Measuring Student Use of Electronic Books

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Abstract

Policy documents within Charles Sturt University (CSU) have recommended the change from the traditional print based method to electronic delivery of instructional material by the year 2000. While there is some discussion in the literature of the viability of electronic books, much of it is speculative. It appears that within the upper management levels of CSU at least, it is taken for granted that electronic delivery of educational materials is a more desirable alternative than the present arrangements. In 1993 the first electronic book was used at CSU to replace printed teaching materials. The results of a pilot study led to modifications and a more extensive study in 1995, of how students actually use these teaching materials. This paper considers issues for the design of electronic books as teaching materials in the light of student use, including the problem of how such use can be measured. While not all of the data have been analysed, the results of the pilot study as well as a preliminary analysis have important implications for organisations such as CSU that are making plans for electronic delivery of instructional material. The discussion focusses on the particular project in question but results could easily be generalised to other situations such as using the World Wide Web and electronic publishing as a whole.

Keywords

distance learning, hypermedia, multimedia, electronic books

1. Distance Education (DE) at Charles Sturt University

CSU is a regional university in New South Wales with campuses at Wagga Wagga, Bathurst and Albury and designated as a Distance Education Centre (DEC). More than two-thirds of its 15,000 students are enrolled in the DE mode and it is one of the largest providers of DE in Australia. Like most other DECs, CSU provides its students with printed study materials, supplemented, where appropriate, by a variety of other resources. In most courses, students are also expected to attend residential schools which are conducted as part of the requirements for hands-on experience. Usually, this involves the students travelling to one of the campuses for periods of up to five days per subject or to some arranged location where the academics associated with the subject conduct the residential school.

Although extensive electronic communication facilities have existed for some time, few courses have used them regularly. The Graduate Diploma of Applied Science (Information Technology) was the first course in Australia to require regular student interaction using electronic communications for all subjects in the course. This has been used to supplement traditional printed material since 1984.

In early 1994, the university planning committee began the task of developing a strategy for the use of technology (Rebbechi and Barnard, 1994) as a means of changing the delivery not only of face-

to-face teaching but also of DE. While the finishing touches to this policy document are still being discussed at the time of writing this paper, the major directions are already clearly defined. The philosophy of this document coincides with Brown's (1994) contention that 'popular consensus points repeatedly and suspiciously toward the trend away from the primacy of print'. The impetus for the report however, appears to be driven more by political and economic imperatives than the desire to improve the educational delivery process. The migration from print-based media to electronic media has already begun. Trials with electronic books for the last two years should see the Graduate Diploma of Applied Science (Information Technology) as the first course in the university to be offered fully electronically by the middle of 1996. The establishment of a multimedia unit within OLI and pilot subjects such as the Grape and Wine Production (WSC110) multimedia project have demonstrated the desirability of this medium as one of the replacements for the current print-based learning materials.

The technology strategy aims, by the year 2000, to have moved as many as 1200 subjects currently being offered using print-based materials into a variety of electronic formats that range from electronic books with hypermedia links through to Internet-based material and full multimedia systems. The electronic format to be used will depend both on the educational requirements of the subjects and the resources available. The strategy aims to redefine the process of distance learning as we have come to understand it at CSU, not only through the use of electronic materials but also through new modes of interaction that are afforded by this technology.

2. Electronic Books

The range of features to be offered to learners may be demonstrated by considering two of the subjects that have been converted into electronic format. Foundations of Programming is a subject offered to first semester students in the Graduate Diploma of Applied Science. In the past, the study materials consisted of a Study Guide which progressively developed the material in association with the textbooks prescribed for that subject and a Subject Outline which contained all the administrative matters as well as assessment material. The electronic book version of the Study Guide is shown in figure 1.

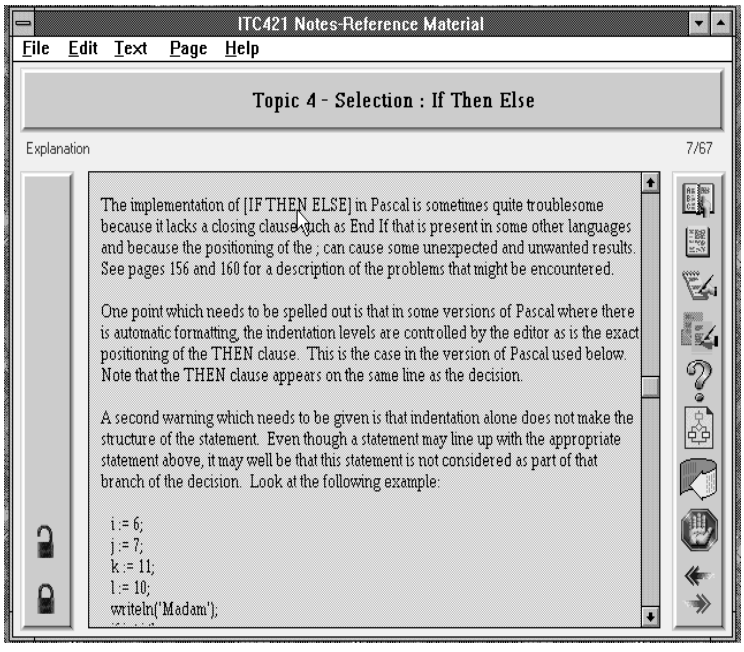

Figure 1. Sample screen from ITC421 electronic book

Apart from the obvious fact that the text now appears on the screen associated with a set of buttons, everything else is much the same as in the printed version. In the studies associated with the use of this format (Messing, 1995) the subject content was deliberately kept identical to the printed version. What is new is the presence of embedded links to the examples and the additional functionality provided by the buttons. Students are able to view the objectives of each page, see a list of all the exercises they are expected to complete, add their own notes about any aspect of the material and view any graphic material associated with that topic. All of these are available using the printed medium.

Additional capabilities exclusive to the electronic format include the ability to unlock the text, thus allowing students to cut, copy or paste sections of the study materials both into the same document and into other documents. This also permits students to add annotations alongside and amongst the text of the original material. The hypermedia links provide quick access to a reference section and the various exercises that accompany the study guide. Students are also able to make their own links to various locations within the document.

This level of conversion to electronic format is relatively easy to achieve; many of the tasks such as indexing of the topics are automated so that a single command will generate a complete table of contents.

Grape and Wine Production on the other hand is a subject demanding high quality pictures and video material. The printed study guide consisted largely of self-contained text-based notes with no textbook. This is one of the introductory subjects in the Wine Science course which is held in high regard both in Australia and overseas. In 1994, with the assistance of funding from the Universidade Catolica Portuguesa, a multimedia version of the teaching materials was developed as a trial of the viability of such a medium. Figure 2 shows one of the screens from the package.

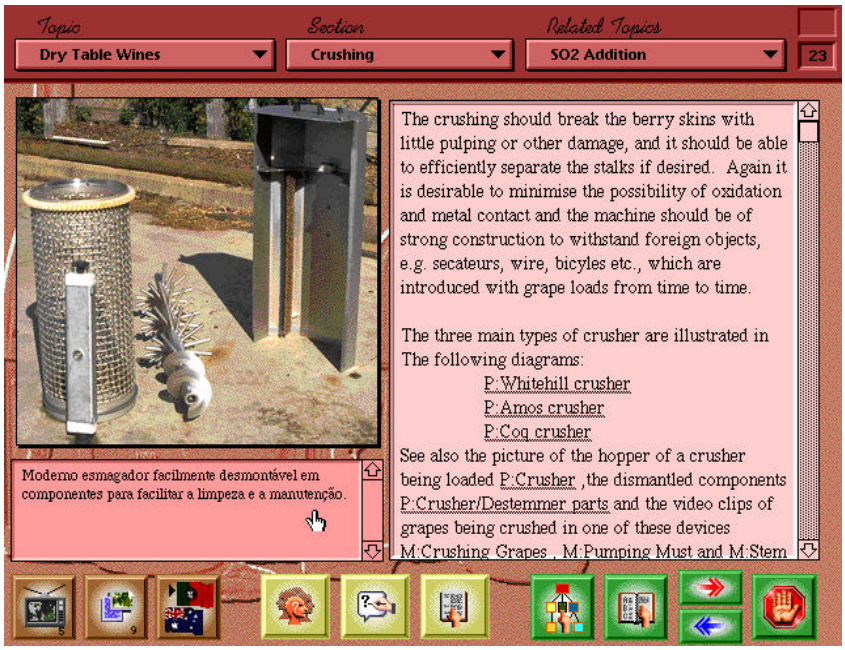

Figure 2. Screen from Grape and Wine Production multimedia system

While the text in the multimedia version is based on that in the printed notes, the graphics are either new or redrawn with colour and better visual attributes. All of the video footage associated with the system is new. The entire package occupies just 40 Megabytes of storage and consists of over 150 individual topics, 230 high quality colour pictures and 22 video clips.

A variety of laboratory, viticultural and wine-making techniques can now be demonstrated more effectively using graphics and video, thus reducing the text requirements considerably. Links to graphics, video clips and other parts of the system are embedded within the text as well as available from buttons provided on the periphery of the screen. Five different methods of navigation are provided, including an on-screen content map which previous research (Messing, 1990) had shown to be involved in a significant number of all navigation actions.

CSU is aiming to provide in its off shore DE packages, multilingual explanations. Users of this system can select Portuguese or English for captions to graphics and video material as well as the explanations provided in the glossary. Access to specific objectives for each topic were considered a necessary feature as well as questions which an academic might ask a face-to-face class. Other attributes of this system which are not obvious from figure 2, include the ability to call up a glossary definition for key terms and the ability to display a content map with or without the conceptual and navigational links between topics.

Designing and implementing such systems is quite different from actually using them as mainstream teaching / learning tools. While these two subjects were developmental in that they were the first of their kind at CSU, they are very much in the vanguard of the sort of thing that has been espoused in the technology strategy. Since the function of all of these materials is to foster learning, it is important to look at the use of these materials from the client's, i.e., the learner's perspective. Studies have been conducted using surveys, group and individual interviews and currently, the use of electronic books is being investigated in considerable depth (Messing, 1995).

3. Measuring Student Use

Measuring how students use such a system is not easy. Ethnographic studies cannot track all the things that occur on computer screens and do not reveal why students do certain things. In order to obtain as complete a picture of how students actually use these materials, a variety of strategies were employed. Additional program code was written which monitored all user interaction and wrote this, as well as timing data, to a log file. This technique was used in earlier research (Messing, 1990) and proved successful in giving data about what physical use was made of features such as the content map, etc.

At the completion of the subject, students were required to return both the log file as well as a copy of their actual electronic book. This was then compared with the original version to locate any differences due to annotation or editing activities. These were categorised into a number of types of change.

Students kept a manual log book of their study activities and approximations of the time spent on these. This was the least reliable aspect of the data. Most log books appear to have been entered at a few significant times in the semester which probably coincided with reminders about keeping accurate log books. Checks between the recorded log data and the manual log books revealed enough discrepancies to throw doubt on the value of the latter.

Students were also surveyed regarding their use of the system, including such things as estimates of the number of pages they printed. The electronic log was able to report that the printing function was used but not on which pages or how many times a particular page was printed. Students had to provide these data themselves. Phone interviews were also conducted with a sample of the students to explore issues in more detail and to confirm the general consistency of other data.

4. Results and Discussion

While the reactions of students to these new methods of delivery have been generally quite positive, some drawbacks need to be kept in mind. While these will not deter the university from pursuing its goal of developing electronic distance education materials, some will affect the design of particular materials and others will limit the University's ability to reach its production targets for the year 2000.

The literature contains numerous works describing electronic books, hypermedia and multimedia teaching materials (e.g. Barker, 1993). Many of these discuss the theoretical basis for the design of electronic learning materials. However, the practical aspects of learning from these are less well reported. The reaction of users should have been predictable from the theory, but is sometimes still a surprise. It appears that the theory of how students actually learn from electronic materials is incomplete. The following are some of the reported reactions from studies that have been conducted for more than two years which do not fit comfortably with the theoretical predictions.

4.1 Readability

The literature appears divided on the issue of readability of computer screens. Rubinstein (1988) and Gould (1987), among others, claim that reading from a screen is slower than reading from paper while Hansen and Haas (1988) believe that neither is demonstrably superior to the other. McKnight, Dillon and Richardson (1989) contend that in the areas of speed and accuracy there is no clear cut evidence in favour of either medium. When considering fatigue, there appears to be a slight performance loss in using some computer screens. However, these effects are not nearly as significant as a user's preference. It appears that this is a much greater determining factor than any of the others. This view appears to have been supported by the studies with CSU students. Some students had a clear preference for reading from paper and reported printing large numbers of pages, while others commented on the readability of the screen and the desirability of more subjects using the electronic medium.

4.2 Annotation

De Diana (1991) believes that demarcation and annotation are key ingredients in making electronic study books a desirable alternative to printed books. Demarcation is the ability to highlight parts of the document for some reason such as perceived importance. The type of annotation afforded by electronic books comes in two basic varieties. External annotation involves the creation of an overt addition to the presented material while internal annotation involves the embedding of additions in the material that was originally present. Both forms of annotation are available with the Foundations of Programming electronic book but neither is present in the multimedia system.

Problems of authorship because of annotation were anticipated. Without some way of distinguishing the student's annotations from the original, the authority of the document could be compromised. Students were encouraged to use a method of demarcation to indicate clearly their additions but they did not use these techniques consistently. While they had an original version with which to compare their annotated copy, doing this was cumbersome and not nearly as easy as for the printed counterpart where authorship was never in doubt.

What was not entirely anticipated was the ease with which students could inadvertently delete sections of their document. A lock / unlock system (see lower left of figure 1) was provided to make sure that an explicit action was required to gain edit level access. Students could, and did, delete sections inadvertently by selecting a region and pressing a key rather than executing the appropriate command. Restoration from the original was unsatisfactory because it also deleted wanted annotations! De Diana and de Vries (1990) argue for modification agents and an environment which supports their use. The lack of annotation ability in the Grape and Wine

Production system was reported as a deficiency, adding support to the modification agent argument. While such argument makes good sense, developing an environment which supports such use without allowing students to 'cut themselves' is a challenge that has yet to be met.

Access to the text can also increase the likelihood of plagiarism but, presumably, the assessors are familiar enough with their own material to recognise such attempts. In the programming subject, this was considered to be a small risk compared to the benefits gained by having the program code for various examples available to students so that they could copy and execute it in their programming language system.

4.3 Convenient access

Collis (1991), in evaluating the likely effectiveness of electronic books in a university setting, concludes that 'making life easier' is one of the benefits provided there is convenient access to the resources. However, convenient access is not defined. No matter how portable the computer is, it will never be as portable as a book. The single biggest drawback that was reported was inconvenience of access. As one student put it 'I used to read in bed a lot but the 14-inch monitor makes my arms ache'. Distance education students study in quite commonsense but inconvenient places—on the train, bus, during lunch at work, waiting for a child at ballet or football training, in bed, etc. All of these are well served by books but poorly served by the current electronic equivalent. Laptop computer systems are a step in the right direction but their development needs to continue with better performance, longer battery life, smaller physical dimensions and easier to use interface. The future electronic pocket-book predicted by Stonier (1991), and the even earlier 'Dynabook' suggested by Kay and Goldberg (1977), are still not common technology. Perhaps when they are, the situation might be more conducive. Even though many Japanese read small electronic novels on trains, that is still a far cry from using study materials in such an environment.

Printed matter was regularly used as a means of overcoming inconvenient access. Students would print sections to take with them. Some students printed as much as two-thirds of the material in the system. To some extent, that defeated the purposes of the system. They no longer had the richness of the electronic environment and the means of making their study more fruitful. Their learning was still print-based but the responsibility for the production of the printed materials had now shifted from the university to the learner. On the other hand, students who had access to the Wine Science package were quite prepared to put up with the inconvenience of being tied to a computer because paper-based materials could not provide the same learning resources. No amount of printing could convey the impact that some of the video clips provided.

4.4 Integration of resources

One of the key ingredients in the Foundations of Programming material was access to a set of 20 fully worked programming problems. Having these available in electronic format was thought to be a significant advantage over printed versions. Students did report the ability to copy and paste sections of program code into their editor / compiler as major benefits of the system. A number used this to advantage by having the compiler software running concurrently with the electronic book. Program code was copied from the electronic book, pasted into the compiler and executed quickly. This appears to be an excellent use of the technology; the programming concepts are able to be demonstrated through interactive execution of the examples.

Using only printed versions of the examples was seen as far less effective as students would have to type in the program code as well as correct typing errors. However, those that did, surprisingly, reported that this was a much better learning exercise. It seems that in the process of actually typing in the code themselves, students learnt far more than just the point that was being made in the explanation. It reinforced their use of the programming language in many ways. Just the act of

typing in the coding statements, for example, reinforced the syntax of various programming statements that they were expected to become familiar with.

There are two implications for the design of the electronic materials as a consequence of this. The first is that resources should not be designed to replace activities that must be carried out by the student. They may serve as a way of illustrating a particular point, but placing any greater value on them is dangerous. The second is that instructional designers need to look at all of the learning which takes place and be aware of what aspects will be missing from the electronic format.

4.5 Traditional learning techniques

The role of traditional learning has already been touched upon but it cannot be underestimated. After spending their entire lives to date learning mostly from printed media, how can students be expected to suddenly adapt to a new medium and make adequate use of its provisions. In a study of 179 undergraduate students using computer tutorials, Messing (1990) found that very few of the students in all of the tens of thousands of interactions monitored over a semester, showed signs of using the full potential of the system to benefit their learning. The vast majority used methods that were adaptations of their techniques used with books. What was missing was an approach to learning that recognises that the use of such materials is not like learning from a book. Can university students really relearn how to learn? Can they afford the time to do so?

Small and Ferreira (1994) look at this phenomenon in the broader context of resource based learning.

> 'Theoretically, multimedia information resources provide students with a faster and easier access to potentially richer bodies of information than any single medium resource. As a result, information skills such as finding, selecting and extracting become even more critical' (p. 253).

It appears that it is not sufficient to provide students with a new genre of learning resources. They must also be taught the appropriate skills to use those resources to their maximum potential.

4.6 Production issues

Very little of the wealth of literature on the subject of design of electronic learning materials addresses the production issues that are foremost in the list of concerns for an organisation such at OLI at CSU. These issues are not ones of adequacy of the design of the materials from an educational point of view but adequacy of the design from a production point of view. Some such as Catenazzi (1993), do look at the production of electronic books but only from the point of view of creating a semi-automatic 'book builder'.

The foremost production issue is that of maintenance. The publishing process has a long tradition and is for the most part, a fairly well defined cycle. The relatively recent use of computers in that cycle has resulted in only minor changes. The revision process at OLI is based on a well defined schedule. This is achievable using print-based media. However, the development time for some materials such as the Grape and Wine Production example is similar to the time that it will take to revise it. How well the system will incorporate structural changes not just minor revisions, is a critical test of the survival of the material. Projects reported in the literature are invariably at an early stage in their life cycle, either just established or even still in development. Maintenance has not really become an issue. However, this has to be an issue with distance education materials which require frequent revision to retain relevance and credibility.

In theory, there are real savings to be made in the reproduction of materials in time and effort, both of which equate to costs from a production perspective. Warehousing, duplication and delivery

should all be significantly cheaper for the electronic versions. Savings would also be made in reducing production over-runs and recycling of media such as floppy disks. Delivery by electronic means also has the potential to reduce both the cost and time to make a delivery.

Associated with this are questions about the life cycle of electronic materials. Libraries and archives around the world are able to give access to printed materials prepared many years ago. Apart from some preservation issues, this extends to books printed hundreds of years ago. How many people can still read data created on an old Apple II less than 15 years ago? The hardware and software change at an alarming rate. In the years to come will there be any computer systems capable of displaying material that was written even 5 years ago? Will there be mechanisms to migrate the data to newer systems? How frequently will such migration have to take place and whose responsibility will it be to make the transition? The ability to read storage media is both a function of the availability of suitable hardware and the durability of the medium. What is the shelf life of data on magnetic media or CD-ROM?

The answers to these and related problems can only be speculation. There is not the experience with these systems to be able to definitively answer them. Before electronic books are going to become the mainstream of educational delivery for DE, some provisions must be made for training the staff involved. This applies not only to production staff but also to the content experts. This is an exceedingly slow process and has not been well thought out in the technology strategy at CSU. Evolution, rather than revolution is likely to be the process that produces lasting results.

5. Conclusion

As a major provider of distance education, Charles Sturt University has taken up the challenge of moving away from paper and into electronic media in a way which seeks to establish a new paradigm for such endeavours. While some of the decisions are reasonably well grounded in the theory of the design of educational systems, the practicalities are far from well understood. The targets set appear to be ambitious in their deadlines. The next few years will see an emergence of a better understanding of the issues involved in producing such large quantities of electronic teaching materials. Some of these have been hinted at as part of various pilot projects but many questions remain unanswered and many have yet to be discovered.

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