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An assessment of the impact of online quizzes and textbook resources on students' learning

Monica Galizzi

Introduction

Despite the widespread diffusion of teaching technology in US colleges and universities (Goffe and Sosin, 2005), for a long time economics faculty were lagging behind instructors in other fields in adopting non-lecture teaching methods (Becker and Watts, 2001). Such hesitation could be partially explained by the fact that we still know relatively little about how different new instructional methods and software affect students' learning in economics classes (Katz and Becker, 1999). The available evidence is mainly based on students' learning outcomes in introductory classes, and it is quite mixed, depending on the technology that is assessed. For example, Agarwal and Day (1998) found that the use of the internet positively affected students' learning and attitudes toward economics and toward their instructor. Elliott (2003) and Lass *et al*., (2007) reported improvement in students' performance and in their enjoyment of lectures after introducing a Personal Response System. Brown and Liedholm (2002) found, however, that students' performance in virtual courses was inferior to that of students who took live or 'hybrid' classes where face-to-face lectures were integrated with a variety of online material.

Web-based homework is an additional teaching tool that is quickly spreading in response to the increasing teaching load faced by many instructors in universities that are operating under increasingly tight budgets. Textbook publishers have responded by offering additional online textbook resources, but we still know little about the effectiveness of these tools. Given the availability of personal computers and young students' familiarity with them, it is not surprising that students evaluate online homework positively (Dahlgarn, 2008; Smolira, 2008). The evidence on

learning outcomes is more mixed, however. For example, Palocsay and Stevens (2008) did not find any significant difference between the performance of students who had been assigned a variety of web-based homework and students who had been assigned traditional textbook-based homework. But Dufresne *et al*. (2002) and Lass *et al*. (2007) found that online homework did lead to higher exam performance.

The following study aims at adding some evidence to this debate by making use of student records in one upper level economics class and in two introductory classes to focus on the effectiveness of a specific learning tool, online homework quizzes. This analysis builds on previous studies where the authors had posted multiple choice questions on course websites as a supplemental study aid for students. Harter and Harter's (2004) study of students enrolled in a highly competitive program which made use of web-based homework quizzes measured their performance over three semesters against a control group of students who had taken the same final exam during a previous semester when the web page was not in place. They found that the opportunity to practice with online quizzes did not statistically increase students' scores. Kibble's (2007) study of medical students and Hadsell's (2009) study of finance students found, however, that exam scores increased for students who had completed the online quizzes assigned as homework. My study differs in its experimental design and in the studied population: I look at online quizzes provided by textbook publishers, and my analysis is of students enrolled in several different colleges within a public university. In addition, I try to cast some light on this issue by using four years of descriptive data on student performance as well as qualitative information collected through a student survey.

The data

The student population

This study examines students' records that were collected in an upper level class in *Labor Economics* and in two sections of an introductory *Principles of Microeconomics* class. These classes were taught in a public university that is characterized by a large number of students who live off campus (65%) and receive some financial assistance (73%). Men students outnumber women (60% to 40%). Conversations with these students also suggest a population composed largely of individuals who are 'first generation' in college. The *Labor Economics* class is offered yearly and usually enrolls about 20 students who are predominantly juniors or seniors. *Principles of Microeconomics* is a prerequisite for this course. In the fall of 2006 this course enrolled 17 students, only three of whom were female. All students were

enrolled full-time, but 61% of them reported that they were also working more than 36 hours per week (only two students declared they were 'only' students with no outside employment). This percentage suggests a student population with higher financial need compared to the US average: Siegfried (1996) found that only 14% of students enrolled in introductory economics classes in the US worked more than 30 hours per week. Additional records were collected to look at students' performance in the *Labor Economics* class over three previous years. On average, over the four years, only 19% of students were female, 44% were seniors and 63% were enrolled in the College of Arts and Sciences to which the Economics Department belongs. The composition of the four classes did not significantly differ in terms of these observable student characteristics: the p-values for $\chi 2$ tests for differences in distribution of these characteristics across the four years were always at least ≥ 0.20.

The two sections of the *Principles of Microeconomics* classes were taught in 2007. One section had an enrollment of 42 students; the other had 44. Students came from three different colleges: Engineering (34%), Management (30%) and Arts and Sciences (36%). Only 21% of the students were females.

This study makes use of records of students' performance on their midterm exams, as well as a survey that was administered to the *Labor Economics* students at mid-semester.

The course and textbook websites

In 2006 the instructor developed a course website as a tool to implement at least three of the seven principles described by Chickering and Ehrmann (1996) as good practice in the use of educational technology: encouraging contact between students and faculty, giving prompt feedback and emphasizing time on task. The website listed announcements, required assignments and links to additional readings. It also included a link to the textbook website which offered chapter summaries, extra problems and online practice quizzes.

There were two main reasons for the need to develop a course website and to assign more online homework. First, the fact that a very large proportion of students were employed for at least several hours per week made it more difficult to maintain high student attendance and alertness during class time, thus challenging the goal of increasing students' learning and retention. Second, usually only half of the *Labor Economics* class and one third of the *Principles* classes are made up of students who have chosen or will choose economics as a major. The rest of the students come from a wide variety of backgrounds including management, engineering, political science and other disciplines. It is expected that

students with different training will differ in their interest toward a particular class (McClure and Spector, 2003). In the author's experience, while the economic majors are usually 'loyal participants' in the class, it is much more challenging to retain the non-economics students. This is possibly due to a variety of reasons: engineering students and others with technical backgrounds often over-estimate their ability to satisfy the requirements of the class. They are not intimidated by the technical and mathematical knowledge that is required by economic analysis and therefore often decide to skip class. This leads them to miss out on discussions related to public policy and therefore eventually to under-perform in their exams. On the other hand, students who come from less technical majors (such as history, political science, etc.) can be intimidated by the technical requirements but often live in denial of their lack of understanding until it is too late to help them fill the gaps. Given the relatively large percentage of non-economics students, therefore, the course website aimed at providing better ongoing communication about course requirements and feedback to students about their performance.

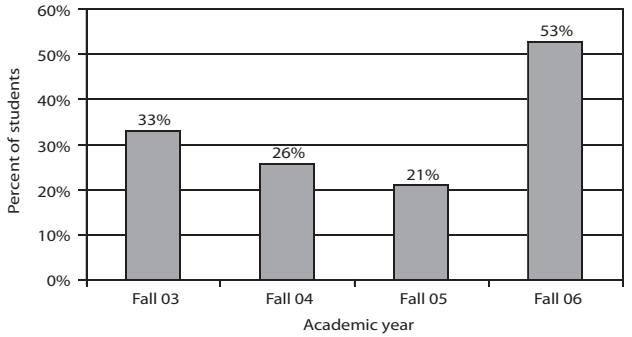
Finally, again because of their job commitments, students often see the class as the main learning time during which they can absorb required material. The very expensive textbooks are bought by students but often used in a very limited way (Kinzie, 2006). The required use of the textbook website (and specifically of tools such as online quizzes to monitor performance) aimed at correcting this discrepancy by increasing the value of the investment students made when they bought the book. The textbook website included chapter summaries, quantitative and econometric exercises, additional readings and online quizzes for each chapter. These quizzes provided a practice opportunity for those students who had claimed 'I am not good at multiple choice questions', and they permitted continuous feedback about students' performance.

Indeed, the introduction of the course website proved to be tremendously effective in increasing students' responsiveness to the posted announcements about the homework which was assigned in class and due on different dates. Figure 1 describes the remarkably positive effect on *Labor Economics* students' awareness of their responsibilities and required work. Compared to the three previous academic years, in the fall of 2006 the percentage of students who had submitted all the required coursework by mid-semester had doubled.

An experiment to test the effectiveness of the textbook website

During the first half of the semester, *Labor Economics* students were assigned several homework exercises: problem sets, extra readings and manipulation of data extracted through the Web. They were also asked to answer six online quizzes corresponding to six chapters of their textbook. This assignment was fully

Figure 1: Percent of students who completed ALL required homework by mid semester (upper level class)



completed by 15 out of 17 students enrolled in the class (88%). After students completed the quizzes their answers were automatically emailed to the instructor. Because the website permitted students to correct wrong answers before submitting the quizzes to their instructor, this homework was graded only on the basis of the completion of the task and not on the actual number of correct answers.

To assess the validity of the textbook online quizzes as a learning tool, the instructor decided to include some of the previously assigned online questions in the midterm exam. The midterm exam was made up of two components: a take-home section that included problems and essay questions (for a total of 50 points) and a section administered in class consisting of 50 multiple choice questions. This is the exam format that the instructor had used in previous years to accommodate

Figure 2: Individual students' scores in midterm term (upper level class)

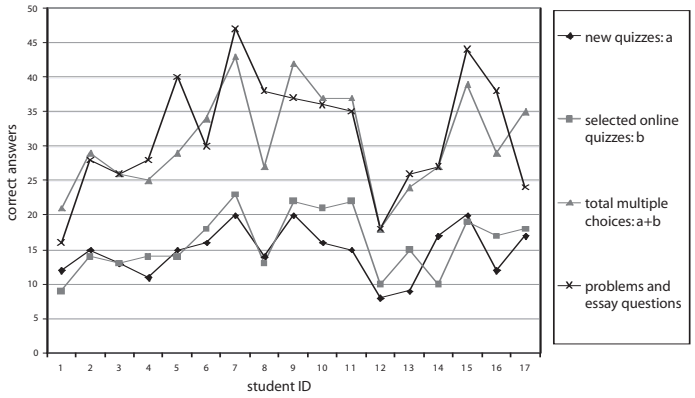


Table 1: Students' performance in exam questions

	Number of students	Average number of correct answers to multiple choice questions: [a]			Average score in essays/ problems section [b]
		questions previously answered online	questions never seen before	all questions	
Labor Economics	17	16	15	31	32
		ρ [c] = 0.63		ρ [c] = 0.74	
		p-value [d] = 0.15			
Principles of Micro: section 1	41	12	12	24	21
		ρ [c] = 0.39		ρ [c] = 0.56	
		p-value [d] = 0.47			
Principles of Micro: section 2	33	12	13	26	24
		ρ [c] = 0.52		ρ [c] = 0.49	
		p-value [d] = 0.12			

Notes:

[a] The total number of multiple choice questions was 50 in the Labor Economics class and 40 in the Principles classes. They were evenly divided between new and previously answered questions.

[b] The total possible score in the essays/problems section was 50 in the Labor Economics class and 40 in the Principles classes.

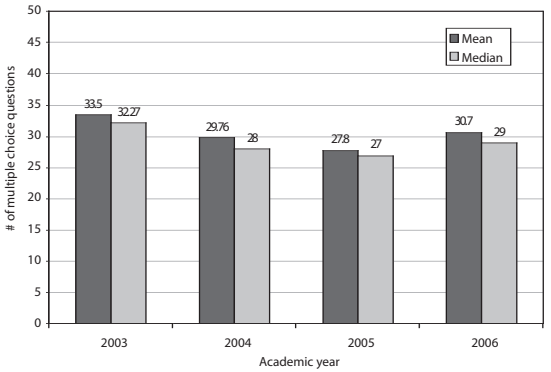
[c] ρ indicates correlation coefficients between individual scores in the two multiple choice sections

[d] The p-value is for a two sample t tests for differences in mean values.

different learning styles and to capture different dimensions of learning. This time, however, 25 out of the 50 multiple choice questions were ones that students had previously encountered and answered in the online quizzes. Students were not told about this design of the multiple choice exam. The results of this experiment were quite surprising as shown in Figure 2.

Overall I found a strong correlation between students' performance in the multiple choice section of the exam and in the section consisting of problems and essays, as shown in the two top lines in the diagram. (The correlation coefficient was 0.74.) However, Figure 2 also shows that there was no systematic pattern supporting the hypothesis that students were better able to correctly answer the quizzes they had already completed online as homework. While there was clearly a correlation in students' performance across the two different sets of multiple choice questions

Figure 3: Correct answers to multiple choice questions (upper level class)



(lines a and b in the diagram; correlation coefficient 0.63), a statistical t-test rejected the hypothesis that there was any statistically significant difference in the mean of correct answers between the two groups of multiple choice questions (p-value = 0.15) (Table 1).

To further assess the results, the instructor compared the overall performance in the two combined multiple choice sections of the exam with records from classes taught in three previous academic years. Grading policy and exam difficulty was consistent across all years because the multiple choice questions had been extracted from the same textbook test bank and were either identical or tested the same concepts at the same difficulty level (except for the exam administered during the experiment with half the multiple choice questions extracted from the homework online quizzes). Figure 3 reflects this analysis.

Once again t-tests were conducted to test for differences in mean scores, and the mean performance was found to be not statistically significant across the different academic years (p-values at least > 0.26). The opportunity to preview and practice online the material covered in the text did not result in better performance: students did not show a significantly greater ability to answer correctly the multiple choice questions they had already been exposed to, and their overall performance in the exam did not improve.

Because students found out about the 'surprise' component of the experiment (students realized that they had been tested on questions they had already answered as homework), it was not possible to replicate this experiment with other exams of the *Labor Economics* class. Therefore, the same experiment was conducted the following year, 2007, with two sections of a *Principles of Microeconomics* class.

This produced a total of 74 additional students. Again, students were previously assigned online quizzes as homework which could be found on the textbook website. Without students knowing, some of these quizzes were then included in the multiple choice section of a mid-term exam. Table 1 compares the results of this experiment across the different classes. This time, the average number of correct answers was actually the same or higher in the 'new' multiple choice questions, but again the mean score was found to be not statistically different from that of the previously answered on-line quizzes. Compared to the upper level class, however, I found lower correlation coefficients between the two sets of multiple choice questions (0.39 and 0.52) and between the whole multiple choice section and the problems and essay sections of the exam (0.56 and 0.49).

These results lead to the conclusion that while multiple choice tests are reasonable predictors of students' overall performance, homework consisting in online quizzes did not have any significant effect on students' performance: most students who did well in the exam did so regardless of whether or not they had already encountered and answered some of the exam questions in their online homework.

Students' feedback

A possible explanation of these results could be that students had not really applied themselves seriously to the solutions of the homework online quizzes. After all, they knew that what counted was their participation in this homework and not their final performance on it: the instructor had decided not to make the performance on the online quizzes a component of the grade because the textbook website technology permitted students to revise their answers before submitting them. A different textbook website could have been 'smarter' in this regard, but still would not have solved the problem of monitoring whether students were answering online quizzes on their own or with other people's help. Had this been the case, then online quizzes would have represented neither a valid performance measure nor a real learning moment for students. Surprisingly, however, students' assertions suggested the opposite. The instructor had decided to administer an open responses survey at mid-semester. The goal was to better understand the use that students had made of the textbook online resources. Specific questions were asked about the textbook online quizzes. 82% of students returned the survey. Their responses could be summarized in this quote:

> 'I did the online quizzes when they were assigned. I found them helpful for pulling out the key points in the chapter. I would go back and reread the sections in the book that contained the answers for the questions. I know if I had gone back over the questions again before the test I would have done better. I didn't mind these assignments; they are easy enough to get to and use.'

There were, however, also some dissenting voices, noting how online quizzes may be difficult to monitor and how quizzes do not really test the depth of students understanding:

> 'I did them each time; it was useful because it made you read the textbook. It was helpful for me but if someone wanted to they could easily cheat on it. I don't think it's the best representation of what students understand'

> 'I have completed every quiz assigned. I found it somewhat helpful because the midterm exam was based strongly on these types of questions. However, I tend to retain information more so when assigned analytical, essay type questions and problems. I did not find it very helpful in studying and understanding concepts because there is very little room for personal relevance. I do find online assignments useful because in any industry these tools are essential. Familiarity with technological application to assignments will better prepare us for a professional career.'

> 'When I did the online quizzes I simply looked at the question and tried go back and find the answer in my book. No problem there. A problem arose, for me, when it came time to decide which of these questions were important or not. (Which ones should I study?) I could not decide. If I cannot decide which questions need more attention in order for me to grasp the concepts, then I will not know what to study for when it comes time for the final or midterm. I actually felt the questions asked were not important because they did not relate so much to the material which was taught in class, and being a student, I focused on what the professor focused on in class. I realize now that I am a fool for underestimating these questions.'

In addition, only three out of the 14 survey respondents reported that they used the additional online textbook resources, and it was always just to read the summaries of the textbook chapters.

Discussion and conclusions

This study aims to assess the value of online textbook resources. In particular, it focuses on the learning that occurs through the use of online textbook quizzes. It makes use primarily of records collected in a *Labor Economics* class. However, because of the small number of students observed in this upper level class, a problem that is often encountered in analyses that explore students' learning in web-enhanced or intermediate courses (Anakwe,2008; Dahlgran, 2008; Mukherjee and Cox, 2001; Smolira, 2008), this study's main results were also tested on two larger sections of an introductory level *Principles of Microeconomics* class.

The use of textbook resources was part of the more general implementation of a course website. The introduction of the course website by itself had a very positive effect in increasing students' commitment to their coursework. The instructor noticed a remarkable increase both in terms of completion of the required assignments and in terms of the use students made of their textbook and of additional written resources. However, participation in online textbook assignments did not make any significant difference in the students' ability to score higher grades on their written exams. This happened, despite the fact that the exam included several quizzes that had been previously assigned as online homework. The analysis of qualitative data collected through an open response survey, however, suggested that many students found the online homework to be quite a useful study tool, feedback similar to what has been documented in other studies (Tse *et al*., 2007; Smolira, 2008).

These results could possibly be explained by the fact that, because of the features of the textbook online quizzes (the website technology permitted students to check and revise their answers before submitting them), the instructor had decided to monitor and reward participation in online homework, but not the scores. It is therefore possible that many students did not review their homework computerized quizzes for errors. The effort of going over homework quizzes has been found to positively influence performance (Johnson *et al*., 2002) although there is also mixed evidence about the benefits of grading homework, giving feedback and providing access to homework solutions (Peters *et al*., 2002; Biktimirov and Klassen, 2008; Hadsell, 2009). In addition, research has indeed shown that when unsupervised online quizzes are tied to incentives for participation (e.g. grades) students may be induced to cheat (Kibble, 2007; Passow *et al*., 2006).

A different or additional explanation could be, however, that the large majority of observed students were heavily involved in work activities outside of school: 61% of students enrolled in the upper level class had responded that they were registered as full-time students but also employed for more than 36 hours per week. This type of student is known to face difficulties with school work (Devadoss and Foltz, 1996; Kirby and McElroy, 2002; Stinebrickner and Stinebrickner, 2003), and for them classroom time constitutes the main learning component of their college experience. The introduction of a course website and the required online homework quizzes increased their dedication and participation in the class. The availability of online textbook resources did not significantly change the effectiveness of the time students actually dedicated to studying, however.

Students' learning is unlikely to be fully captured by one simple assessment tool such as multiple choice questions ((Becker and Johnston, 1999; Krieg and Uyar, 2001; Buckles and Siegfrid, 2006), although this study confirms that multiple choice tests are reasonable predictors of students' overall performance (Walstad and Becker, 1994; Mukherjee and Cox, 2001; Anakwe, 2008). But multiple choice tests are unlikely to disappear (Schaur *et al*., 2008), given the heavy teaching load faced by faculty in many academic institutions. These are often the same schools where, given students' socio-economic status and conflicting time demands, online work may legitimately be seen as a tool to increase students' learning and retention. The results of this study confirm that web homework increases students' participation, but that textbook online multiple choice quizzes do not represent the best investment for time spent online. They are not the useful learning tools that textbook publishers and, even more so, instructors would like them to be. Students need more comprehensive and interactive online assignments.

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