INTERACTIVITY IN ON-LINE ASSESSMENT IN SCIENCE

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Abstract

The ability of students to interact with teaching material is a key feature adopted by academic staff and publishers as a method to enhance student interest when using resources prepared for web delivery. Multimedia presentations are also frequently used in university courses and students usually respond favorably to well prepared, visually stimulating material. It should be possible to use this same approach to enliven both formative and summative assessment tasks that are delivered via the web. We are developing modules for online assessment using the commercial package TestPilot [http://www.clearlearning.com]. In particular, we are incorporating freeware or shareware java applets into student assessment tasks. Our goal is to enhance the experience and performance of students undertaking any form of online assessment or web-based, interactive activity by providing a suite of tested applications that can be embedded into the assessment or online activity. Although browser plugins may be used for providing interactivity in web pages through packaged applications, we have found this is distracting for students who may not have the appropriate version on their home computer.
This paper discusses the criteria we are currently using to assess existing java applets for incorporation into online assessment in science subjects. We will present examples of java applets in tests and present details of the advantages and disadvantages of using these applets in different browsers and on different platforms. The approach we are taking is not dependent on the commercial software

we are using to deliver the online tests, but would be applicable to many of the online assessment tools available.

Introduction

Assessment and evaluation serves four main purposes:

- setting avenues and contexts for learning;
- monitoring learning and teaching through feedback;
- grading students' work;
- providing a means of measuring the quality of learning and teaching in the institution.

Assessment should be projected as a positive process providing challenging opportunities for students to demonstrate knowledge, understanding, skills and attitude (Biggs 1999; Brown and Glasner 1999). Assessment influences learning because students generally consider that topics assessed are the most important, both intellectually and for the purpose of harvesting marks. Thus, in a very real sense, what is assessed and how it is assessed drives student learning (Ramsden 1992). This is particularly true when students have limited time to study.

Why use the www for assessment? The CAA Centre [http://caacentre.ac.uk] has a repository containing papers that discuss the numerous advantages and disadvantages of using different web-based packages for assessment. This paper will not discuss the efficacy of the web for assessment but seeks to examine how to make such assessment more effective. Assessment is a learning experience for students and can achieve a considerable degree of improvement in student learning if used appropriately. The improvement discussed in this paper relates to students using web applications that can be embedded into the assessment activities so that more interesting and challenging problems can be presented to students in an online format.

Online assessment is often associated with simple multiple-choice questions (MCQ's), and the responses linked to recall rather than application (Maier, Barnett, Warren and Brunner 1998). This familiar situation can be improved when teachers are able to adopt well-established protocols for the construction of MCQ's (Airasian 1994; http://caacentre.ac.uk and http://www.up.ac.za/academic/medicine/cbt/test_setup.html). Many publishers now offer web sites that adopters of their texts can use and this often includes online test banks. The problem with these existing protocols is that the level of interactivity required from the student is very limited. The student normally reads the question, looks at the associated graphics or sounds and answers the question. It is rare for students to be asked to manipulate data with a helper application, or to be asked to construct hypotheses and test them before submitting a response. Although it is possible to construct questions that test synthesis and evaluation, it is very time consuming as the teacher is trying to "verbalise" abstract concepts that require a complex manipulation of ideas, data and visual construction.

It is worth reiterating a comment often made about the use of the www for learning and teaching. Web-based activities will not reduce the total time devoted to teaching or to learning. Both staff and students will spend a considerable amount of time and

effort either preparing or delivering material and interacting with the material. The benefit for staff is a more effective use of their time and resources, whilst for students the benefit is a better learning outcome for their efforts. The rationale for the use of the www for assessment should be to improve student learning outcomes.

Use of java applets

What are Java Applets? Java applets are programs written in the Java computer language [http://java.sun.com/] that most commonly use a www browser to run them. Java applets offer several advantages over other web-based applications, including:

- java applets run from the client-side, so are usually quicker than applications running on remote servers;
- java applets can use many of the multimedia formats, such as sound, animations and graphics, commonly available for the www;
- java applets can provide interactivity on the web without having to use complicated, sizable applications;
- java applets are reasonably platform and browser independent;
- java applets can access and share data on remote servers;
- java applets do not require plugins

Although these attributes contribute to the advantages of using java applets there are still a number of disadvantages associated with their use. Java applets use a java virtual machine to enable cross-platform compatibility, and this can be slow unless a reasonably recent, high end cpu and sufficient ram is available. A recent version of the browser is also advisable, as some features in recent java applets are not compatible with older versions of either Internet Explorer or Netscape.

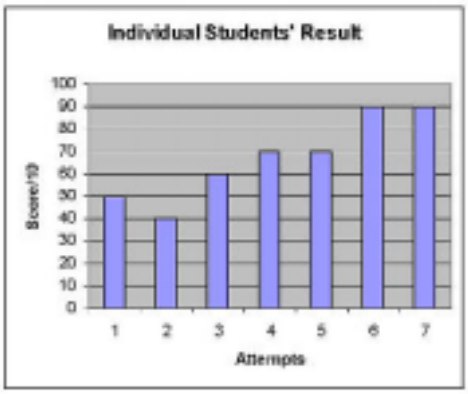
Why use java applets in teaching? Java applets can facilitate asynchronous learning since students are able to generate and manipulate data and exercise some control over the outcomes from a particular problem or concept presented to them. Students can analyze information and then use tools to test their hypotheses. In order to encourage the development of skills for effective life-long learning the teacher must present a learning environment that requires students to seek and use appropriate tools for synthesis and evaluation. This should facilitate the capacity of students to be reflective learners and to adapt their learning strategies on the basis of the feedback from the tools used to construct solutions to problems. By presenting students with tools that they can manipulate, the learning environment is enabling a level of student control, a necessity for a reflective and informed learner.

Java applets can be used to play “what if’ games. Students can explore consequences and results without having to be concerned that a staff member is analyzing their every move. Teachers can also use java applets for demonstrations in the face-to-face sessions with students. This activity is useful for illustrating the uses of the applets as well as explaining concepts. Laboratory simulations are particularly useful in this regard and the use of java applets to simulate a practical exercise before an actual laboratory session can increase a student's level of confidence when engaging with the real situation. Manipulations in real time are

usually more convincing as demonstrations compared to static, paper-based explanations.

One problem associated with the use of computer based assessment is that there is often a lack of consistency between the stated objectives for a task and the assessment presented to students. This occurs because teachers will express the stated aims in terms of, say, synthesis (putting knowledge together in a different way), yet only assess those skills that are readily converted into MCQ's. Java applets, because of their potential to allow students to explore trends and consequences by manipulating data, should provide opportunities for teachers to develop the complexity of the assessment task to include higher cognitive skills. By allowing students to take some control of their own learning goals the use of the java applets facilitates the constructivist approach to learning.

Use of java applets in chemistry



If than MCQ's testing recall it will need to motivate st activity. Students need to actively test ideas and c o make connections between numerous abstract c arlearning.com] is a commercial application that w ssessment to students in the Faculty of Science. It ith other commercial products that deliver online a directed towards a comparison of the various p protocols we are designing for staff in the d assessment attempt to minimise dependence on a nstructing our tests so that they encourage the re pg, pdf and html files that are called by the application rather than coding too much text directly into the application. The particular features of TestPilot as an application can be coupled with embedded Java applets to dramatically enhance the student learning experience. Our approach is that assessment should not be seen as an activity that takes place after learning, but rather assessment becomes an integral part of the learning process. It would seem reasonable then that all such assessment should be formative rather than summative, as this would reinforce the learning aspects for students. Our experience has been that the majority of students do not respond favourably to purely formative assessment modes. Given the time constraints that students are under with work, study and social activities, formative assessment is often given a lower priority compared to summative assessment tasks. We use a model that is a hybrid between formative and summative modes. Our online tutorials are delivered as part of a database so students are presented with questions at random from predefined categories. Students may attempt the tutorials as many times as they wish and their highest grade is used for assessment purposes. This encourages students to use the online assessment in a formative mode until they are satisfied they understand the concepts and what is being asked of them. An individual student’s results are shown over 7 attempts. A gradual improvement in performance is seen as the student revises the concepts.

What are the types of Java applets required for this enhancement in learning? We require applications that are relatively simple to use, but not simplistic. If students are required to spend many hours learning a particular package, yet will only spend a few hours using it, then the benefits are minimal for the time invested. The types of Java applets that Chemistry is presently using include 3 dimensional representation of molecules that can be rotated in real time (Figure 1a), an online scientific calculator (Figure 1b), a structure drawing package that allows students to draw chemical structures over the web (Figure 1c), spectral data manipulations (Figure 1d), graphing and statistical applets and a number of titration applets.

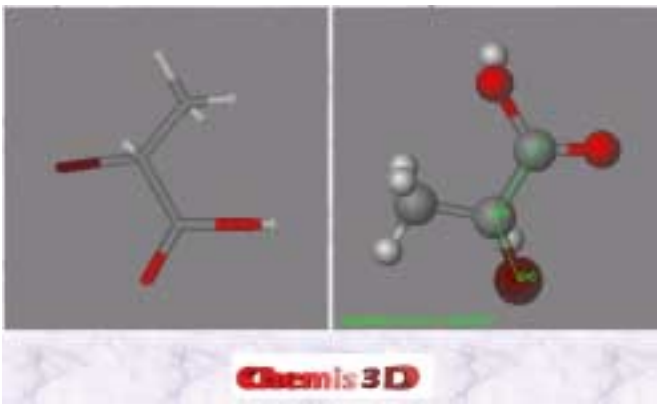


Figure 1a

Figure 1b

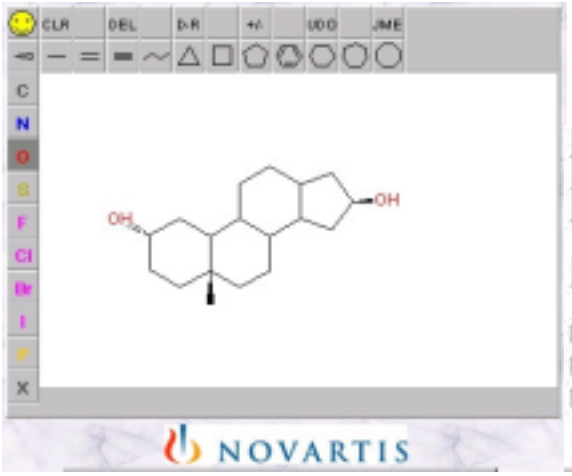


Figure 1c

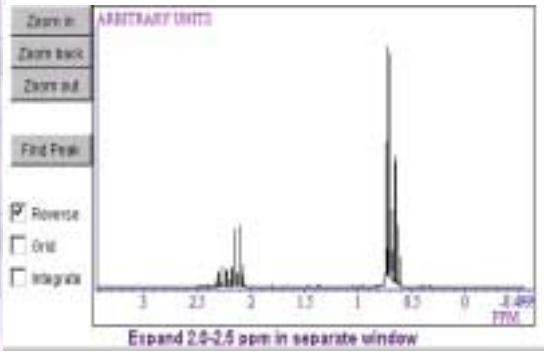


Figure 1d

For each of these java applets students typically required 1 hour of training to familiarise themselves with the use of the applets online. The structure drawing applet (Figure 1c) requires a longer training session to use all of the capabilities such as drawing reaction schemes and placing charges on atoms. We tend to stage the use of advanced capabilities in the applets for students in higher year levels in our programs. The training is not undertaken separately from using the applets in the actual tutorials, since students are able to complete the tutorials as many times as they wish with no penalty. They are able to "play" with the assessment package and its components as part of the learning process. This procedure also reinforces the

concept that students are required to seek information and appropriate tools in order to solve problems.
For the java applet showing 3 dimensional representations of molecules (Figure 1a) students cannot generate their own structures, this would require a more complicated application and many more hours of training. The purpose of this applet is to allow students to explore molecular shape in a 3 dimensional world and develop their understanding of how reactions occur in the "real world". These applets can be used in conjunction with graphic or sound files to generate the question, students then use the applet to manipulate data, explore possibilities or to generate an answer and then feedback is provided to students based on their particular answer. These applets are available free of cost for academic use.

The criteria we have used for using java applets in our online assessment are:

- the applet should be freeware or shareware;
- the applet must function in Internet Explorer 5 or Netscape 4.7;
- the applet must function in a Macintosh (System 8 or later) and Windows (95, 98, 2000) operating system
- the applet must provide an opportunity for the student to be able to interact with data or information and be able to generate a result that the student can use in assessment.

We have examined dozens of java applets over the last 18 months and many have not been used because they did not meet one or more of the above criteria. One of the major problems we have encountered is the incompatibility of some applets across operating systems. Some applets do not function correctly on a Macintosh yet function correctly on Windows, and some only function correctly in Internet Explorer version 5 and not on Netscape. Since one of the purposes for using the java applets was to minimise the technical intervention required from students, these issues have prevented us from incorporating some educationally useful applets into our assessments.

Use of java applets in other science disciplines

The Online Learning and Teaching Unit within the Faculty of Science has been examining java applets for other science disciplines. These may be viewed at http://ajax.chemistry.adelaide.edu.au. These have not been incorporated into online assessments at this stage as teaching staff in the separate disciplines are evaluating the effectiveness of the applets in their own courses. The range of java applets available for use in online student activities is quite broad and most are available at no cost for educational institutions or for a shareware fee.

Evaluation

Teaching staff should ask themselves about the appropriateness of particular java applets, and why they would like to use them? They should also address the critical issue of student training. Was adequate training provided for the students so that

they could use the applets effectively to improve their learning? Was too much time required to learn how to use the applet in relation to the time it was used? It is often easy for teaching staff to be impressed by digital material and visually stimulating online applications, but the real question that must be answered is whether it actually improves student learning.

We have performed a number of surveys of students and also monitored their use of the online assessment modules. A summary of student feedback from a first year chemistry class is shown below in Figure 2. We have not asked students to provide feedback on the use of java applets independent of feedback related to the online assessment. This is because we have not provided examples of online assessment both with and without applets to the same group of students. It is often difficult to measure absolutely a direct relationship between one variable, such as the use of java applets, and student achievement. We have found that in using the java applets and being involved in online assessment we now spend more time thinking about all our assessment and teaching activities and have developed our skills as teachers overall.

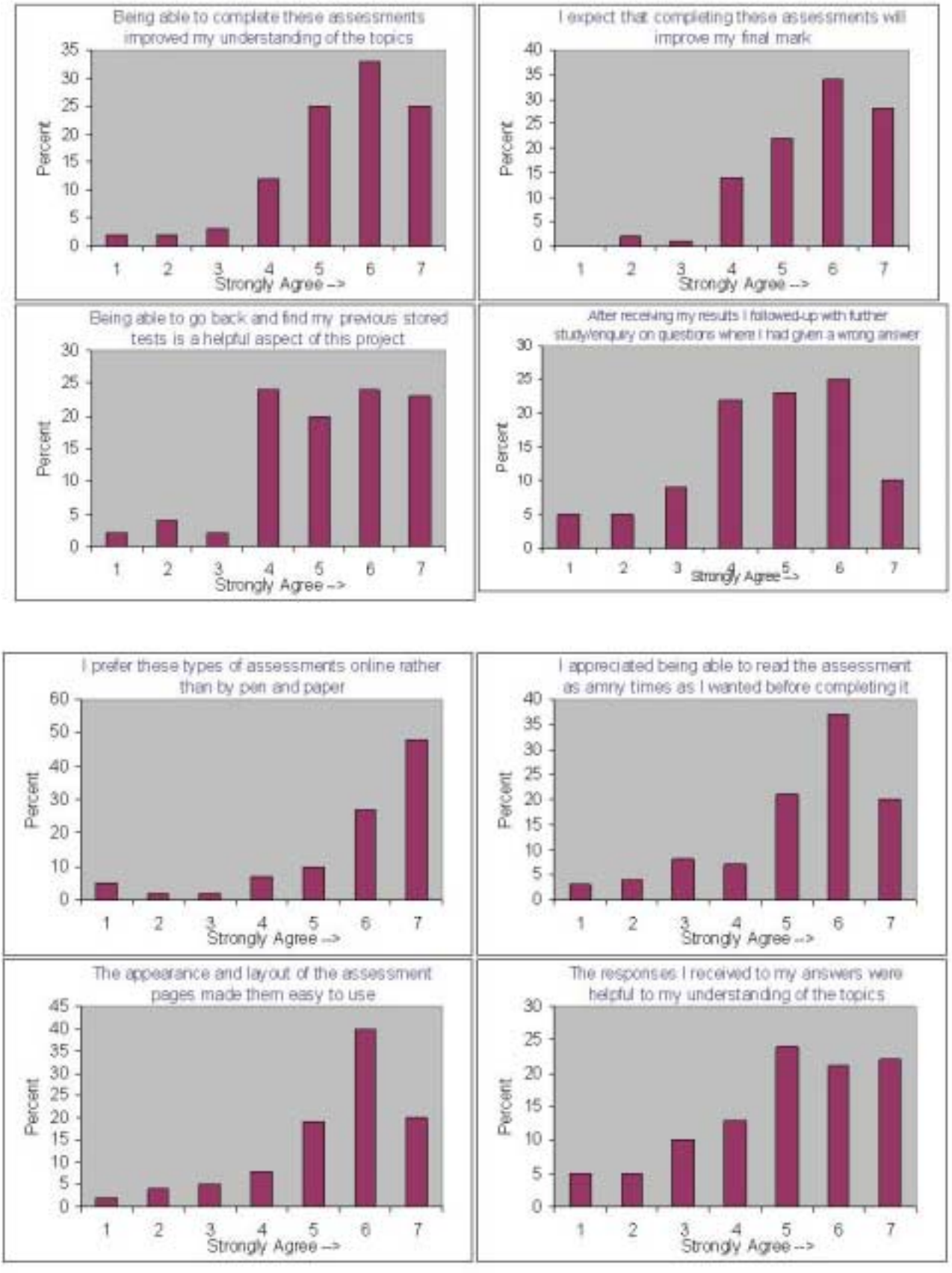

Being able to complete these assessments improved my understanding of the topics
I expect that completing these assessments will improve my final mark
Being able to go back and find my previous stored tests is a helpful aspect of this project
After receiving my results I followed-up with further study/enquiry on questions where I had given a wrong answer
I prefer these types of assessments online rather than by pen and paper
I appreciated being able to read the assessment as amny times as I wanted before completing it
The appearance and layout of the assessment pages made them easy to use
The responses I received to my answers were helpful to my understanding of the topics
Percent
Strongly Agree -->

Figure 2

Measures of student performance may then be a cumulative result of a number of variables, all leading to an overall favourable result. Students tend to respond positively to new initiatives, they may spend more time on an activity when it is novel. Since they are allocating more time to the activity their performance tends to improve. The efficacy of the use of java applets in assessment will need to be monitored over a number of years. One conclusion we have drawn from past teaching activities is that an improvement in student performance always occurs in the first year of a new project when staff are enthusiastic and funds are available for testing. This improvement gradually reverses over a period of 3-4 years if staff move on to other projects or funds for maintenance and reflective improvements are not available.

Since introducing online assessment modules, and more recently, java applets to our first year chemistry class we have seen a significant improvement in the final grades achieved by students, as shown in Figure 3. We now incorporate a 15% component for computer-based assessment in the final grades for these students. Part of the improvement is due to this change in the assessment procedure but we have also seen a corresponding improvement in the end of semester examination results for questions that are similar to those used over the comparison period.

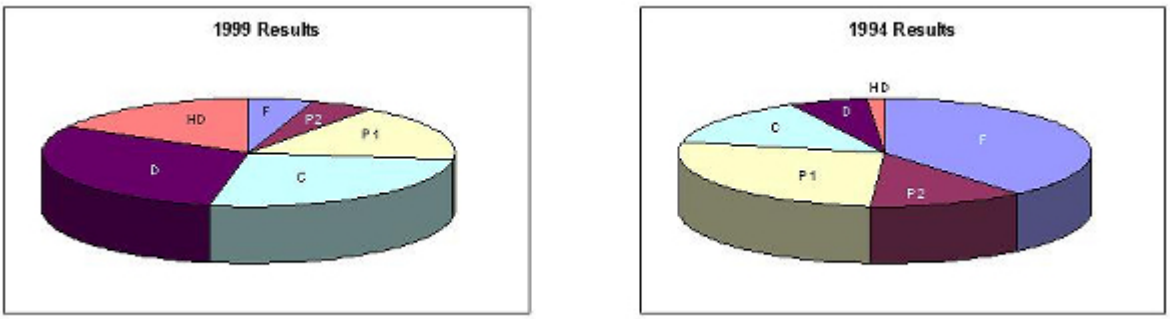


Figure 3

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