Print vs. electronic readings in college courses: Cost-efficiency and perceived learning

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ABSTRACT

We report surveys of 101 students in two undergraduate college courses about their use of required readings accessed via a university-administered electronic reserve system. About two-thirds of respondents printed at least some readings, although nearly half of the total pages were read online. Most students who printed incurred substantially lower total costs (in terms of both direct printing expense and time opportunity costs) than the projected price of a printed and bound coursepack with all of the readings—thus suggesting electronic provision to be cost-efficient for most students. Respondents reported an overall preference for electronically supplied readings. The advantage of electronic reserves was overwhelmingly perceived to be cost, but large majorities said they usually read more, and learned more, when printed readings are supplied. These findings suggest that university and student incentives to employ electronically supplied readings may be misaligned.

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1. Introduction

Technology, cost, and political pressures are driving a strong trend throughout higher education toward the use of e-texts or other electronically accessed reading resources, such as electronic reserves or posted URLs (Buczynski, 2007; Murray & Pérez, 2011; Young, 2010). These changes are occurring both in face-to-face courses and perhaps to an even greater extent, within e-learning or blended learning environments (Murray & Pérez, 2011; Rogers et al., 2011; Thomsett-Scott & May, 2009). Possibly contributing to the pace of change, administrators often seem to assume that electronic reading resources are not only cheaper, but that they are superior for learning (or are rapidly becoming so) as digital natives continue their inevitable march into post-secondary student bodies.

This article is concerned with two broad debates about whether these assumptions are realistic. The first and most general question has been actively explored in the academic literature for more than two decades: Do electronically accessed readings lead to more effective, or less effective, learning than do print based readings? The second question, much less frequently discussed in the academic literature: Is the use of electronically accessed readings a more cost-effective and economic welfare enhancing way to provide students with readings, than is the use of ready-made print resources? The answer to the latter question may seem obvious. To the extent, however, that students may choose to print off the electronically accessed resources for later use, the

money as well as time resources they expend could outweigh savings from reduced publisher and book seller costs.

We address aspects of these questions with surveys of 101 undergraduates enrolled in two Indiana University at Bloomington courses in fall, 2010, one a social science-oriented course in the Dept. of Telecommunications, the other a Dept. of Biology course. Both courses supplied all required readings in freely available electronic form via an electronic reserve (e-reserve) system administered by the Indiana University Libraries. Our surveys questioned students on their printing and reading behavior in these particular courses, and collected information about the students and their general preferences for, and attitudes toward electronic vs. printed readings. Using these survey and related data, we directly evaluate the economic efficiency issue in terms of the time and money costs of student self-printing and binding activities. By also providing a detailed picture of student use of an e-reserve system, as well as student attitudes toward printed vs. online readings, we inform the learning efficacy debate.

2. Literature review and research questions

2.1. Studies comparing use and learning efficacy of electronic vs. print resources

A number of studies in the education, psychology, computer science and library science literatures have reported on experiments or surveys that investigate student preferences for electronic vs. print-based library reserves, for online (or on-screen) vs. printed course readings, the behavior of students in using electronically accessed compared to printed resources, and on the learning efficacy of these alternatives.

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Most of these studies have been surveys conducted within traditional face-to-face, online, and blended learning courses, or in some cases, laboratory experiments.

After electronic reserves (e-reserves) began to replace print-based library reserves in the 1990s, several authors reported on surveys showing strong student preferences for electronic over print-based library reserve systems (Austin & Taylor, 2007b; Isenberg, 2006; Pilston & Hart, 2002). Hughes (2004) and Austin and Taylor (2007a) also found that students printed extensively from the e-reserve systems. Austin and Taylor (2007b) reported that students were more likely to read electronically-supplied rather than print-based reserve materials, but this comparison apparently incorporated student printing or copying from either resource.

Turning to the comparison of e-reserves with coursepacks, hardcopy texts, or other printed course readings available for purchase, published studies have consistently found that students prefer to read and study printed rather than on-screen materials. In an early survey of the literature, Dillon, McKnight, and Richardson (1988) reported that reading from computer screens was slower, more fatiguing, had decreased comprehension, and was rated as inferior by readers. They also cited evidence that image quality of the screen display was a crucial factor, thus suggesting the potential for technology to bridge the gap.

More recent studies, however, have found a persisting gap in favor of print for generally similar reasons, in spite of obvious technological advances in onscreen presentation. In a survey of graduate students from 11 different face-to-face classes, Chang and Ley (2006) found that a high percentage preferred to read print. Spencer (2006) reported a survey of distance education students showing preference for printed text materials for reasons, among others, of portability, flexibility, and less eyestrain. Precel, Eshet-Alkalai, and Alberton (2009) found that a majority of college students in a blended learning course who could freely migrate between a printed and digital text, used the printed text more often and believed that it contributed more to their learning. In a large scale nationwide Canadian study of e-learning, more than 80% of surveyed college students reported a preference for reading in print rather than on-screen (Rogers et al., 2011). In a series of face-to-face classroom study and testing sessions, Garland and Noyes (2004) found information retrieval from on-screen reading to be generally slower and less accurate than reading print. In a diary-based study of college students' general reading habits, Foasberg (in press) found that subjects tended to use electronic media for shorter, non-academic reading, but that they did not wish to switch to electronic media for academic reading.

Among other studies reaching similar conclusions based on surveys or on classroom experiments in which students are able to choose between using a textbook in printed or in e-text form, are Buzzetto-More, Sweat-Guy, and Elobaid (2007), Ismail and Zainab (2005), Annand (2008), Vernon (2006), and Robinson (2011). Among reasons cited by these authors for student preferences for print were easier use of multiple resources at the same time, easier future use, and a belief that print enhanced comprehension. Based on a survey of undergraduates, Woody, Daniel, and Baker (2010) noted the well-known historical gender differences in computer use, but reported in their survey that students preferred printed texts over e-books regardless of gender, computer usage rates, or comfort with computers.

In spite of these preferences for print, several authors (including Annand, 2008; Daniel & Woody, 2013; Chang and Ley, 2006; Murray & Pérez, 2011; Spencer, 2006) report finding no significant differences in learning efficacy between on-screen and print users in classroom experiments. Annand (2008), for example, measured student performance in an introductory financial accounting course, and using pre-test controls as a benchmark, found no significant differences in final grades of students who chose to use an e-text compared to those who chose the printed version.

It is difficult, however, to obtain conclusive measures of learning efficacy outside of a laboratory environment. To measure learning differences in such a lab experiment, Ackerman and Goldsmith (2011) found that when subjects regulated their own study time, those reading print performed better on comprehension and retention tests than did on-screen readers. (see also Ackerman, 2009; Ackerman & Goldsmith, 2008). They attributed these differences to "metacognitive" factors; on screen readers had more erratic study time and were less able to evaluate how much they had learned, both of which tended to diminish test performance. Daniel and Woody (2013) examined learning efficacy of printed text vs. e-text readings in both lab and at-home conditions. Although they found no significant differences in learning, e-text reading times were significantly longer than for printed texts, especially for subjects in the at-home condition, who notably reported significantly higher levels of multi-tasking than did lab respondents.

Related to these findings, some authors have also found that when given the opportunity, substantial numbers of students choose to print off e-text or other electronically accessed readings for later use. Chang and Ley (2006), for example, reported that about two-thirds of their survey respondents said they printed 75% or more of online class reading materials. Vernon (2006) reported that a majority of 23 students in a course with only electronically supplied readings initially available relied on making paper copies, with only about 20% reading everything in electronic form.

There are indications from previous research that student preferences for print, along with advantages that print-based learning may have over electronics-based learning, are likely to diminish in the future. Ismail and Zainab (2005) found that previous experience with e-books reduced preferences for printed textbooks, although to a relatively minor extent. Eshet-Alkalai and Geri (2010) report an experiment with 11th grade high school students in which they found a negative effect of "incongruous" forms of onscreen reading (i.e., on-screen displays of materials that were originally designed to be read on paper, such as electronically scanned books), suggesting that continuing transition to computer-generated e-text and other reading materials will diminish the print advantage. In addition, Ackerman and Goldsmith (2011), Robinson (2011), and Woody et al. (2010) all report that students tended to underutilize various enhanced features of e-texts or other on-screen readings, such as digital highlighting and note taking. A recently completed five-university e-text pilot study reportedly reached a similar conclusion (Internet2, 2012; Chen, 2012).

2.2. Economic efficiency

Questions of the economic efficiency of print vs. on-screen readings have not, to our knowledge, been systematically studied, with the exception of Annand (2008), who compared the costs per student of providing an e-text vs. a printed version of the same textbook under alternative assumptions about class size.

Of course, if students read and study an assigned article or e-text online, that saves distribution costs by reducing paper and other physical costs, such as production and sale of a hardcopy coursepack. Similarly for e-texts, which avoid physical duplication and distribution costs.

To the extent, however, that students may simply print off electronically supplied materials and read them later, provision to all students of published hardcopy text materials could be more economically efficient. In classic articles in the economic literature, Besen (1986) and Besen and Kirby (1989) compared economic welfare in a model of centralized duplication and distribution to consumers of a printed product (e.g., a book) by a commercial publisher vs. a model in which the same consumers individually obtained a single master and all made their own photocopies. They showed that centralized duplication and distribution are more socially efficient than individual copying if the publisher has lower duplication and distribution costs than do the copiers—each of whom must obtain the original, then incur time and money costs to duplicate the original.

While Besen wrote over 20 years ago, a modern interpretation of his work is that to the extent students simply print off e-text or other