THE USE OF MULTIMEDIA IN INTERNAL AND EXTRAMURAL TEACHING

Chris Jesshope
Massey University

ABSTRACT

This paper describes the production and delivery of two courses at Massey University using web-based, multimedia material. One course is a first year computer science paper, which is delivered entirely in distance mode. The second example is a post-graduate computer science course delivered internally only, although making use of the same delivery techniques. The tools and methods used in the production of this extensive multimedia database will be described, and it will be shown that the effort in producing multimedia courses on CD is not prohibitive if the correct tools are used. These results have significant implication, to lifelong learning.

INTRODUCTION

This paper describes some experiments carried out at Massey University in the production and delivery of two courses using web-based multimedia teaching material. This experiment is the culmination of considerable prior research and software development in the automation of teaching delivery using computers, for example, Jesshope & Shafarenko (1997), Jesshope et al., (1998), Jesshope & Slusanschi (1998), Pearson & Jesshope (1988) and Jesshope (1999). The methods of teaching that we have applied are very similar to what has been named *Just in Time Teaching* (JITT) (Novak & Patterson, 1998).

The courses taught in this mode include a 100 level computer science paper, which is being delivered entirely at a distance. Students receive a small study guide of written material and a CD ROM containing a multimedia website that they can browse at their own pace and as required by the assignments. The CD is mirrored online. In the past, this course has been delivered using a written study guide and the course text only. The new delivery mode makes use of multimedia presentations taken on the students' own computers in their homes. The course is driven by a set of assignments, which are supported by the multimedia material. The multimedia 'lectures' are supplemented by worked examples again using recorded multimedia and voice-animated computer code.

The second example is a post-graduate computer science course delivered internally only, but in the same mode as described above. Previously, this course has been delivered in a variety of modes, including face-to-face lectures, video lectures at a distance (Pearson & Jesshope 1988) and, in 1999, using web-based multimedia. It is the 1998 and 1999 delivery of this course on which the results of this paper are based. We compare the results of receiving face-to-face, formal lectures, with those using the web-based multimedia presentations, which comprises some 20 hours of recorded lectures in multimedia format. The time freed up by using a computer-based, self-paced delivery of the instructional material was then used to provide tutorial support in smaller groups, where difficulties with the concepts were discussed and where problem-solving work was undertaken.

It should be noted that all of the multimedia material used in both of these courses is freely available on the World Wide Web (Jesshope, 1999b) and direct references to these online components will be given in lieu of reproducing static diagrams in this text. The reader is therefore expected to browse this material in conjunction with reading the paper.

Although this experiment was undertaken with internal students, the implications to online continuing or lifelong learning are obvious, as exemplified by our future use of this mode in the delivery of extramural teaching. Traditionally, education has been viewed, by a large number of professors, as the passive delivery of lecture material, but this has been shown to be ineffective (Hake, 1998). Using multimedia, our approach brings an expert in a given domain into the home of the learner, to act as a virtual instructor, mentor, and tutor on a one-on-one basis.

MULTI-MEDIA TOOLS

Clearly, there are advantages in using multimedia in education, but there are also a number of potential disadvantages, the main ones being the learning curve of the authoring tools and the time required in the preparation of the material. This is

estimated by professionals as requiring between 100 to 200 hours of preparation for every hour of presentation, which would have required up to 4,000 hours of preparation for the course described above. To put that in perspective, that is 500 days, or approximately 2.5 years of full time effort; that is one big disadvantage! The advantages, on the other hand, are pretty much self evident. A multimedia presentation provides the ability to utilise more than one sensory input in the dissemination of information. As an example, consider talking students through a complex diagram. In multimedia, as well as when teaching face-to-face, information is absorbed simultaneously by sight and sound. In reading, the reader's sight has to be continually switched between the diagram and the descriptive text, making it more difficult to assimilate the information. Another advantage is the ability to use interactive, animated diagrams in multimedia presentations, which is a very powerful learning aide not normally possible in face-to-face teaching. These advantages are very strong provided that the disadvantage in preparation time mentioned above can be ameliorated.

The next issue to consider is what a multimedia presentation comprises, how it is authored, and what tool to use for its preparation. Silgar (1999) presents a thorough introduction to multimedia authoring in his FAQ (frequently asked questions), in which he defines: "An Authoring System [for multimedia] is a program which has pre-programmed elements for the development of interactive multimedia software titles". Authoring systems vary widely in the following features:

- what they are capable of – for example, the media elements that may be utilised in the presentation (i.e. text, images, graphics, video, etc.);
- how they target end-users – for example whether they produce stand-alone programs or programs that are delivered by the World Wide Web, and if the latter case, how that material is reproduced and whether it uses streaming media (i.e. it starts to play before it has been completely downloaded);
- the authoring interface and the complexity of programs it produces and;
- how easy it is to learn.

Whether multimedia authors realise it or not, authoring is actually just a speeded-up form of programming, but the authoring tool simplifies this process. These tools vary considerably in the complexity of the programs they can generate and, generally speaking, the simpler the program the tool produces, the simpler the interface and the easier that interface is to learn. We can identify three different programming models used:

- *simple sequence* – this is the easiest model of authoring, components are organised in some strict sequence and, on playback, presented to the learner in exactly that same sequence;
- *control flow* – this model allows some form of choice in the presentation and, depending on some input from the learner, the sequence of the presentation can thus be customised to their needs; clearly this has significant pedagogical advantages;
- *concurrency* – this allows different actions to be active in different areas of the presentation at the same time; it is the most difficult to author and has little pedagogical benefit as it is mostly used to provides a gloss on a presentation.

In terms of authoring styles, Silgar (1999) identifies the following classification:

- *scripting language* – this is the closest to real programming and is difficult;
- *iconic/flow control* – this is an iconic or visual form of programming and is the easiest;
- *frame* – a combination of the above;
- *card/scripting* – like juggling a stack of post cards;
- *cast/score/scripting* – like writing an orchestral musical score – it supports concurrency (e.g. many instruments in an orchestra);
- *hierarchical object* – like object-oriented programming;
- *hypermedia linkage* – like 'what you see is what you get' Web editing and;
- *tagging* – like HTML Web editing.

When we started our investigations into Just in Time Teaching in 1995, there were no tools available that were suitable for the rapid production of the kind of material we had anticipated using. We therefore decided to develop our own tools, namely the AudioGraph, first a prototype (Jesshope & Shafarenko 1997), which was used at Surrey University and evaluated by Segal in 1997. Later we developed a more robust tool that could be maintained and used outside our own environment (Jesshope & Slusanschi 1998; Jesshope et al., 1998). These tools are now available from NZEdSoft (1999).

A companion paper by Gehne & Jesshope (2000) describes the technical details of these tools in more detail and also the future development of them following our experience described here in this paper. For this reason, we just classify the AudioGraph tools here according to the introduction above, based on Silgar 's (1999) FAQ. Thus the AudioGraph system supports audio, images, and graphics as its media elements, and generates presentations – which are strictly sequential – using an iconic interface. The main advantage of these tools is the shallow learning curve and the low ratio of preparation time to presentation time involved. The 20 hours of multimedia presentation prepared for the postgraduate paper required less than 200 hours of preparation time. This is still slightly over one month of full-time effort but compares very favourably with the 2.5 years projected by the experts. This fact turns the project from being a non-starter (academics have very little spare time for investment in this kind of activity) into a project that was feasible (if not stressful) as a 'spare-time' activity for the author.

Another major advantage of AudioGraph is that it produces streaming, web-based presentations that require a very small footprint on the web server. The latter is important if mounting many courses online. It is not just the storage that is at issue but the volume of data that has to be shifted. Also, having presentations embedded in an HTML environment allows for interactivity within the containing Web pages, and offsets the potential limitation of the strict sequentiality imposed by the AudioGraph's authoring model. Thus, its simple authoring model can be extended to arbitrarily complex presentations, using web-editing tools.

TECHNIQUES AND EXAMPLES

In this section, a number of examples are given of the different techniques used in the preparation of the above two courses. The presentation material can all be found at *http://www-ist.massey.ac.nz/~crjessho/html/teaching.html*. The two courses in question are 59.102 Computer Science Fundamentals, and 59.703 Advanced Computer Systems. The reader is free to browse both complete courses online from the Web page but this may require considerable time. This section, therefore, identifies each technique that has been used in generating the multimedia Web pages and points the reader to the appropriate Web reference in one of the above courses.

Indexed presentation units based on PowerPoint slides

The first example is the standard technique supported by the AudioGraph tools. To generate such sites, no additional web-editing is required as the pages are generated by the AudioGraph automatically. In this technique, a set of related presentation units are grouped together in a single Web page (the index) on a given topic. These index pages can themselves be further structured into sections or larger components of the course. Each presentation unit is based on a presentation graphic, in most cases a PowerPoint slide, although in some cases they are based simply on 'chalk and talk' techniques transferred to multimedia by using a pen-pad for input and in interleaving verbal explanation with the hand-written text or diagrams.

The student can navigate this material at will using the index pages, and while playing a presentation unit, can fast-forward, re-wind and replay any part of the material. As an example, refer to Lyons (1999) from the 1st year course in computer science described above. In this example, slides on three related topics are grouped into one index page. Each link will bring up a small presentation (from 1 to 5 minutes in duration) on a particular aspect of that topic, and the student is free to browse this material as required.

Larger presentation units based on many PowerPoint slides indexed using image maps

The second example is similar to the above, except that the index makes use of image maps and that some of the presentation units are based on many PowerPoint slides. It also introduces dynamic, animated diagrams, built using simple screen capture of the PowerPoint slides. For an example try clicking anywhere on the list data-structure in Jesshope (1999c) and exploring the rather long presentation. Here, each kind of data structure is supported by a mini-lecture of approximately 10-20 minutes duration.

It is important to note that because AudioGraph files are streaming media, the presentations start playing as soon as sufficient data has been received, usually just a few percent of the file if that file is large. Thus, there is no practical limit on the size of the presentation units. The data continues to download while playing the presentation. The student is free to stop playback and rewind in order to review material or fast-forward over unwanted material. During download, this only applies to the already downloaded portion of the file.

Presentation units based on pop-up windows

The third example can be retrieved from the same Web page above (Jesshope, 1999c) where, by clicking on the code icon, you can see the text of the code required to implement the particular data structure. This is perhaps the most interactive example in either of these courses. The student is prompted to read and understand the way in which the code works. If they do not understand any part of the code, simply by directing a click to that part of the code, they will pop-up a window within which a very brief (less than 1 minute) multimedia explanation of that portion they do not understand will be given. In this way the student does not have to listen to an explanation of the portions of the code that are understood but can be selective in finding explanations by clicking only on the required sections.

Presentations in pop-up windows based on arbitrary graphics

Another example is given in Jesshope (1999d), which uses a much smaller window size than is required for a PowerPoint slide, and which is based on graphics prepared in simple graphical packages. This example uses the same image map techniques to pop up mini-explanations on a given topic. Some of the presentations are quite animated in putting across their information.

Presentation units based on complex diagrams which are animated with highlights

A good example of an animated diagram that would be very difficult to put across in a face-to-face lecture is given in the last example. This example comes from the post-graduate course in Advanced Computer Systems and can be found at (Jesshope, 1999e). In a face-to-face lecture, the lecturer would use a presentation graphic, perhaps a PowerPoint slide or similar, and talk the student through the diagram using some pointer device, like a laser pen. In this AudioGraph presentation, there is a very flexible pointing technique using a highlight, which is a transparent block of colour. In this example you will note that the diagram is animated using complex groups of such blocks, which track the key features in the diagram. This provides much better attention focussing than any pointer device.

RESULTS

This section gives some qualitative and quantitative results from the experiment of running the post-graduate paper internally using the multimedia material outlined above.

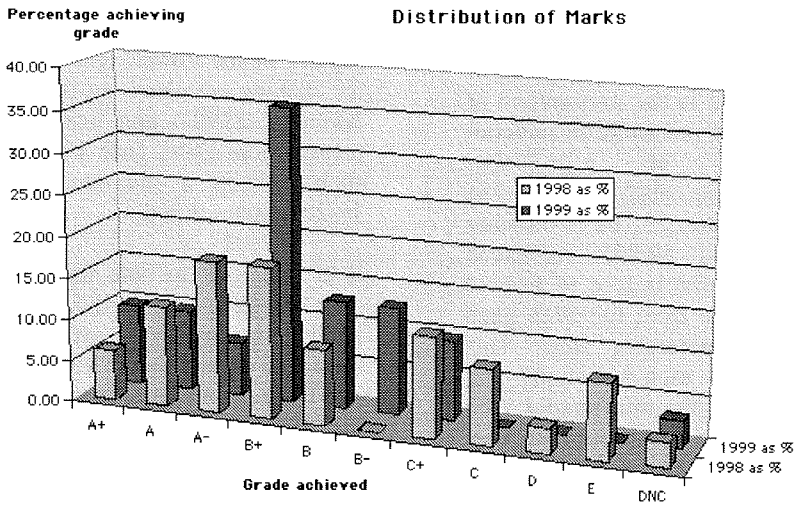

Figure 1. Showing the marks distribution for the control group (of 33) in 1998 and the experimental group (of 31) in 1999.

In 1998, the control year, the paper was offered using a mixture of face-to-face and remote video lectures. The same course was given in 1999 using AudioGraph, web-based multimedia material, backed up with small tutorial groups. The results from these two cohorts of students are summarised in Figure 1, according to the percentage of the class receiving a certain grade. While these results are certainly not conclusive, due to the relatively small samples (31 and 33), they do give an indication of a certain improvement in learning. There is a substantial improvement of the average mark for the class from a GPA of 4.0/8 in 1998 to 4.7/8 in 1999. Moreover, the most surprising result was that in 1999, with the exception of one student who did not complete the course, all students received a C+ grade or better, whereas in 1998 the failure rate was about 12%.

Another difference in the results is seen as a modification of the distribution from a bimodal one (1998) to a more normal one (1999), which seems to be characteristic of a shift from face-to-face to self-paced learning, when the input ability to a course is mixed. Exactly the same shift in the distribution of the results was seen in trials based on the prototype AudioGraph (Jesshope & Shafarenko 1997), which was evaluated by Segal in (1997), although the distribution of students' results for that experiment were never published.

At Massey University, we have a formal system for providing feedback from students via questionnaires. The detailed results of this process are confidential, and it is only possible to summarise the results here. The evaluation for this paper gave an average quantitative response that was above (or in some cases well above) the neutral response in all categories. This shows, at the very least, an acceptance of, if not a preference for, this mode of delivery compared to the face-to-face delivery of lectures. In the qualitative feedback, comments were received that showed quite different learning patterns using this material. Some students thought the extensive use of verbal comment was not so helpful, and found the visual aids usually sufficient to understand the material, whereas others found the verbal comment and the ability to replay these, of great help in assimilating the material. It is surmised that these represent the extremes of the class in learning ability, and clearly indicates the advantage of self-pacing the delivery.

It is interesting to project these results onto the characteristics of typical lifelong learning situations. The concept of just in time teaching is quite appropriate in this situation. Courses are likely to be taken on demand rather than in institution-designed programs, and the input ability is likely to have a high standard deviation, exactly as in our experiments described above. These are the situations where the use of multimedia material excels, not only due to the self-paced nature of the delivery but also because of the ability to link together a whole corpus of related material to provide background for the lower quartile of input ability and to stretch the upper quartile.

CONCLUSIONS

AudioGraph multimedia recorded lectures have been used in the delivery of two courses at Massey University, both in internal and extramural modes. From this experiment it has been shown that multimedia preparation time is nowhere near as time consuming as multimedia professionals would have us believe, providing the correct tools are used. We have also seen a very positive response on this experience in both feedback from the students involved and also in the results that they have achieved. Finally, we have discussed the applicability of these results to lifelong learning scenarios.

REFERENCES

Gehne, R., & Jesshope, C. (2000) Tools for the production of small-footprint, low-bandwidth, streaming multi-media for distance education. In Lifelong Learning. Selected papers from the inaugural international Lifelong Learning Conference sponsored by Central Queensland University, at Yeppoon, Queensland, Australia, July 17-19. Rockhampton: Central Queensland University.

Hake, R.R., (1998). Interactive-engagement vs. traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses, American Journal of Physics 66. 64-74. Retrieved from the World Wide Web: http://www.physics.indiana.edu/~sdi>http://www.physics.indiana.edu/~sdi

Jesshope, C.R. & Shafarenko, A., (1997). Web Based Teaching: a minimalist approach. Proceedings of the Second Australasian Conference on Computer Science Education, (pp 16-23). New York: Association for Computing Machinery.

Jesshope, C., Shafarenko, A., & Slusanschi, H. (1998). Low-bandwidth multimedia tools for web-based lecture publishing. IEE Engineering Science and Educational Journal, 7(4), 148-154. Also published in IEE Computing and Control Engineering Journal, 9(4), 156-162; and on the World Wide Web: http://forum.iee.org.uk/forum/library/

Jesshope, C., & Slusanschi, H. (1998). Distance Education Using the AudioGraph Authoring Tool, Proceedings of the International Conference on Multi-Media Information Systems in Practice, Hong Kong, Dec 1998, (pp 266-278).

Jesshope, C., (1999). Web-based Teaching – Tools and Experience. Australian Computer Science Communications, 21,(1), 27-38,

Jesshope, C. (1999c). Recursive data structures. Retrieved January 28, 2000 from the World Wide Web: http://www-ist.massey.ac.nz/~crjessho/foundations/Audiographs/Data/recursive.html

Jesshope, C. (1999d). Networks. Retrieved January 28, 2000 from the World Wide Web: http://www-ist.massey.ac.nz/~crjessho/foundations/Audiographs/Networks/Concepts/index.html

Jesshope, C. (1999e). Power PC 620. Retrieved January 28, 2000 from the World Wide Web: http://www-ist.massey.ac.nz/~crjessho/comp_arch/audiograph/outoforder.%C4/outof020.htm

Lyons, P. (1999). Computer Systems. Retrieved January 28, 2000 from the World Wide Web: http://www-ist.massey.ac.nz/~crjessho/foundations/Audiographs/CompSyst/Index.htm

NZEdSoft (1999). AudioGraph Home Pages. Retrieved January 28, 2000 from the World Wide Web: http://www.nzedsoft.com/

Novak, G., & Patterson, E. (1998) Just-In-Time Teaching: Active Learner Pedagogy with the WWW, paper presented at the IASTED International Conference on Computers and Advanced Technology in Education, May 27-30, 1998 in Cancun, Mexico: Retrieved from the World Wide Web: http://webphysics.iupui.edu/JITT/ccjitt.html>http://webphysics.iupui.edu/JITT/ccjitt.html

Pearson, M., & Jesshope, C. (1988). Multi-campus teaching using computer networks. Proceedings of the Third Australasian Conference on Computer Science Education July 1998 (pp 106-111).

Segal, J. (1997). An evaluation of a teaching package constructed using a web-based lecture recorder. Association for Learning Technology Journal, 32-42.

Silgar, J. (1999). Multimedia Authoring Systems FAQ Version 2.23. Retrieved January 28, 2000 from the World Wide Web: http://www.tiac.net/users/jasiglar/MMASFAQ.HTML