Concurrent Development and Cost-benefit Analysis of Paper-Based and Digitized Instructional Material

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Abstract

This article describes the simultaneous development of paper-based and digitized versions of a textbook and related instructional material used in an independent study, undergraduate introductory financial accounting course. Faculty and managers of post-secondary institutions will be particularly interested in the development process, as there is an increasing need to produce instructional material in these two media. Break-even analysis is used as an initial evaluation measure to determine cost-effectiveness. An ongoing study is described that, when completed, will evaluate the relative efficacy of each medium in terms of learning outcomes, completion rates, and selected qualitative attributes.

Key words: distance education, digitized media, cost-benefit analysis, online learning
Athabasca University is Canada’s largest distance-based, open university. Its courses include Introductory Financial Accounting (ACCT 253), an independent study course offered for credit within the Bachelor of Commerce and Bachelor of Management programs administered by the School of Business. The course has about 1,000 annual enrollments. In common with other courses offered by the University, students can register in the course at the start of any month. They have six months to complete it, proceed at their own pace, and have telephone and e-mail access to academic and administrative advice throughout the duration of the course. Each student is provided with a set of paper-based course materials. These include a textbook, a Student Manual, a Study Guide, an Assignment Manual, and a manual containing solutions to selected textbook problems.

All materials are carefully designed and integrated by a team of academics, editors, instructional designers, and graphic artists at Athabasca University. The Student Manual describes the course, summarizes the lessons, tells students how to obtain administrative and academic assistance, explains the assessment scheme, and suggests a study schedule. The Study Guide describes in detail how to proceed through the course material. The course is divided into ten lessons. Each lesson in the Study Guide contains an introduction to the main topic(s), identifies the pages of the text to be read, and provides additional notes and example problems as an aid to student comprehension. There are four assignments in the course, which are presented in the Assignment Manual. There are two exams,
each worth 30% of the final course grade. These are administered by Registry Services, and are invigilated.

Conversion to Digitized Material

At one time, and in common with most present courses at the University, a purchased textbook was used in conjunction with the instructional material noted above. For various reasons, the publisher of the textbook used in ACCT 253 decided not to produce a third edition and the copyright reverted to the author. Representatives of Athabasca University approached the copyright holder about revising the text, then publishing it in-house. One motivation for this was the potential for reducing costs. The University provides all instructional material to students as part of their registration fee, including textbooks. The University can purchase an equivalent text for about $50 US. Publishing the paper-based text in-house reduced variable production costs to about $25 US per text. As a result of these savings, the University committed funds and staff to the conversion process. About $55,000 US of one-time, fixed production costs were required to convert the second edition of the textbook and instructors’ solutions manual from the publisher’s publishing system to Interleaf®, the software standard for the University. It had to be optically scanned, then converted to Interleaf format and compared to the original by proofreaders. Many of the graphics had to be re-done. This process took several months. Only then could the third edition revisions be inserted and the new textbook produced. The process took about three years to complete. However, because of the high yearly enrolments in the course, these conversion costs have been recovered in a little over two years ($55,000/$50 –
25] = about 2,200 texts to recover costs/1,000 students per year = 2.2 years).
Future revisions will be much less expensive and time-consuming because the initial conversion process will not need to be repeated.

A beneficial by-product of this process was that Athabasca University obtained the right to distribute the textbook material in any medium. As a result, and at about the same time the paper-based textbook was completed and contracted out for printing, the Interleaf files of the textbook, Study Guide, Solutions Manual, and Assignments Manual were converted to .pdf format using Acrobat Distiller®. About 1,000 pages of instructional material were exactly reproduced for digitized presentation. Deleting unused textbook material reduced the total course package by about 300 pages. Since much of the deleted material was unused end-of-chapter cases based on copyrighted newspaper articles, clearance for the digitized textbook was significantly simplified.

Using the bookmark features of Adobe Acrobat®, an extensive navigation system was then developed that enabled students to quickly proceed to any portion of the digitized material, much like a paper-based table of contents. In addition, hyperlinks were added at applicable points, starting at an opening screen (see appendix A). This was adapted from the course outline in the paper-based Student Manual. It links students to the appropriate readings and suggested practice problems in the Study Guide and digitized textbook. This enables the instructional design of the paper-based material to be maintained. In addition, hyperlinks within the textbook allow students to view comprehension questions interspersed throughout each chapter, as well as solutions to end-of-chapter problems and
additional explanatory information previously contained in the Study Guide and Solutions Manual. Assignment material is also accessible through the course outline. This material can be viewed, then completed in a word processor or spreadsheet software package and automatically e-mailed to an assignment marker drop-box at the click of a button. The digitized version simplifies e-mail submission processes for students, while at the same time fitting in well with electronic assignment marking procedures that are established within the School of Business for print-based students as well.

Some new design features were incorporated into the digitized material. About ten different audio-visual segments were videotaped in a local fine arts theater and digitized using Athabasca University media production facilities. The scripts for these segments were taken directly from the introductions to each lesson provided in the paper-based Study Guide. The footage totals about 45 minutes in length and provides brief introductions to each lesson’s material. Each file is linked accessible through the opening screen using Acrobat’s “Movie” icon feature (see appendix A). The entire audio-visual process took two individuals about 24 hours in total to complete.

In addition, portions of a Canadian business’ 1998 annual report are studied extensively in chapter 7 of the text. At this point in the digitized material, a link takes students to the web site of this company where they can view several years’ annual reports in full color. Since these are stored in Adobe Acrobat (.pdf) format at the web site, and with the permission of the company, the full color version of
the 1998 annual report was able to be included in the digitized textbook, rather than the two-color version used in the paper-based book.

Two computer-based instruction (CBI) modules were also added to the digitized material, available by Acrobat hyperlinks from appropriate points in the textbook. These modules provide about three hours of alternate instruction to students. Animations and interactions are used to demonstrate the accounting process and the construction of the Cash Flow Statement, two concepts that are traditionally difficult for accounting students to understand. Since this material was already developed, there were virtually no incremental costs incurred when it was incorporated into the digitized version. Previously, students who used the paper-based version of the material were informed of these optional CBI modules in their Study Guides, but needed to contact a faculty member to obtain access to the appropriate web site and then download about 11 MB of files. Since all of the digitized material is included on one CD-ROM for distribution to students, the CBI modules are now easily accessible to students at the appropriate point in the course, and on demand.

As a final enhancement, pop-up definitions of unusual terms were added using the “Forms” capability of Acrobat. When a mouse is rolled over a dashed box around the term, the related definition appears in the margin. Again, relatively small incremental costs were incurred to do this. About six months earlier, all of the ACCT 253 instructional material had been reviewed by an English as Second Language (ESL) expert to identify phrases that were likely unfamiliar to foreign students. The project was undertaken because the paper-based version of the
course was to be marketed and delivered to students in the Far East. Since these references were done in Microsoft Word®, only about two days of clerical time was needed to locate, cut, paste, and program over 80 definitions into pop up boxes at appropriate points in the digitized course material.

All of the digitized material can be viewed using Acrobat Reader® software. This is freely-distributable and included on the CD-ROM sent to students in the course. Besides the navigation and hyperlink features noted above, the reader software also allows students to change digitized text presentation size, print material, cut and paste information to other software programs, and search for key words or phrases. Security features can be added that prevent printing and copying functions, but these were not activated in order to increase functionality. The digitized material was ready for distribution in CD-ROM format after about two months, and before the paper-based texts arrived back from the outside printing firm. The digitized files take up about 200 MB of space. This includes the Acrobat Reader® software, run-time versions of the CBI modules, and an executable file that automatically installs and de-installs files on students’ hard drives.

Cost-benefit Analysis

This process has several advantages for post-secondary institutions that need to develop both paper-based and online versions of courses. Using the CD-ROM, distribution is simplified, and handling costs are decreased. Distribution costs can approach zero if the digitized material is downloaded from a web site. This will be
instituted in the future, as bandwidth restrictions are less problematic for many students. Production costs are also lower for the digitized material. As noted above, the variable costs to produce the in-house version of the paper-based textbook amount to about $25 US per text, including a $7 US per text copyright fee. Costs of printing the additional Study Guide, Assignment Manual, Solutions Manual and Student Manual material for each registration amount to about $7 US, or $32 US in total. By comparison, the variable costs to produce the digitized material are about $8 US per registration, including the copyright fee. The incremental fixed costs to produce this digitized material, including estimated learning curve for the software, were as follows:

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adobe Acrobat and Distiller software</td>
<td>$100</td>
</tr>
<tr>
<td>Copyright clearances</td>
<td>200</td>
</tr>
<tr>
<td>Conversion of Interleaf files to .pdf files</td>
<td></td>
</tr>
<tr>
<td>1 person x 8 hours @ $17 US</td>
<td>136</td>
</tr>
<tr>
<td>Deletion of unused material, insertion of hyperlinks, bookmarks, and other features</td>
<td></td>
</tr>
<tr>
<td>1 person x 20 days x 8 hours @ $17 US</td>
<td>2,720</td>
</tr>
<tr>
<td>Production of audio-video clips</td>
<td></td>
</tr>
<tr>
<td>2 persons x 3 days x 8 hours @ $17 US</td>
<td>816</td>
</tr>
<tr>
<td>Insertion of pop-up definitions</td>
<td></td>
</tr>
<tr>
<td>1 person x 2 days x 8 hours @ $10 US</td>
<td>160</td>
</tr>
<tr>
<td>Final check, creation of install program, and production of master CD-ROM</td>
<td></td>
</tr>
<tr>
<td>2 persons x 2 days x 8 hours @ $17 US</td>
<td>544</td>
</tr>
<tr>
<td>Total incremental costs</td>
<td>$4,676</td>
</tr>
</tbody>
</table>
The break even point to recover these approximately $4,700 of fixed costs occurs after about 200 students choose to use the CD-ROM version of the course ($4,700/[$32 – 8]). This break-even point will be significantly reduced when future versions of the onscreen textbook are produced because the time needed to design the look and feel of the new media and master the software will be reduced.

Formative Evaluation

A formative evaluation of the digitized learning material was undertaken from September to December 2000. Nineteen classroom students enrolled in an introductory financial accounting course at an Alberta college were offered the option of purchasing the paper-based text for about $50 US from the college bookstore or using the CD-ROM material free of charge. Seventeen students completed an end-of-term questionnaire. Of these, 5 students used only the paper-based textbook, 5 used only the CD-ROM, and 7 switched from the CD-ROM to the paper based material. The cost of purchasing the textbook did not appear to be a significant incentive for students to use the CD-ROM in many cases. Because the questionnaires were anonymous and the class size was relatively small, a correlation between choice of medium and course performance could not be established.

No navigation or installation problems were reported by any CD-ROM users. One student reported that the CD-ROM version might have been used more if computer lab time allotted to each student had been extended. This was neglected in the planning process. Several students were dissatisfied with their
inability to print out the material, or make notes in the CD-ROM material. To address this problem, students are now able to print the material, or cut and paste the digitized material into a word processor or other similar software. These features were not enabled in the initial trial.

The students who used the digitized material throughout all or part of the course did not find the material difficult to decipher and appreciated the ease of accessing related learning material like the CBI modules and solutions to end-of-chapter problems. However, many did find the process of reading from a computer screen tiring. Students using the paper-based material in Athabasca University’s introductory financial accounting course, though, have reported similar problems. These problems likely cannot be resolved without fundamentally revising the course material - by reducing the amount of material and changing presentation format in both the paper-based and digitized versions of the course material, for instance. This process will likely commence sometime in 2002.

The digitized material has been offered as an alternative to students enrolled in the School of Business’ introductory financial accounting “e-Class” learning environment as of September 2001. E-classes are fifteen-week, paced online courses. This environment enables students in the School of Business’ Bachelor of Commerce program to communicate with markers, academic experts, and peers by e-mail and synchronous or asynchronous online conferencing. Students can submit and receive back assignments electronically and access online library resources. With the recent integration of an online exam system into the e-Class
platform, ACCT 253 students who use the CD-ROM material are now able to complete the entire introductory financial accounting course by computer.

The Next Phase of Analysis

As academics and managers of both campus- and distance-based post-secondary institutions attempt to meet the needs of their traditional students and at the same time transform their institutions into providers of online learning, the question of how to support both paper and digitized mediums in a cost-effective manner is an important one. Based on cost-benefit analysis and the formative evaluation performed to date, it appears that digitized instructional material can be produced in a cost-effective manner. However, questions remain about students’ preferences and the relative instructional effectiveness of the new medium. These questions are currently being addressed by a study now underway. The study will assess differences in learning outcomes of 400 students who use either paper-based or digitized versions of the ACCT 253 material. Other factors like relative rates of completion and student satisfaction will also be examined. The study should be completed by about December 2002. Quantifying differential learning effects is difficult, but at some point an analysis must be attempted and the least costly alternative selected (Clark, 1994).

Similar comparative media studies have been carried out in this regard (for example, see Kaminski, 2001). However, the research design of these studies is often confounded by differences in instructional design among the compared media and unaccounted differential costs of developing new media (Clark, 1983).
By proceeding in an incremental fashion described in this paper, the design of the ACCT 253 project should significantly reduce the influence of these factors.

Even when learning outcomes, student preferences, and relative cost comparisons have been completed, issues like equality of access, quality of interaction, impact on revision cycles, and future goals of the institution need to be studied (Bates, 1995). However, results of the ACCT 253 project to date and the research study underway should usefully inform this more comprehensive analysis.
Bibliography


