available at the following Web sites:

For Physics questions:
[http://mazur-www.harvard.edu/Education/
EducationMenu.html](http://mazur-www.harvard.edu/Education/EducationMenu.html)

and
<http://galileo.harvard.edu/home.html>

For Chemistry, questions probing understanding, are available at:
<http://www.chem.wisc.edu/~concept/>

The Minute Paper

Another very useful and readily adaptable means for enhancing active student involvement in lectures (or any classes) and providing instructors with valuable feedback on their teaching is “The Minute Paper” (Angelo and Cross, 1993). To encourage active listening and help students focus, the instructor announces at the beginning of the class that there will be a short exercise at the end of the session which

will require students to write down anonymous (hence non-threatening) responses to the following questions:

- 1 What was the most useful or meaningful thing you learned during this session?
- 2 What question(s) remain uppermost in your mind from the session?
- 3 What was the “muddiest” point in this session? (i.e. what was least clear to you?)

To assist the students complete the exercise, the instructor, in an earlier class, may need to provide examples of answers to the three questions, and in particular, a clear example of a muddy point - “clear” in the sense that the muddiest point can be addressed within the context of the course. To be fair to the students, and to demonstrate that this is not yet another survey/questionnaire, the instructor should summarise the results and provide feedback to the class at the next session. In my experience, asking these questions has led to useful and sometimes surprising student responses and helped me realise that one should not make assumptions about the students’ levels of understanding. The responses are useful in monitoring students in terms of their level of understanding of the course (without requiring a full scale test), and allow the instructor to modify the content and emphasis in following classes.

In summary, many instructors, including myself, have found the above methods very valuable in obtaining rapid feedback on student learning and understanding. This has enabled me to modify materials appropriately, with the continual aim of increasing active student learning. Most importantly, the students benefit by being actively involved in their own learning processes.

*Note: In using the terms “traditional/standard/conventional lecture”, I am assuming the same meaning as Gibbs, Habeshaw and Habeshaw (1984) which is: “50-55 minutes of largely uninterrupted discourse from a lecturer with no discussion between students and no student activity other than listening and note-taking”.

Acknowledgements

I am indebted to the former Committee for the Advancement of University Teaching (CAUT) for the Award of the National Teaching Fellowship to allow me to investigate best practice in Physics instruction in Germany and the USA, and to my Curtin colleagues, Dr Robert Loss and Ms Shelley Yeo (Department of Applied Physics), Professor David Treagust

(Science and Mathematics Education Centre) and Associate Professor Alexandra Radloff (Centre for Educational Advancement) for their constructive criticism and for sharing their knowledge and wisdom.

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CALISCE '98

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This conference, held at Chalmers University of Technology in Gothenburg, Sweden, June 15-17, was the fourth in a series of international conferences held in different countries in Europe, devoted to the topic of Computer Aided Learning and Instruction in Science and Engineering. Since most of the institutions represented in the organizing group are the European Technical Universities, it would be more accurate to say "... in the Physical Sciences and Engineering". There were no life scientists represented at all, just lots of physicists, chemists, computer scientists and engineers. The tone was set by the opening invited speaker, the educationalist Ference Marton, world renowned for his work in the theory of learning, who also happens to have Chalmers as his home university. His paper, entitled "The University of Learning" posited that in a university, what students do (learning) and what academics do (research) are essentially the same process, and that any introduction of IT into teaching should take that fact into account in its design. His presence also had another effect. Most of the papers, particularly from the locals, showed evidence of relying on a background of educational research, and a strong emphasis on careful evaluation. Unusual indeed for a conference of this type.

Because of the preponderance of physical scientists and engineers there were very few

CAL-type tutorial packages in evidence, but much stress on simulations and professional computation tools. Among the computer science contingent there were several projects described which talked about intelligent tutorial systems and quite elaborate templates for employing them in developing teaching materials.

Australia was surprisingly well represented. Carmel McNaught, from RMIT, Melbourne, was one of the invited speakers, talking on "Evaluation Tools for Developing and Using Computer Facilitated Learning Environments". There were two others from Melbourne, one from Wollongong, as well as yours truly. What was all the more noticeable however, was the absence of representatives from the USA. Apart from one invited speaker, Mark Gudzial from Georgia Tech, Atlanta, there was no one. It is an unfortunate feature that many of us notice at international conferences — the great divide between Europe and the USA. They each have their own conferences, in isolation from one another. And often it is the Australians who turn up at both. Is there a niche role there for us as information brokers?

Anyhow it was a pleasant and informative three days. The weather was appalling, cold and wet, rather like the winter I thought I was leaving behind. The next conference in the series, October 1999, is in Sophia. Now there's a place to visit!

UniServe S C I E N C E W O R K S H O P

Friday 9th April, Saturday 10th April, 1999

at

The University of Sydney

Theme to be announced We are looking for web-related topics that we could use as a central theme or strands within a broader theme.

email suggestions to PhySciCH@mail.usyd.edu.au
or BioSciCH@mail.usyd.edu.au

UniServe Science Workshop: University Science Teaching and the Web

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UniServe Science held its 3rd annual national workshop on April 17-18, 1998, in Sydney. The theme was University Science Teaching and the Web. The workshop was attended by 85 tertiary science educators from around the country.

Prior to 1997 it would seem that most of the web usage in tertiary science education was carried out by the 5-10% of academics who were keen to try out new things and take risks. 1997 saw many more projects, involving the use of web-based teaching materials, being implemented. Sixteen of these were showcased at the workshop.

The two keynote speakers were deliberately chosen to complement each other. Shirley Alexander, UTS, covered the theoretical and pedagogical issues associated with Internet-based teaching and learning, while Peter Lee, Murdoch University, described the experiences gained through developing and implementing their entire Engineering curriculum for web-based delivery.

The programme was a combination of presentations, posters and informal laboratory

sessions. Presentations and posters covered: web-based assessment; the use of the web as a delivery mechanism to students within specific courses; ways in which the web may be used to fill part of the role of staff, such as, web-based delivery of practicals; web-based communication between staff and students; web-based teaching resources; the migration of traditional computer-based tutorials towards web-based delivery; and the use of student-created hypertext to increase understanding. The informal laboratory sessions were for attendees to pursue, with the presenter(s), any paper(s) of particular interest. These proved to be very useful as they allowed the presenters time to demonstrate their websites and/or web-based material.

As with most workshops the information and knowledge gained from the formal sessions were only a part of the valuable experience. This was a great opportunity to meet others and discuss, in an informal atmosphere, experiences with using the web in tertiary science teaching.

The proceedings of the workshop will be available from the UniServe Science web page <http://science.uniserve.edu.au/su/SCH/pubs/>

WebBytes



This space is reserved for your *WebByte*.

WebBytes gives you a chance to:

- find out what is happening in the use of the web in science teaching and learning;
- tell other educators about what you are doing in your own teaching using the web;
- exchange ideas and problems with others in the field;
- benefit from the experience of others; and
- contribute to the growing pool of web-based teaching resources.

Just submit a short report (200 - 400 words) on work-in-progress to

PhySciCH@mail.usyd.edu.au or BioSciCH@mail.usyd.edu.au
and we will include it in our next newsletter

Organic Chemistry Animated Reaction Mechanisms (ChARMs) Volume 1

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The *ChARMs* CD-ROM contains a set of animations depicting reaction mechanisms of a range of fundamental organic reactions, together with a set of *PowerPoint* lectures. It is designed for use by both students and academics.

The CD-ROM was reviewed on a Macintosh LC-630 (32 Mb RAM), a Macintosh 7300/200 (64 Mb RAM), and a Digital Venturis FX (Pentium 133 MHz, *Windows 3.1*, 32 Mb RAM). The package requires little (the appropriate version of *QuickTime*) or no installation and the accompanying "Read Me" file contained all the information required. The *ChARMs* program ran smoothly and quickly on the platforms above.

The layout of *ChARMs* is very clear and consistent throughout, and navigation through the package is intuitive. The program can be quit and recommenced at any stage. The animations are well constructed and a great aid to understanding of this conceptually difficult area of organic chemistry. The program is stand alone and cannot be modified. However, the

number of mechanistic classes that are covered is sufficiently wide that this is unlikely to be a difficulty — most undergraduates would find the content more than adequate.

The only criticism of this package lies in the fact that neither the objectives nor the prerequisites are made clear. This potentially makes it difficult for a student, as some of the material presented would be difficult without an adequate background in the fundamentals of mechanistic organic chemistry. In any event, some preparation by the student would be highly desirable prior to use of this resource.

The *PowerPoint* lectures included on the CD-ROM provide an excellent resource for an academic teaching such a course, but they do not appear to be tightly integrated with the *ChARMs* package.

Overall this is a good package and should be seriously considered for purchase both by instructors and students.

(See page 26 for product information)

3D Molecular Models Workshop Student Edition

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The CD contains a self-contained set of problems and answers on organic stereochemistry involving alkane conformation, R and S configuration, IUPAC nomenclature, E and Z configuration for alkenes, cis and trans configuration for disubstituted cycloalkanes and structural isomers for disubstituted benzene compounds.

The CD-ROM was reviewed on a Macintosh LC-630 (32 Mb RAM), a Macintosh 7300/200 (64 Mb RAM) and a Digital Venturis FX (Pentium 133 MHz, *Windows 3.1*, 32 Mb RAM). The package requires *QuickTime* (supplied on the CD) and can be run efficiently from the CD drive or loaded onto the Hard Disk.

The package tests concepts related to stereochemistry and nomenclature covered in a common first and second year organic syllabus. Detailed instructions on how to proceed through the package are provided and navigation within the program is straightforward. The application proceeds in a linear manner with no opportunity to return to previous problems within a set. The user cannot modify the package but can choose which set to do next. Minimal feedback is provided for incorrect answers. Students would find some questions relatively easy and progress to more difficult examples.

It is essential to read all of the instructions in the "Read about" file as some details on

navigation and what to expect next are not intuitive when the application is running. The ball and stick models are adequate but not outstanding although by clicking on them a more detailed space filling graphic appears. It would be difficult to answer the questions if the user was not familiar with the short hand way of drawing chemical structures. The scoring system starts with a mark of 100% and deducts marks for incorrect answers. One problem is that it is not clear how many marks are being deducted for a wrong answer until the final score appears (the number of marks deducted for incorrect answers varied). The overall score is an average of the best score for each category of question.

The range of questions is comprehensive, although it is not clear on the initial run through

the application what type of question was coming next. After completing a couple of question sets the pattern is repeated and this is no longer a problem.

Overall the package would be suitable as a revision or a diagnostic test for students who had a good knowledge of chemical structures and the concepts of structural and configurational isomers. The package does not appear to be directed at teaching these concepts and no stated objectives are provided with the package. There is software available for instructors for recording and collating student results but this was not reviewed.

(See page 26 for product information)

Chemistry Prelabs II

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Chemistry Prelabs II is a simulation package for chemistry experiments. It allows the user to practise experimental techniques in safety, before entering the real laboratory. There are 12 pre-labs on the CD, which covers basic experiments such as chromatography, corrosion of metals and acid-base titrations.

This program invited me (with an uncontrollably loud voice) to put on the required safety lab coat and glasses, pick one of the 12 first year level experiments on offer, and enter the virtual lab wearing my gum boots (well that's what it sounded like!) through a squeaky door. The virtual scene was graphical rather than a photographic image of a real lab.

I like baths so I chose to analyse Radox Bath Salts. A lab notebook gave me instructions on what to do next, and I had access to:

- a calculations book with spaces for me to insert calculations, with a calculator to help me;
- a techniques book with text and *QuickTime* movies describing a range of experimental procedures;
- an equipment book to describe the glassware I would be using;
- a chemicals book with brief safety information on each chemical I would use; and
- a glossary book with brief meanings for important terms.

This titration experiment required me to use a pipette to transfer 25.00mL of Radox solution. The only way I could do this was to click and drag the pipette to the volumetric flask and remove the solution directly from the flask. I didn't think this was good technique so I checked with the demonstration movie in the techniques book and was shown, more correctly, solution removed from a beaker using a pipette. One of the problems with using graphical simulation in a virtual lab is that there are inevitable simplifications. Whether they can reinforce or lead to poor technique is debatable.

I was able to click and drag my way through three titrations using a clever simulation of using a burette. However, in each case I was not encouraged, or able to:

- do a rough titration to find the approximate end points, without having to count it in my titre averaging;
- add solution with split drops; or
- read the burette clearly to two decimal places.

However, perhaps this fine tuning is best taught in the real wet lab, and the function of the simulation is to give a simplified overview. The videos on this and other techniques could be criticised by an analytical chemist for small omissions, and by a video producer for not showing sufficient close-up views, but once again, the fine technique details should come

later in real time, with directions from a real demonstrator.

The calculation protocol requires a stepwise progression of mini-calculations set out for the student, without any need for thinking. Not all chemists work this way - many accumulate the steps into one long calculation at a suitable point. This habit is recommended to avoid compounding rounding-off errors. I would also have preferred to see units associated with every quantity, and cancelled out, to encourage students to think about any unit conversions required, and as an internal audit of correct formula rearrangements. However, perhaps these calculations are also designed as an overview before students have to do the real thing in the lab on their own.

Despite some strange sound effects, a calculator that must be turned off before you can type in a result, and some pedantic criticisms of technique, this program provides a useful 'dry run' to a variety of common experiments. As such it is a good solution to the problem of encouraging students to preview an experiment

without stress, before they enter the lab with an over-zealous demonstrator looking over their shoulders.

[Author's response:

- Students are not expected to include titration results if they are not within the range required. Indeed the results will not be accepted if they use all values in such an instance.
- Burette readings are required to 2 decimal places - the last figure is always estimated even in the wet lab.
- Stepwise calculations are provided to assist those with low short term memory capacity in these early stages of tertiary chemistry.
- An important feature is that students may access the material at their own pace and when and as often as they wish in their preparation on either a PC or a MAC.]

(See page 26 for product information)

Electronics Workbench EDA

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The *Electronics Workbench (EWB)* appears to be your Virtual Electronics Laboratory of the 21st century — useful both in tertiary education as well as in (virtual!) prototyping. It is in fact an electronic simulation software developed by a Canadian company, around the analog *SPICE3* simulator kernel and extended by a smart switch level digital simulator. Version 4 has been on offer in 1996/7 but it can be upgraded now to an improved version 5. The product covers a range of options available at different prices. All are based on the same simulation kernel, have the same simulation power but have certain limitations.

Electronics Workbench Engineering pack — intended for simple verification of electronic circuits and equipped with:

- libraries of thousands of commercial components;
- facilities to import/export standard *SPICE* .cir files; and
- offering export to PCB (printed circuit board) design netlists files (for software like *OrCAD*, *Protel*, *Eagle*).

Electronics Workbench Education pack — aimed at tertiary users including laboratory classes and minor projects, offers only a 200 component library and no extended facilities.

Electronics Workbench Student pack — with a minimum component library and with limitation of circuit size to 25 analog components.

Electronics Testbench — an add on software tool for lecturers to generate multiple choice tutorials, including circuit files generated using the main *EWB* software.

Educational discounts are available.

EWB is very fast, faster than the conventional *PSPICE*-based simulators in mixed analog-digital simulation mode and it is very easy to learn and use. For those reasons only it can make even the Systems and Software stream students attracted to solving hardware problems — a phenomenon hard to believe though witnessed by myself on a number of occasions. Its limitations may not be noticed by users — that the laboratory is virtual, i.e. it is idealised. The noise is not present and the output plots (whether accurate or not) are produced with a wide choice of simulation parameters.

Therefore engineering users need their own good judgement and some caution.

From a teacher's perspective, the most important aspects are: the *EWB*'s rapid learning curve, its simplicity and the fact that it is 'unbreakable'. While the virtual world is slowly taking over, the maintenance of conventional laboratories used by multiple classes remains a costly aspect of teaching. A squad of workaholic technicians led by heroic academics may be put to rest by running all the usual instruments off the screen using *EWB* installed on a local network. Students will still be able to become familiar with: Waveform Generator, Oscilloscope, Multimeter, Logic State Analyzer, Logic Vector (Word) Generator, Bode (frequency response) Plotter and some sophisticated components like Analog-Digital Converters or an Arithmetic Logic Unit. They will not be discouraged by noise, faulty wires, dry soldering points and by difficulties resulting from their impatience or lack of common sense (they will be hit by the 'real world' later on when they have gained some experience).

EWB 4.1 offers schematic editor and analysis tools (instrument icons) with analysis options/parameters available from menus. Components, grouped in categories, unfold from toolbar icons. Semiconductors are backed by full models but may become idealised by ignoring/zeroing most parameters. Special devices, like controllable switches, analog multipliers, switchmode converters or nonlinear devices represent several lines of a background *SPICE* listing. Information on their detailed implementation is rather brief and users need to gain their own experience. There are other attractive features, such as: an attached window for description/comment, nested design hierarchy made available through user defined macros (subcircuits), functional (ideal) device models and even symbolic operators (from Ver. 5) like differentiators, integrators, s-plane filters etc.

Be aware that DC sources need several milliseconds to produce full output — like in a real laboratory (that software is realistic). Therefore to observe short transients — Transient Analysis option should be avoided or else the simulation can take an eternity. Use Steady State analysis option instead and apply repetitive excitation — as one would do in the real laboratory.

For a balanced review I may need to drop a few drawbacks: selection of components has a North American bias; only single instruments are available; and the rubberbanding tends to produce fractals. Other problems have been removed in Version 5: the drawing area is larger and

zooming is possible; the transmission line and pulse or piecewise sources are available; and separate DC or Fourier analysis can be run.

Version 5 offers access to most simulation and convergence options, to make regular engineers happy. For that reason, it is very different from Version 4.1 which offers access to two only: the number of iterations per timestep and the limiting accuracy.

Using either a 486DX-66, PentiumC90 or even Pentium Pro200 with small or large numbers of monitored nodes had little effect on the performance but the size of the circuit had. Generally as a circuit was approaching the size of the full screen, the simulator was struggling and would eventually give up complaining about too demanding iteration conditions (although I was already at the most relaxed end of the scale). Version 5 (32 bit) performed a bit better. Like in a real laboratory, problems may be avoided by developing circuits gradually, starting at a minimum complexity and using idealised models. This is because convergence difficulties are sparked by the accumulation of demanding or critical nodes in a circuit, especially when their requirements are contradictory (like the size of iterations for integrating components vs sharply nonlinear ones).

Which version should be purchased for a tertiary environment?

Purchase a few engineering packs for projects, both v4.1 and 5 (for undergraduate and for more advanced users) and get a quantity of educational packs just to run an undergraduate virtual laboratory.

Let students buy their own cheaper versions so that they could do their work at home as well. In order to allow the staff to generate tutorials and assignments, purchase a few copies of *Electronics Testbench*.

Is *Electronics Workbench Engineering* useful only for Electronic Engineers?

Yes, in the case of Version 4, BUT the new version 5 has general symbolic operators and may be used to model non-electronic systems. However the user needs to know the operation of the remaining electronic blocks to be able to utilise them.

(See page 26 for product information)

Interacting With Real-World Physics in a Web-based Learning Environment

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Background to the project

Among the challenges facing physics educators are the following characteristics of many students.

- Students often perceive that physics does not apply to their own lives.
- They develop their own conceptions about physical cause and effect relationships from their own experience. These conceptions often do not coincide with physicists' views and are very resistant to change.
- Students tend to separate the explanatory models they apply in the physics classroom from those they apply to their real-world experience.

Underlying many of the teaching strategies being explored by physics teachers is the desire to assist students to recognise the powerful insights physics offers in understanding their everyday experience. We seek to help students resolve conflicts between their prior conceptions and the accepted physics view and to integrate the physics understanding they gain during formal instruction into the conceptual framework they use to understand everyday events.

In this project we aimed to tackle this challenge by providing opportunities for students to construct their own understanding of physics principles from measurement of real-world events and exploration of the implications of physics for people involved in those events.

The project

This project developed a web-based learning environment in which students view closely, and analyse, short video segments of real-world events or key lecture demonstrations. The central feature of the environment is a Java applet, called *MotionWorkshop*, which the project developed for the analysis of video-clips. Use of *MotionWorkshop* is embedded in a library of modules that guide students' learning.

A strong thread in the design of this package is the opportunity it provides for students to visualise data in different ways. It attempts to cater for the diversity in the ways students learn by providing multiple representations of data —

as video images of object positions, numbers in a spreadsheet, or graphically, together with video interview input.

Features of each module

Introduction on the web

Upon selecting a module students are presented with a web document which provides some background to the context of the motion to be explored, outlines the requirements of the module, presents a short video of the motion to be analysed and solicits feedback from the student (via a web form) concerning their initial conceptions about the physics underpinning the event. This background acts as a springboard for analysing the event. The example we focus on here is the *Ups and Downs* module, in which students examine the motion of three balls being juggled.

MotionWorkshop

After launching the *MotionWorkshop* applet the student selects the appropriate video segment for analysis. Clicking on the chosen object in each frame of the video automatically enters the sequence of position data for the object into successive rows of the spreadsheet. For rotational motion it is possible to perform the analysis in polar co-ordinates.

After entering position data into the *MotionWorkshop* spreadsheet the student can then elect to display columns of data representing various parameters, such as velocity or acceleration, and choose the degree of smoothing to be applied when calculating these data. The video can be calibrated using the "ruler" shown in the video-clip. The student can choose to plot a graph of one or two of the quantities, and scale and/or shift the graphs to optimise their usefulness. The direction taken in this exploration is motivated by the key questions the student is seeking to answer about the motion. Throughout this process, the student makes decisions and sees their immediate consequences.

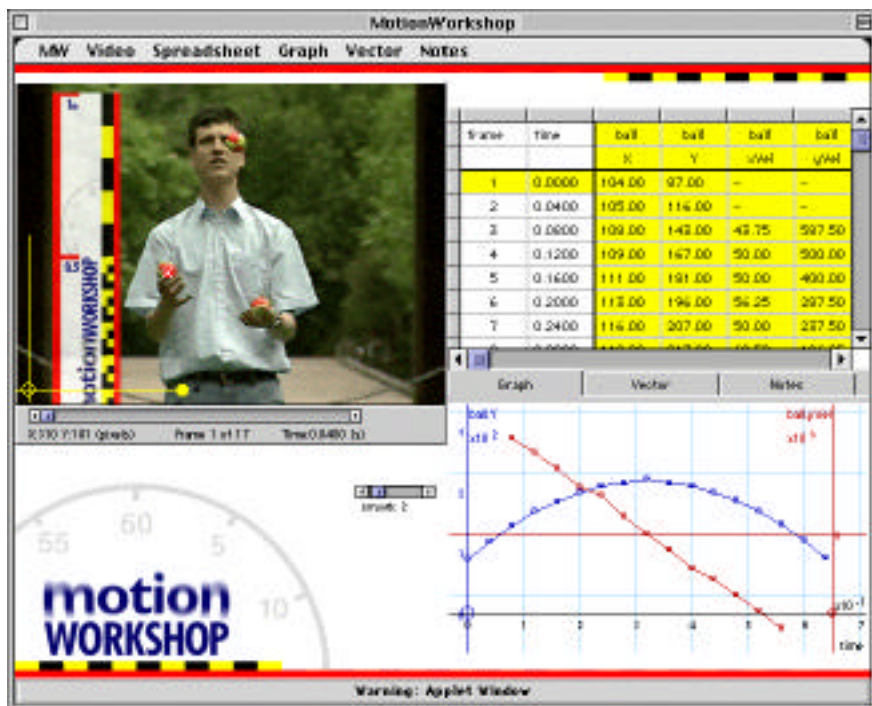


Figure 1. The *MotionWorkshop* screen, showing an analysis of the motion of a ball being juggled. The position-time and velocity-time graphs for the ball illustrate that the velocity changes at a constant rate and that its value at the topmost point of the ball's flight is zero.

Booklet Guide

Students use module booklets that guide their exploration of the motion, challenge them to think, to analyse, and to record their learning. The booklet provides a take-away record of students' learning. The degree of guidance varies from module to module depending on the explicit objectives of the exercise. For example, after a guided exploration of the juggling of three balls in *Ups and Downs*, a more open-ended exploration of the juggling of clubs is provided in *Juggling Physics with Clubs*.

Interviews

Where appropriate, the analysis activity is coupled with "virtual interviews" with the protagonist of the video clip. By choosing from a set of questions, and viewing previously

videoed replies, students gain insights into how the physics ideas apply in practice. Students can ask the juggler about how he uses a knowledge of physics (or lack of) whilst juggling e.g. "*Do you have to vary the spin of the club if you want to throw it higher?*" The question/answer process also allows the modules to prompt the student to further analysis.

Reflecting on learning

Students are encouraged to make reflective comments about what they have learned, the problems encountered and thoughts on the process. The booklet entries produce a record of what the student has done as well as providing feedback to us about learning outcomes and student impressions.

Modules developed so far include:

• The First Second	Measurement of a sprinter's acceleration while starting, and comparisons of acceleration with and without blocks.
• Ups and Downs	Motions of balls being juggled and bouncing balls are analysed and compared.
• Juggling Physics with Clubs	A more open-ended investigation of the apparently more complex motion of juggled clubs.
• Analysing a Golf Swing	Analysis of a multi-exposure photo of a golf swing focussing on the relationships between angular quantities.
• Magnets Moving Charge	Exploration of the induction of current in a coil as a magnet moves through the coil.



Students have responded positively to the opportunity to examine motion closely, especially when their analysis challenges them to change their understanding. Each of these modules is still undergoing development.

Due to the constraints of integrating *QuickTime* movies with Java, currently video-clips are delivered as a sequence of image files. With rapid Java developments it is expected that users will soon be able to analyse *QuickTime* movies, accessing the wealth of real-world movies accessible on the web, as well as their own productions.

Comparison with other strategies

Another strategy that is increasingly commonly being used to help students grasp concepts of motion is the micro-computer-based laboratory (MBL) approach. Students are able to move themselves or another object in one-dimension near an ultrasonic transducer that detects the distance between the transducer and the object. Computer software converts this information into graphs of position, velocity and acceleration that can be displayed on the screen in real time. We are in the process of comparing the nature of student learning using *MotionWorkshop* and this teaching strategy.

Continuing development

This project attracted further CUTSD funding for 1998, principally to enhance the capability of the *MotionWorkshop* software. Interesting real-world events are often described by vectors in three dimensions, for example rotational motion, so the spreadsheet is being expanded to include

the third dimension. More important is extension of the numerical modelling capability of the spreadsheet. New modules will enable students to analyse a real motion, attempt to model the motion on the basis of physics principles, display their model graphically and then refine their model to match more closely the real motion. This refinement process is expected to contribute to a deeper understanding of the physics of the motion.

The project resources can be found at <http://www.science.unimelb.edu.au/rwp/>

Acknowledgments

We have been very appreciative of the skilled Java programming of Duc Do Minh in bringing the complex *MotionWorkshop* applet to this stage of development. Duc Do Minh is currently the Information Technology manager of Commercial Interactive Media.

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An Interactive Multimedia Package to Assist Learning about Genetics and Gene Manipulation

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Introduction

Investigations in Australia, USA and the UK have demonstrated that students find the study of genetics difficult (Smith 1991), perceiving many of the concepts as abstract and the applications as having little or no relevance to their lives. Studies have also shown that

teachers find genetics among the most difficult of biological concepts to teach (Mitchell 1992). The limited understanding achieved by students stems from a variety of sources of conceptual difficulty, ambiguous use of terminology, potential confusions in graphic representations, predominant exposure to problem settings that test cause-to-effect reasoning without exposure

to problem settings involving effect-to-cause predictions. Similarly, rote application of algorithms has resulted in superficial learning with little deep understanding. Introductory genetics courses generally involve student numbers in excess of one thousand and assistance to individuals makes heavy demand on staff time. Exposure of students to computer-based activities has improved student learning outcomes (Kinnear, Martin and Novak 1982), and the significant changes that have taken place in technology in recent years has opened new opportunities and new ways of providing those activities.

Description of the project

The project developed an interactive multimedia package designed to enhance the teaching of genetics and have a positive impact on student learning. The aim was to introduce beginning biology students to basic structures and

terminology related to genetics, and to provide simulations that could act as alternatives to laboratory work and challenge their problem solving skills. The program has three modules: Chromosomes; Genes and Alleles; and DNA – the Genetic Material. Users can access a glossary of terms used in the program via a book icon present throughout the modules.

Chromosomes

After a brief introduction to prokaryotic chromosomes, the program concentrates on eukaryotic chromosomes. Aspects dealt with are: composition, structure, how many, and transmission. The Ideas are presented using human chromosomes and karyotypes as exemplars however self tests in this section and others include a range of organisms. Self tests take different forms, from the easy self check of terminology as presented in figure 1, to the more detailed questions relating to pedigrees, blood groups and linked genes.

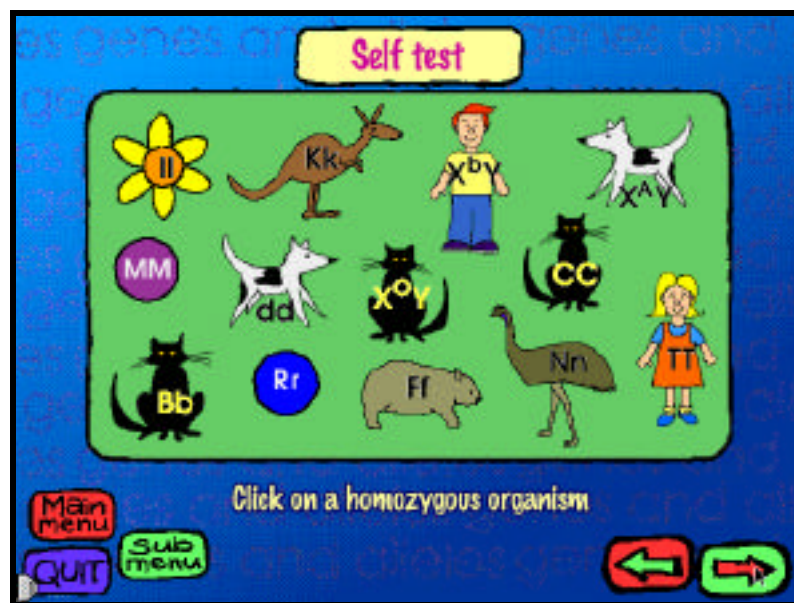


Figure 1. A straight forward self test that allows users to test their understanding of terms such as homozygous, heterozygous and hemizygous. The feedback on this kind of screen was either *Correct* or *Try again*.

A short movie showing mitosis is included in the transmission segment. Meiosis is briefly visited in this section and is revisited at the time linked genes are considered.

Genes and Alleles

Users are introduced to genes by the option of considering one or more genes with some of their alleles in context on each of the human chromosomes. Various relationships between genes and their alleles and the impact of the environment are explored. Genes are considered one at a time and then two at a time,

contrasting linked with unlinked genes. This module also contains two simulations – pedigree generation and blood typing.

Users are introduced to pedigree symbols and the pedigree characteristics for the four main modes of inheritance (for example refer to figure 2). Many students made special mention of this feature.

In the program, pedigree generation is based on a statistically driven mathematical model that operates in a way to ensure that each user receives a unique set of pedigrees for analysis. Each time the computer is asked to move to

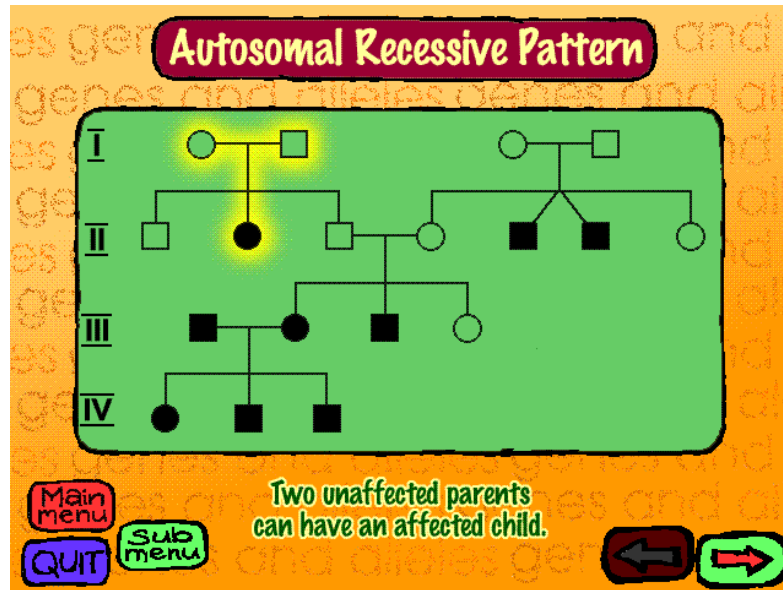


Figure 2. Users can investigate the pedigree patterns of each of the four main modes of inheritance before beginning the pedigree analysis simulation. A frame related to autosomal recessive inheritance is shown. Note that as *Two unaffected parents can have an affected child* appears, an appropriate segment of the pedigree flashes.

another trait, the choice is made randomly from the four possibilities. A user is in control of how many pedigrees are generated for any one trait before a decision is made about the mode of inheritance. Users can also decide how many unknown traits they investigate. Users may need four or five pedigrees before they have sufficient data to make a confident decision.

This activity is far more challenging than a pencil and paper task in which a single pedigree is usually given for a student to analyse. A single pedigree must be fully informative. Computer generated pedigrees are generally less well defined. Figure 3 shows the pedigree analysis screen of the program.

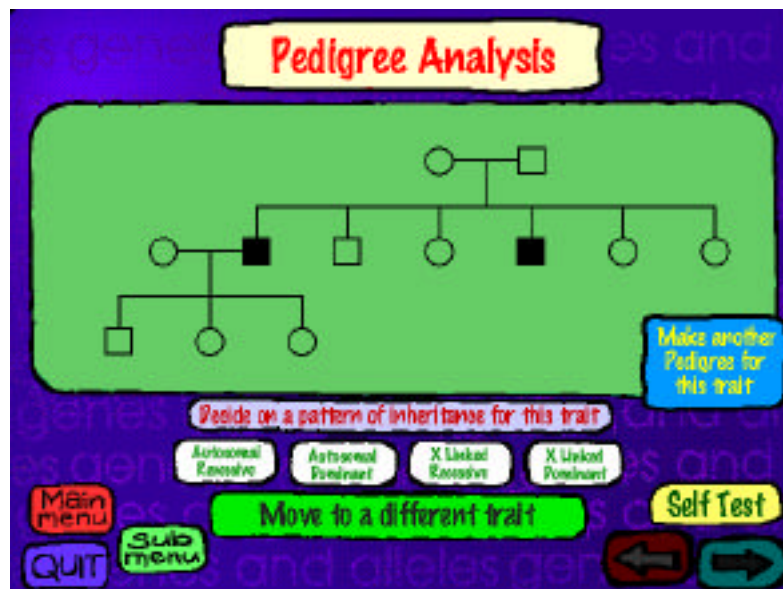


Figure 3. A sample pedigree analysis screen.

The pedigree self test takes the form of sets of multiple choice questions, each relating to a given pedigree. These self tests differ from the type shown in figure 1 in that users receive some feedback if they have chosen an incorrect answer. The feedback is such that the answer is

not given however, a comment is made that directs the user to some specific point about the problem. This type of feedback is given in a number of self tests, for example in a problem involving a gene with multiple alleles shown in figure 4.

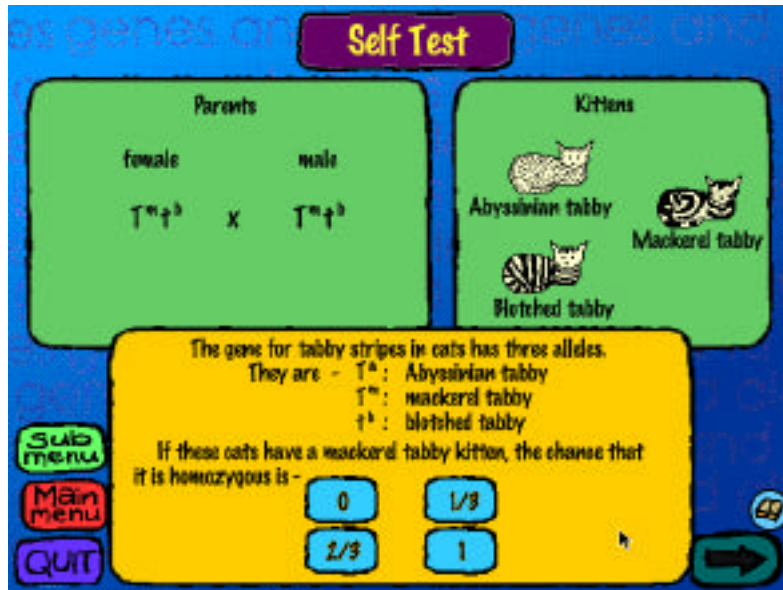


Figure 4. A multiple choice self test using an example of a gene with multiple alleles. If a user selects incorrectly, the feedback is *A mackerel tabby can be $T^m T^m$ or $T^m t^b$ but not $t^b t^b$.*

In recent years, blood typing has virtually disappeared as an activity in introductory biology courses. Computer simulation provides an opportunity for students to experience the analysis and problem solving that generally accompanied such activities. Blood typing of ABO and Rhesus blood groups is possible in the blood typing simulation. Testing of known

samples of blood is followed by unknowns. Note that there is a demonstration of antigen-antibody specificity for users who are unfamiliar with this concept. A sample screen of blood typing is shown in figure 5.

The blood typing segment also contains a comprehensive self test.

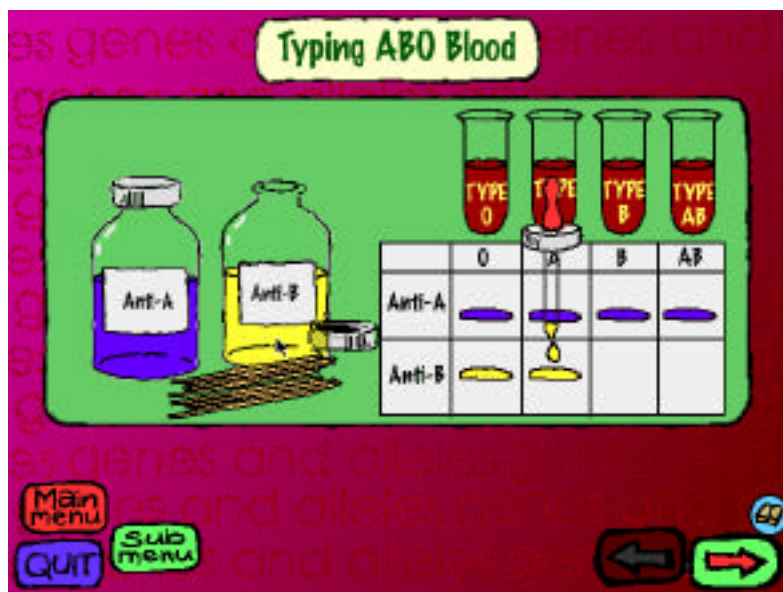


Figure 5. A simulation testing known samples is followed by the opportunity to test unknown samples of blood for ABO and Rhesus groups.

DNA – the genetic material

This module includes the structure, replication, changes in and manipulation of DNA. The latter segment comprises plasmids, restriction

enzymes, denaturing DNA hybridisation, PCR and gel electrophoresis with activities for some of the manipulations. One type of activity is shown in figure 6.

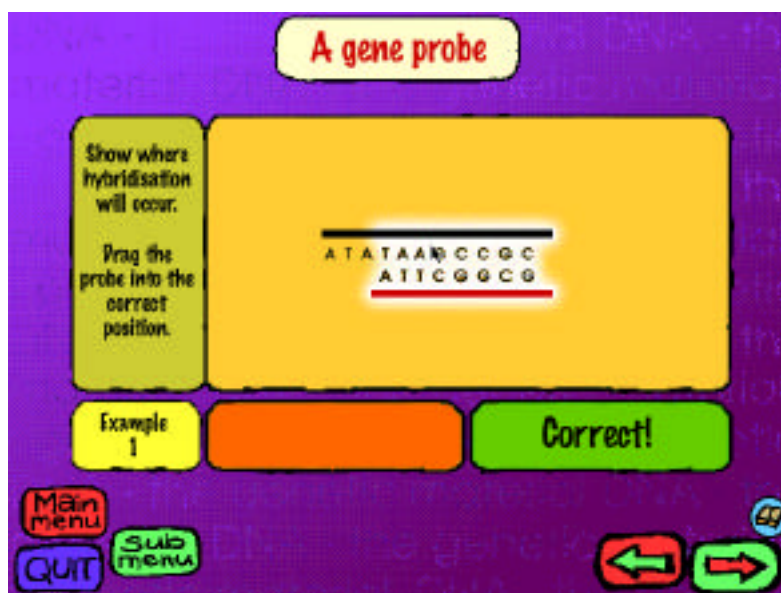


Figure 6. The manipulation of DNA segment contains activities such as the one shown in this screen.

Conclusion

This genetics package provides an overview of important areas in basic genetics courses. It was developed to introduce students to the learning of some sections of genetics in a more flexible way than is offered with pencil and paper tasks. In the formative evaluation of the program, feedback was obtained from university students who commented most favourably on their enjoyment in using the program. Over 92 per cent of students said they would use further modules of such a program.

The product

The CD-ROM developed is called *Genetics and Gene Manipulation* and is available for both Mac and IBM computer systems. It is accompanied by a booklet which outlines the contents of the program and includes a number of ten question tests. Each test focuses on either analysis of pedigrees or on blood groups.

The program was developed under a CAUT grant awarded to Marjory Martin, Dawn Gleeson and Judith Kinnear. Ruth Leslie was Research Assistant for the project.

All enquiries about the program should be directed to Professor Marjory Martin, Deakin University, email: mdm@deakin.edu.au

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Product Information

3D Molecular Models Workshop is available from:
 Jacaranda Wiley
 PO Box 1226
 Milton, Qld 4064
 Tel: (07) 3859 9755

ChARMs 1 is available from:
 Jacaranda Wiley
 PO Box 1226
 Milton, Qld 4064
 Tel: (07) 3859 9755

Chemistry PreLabs II is available from:
 University of Wollongong
 Northfields Avenue
 Wollongong, NSW 2522
 Tel: (02) 4221 4895

Electronics Workbench EDA is available from:
 Emona Instruments
 86 Parramatta Rd
 Camperdown, NSW 2050
 Tel: (02) 9519 3933

The Use of Computers in Teaching the Natural Sciences in Indonesia

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Abstract

The natural sciences are full of abstract concepts so that many of the students have difficulty in understanding some of the topics. Many of the teachers address this problem by doing demonstrations or showing films to their students. Nowadays, they also use computers for showing visualizations, where the software may be bought in the market or, for teachers who know programming, written by themselves. This paper will show the success of using computers in teaching the natural sciences in Indonesia.

Computers in secondary schools

Since 1989 the Department of Physics, Institut Teknologi Bandung, has introduced teachers of the natural sciences in secondary schools to the computer as a teaching aid in their subject area. Prior to 1989, the teachers learnt computer programming at Curtin University in Perth. Our program consists of two main activities. Firstly, 10 days training where teachers are introduced to computer programming in Turbo Pascal. Secondly, about three months later, we invite those teachers for another 10 days training to write simple visualization computer programs. There are 20 teachers involved in each activity and they come from different cities in Indonesia. Most of them come from Sumatra, Java, and Bali. The reason we focus on those three islands, is because the populations of the secondary schools are greater than on other islands.

The training itself is not carried out on the campus of Institut Teknologi Bandung, but in Pusat Pengembangan Penataran Guru Ilmu Pengetahuan Alam (Center of Development and Training for Teachers of Natural Sciences). In 1992 the training for teachers of Mathematics was delegated to the University of Gajah Mada in Yogyakarta, where the training is carried out in Pusat Pengembangan Penataran Guru Matematika (Center of Development and Training for Teachers of Mathematics).

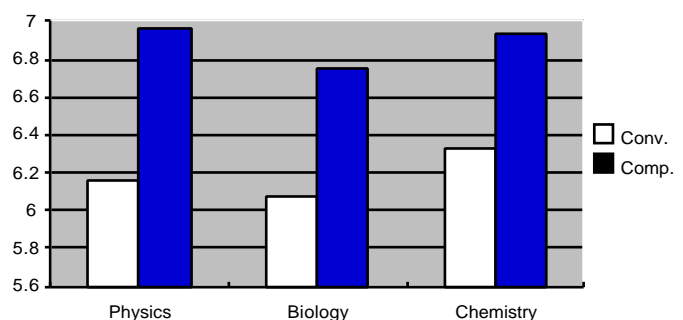
This program is not always smooth. Especially in islands other than Java, because many schools do not have enough computers or

the head of the school does not support the teachers' use of the computers for writing computer programs. The main problem is that this program is not found in the secondary school's curriculum. However, those teachers who realize the benefit of using visualization, whenever possible, will use visualization while they are teaching.

Within the first 10 days in Bandung, the teachers learn programming theory (40 hours) and laboratory activities (80 hours). Within the next 10 days they learn visualization theory (40 hours) and laboratory activities (80 hours), in which 40 hours is used for writing their own program. At the end of the program, teachers present their computer programs in front of the jury that consists of lecturers from Institut Teknologi Bandung.

Serious teachers, after they finish both programs, usually write letters or send email to us when they meet difficulties in writing computer programs. We always welcome such questions.

The following histogram shows average grades for Physics, Biology and Chemistry, from two classes, one which was taught conventionally and the other which was taught using computers. We see that grades for classes taught conventionally are lower than those for classes taught using computers.



Acknowledgement

Particular thanks to Ika Ayutrisno, a teacher of Physics in Surabaya, Hidayati, a teacher of Biology, and I Gede Mendera, a teacher of Chemistry, both in Palembang, who supplied me with the data.

Calendar of Coming Events

Distance Learning 98

August 5 - 7, 1998, Madison, Wisconsin, USA
<http://www.uwex.edu/disted/distanceconf/deconf.html>

ISL 98

Improving Student Learning Outcomes
September 7 - 9, 1998, Brighton, UK
<http://www.brookes.ac.uk/services/ocsd/ISLtop.html>
f.lam@brookes.ac.uk

ALT-C 98

Lifelong Learning on a Connected Planet
September 21 - 23, 1998, Oxford, UK
<http://www.tall.ox.ac.uk/alt/alt-c98/>
altc98@conted.ox.ac.uk

IN-TELE 98

Educational Uses of Internet and European Identity Construction
September 24 - 26, Strasbourg, France
<http://in-tele.u-strasbg.fr/content.htm>

ASBMB/ASPP

September 28 - October 1, 1998, Adelaide
<http://cal.fmc.flinders.edu.au/conference98/home.htm>
asbmb@camtech.net.au

OzCUPE4

October 1 - 2, 1998, Perth
<http://www.physics.curtin.edu.au/OzCUPE4/>
rlossrd@cc.curtin.edu.au

Telelearning 98

Riding the Winds of Change
October 11 - 14, 1998, Portland, Oregon, USA
<http://www.tgdlc.org/Markets/Telelearning/Telelearning.html>
cdalziel@aacc.nche.edu

ICCE98

Global Education on the Net
October 14 - 17, 1998, Beijing, China
<http://www.isi.edu/isd/icce98/>
icce98@center.njtu.edu.cn

Tel*Ed 98

Telecommunications and Multimedia in Education
October 29 - 31, 1998, New Orleans, USA and Victoria, BC, Canada
<http://teled98.openschool.bc.ca/>
<http://www.iste.org/Conferences/TelEd/1998/>

WebNet 98

World Conference on WWW, Internet and Intranet
November 7 - 12, 1998, Orlando, Florida, USA
<http://www.aace.org/conf/webnet/>
aace@virginia.edu

ONLINE EDUCA BERLIN

Technology Supported Learning
December 3 - 4, 1998, Berlin, Germany
http://www.online-educa.com/Web_pages/berlin98.htm
icefberlin@aol.com

ASCILITE 98

Flexibility: The Next Wave?
December 14 - 16, 1998, Wollongong
<http://cedir.uow.edu.au/ASCILITE98/>
ASCILITE98@uow.edu.au

SITE 99

Society for Information Technology and Teacher Education
February 28 - March 4, 1999, San Antonio, Texas, USA
<http://www.aace.org/conf/site/>
aace@virginia.edu

M/SET 99

International Conference on Mathematics/Science Education and Technology
March 1 - 4, 1999, San Antonio, Texas, USA
<http://www.aace.org/conf/mset/>
aace@virginia.edu

UniServe Science Workshop

April 9 - 10, 1999, Sydney
<http://science.uniserve.edu.au/>
PhySciCH@mail.usyd.edu.au

CATE 99

Computers and Advanced Technology in Education
May 5 - 8, 1999, Philadelphia, USA
<http://www.iasted.com/>
iasted@cadvision.com

World Wide Web 8

Eighth International World Wide Web Conference
May 11 - 14, 1999, Toronto, Canada
<http://www8.org/>
info@www8.org

ED-MEDIA/ED-TELECOM 99

World Conference on Educational Multimedia/Hypermedia and Educational Telecommunications
June 19 - 24, 1999, Seattle, Washington, USA
<http://www.aace.org/conf/edmedia/>
aace@virginia.edu

CBLIS 99

Computer Based Learning in Science
July 2 - 6, 1999, Enschede, Netherlands
l.deBruijn@tn.utwente.nl

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