GECKO: THE INTEGRATION OF MULTIMEDIA RESOURCES INTO THE TEACHING OF INTRODUCTORY BIOLOGY PRACTICALS

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ABSTRACT

The teaching of biodiversity and organism structure and function in large first year classes suffers from limited access to suitable specimens because of resource and logistic costs. As a means to address these problems we have developed, trialed, refined and implemented a computer package, called Gecko, using Macromind Director. Gecko provides easy-to-access, accurate information whilst encouraging independence in learning. We view Gecko as a tool that is integrated into practical classes rather than a stand-alone activity.

Gecko is ideal for practicals where students view a range of specimens to understand diversity and structure. We currently use this teaching tool in six practicals, ranging from plant diversity, reproduction and structure, to invertebrate diversity and structure, through to cell structure and division. The general structure of these practical sessions involves a series of tasks explained in a practical manual. This manual provides all the necessary information required to complete the task and enables students to work individually, at their own pace through the series of tasks in each practical. As a student completes the task he/she can check the computer, if necessary, to ensure their accuracy. Demonstrators are freed from addressing 'what is this' questions and rather can challenge students' understanding of the material.

Three cycles of observations of student learning during these practicals, together with student evaluations, suggest that the majority of students feel that these practicals helped them achieve their learning outcomes and that they were able to engage with the subject material more than in other practicals.

1. INTRODUCTION

First year biology classes are often large (> 200 students) and this can make it difficult for teachers to create a positive learning environment while promoting independence in learning. Furthermore, with large classes it can be difficult to assess whether students have gained the basic skills and knowledge required to proceed to the next step in their learning.

Through teaching introductory biology at the University of Wollongong we identified a number of areas as being particularly problematic. In this subject, students are required to gain an appreciation of the diversity of life, as well as the significance of the structure and function of organisms. To achieve these learning objectives students must observe a large number of specimens and learn many new terms. Some students find this overwhelming and/or tedious, and there can be a heavy demand on the teacher's time. Problems with some generic skills are also encountered which include designing scientific experiments, statistical analysis of biological data, and scientific writing.

To address these problems we redesigned the subject, keeping in mind the advantages of multimedia technology that have recently been highlighted for teaching in general (Laurillard 1992, Akerlind and Trevitt, 1995, Wilss 1997) and biology in particular (Gleadow *et al*. 1993, Franklin and Peat 1995). We recognised that different learning problems may require different teaching methodologies and felt that multimedia technologies may provided an appropriate means to address some of the problems we had highlighted.

This paper reports on one aspect of our redesigned program; facilitating the teaching of structure and function of organisms, and biodiversity during practical classes. Our aim was to increase students' ability to engage with the material, and enable them to work at their own pace, in a more independent manner.

2. THE PROBLEMS IDENTIFIED

There are obviously problems inherent with teaching large numbers of students; a logistic obstacle often encountered in first year biology subjects. It can be difficult for teachers to create a positive learning environment while promoting independence in learning with large classes.

Secondly, there are the problems specific to introductory biology. When studying biodiversity, organism structure and function, and cell biology, students must examine a diverse range of specimens and learn many new terms. The terminology is often overwhelming resulting in students experiencing frustration in practical classes. This combined with having to find the structure associated with the new terminology, compounds the difficulties. Resource and logistic limitations of the traditional 'wet' laboratory result in demonstrators being unable to provide help to all students with interpreting specimens, especially microscopic ones. This results in students spending time waiting for help rather than working effectively. It is clear from the errors in their reports that students frequently wrongly identify or label a significant proportion of their specimens. Except for material formally assessed, resources do not allow demonstrators to thoroughly check all the practical records of each student. The student will be preparing for exams with erroneous material.

We identified a number of other difficulties as well. Whilst not the focus of this paper these problems included, difficulties in experiencing experimental approaches to science and coping with standard statistical procedures, providing a mechanism for self assessment and revision, and providing students with demonstrators equipped with teaching training and experience.

3. REDEVELOPING THE FIRST YEAR COURSE

As an overview we present the five main changes that we are integrating into introductory biology.

1. A new emphasis on self-teaching of biodiversity, structure and function and cell biology by using multimedia technologies in conjunction with a detailed practical manual (detailed in this paper).
2. An increased emphasis on practical exercises involving data collection and analysis, including out of lab activities. This also involves the development of a series of self-teach multi-media tutorials on experimental design and statistical analysis currently being developed.
3. The development of a series of tutorials, in collaboration with the Learning Development Centre (University of Wollongong), which concentrate on scientific writing skills. Assignments in which students used the skills taught in these tutorials were of a significantly higher standard than previous years (Trevitt, Skillen and Rodgerson, in preparation).
4. A computer-managed assignment system. Currently this system, called 'Ralph', provides continuous monitoring for students and assessment of their revision. Plans are in progress to update this module to become more interactive. This will be the fourth major development planned once the above three components are in place.
5. A training course for demonstrators, particularly aimed at first year demonstrators. This course outlines how to encourage a deep rather than surface approach to learning, how to question students and provides realistic methods for demonstrators to help students achieve the objectives of each practical class.

6. A series of lectures that approach particular topics in considerable detail, perhaps more than first year students traditionally encounter. A number of other lectures are also given that inform students about current research being undertaken and current environmental issues. These enhance the interest of students in the subject.

Two first year biology subjects are involved in this restructure*:* the first subject is based on evolution, biodiversity and ecology and the second subject covers the structure and function of cells, tissues and organisms. The first subject has about 200 students while the second subject enrols about 400. Each practical class has around 80 students.

4. THE SOLUTION TO TEACHING BIODIVERSITY AND STRUCTURE AND FUNCTION

We developed and incorporated a significant program of self-teach modules into these subjects, which allowed staff to provide greater assistance in the conceptually difficult components of the subject. We felt that given adequate resources students would be able to explore organisms by themselves increasing their own interest in the module.

Central to this approach was the development of a resource package on the computer, which was available to students during a number of practical classes. These practical classes focused on biodiversity and structure and function of organisms where a range of specimens were viewed by students. Instead of the traditional printed 'pictorial atlas' to aid in interpreting the specimens, a computer package was developed which allowed a more interactive and independent approach to learning. With this resource, students were able to complete set tasks at their own pace and confirm their ideas using the computer program. Demonstrators, since they have been freed from repeatedly answering the same questions, have time to interact with students in a way which is more conducive to fostering a deeper understanding of the material. The extra resources provided by computer program also facilitate this.

This program was developed using Macromind Director and was called, *Gecko.* A template approach was adopted which allowed for easy incorporation of new material and improvements in subsequent years. *Gecko* has been through a number of iterations since it was first incorporated into the course at the beginning 1996. Student evaluation and new ideas have improved the modules each year. This is, naturally, an ongoing part of this program.

5. STRUCTURE OF A 'GECKO' PRACTICAL SESSION

The program is currently used in 6 practical sessions which involve looking at material and organisms, identifying features in the material and drawing specimens/slides. Other practicals teach students skills in carrying out experiments, dissections and research protocols and do not lend themselves to this learning tool. However, for practicals where students view a range of specimens to understand diversity or structure and function, this mode of teaching is ideal.

The practicals with computer modules are:

1. Plant structure
2. Plant reproduction
3. Cell structure
4. Cell division
5. Invertebrates (2)

The practical manual is the main learning tool for students during the self-teach practicals that use *Gecko.* The practical manual allows students to work individually, at their own pace, through the series of defined tasks. Each task is set out with background information as well as information to aid in the interpretation of the specimen. The quality and quantity of this information is critical since the practical manual is the primary learning tool. If students have

difficulty, or have completed the task, they may use the computer to check the correct answer. Not all tasks are found on the computer – only those specimens that the student finds difficult to interpret or are important features of the practical.

One of the advantages of the computer program is that a specimen that can not be obtained – (either it is rare, not available in that year or from an obscure habitat etc), can still be viewed and incorporated into the class. This allows for more complete consideration of each group and enhances the ability of students to generalise and recognise particular taxa.

Each computer module is self-contained but linked within the package through a frontispiece. Within this front section is a glossary for exploration. The glossary is also accessible from within each module but only for the words selected. Each module is menu driven and students choose a particular section and then a particular page within each section (Figure 1). Simple arrows allow students to move within any section of the module. Each page has a picture with labels that point to the feature when clicked. A double click opens the glossary which provides a definition for the word that has been double-clicked.

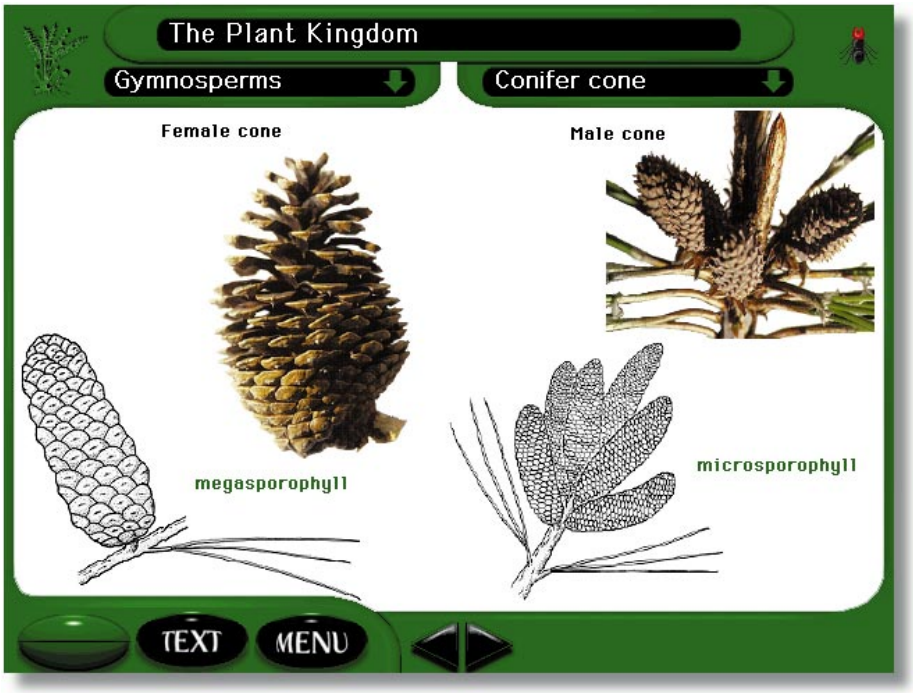

Figure 1: A Page from the module, The Plant Kingdom. This page, entitled 'Conifer cone', is within the section on Gymnosperms.

For some pictures, particularly slides and electron micrographs, a line drawing has been added. Students can use a scroll bar to change between the photograph and the line drawing. This enables features that are often difficult to see to be highlighted easily. For other pictures the line diagram is provided next to the picture (Figure 1).

A textbox can be opened on each page which provides a more detailed explanation of the material pictured (Figure 2). The idea of the textbox is to take students further than the practical manual or to emphasise particular points.

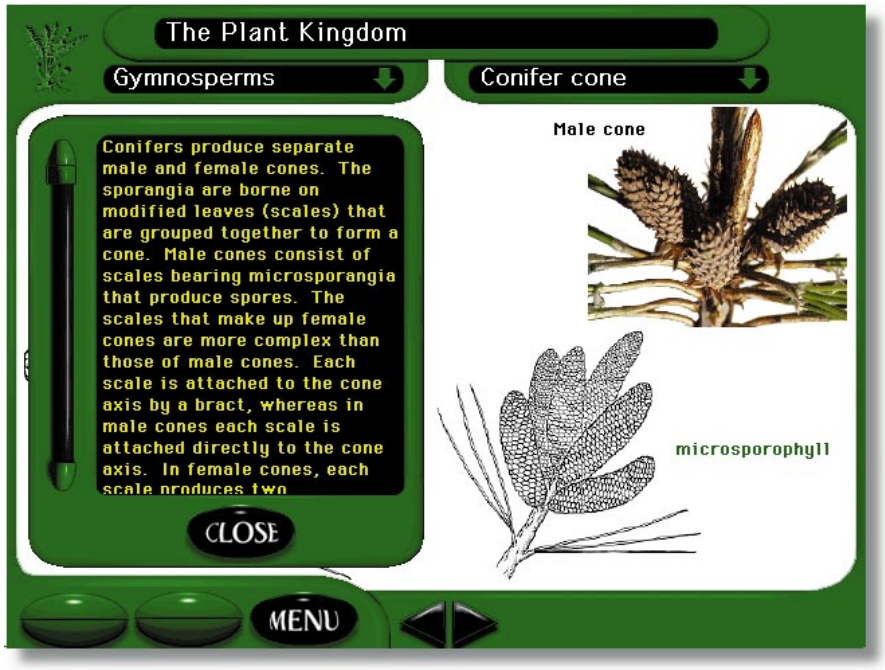

Figure 2: The Textbox opened on the 'Conifer cone page where more detailed information on the page can be viewed. The textbox scrolls down and can be closed.

6. ASSESSING GECKO

We assessed the project both quantitatively and qualitatively. In 1996 and again in 1998, we quantitatively assessed these practicals during the standard evaluation report for the subject. We have also assessed the project qualitatively through extensive observations of, and discussions with, students and demonstrators in practical classes.

One of the teaching difficulties that we encountered early in the development of each module was the necessity for a complete practical manual that matches the computer module. We initially found many students copying all information from the computer and making drawings from the computer before doing the exercise themselves. This tied up the computers and meant that demonstrators had to intervene in the time allowed on the computer. Wilss (1997) surveyed students using CAL and found that they had concerns over limited access to computers. Following discussions, it was realised that the practical manual was not giving enough information for them to complete the task. Whilst some students will always focus heavily on the computer package, we have always emphasised the importance of the practical component in the laboratories, stressed in the practical exam which only uses fresh specimens. Part of the difficulty lies in students learning to use the resource effectively. New technologies can cause stress in students and there is a need to train students to be self-directed (Akerlind and Trevitt 1995). Demonstrators and lecturers spend some time explaining the best way to use the system and encouraging students to move from computers when they have been on them awhile.

In 1996 and 1998 we assessed these practicals during the standard evaluation report for the subject. The initial results suggest that the computer modules helped the majority of students learn in the practicals and helped them enjoy the practical session more than other practicals. The information provided in the modules was considered useful with over 80% of students using the computers regularly. Students wanted greater access to the computers (currently 8 operate for 80 students) but it was likely that this was due to some students spending too long on computers gaining information which should have been in their manual. Feedback in 1998 was extremely positive.

7. LEARNING OUTCOMES OF THE REVISED FIRST YEAR COURSE

Students have an enhanced practical experience through variation in practical structure: some weeks are self-teach practicals with *Gecko* and other weeks have a more experimental approach. Students are better able to learn the various components of the course because each module uses the resources that are most appropriate for that module. For example, experimental design is best taught using tutorials, followed by a practical example of an experiment in a practical class, feedback from a report and then a repeat of the procedure to show improvement. Practical classes where many specimens need to be viewed and understood are best taught by allowing students to move at their own pace and allowing students their own time to consider, draw and check specimens. These practicals are ideal for the use of *Gecko.* The combination of resource material available in *Gecko* and the specimens available to study, facilitates a more thorough and accurate investigation. Students are able to self-correct their work and improve their accuracy by reference to *Gecko.*

Gecko has extended the number and nature of examples used in first year teaching of both biodiversity and organisms structure and function. For example, within the Echinoderms there is a new Order, Order Concentricycloidea, which is only found in the deep oceans. Information on this animal is available in *Gecko*, providing a more complete picture of the Echinoderms as well as a broader interest in the fact that new species are constantly being discovered from unusual places.

8. REFERENCES

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