

Learning Efficacy and Cost-effectiveness of Print Versus e-Book Instructional Material in an Introductory Financial Accounting Course

David Annand
Athabasca University

Abstract

This article describes the concurrent development of paper-based and e-book versions of a textbook and related instructional material used in an introductory-level financial accounting course. Break-even analysis is used to compare costs of the two media. A study conducted with 109 students is also used to evaluate the two media with respect to relative learning effectiveness and selected qualitative attributes. Print-based material was generally preferred by learners. No significant difference was found regarding learning effectiveness. Implications of lower relative production and distributions costs for e-books are discussed in this context.

Introduction

As academics and managers of postsecondary institutions attempt to meet the challenge of technological change and the shifting learning preferences of their students, their institutions have gradually provided more virtual learning experiences. An important consideration of this evolution is whether to use paper or digitized media as a primary instructional resource. Many studies have investigated the relative merits, attributes, and learning effectiveness of these media. However, few studies have quantified and compared their relative costs. This study attempts to measure both relative learning efficacy and cost-effectiveness of these so-called “e-books.”

Review of e-book and Other Media Learning Research

An e-book is defined herein as a printed book that is made available in a digital format to be read onscreen or downloaded to a portable electronic device. Characteristics of e-books include use of multimedia, hyperlinks and other interactive components, search features, the ability to customize appearance or convert text to audio, presumed lower reproduction and distribution costs, and longevity (Downes, 2007; Mattison, 2002; Shirattudin, Hassan, & Landoni, 2003).

Problems associated with e- books and other onscreen, often text-based materials have been noted in the literature. Vernon (2006) abstracted comments and arranged these into themes based on the experiences of 23 respondents who used an e-book, then in turn a completely paper-based textbook to acquire certain software skills. The students' primary learning strategy was to make paper copies of online material when permitted to do so. Most students did not adapt to the electronic textbook because of interface design, time constraints, and established study strategies. Similarly, Spencer (2006) found that learners preferred print copies of text materials, citing advantages of portability, dependability, and ease-of-use.

Bradshaw (2005) noted that e- books typically have lower resolution and require a power supply or network connection. Studies by both Mercieca (2004) and Matthíasdóttir and Halldórsdóttir (2007) suggested learner reluctance to move to digital textbooks unless these

resources provided better or easier access to instructional content. Garland and Noyes (2004) suggested that on-screen reading transferred less information to long-term memory, possibly because cathode-ray tube monitor characteristics created cognitive interference. Though knowledge acquisition did not differ among learners, it appeared that closer and more frequent reading of on-screen material was needed. In a study of 125 students enrolled in a distance-delivered nurse practitioner program offered across 10 Ontario universities, Cragg, Andrusyszyn, and Humbert (1999) reported that students were satisfied with the learning attributes of, in descending order, print-based learning packages, Internet websites, CD-ROM based multimedia, videotaped materials, computer conferencing, audiotaped lectures, and audio-teleconferencing. Although print-based materials were most often preferred, the authors suggested that a variety of delivery methods were likely the best means to satisfy varied types of learning strategies and styles.

However, there are some indications from the literature that e-books will become more popular. Armatus, Holt, and Rice (2003) compared approaches between Deakin University on-campus and off-campus students in an online, resource-based learning introductory psychology course. The off-campus students used electronic resources more often and attached greater value to them. They suggested that learner characteristics that may have differentiated these two groups need to be analyzed and considered when designing learning environments, while still preserving overarching pedagogical goals. Though Rowlands, Nicholas, Jamali, and Huntington (2007) reported that e-books compared unfavorably for perceived ease of reading, they cited some benefits, including ease of making copies, currency, and availability.

Also, many researchers point out that younger users seem to prefer e-books to print-based learning resources, e-book capabilities will be continually improved, and their costs will likely be lower in the future (Chang & Ley, 2006; Liew, Foo, & Chennupati, 2000; Sathe, Grady, & Giuse, 2002; Spencer, *op. cit.*; Strouse, 2004; Temple, Kemp, & Benson, 2006). All these factors suggest that e-books will be more accepted in the future. Despite the present ambivalence, even negativity, in the literature about the desirability of e-books as a primary form of instruction, there seems to be little evidence to suggest that learning outcomes are significantly affected by choice of either print-based or e-book media. Clark (1983) argued that media are merely the delivery mechanisms for instructional content. He suggested that differences in instructional design and learning activities, applicable to almost any medium, are the fundamental causes of observed learning differences. Any appropriately-designed medium can fulfill the conditions for good-quality instruction

Kozma (1994) countered Clark's assertions, claiming that media and methods are interconnected and should not be treated as independent variables. The capabilities of a medium can impact learning outcomes, he asserted, as learning is contingent upon on how well the medium corresponds to the particular learning situation. The question of "Do media influence learning?" should be changed to, "In what ways can we use the capabilities of media to influence learning for particular students, tasks, and situations?" Further, though there may be no established relationship between medium and learning as yet, this does not preclude such a relationship in the future. By viewing media as "mere vehicles," Kozma contended that the potential relationship between media and learning would never be realized.

Jonassen, Campbell, and Davidson (1994) suggested that by focusing on learning as a learner-centred process, rather than an instructor-centred one, the link between media and learning effects might be more evident. The learning theory underlying these views proposes that knowledge is constructed rather than acquired, and thus additionally confounds the efficacy of

media effects research. Diaz (2000) also criticized research designs of media effects studies, arguing that these are primarily informed by an ‘instructivist worldview’ rather than learner-centered and constructivist forms whereby relationship and social communication far outweigh the effect of the media that support the learning process.

However, Kirschner, Sweller, and Clark (2006) provided a comprehensive refutation of constructivist learning theory and its antecedents, based on both a synopsis of advances in the neuroscience of learning and the results of controlled experiments that compared learning within the broad areas of instructivist vs. constructivist theory. They concluded that in almost all cases involving novice learners, instructional design techniques based on instructivist learning theory produced superior learning results.

Recognizing a variance within the literature that at its fundamental level reflects differences in opinion about the purpose of learning and therefore formulation of appropriate learning theory, the study described below is acknowledged as being specifically oriented within an instructivist learning paradigm. Instructional design principles of this paradigm generally prescribe observable, measurable, and pre-defined learning outcomes. Instructivism also utilizes techniques like pre- and post-assessment of learners’ knowledge levels, mastery learning, and the use of practice and feedback to support or correct performance.

Clark (2000) suggested that any evaluation of student-content interaction must recognize that every technologically-mediated learning context consists of two distinct levels of such interaction – the first dealing with attributes of the media that supports the interaction and the second with the ‘technology’ of the learning or instructional design. Confounding these two separate types of student content interaction, according to Clark, is at the root of many of the terminology and research problems debated in the literature. Thus, comparative studies within the instructivist paradigm are useful only if the media employ the same instructional design (e.g., similar learning outcomes and assessments).

The study described below attempted to minimize the confounding effects of varied design, content, context, learners, and measurement by holding these constant between the two compared media. Similar to a study of electronic medical database information conducted by DeZee, Durning and Denton (2005), it examines how electronic or paper-based resource choices might influence an objective, generally accepted measure of knowledge acquisition. In contrast to virtually all media effects research to date, though, the analysis of relative costs of the compared media are treated as an important factor in the evaluation.

Context of the Study

Athabasca University is Canada’s largest distance-based, open university. Its undergraduate courses are offered mostly by “individualized study.” Students can register in courses at the start of any month. They have 6 months to complete a course, can proceed at their own pace, and have telephone and e-mail access to academic and administrative advice throughout. In most cases, each student is provided with a set of paper-based course materials. These generally include a textbook, a Student Manual that provides a course outline, a suggested timetable, and salient administrative advice like how to request exams and access library materials, a Study Guide that provides specific direction about how to proceed through the instructional material, an Assignment Manual, and in the case of many numeric, problem-based courses, a Solutions Manual containing suggested answers to selected textbook problems.

The study involved students enrolled in ACCT253, an introductory-level financial accounting course offered online by the School of Business at Athabasca University. It was conducted over three academic years. About 1,000 students per year enrolled in the course during the period of this study. In common with most courses at the University, a purchased, print-based textbook is used in ACCT253. For various reasons, the publisher of the textbook 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 to reduce costs. The University provides all instructional material, including textbooks, to students as part of their course fee. Any reduction in material costs would therefore directly translate into cost savings for the institution.

At the time, the University could purchase an equivalent text from a publisher for about U.S. \$50.¹ (Hereafter, all figures are in U.S. dollars). Publishing the paper-based text in-house reduced variable production costs to about \$25 per text. Projected savings were estimated to be about \$75,000 over the estimated three-year life of the text.² About \$55,000 of one-time fixed production costs were required to convert the second edition of the textbook and instructors' solutions manual to the revised third edition, which was published by Athabasca University. As a result of the estimated \$20,000 cost savings, the University committed funds and staff to the conversion process.

A beneficial by-product of this process was that Athabasca University obtained the right to distribute the instructional material in any medium. As a result, and while the paper-based textbook was being printed, the files of the textbook, Study Guide, Solutions Manual, and Assignments Manual were converted to .pdf format using Adobe Acrobat Distiller®. About 700 pages of instructional material were exactly reproduced for onscreen presentation and the instructional design of the paper-based material was maintained.

Using the bookmark features of Adobe Acrobat Professional®, an extensive navigation system was then developed that enabled students to proceed to any portion of the digitized material, much like a paper-based table of contents. Hyperlinks were added at applicable points, starting with the course outline as presented on the opening screen. These linked students to the course readings and appropriate practice problems in the e-book. In addition, hyperlinks within the each chapter allowed students to view solutions to selected end-of-chapter problems and additional explanatory information previously contained in the Study Guide and Solutions Manual.

Assignment material was accessed from the opening screen. The assignment questions could be viewed then completed in a word processor or spreadsheet software package and automatically e-mailed to a marker's drop-box. The digitized version simplified the assignment submission processes for students, while at the same time fitting in well with established procedures of the School of Business.

Some design features were adapted during the production of the digitized material. Ten different audio-visual segments, totaling about 45 minutes in length, were videotaped in a local fine arts theater and digitized using Athabasca University media production facilities. The scripts for these segments were adapted from the introductions to each lesson found in the paper-based Study Guide. The videos provided brief introductions by the course professor to each lesson's material. Each file was linked from the opening screen using Acrobat's "Movie" icon feature. The entire audio-visual process took two individuals about 48 hours in total to complete.

¹ The price is currently \$130 per text.

² $(\$50 - \$25) \times 1,000 \text{ registrations per year} \times 3 \text{ years} = \$75,000$.

Two computer-based tutorials were also included in the digitized version of the course. These modules had been previously developed as optional, animated enhancements to help students visually comprehend two areas of introductory financial accounting that traditionally are difficult for students to understand – using double entry methods to record financial transactions and understand the resulting effects of various types of transactions on financial statements, and the Statement of Cash Flow. These modules were accessible from the main menu of the course material and also at the appropriate points in the e-book material.

Pop-up definitions of unusual terms were added using the ‘Forms’ capability of Acrobat Professional[®]. When a mouse rolled over a dashed box around the term, the related definition appeared in the margin. Again, relatively small incremental costs were incurred to do this. Earlier, all of the ACCT253 instructional material was reviewed by an English as Second Language 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. Only about two days of additional clerical time were needed to locate, cut, paste, and program over 80 definitions into pop-up boxes at appropriate points in the e-book.

All of the digitized material could be viewed using freely-distributable Acrobat Reader[®] software. The reader was included along with the e-book on CD-ROMs that were sent to students who participated in the study. The digitized files took up about 200 MB of space. This included the reader software, run-time versions of the two CBI modules, and an executable file that installed and de-installed files on students’ hard drives. The digitized material was ready for distribution at about the same time the paper-based texts were printed.

Before the formal study commenced, a formative evaluation was undertaken with 19 students who were enrolled the classroom version of the introductory financial accounting course. There were no navigation or installation problems reported by any e-book users. One student reported that the e-book 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 within the onscreen material. To address this problem, Acrobat Reader[®] features were enabled to allow the textbook material to be printed, or cut and pasted into a word processor, though this was not an entirely satisfactory remedy based on student responses during the formal study. The students who used the digitized material throughout all or part of the formative evaluation did not find the material difficult to decipher and appreciated the ease of accessing related learning material like the solutions to end-of-chapter problems. However, many did find the process of reading from a computer screen tiring.

The Formal Study of Learning Efficacy and Cost-Effectiveness

Following this formative evaluation, the larger evaluation of the e-book versus printed material in the independent study version of ACCT253 commenced. This consisted of three parts. First, the incremental costs of producing the e-book were calculated and compared to the paper-based learning material. This was done to address the previously-noted concerns with comparative media studies raised by Clark (1983, 1994, 2000). Clark argued that the additional costs of developing alternate media resources are seldom calculated or included in comparative media studies. If these were calculated and the same resources applied to improving a conventional medium like classroom instruction or paper-based learning materials, even fewer media effect differences would be observed.

Second, pre-and post-tests were used to determine if learning outcomes of students using either of the two media differed. Third, a telephone questionnaire administered to participants at the end of the course was used to gauge ease-of-use and other affective considerations of the e-book presented compared to the entirely print-based version of the instructional material.

Study participants volunteered by responding to requests included in the paper-based learning materials that were initially sent to all ACCT253 students. Participants were randomly assigned to use either the e-book or printed instructional material. Those who were assigned to the e-book version then had the CD-ROM shipped to them along with installation and operating instructions. They were not required to return their printed materials, so that if they decided not to continue with the e-book version they could revert to the print-based instructional material without delaying their studies. If students assigned to use the e-book chose to revert to the printed material, they were dropped from the comparative study. However, their experiences with the e-book were still investigated by means of the end-of-course telephone questionnaire. The same questionnaire was also administered to students remaining in the study. Each student who completed the course and the questionnaire received a \$40 honorarium.

Cost-benefit Analysis

Clark (2000) stated that media comparison studies are only valid if they use baseline information to evaluate changes in technological effectiveness, particularly cost-effectiveness. Few studies exist that study this aspect in detail, however, and often there are methodological problems.

For instance, Buzzetto-More, Sweat-Guy, and Elobaid (2007) found that only a minority of students would purchase an e-book instead of a print based book. However, comparative costs were not calculated, so participants could not evaluate the question on the basis of economics as well as usability. Though Mercieca (op. cit.) noted that students were reluctant to use e-books unless these were made available at approximately one third of the cost of the printed text, no comparative costs were calculated.

Inglis (1999) concluded that print-based material was less expensive to develop than instructional material converted to HTML. However, irrelevant costs were considered in this analysis, like the cost of Internet connectivity. Since material could be included on a CD-ROM and mailed or picked up from a central location if these were campus-based student for instance, connectivity was not an essential cost difference. Similarly, assignment marking costs were included. These should have been ignored, as they did not differ between the alternatives. Costs of providing increased group interaction and the cost of handling student interactions by email rather than by telephone should have also been excluded, as these features changed the underlying instructional design of the compared media and confounded the analysis.

Annand (2008) stated that when conducting any economic analysis of comparative educational media, essential relevant cost characteristics are only those that a) are represented by actual cash flows (amortization, for instance, is an irrelevant cost); b) occur in the future (sunk costs are irrelevant), and c) differ under the various alternatives. For instance, recall the earlier-mentioned pop-up definitions that were included in the ACCT253 e-book. The initial expense of paying an ESL expert to identify and prepare these definitions is a sunk cost. It was incurred before the decision to create an e-book was made. It is therefore not relevant to the analysis at hand. Similar logic applies to the costs of the two computer-based modules included in the e-book, as these were created independent of the decision to create an e-book. Finally, the \$55,000 of fixed production costs needed to convert the second edition of the ACCT253 textbook and

instructors' solutions manual to the revised third edition are irrelevant. These are "joint product costs" that do not differ between the alternative media. When comparing the costs of the print-based and e-book material, the only relevant costs are those incurred after the so-called "split-off point" - the stage in the production process where previously indistinguishable products can be identified as distinct. This occurred when the revised third edition material was ready to be either printed or converted to e-book material.

As noted above, the variable costs to actually print the in-house version of the paper-based textbook amounted to approximately \$25 per text. Costs of producing the additional print-based Study Guide, Assignment Manual, Solutions Manual, and Student Manual material for each student registration amounted to approximately \$7, or \$32 for the entire print-based version of the course. By comparison, the variable costs to produce the e-book (primarily the cost of the CD-ROM and reproduction time) amounted to approximately \$8 per registration. The fixed costs to produce the e-book after the split-off point were as follows:

Adobe Acrobat [®] and Distiller [®] software	\$100
Copyright clearances	\$200
Conversion of textbook files to Adobe Acrobat [®] format, 1 person x 8 hrs. @ \$17	\$136
Deletion of unused textbook material, insertion of hyperlinks, bookmarks, and other features, 1 person x 20 days x 8 hrs. @ \$17	\$2,720
Production of audio-video clips, 2 persons x 3 days x 8 hrs. @ \$17	\$816
Insertion of pop-up definitions, 1 person x 2 days x 8 hrs. @ \$10	\$160
Final check, creation of install program, and production of master CD-ROM, 2 persons x 2 days x 8 hrs @ \$17	\$544
Total incremental fixed costs	<u>\$4,676</u>

The break-even point to recover these fixed costs occurred after about 200 students used the e-book version of the course material.³ After that point, the net saving to the institution by using the e-book material amounted to approximately \$24 per student (\$32 - \$8). Assuming 1,000 students per year in the course and an average three-year revision cycle, total incremental costs savings by using only the e-book could approximate \$67,000.⁴

Differences in Learning Efficacy

The second part of the study evaluated the differential learning effectiveness of the paper-based material and the e-book. A total of 283 students volunteered for the study. Of these, 139 withdrew from the course. This was not an unusually high percentage of non-completers, given the difficult nature of the course and the fact that most Athabasca University students are part-time, mature learners who have significant other responsibilities like work and family. An additional 18 students completed but failed the course, while 126 volunteers completed and passed the course.

Only 109 students finished all aspects of the study (completed the course and questionnaire, as well as the pre-test assessment). Of these, 71 participants were female and 38 were male, which is a slightly higher ratio than Athabasca University's overall gender balance (2/3 female). The average age of the participants was 36 years, slightly higher than the average age of Athabasca University students during this period (about 31 years). Age distribution is recorded in Table 1.

³ \$4,676/(\$32 - \$8) = 195 students.

⁴ (\$24 x 1,000 students x 3 years) - \$4,676 fixed costs = \$67,324.

Table 1

Age distribution

Age Range	# of Participants
18-25	13
26-35	40
36+	56

During the course of the study, 20 participants switched from the e-book to the print version. Therefore, of the 109 students who participated in the study, 34 used the e-book version of the learning material for the entire course, whereas 75 participants used the print version.

A pre-course test was constructed and administered to participants. This consisted of 10 multiple-choice, problem-based questions similar to those used on the mid-term and final exams. Results were compared to end-of-course grades and the differences used as proxies for learning over the duration of the course. Average increases in learning were then computed for the print-based and e-book groups and compared to determine if the medium of instruction affected course performance. Average increases in final course grades compared to pre-test results is recorded in Table 2.

Table 2

Average increases in final course grades compared to pre-test results

Group	Pre-Course Test Average	Final Course Grade Average	Difference	Standard Deviation
e-book	32.6%	78.8%	+46.2%	15.8%
Paper	35.1%	76.8%	+41.8%	17%

Several null hypotheses were constructed and tested:

H_1 = The likelihood of belonging to the e-book or print group is the same for males and females.

H_2 = There is no significant difference in age between the e-book and the print groups.

H_3 = There is no significant difference in the effect of the medium on the observed increase in test scores.

H_4 = There is no correlation between age and performance.

H_5 = There is no correlation between gender and performance.

There was no statistically significant difference in age or gender between the two groups. Neither the print or e-book learning material, nor age, nor gender had a significant effect on the observed increases in learning. Statistical analysis of the five null hypotheses is recorded in Table 3.

Table 3
Statistical analysis of the five null hypotheses

Hypothesis Tested	Statistical Test Used	Confidence Level	Result	Accept/Reject Null Hypothesis
H_1	chi-square test	$p = 0.05$	Asymptotic Significance (2-sided) = .095	Accept
H_2	independent samples t-test	$p = 0.05$	Significance (2-tailed) = .385	Accept
H_3	independent samples t-test	$p = 0.05$	Significance (2-tailed) = .202	Accept
H_4	Pearson product-moment correlation	$p = 0.05$	Significance (2-tailed) = .262 $r = -.108$	Accept
H_5	Pearson product-moment correlation	$p = 0.05$	Significance (2-tailed) = .177 $r = .130$	Accept

Extensibility of results is hampered by the relatively small study size. These issues are somewhat minimized by the fact that many previous studies have indicated that no differences in learning outcomes should be observed, especially given that so many facets of the research design in this study were able to be controlled. However, the study covers only one course in one institution, so readers should use caution when extrapolating these results to their own situations.

Usability and Affective Considerations

As noted above, all participants were asked to complete a telephone questionnaire that dealt with issues of usability and design of e-book compared to the printed instructional material. The questionnaire was open-ended. Some questions pertained to all participants. Some were targeted specifically at the e-book or print groups. The questionnaire consisted of three parts. The first section contained three questions. All participants were asked to identify their initially-assigned medium, whether they switched media, and whether they would be willing to use the e-book version if they could pay less for the course. The second part consisted of four questions directed at the print-based users, three of which were open-ended. Participants were asked to comment on whether they found the material clear and understandable, and what changes they could suggest to the printed material. The third part of the questionnaire was directed at e-book users. It consisted of 15 questions, four of which were open-ended. Questions in this section dealt with the usability and suitability of the two computer-based modules, the videos at the start of each lesson, pop-up solutions, and the electronic assignment submission feature; whether the navigation features were easy to use; adequacy of the installation instructions; and general comments about the medium. Most of the participants were similar to those quoted in other studies (e.g., Bradshaw, 2005; Mercieca, 2004; Vernon, 2006).

Advantages of the e-book

One of the participants felt that the organization of the electronic materials improved navigation and made it easier to move from one content area to another. Three participants found that the electronic format made the material more convenient and accessible. One student especially liked being able to download the electronic content to a computer hard drive to improve access to the material. Another found that the electronic format was extremely portable, much more so than a standard textbook. The portability of the electronic material was especially beneficial for another student who traveled quite frequently with a laptop. One participant indicated a preference for the flexibility that the electronic format offered, specifically being able to access the material onscreen as well as to print pertinent information when needed.

Disadvantages of the e-book

Seven participants found it difficult to read the e-book materials from their computer screen. They expressed incidents of eye strain and fatigue, which negatively impacted their experience with the electronic material. In addition, one participant felt that the font size of the e-book was too small and difficult to decipher. User instructions may have been deficient, since text size can be adjusted significantly within Adobe Acrobat Reader®. One participant underwent eye surgery and found that the e-book material was too difficult to read for extended periods of time.

As a result of the difficulty in reading the electronic material on-screen, six participants chose to print out material in order to read it. This seems unusual, because their entire print-based course package was always available to them. It is not known if these individuals eventually switched to the paper-based material study. At any rate, the need to print out material sparked complaints about printing costs and lack of access to printers, as well as comments about the inconvenience of having to switch between print and electronic materials. In addition, one participant found that when e-book material was printed out, the pages numbers did not correspond to those of the e-book. Another participant did not have a CD-ROM drive on a work computer and as a result had to print out any materials to access these while at work.

Three respondents complained about the inability to highlight and annotate the content. Three participants complained that they could not bookmark, which would have been useful for review and study purposes. Eleven participants criticized some features of the e-book navigation system. Some found that there were insufficient instructions provided to explain this feature. Some identified an error in the navigation which prevented them from being able to go back to a previous page in one part of the material.

Three participants found that the e-book did not fit well into their personal lives. For instance, there was only one (shared) computer available in one student's home. This made it difficult to gain access for extended periods of time to study. As another example, the shared computer was located in a central area in the home and distractions were more common. One participant traveled frequently because of work and did not always have access to a computer. Two other students noted that they did not like being tied to the computer, preferring the freedom and portability of paper-based materials.

Overall, the usability of the e-book appeared to be a concern for many of the study participants. In future iterations, the design of the e-book needs to be improved to address as many of these issues as possible. Still, issues of portability, inability to annotate, and difficulty/dislike for reading onscreen will likely continue until new generations of e-book readers gain wider market acceptance. Many of the currently-perceived disadvantages may also be somewhat offset by offering a lower course fee to students who choose the e-book option. A

total of 50 participants said that they would be willing to use only on-screen based material if there was a significant discount. In this study, no such discount was available. Possible price points for preferring e-books over print were not explored with participants.

Conclusion

Though sometimes conflated by differing instructional designs among compared media, other similar media studies to date suggest that instruction can be delivered without differential learning effects in many ways, by many media. Likewise, one conclusion of this study is that the use of e-books does not affect knowledge acquisition. Further, e-books are less expensive to produce than print-based material in large enrolment courses. However, issues of usability led most participants to prefer print-based materials.

Even if e-books may negatively influence certain aspects of the learning experience at present, these will likely diminish over time. As Spencer (op. cit.) noted, generational differences and technology advances will likely result in greater learner acceptance of e-books in the future. These trends, coupled with equivalency of learning outcomes among media, imply that questions of cost-effectiveness should be given more emphasis in future media effects research.

The results of the study eventually could have significant impact on the operations of Athabasca University. Widespread adoption of e-books would enable the University to produce and distribute its instructional material at lower cost. Unlike most post secondary institutions, significant cost savings and other benefits could be realized by eliminating paper-based material or supplying this only to students who are not able or willing to use e-books as learning materials, since these costs are included in course fees.

Perhaps most importantly, this paper has argued that decision makers, whether in profit-oriented enterprises or in the academy, need to base financial decisions on relevant costs. These only include future cash flows that differ among alternatives. Though not applicable to this study, techniques should also be considered when necessary to equate future cash flows back to their present values so that alternatives can be compared on an equivalent basis (Annand, op. cit.).

It still appears relevant, as Bates (1995) stated, that even when analysis of learning outcomes, student preferences, and relative costs have been completed, issues around the design of learning experiences - like appropriate instructional design, equality of access, quality of interaction, impact on revision cycles, and future goals of the institution - need to be considered in media comparison research. However, results of the current study should usefully inform a more comprehensive institutional analysis. With increased interest in virtual learning, all of these concepts are essential components of any analysis dealing with proposed changes to the way teaching and learning is conducted in institutions of higher learning.

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