# Innovative Teaching: An Empirical Study of Computer-Aided Instruction in Quantitative Business Courses

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**Key Words**: Fixed effects; Khan Academy; Online teaching aids.

## Abstract

We investigate business undergraduate mathematics-based courses in a blended environment of online assignments and exams and offline lectures, and report the impact on academic performance of factors such as classroom attendance, web-based course supplements, and homework. We present results from both ordinary least squares and fixed effects, where the latter method controls for unobserved heterogeneity among students. We discuss biases in estimation when the ordinary least squares method is used, resulting from the fact that it ignores unobserved heterogeneity. The fixed effects results suggest that (1) class attendance has a positive impact on exam score, (2) a student who achieves proficiency in a greater number of Khan Academy skill-sets to prepare for an exam takes longer to complete an exam but does not experience a significant change in exam score, (3) a student who spends more time completing the homework spends more time completing the exam but does not experience a significant change in exam score, and (4) students who score relatively higher in homework tend to score relatively higher in exams and finish in less time than other students.

## 1. Introduction

The variety inherent in students' learning skills is often unobservable. A common challenge for professors teaching quantitative courses in business schools is to enable students to learn mathematics-based courses, such as business statistics, economics, marketing research, operations management, and others, when the student body is heterogeneous in its ability and background in quantitative skills. We explore to what extent student attendance, submitted homework (HW), and Khan Academy assignments (explained below) affect performance in exams. The fixed effects (FE) methodology enables us to control for unobserved student-specific characteristics. We compare results with the popular ordinary least squares (OLS) method.

In many business schools, students struggle with business statistics, and their discomfort affects their performance in more advanced courses that rely on statistical skills (Nonis and Hudson 1999). Research demonstrates that when students have previously taken mathematics courses their course grade improves. Johnson and Kuennen (2006) and Lunsford and Poplin (2011) show a significant positive relationship between basic mathematics skills and performance in quantitative courses. Rochelle and Dotterweich (2007) find that student absences, grade earned in a previous introductory quantitative methods course (algebra and differential calculus), and GPA are highly correlated with performance in business statistics. Green, Stone, Zegeye, and Charles (2009) recommend at least a C- grade in prerequisite mathematics to support performance in business statistics.

Lovett and Greenhouse (2000) rely on cognitive theory to discuss how students learn applied statistics best, and demonstrate that the best learning is self-learning and experiential, that knowledge is often specific to the context in which it is learned, and that real-time feedback on errors is more useful than delayed feedback, all of which characterize online teaching aids such as the Khan Academy. With higher education institutions facing reduction in public funds, exploiting appropriate free resources is becoming increasingly important to produce graduates with sufficient quantitative/analytical skills to succeed in the workplace.

The remainder of the study has the following structure. The next section summarizes the literature review and presents research questions. Section 3 describes the databases compiled from university records and online sources that track student performance. Section 4 depicts the empirical models we construct. The fifth section presents and discusses the results of our estimation. Section 6 summarizes and concludes the paper.

## 2. Literature Review

### 2.1 Online Teaching Aids

The future of education is the Internet, as online universities, distance teaching, and cyber schools experience rapid growth (Gonul 2005). In the past, professors relied on the chalkboard, lectures, story-telling, and film strips. Today's students expect, at minimum, PowerPoint presentations, occasional videos, and updated content from news delivered in real time via the Internet. Professors, in turn, demand such teaching aids from textbook publishers.

Online and blended learning environments are rapidly becoming more available as advances in information technology (IT) enable the development and introduction of new tools to improve the learning experience. Moore and Kearsley (2005) summarize the evolution of education outside the classroom, starting with correspondence courses and progressing through broadcast radio and television and teleconferencing to Internet/web technology. Beldarrain (2006) reviews the history of computer-assisted instruction (CAI) and discusses how technology distorts the concept of distance between the learner and the educator and enables learners to access education at any time and at any place. Tishkovskaya and Lancaster (2012) compile innovative teaching techniques in statistics and review a collection of online resources.

Online educational tools allow professors to track and keep accurate records of performance, interact with students on the basis of their performance, provide immediate feedback and help, and offer the review of past performance on demand. Students know their grade in HW and exams first, before the professor does. Furthermore, online teaching aids serve as third-party testimonials that add to the credibility of the lectures or, if they conflict with the live lecture content, add dynamism and realism to the on-ground classroom setting.

Interactive IT, such as Coursera, Khan Academy, MyPearsonLab, and OpenCourseWare, is increasingly used in education to enhance knowledge. Communication between students and professors is progressively through e-mail as the conventional practice of office hours wanes (Dickson and Segars 1999). Accordingly, classrooms are being re-defined in both physical and virtual space.

In both commercial business and government, the use of IT and social media is ubiquitous. Lohmann (1998) offers examples of high-tech classrooms in business and government units. How-to books are being published to help business and government manage social media, integrate social media into existing marketing programs, measure results, and enhance profitability (Evans 2010; Miller 2011).

Further examples of IT-related changes are numerous, sometimes with conflicting results. Becker and Watts (1998) compile 12 papers in their edition on teaching economics with innovative techniques to increase student performance. Kozma (2003) reports the results of an international study of 28 countries on how technology is changing today's teaching and learning efforts. In an experiment designed to evaluate the benefits of a popular course management system in principles of financial accounting, Hall and Lang (2007) report no improvements in student performance, but Beal, Walles, Arroyo, and Woolf (2007) finds that mathematics skills of high school students who use an online tutorial improve more than those of the control group. Hazari and Johnson (2007) find that students value quality of content and ease of navigation over multimedia capabilities and interaction with the system. They point out that education websites often do not take a pedagogical approach, possibly because they are prepared by IT people who may lack training in pedagogy. Such websites are then used by faculty who are in turn not trained in IT and may experience difficulties in integrating online material into the traditional curriculum.

A meta-analysis of more than 1,000 empirical studies concludes that on-line learning is beneficial to student performance (Means, Toyama, Murphy, Bakia, and Jones 2009). However, in another meta-analysis, Larwin and Larwin (2011) document concerns that CAI may exert stifling effects on understanding difficult concepts in statistics. They report only a modest increase in student learning due to CAI. A further meta-analysis on the effectiveness of computer-assisted statistics instruction finds that it yields a reasonable advantage on average performance (Sosa, Berger, Saw, and Mary 2011).

In recent years, social media websites such as Facebook and Skype have been used to facilitate learning (Ractham, Kaewkitipong, and Firpo 2012; Strang 2012). Several higher education institutions offer open education resource systems, such as MIT's OpenCourseware. These systems have evolved into open online courses and massive open online courses (MOOCs) (Fini 2009). Currently, several companies offer both for-profit and not for profit MOOCs, such as edX (founded by MIT, Harvard, and Berkeley), Coursera (founded by two Stanford professors), Udacity (founded by a Stanford professor), Khan Academy (founded by Salman Khan), and Udemy (founded by Eren Bali, Oktay Caglar, and Gagan Biyani). MOOCs are expected to have a significant impact in the pedagogical and economic models of higher education (Martin 2012).

We now turn to literature more specific to the variables in our model.

## 2.2 Dependent Variables: Exam Score and Time to Complete an Exam

Speed and accuracy are common indicators of success. For example, in customer service centers response time and accurate feedback are sure generators of customer satisfaction. In a classroom setting, exam scores are a natural candidate for a measure of success, and most students feel that finishing an exam faster than others in class is a sign of success. Completion time as a measure has not been used often in the prior literature, possibly because reliable data did not readily exist. However, current CAI tracks it precisely. In the recent literature, for example, Thompson, Thong, and Chauvin (2009) argue that both speed and accuracy are performance measures, especially in medical professions where response time is critical. In the psychology literature as well, information processing speed has been used as a variable to rank order cognitive skills across individuals (Kyllonen and Christal 1990). In business, fast and accurate response is also important. Thus, we include exam completion time in our model as a dependent variable in addition to exam score.

## 2.3 Explanatory Variables: Student Attendance, Khan Academy Assignments, Homework

### 2.3.1 Student Attendance

As noted in the Introduction, the number of student absences significantly affects performance in mathematics-based courses (Rochelle and Dotterweich 2007), and attendance has positive effects on exam scores (Westerman, Coffey, Pouder, and Perez-Batres 2011).

Porter, Griffiths, and Hedberg (2003) argue for enrichment of online experience to resemble the live classroom with interaction among students and between faculty and students. Ganesh, Sun, and Barat (2010) find that a unique marketing math course improves students' mathematics skills when classroom and online techniques are combined, but less so when online teaching is used by itself. Lumsden and Scott (1983) find that students value an enthusiastic lecturer and a clear presentation. These are factors that may be difficult to replicate in an online class, since instructors often read the audience and adjust their energy and delivery during a live lecture to control student concentration and enjoyment which help improve learning (Guo and Ro 2008).

All these studies argue for the value of physical attendance that enables face-to-face interaction with the professor and other students.

### 2.3.2 Khan Academy

In our current schooling system, lectures are often delivered in a one-to-many format with little room for active learning (Dickson and Segars 1999). In contrast, online learning usually takes place in solitude. A number of resources are available, including AVID/Advanced Path, Coursera, K12, Rocketship, School of One, and Khan Academy.

Khan Academy, a nonprofit organization created by Salman Khan, is a free online source that offers a set of educational materials and an integrated assessment system (Khan 2010). Quillen (2011) reports on the use of adaptive learning software and on-demand instructional videos, including those offered through the Khan Academy, to customize learning mathematics. Khan aims to unlock the black box of difficult analytical/quantitative concepts with a no-frills approach—that is, without fancy graphics and animation (Russo 2011).

As discussed in the Introduction, research shows a significant relationship between students' basic math skills and performance in statistics and similar quantitative courses. Some of these basic skills are mastery of elementary concepts in arithmetic, algebra, and geometry, simple systems of equations, percentage calculations, ratios, proportions, fractions, order of operations, area of a right-angled triangle, and numerical substitution into and evaluation of formulas (Johnson and Kuennen 2006; Green et al. 2009; Lunsford and Poplin 2011). However, not every student enters college equipped with such basic skills.

Khan himself lectures in the YouTube videos with a chalkboard and eraser, mimicking an offline teaching experience. Some educators debate the knowledge content and accuracy of the videos posted on Khan Academy (Strauss 2012) on various blogs in social media. However, students in this study are not asked to watch the YouTube videos. Instead, they are assigned a set of exercises, called skill-sets, from the Khan website.

### 2.3.3 Homework

Homework (HW) is crucial to students' engagement with the material and preparation for exams. However, grading HW by hand tends to be time-consuming, prone to inaccuracy, and sometimes subject to argument from students. In our experience, students appear to value the interactive nature of online HW and are less likely to question it, possibly because they are familiar with social media.

The evidence in the literature is mixed on the effect of HW. Peters, Kethley, and Bullington (2002) investigate the effectiveness of graded HW problems (traditional pencil and paper) in an introductory operations management course and conclude that the graded HW requirement negatively affects exam performance. In their widely cited meta-analysis of effects of HW in K-12 grades, Cooper, Robinson, and Patall (2006) report that although the literature suggests positive effects of HW on performance, each study suffers from design flaws. They find no strong evidence for positive effects of HW.

More recently, several studies evaluate effectiveness of online HW (either by itself or in comparison to offline HW). Palocsay and Stevens (2008) compare online and offline HW effects on student scores and report no difference. A study of the impact and effectiveness of online HW in principles of accounting classes concludes that online HW increases student performance (Dillard-Eggers et al. 2008). Haverty (2010) compares final examination scores in a first-year managerial accounting course and finds no evidence that the use of a web-based HW system as opposed to manual HW actually improves student learning.

Hsu (2011) compares students participating in online HW activities (MyStatLab) with a control group that uses traditional paper HW, and concludes that students who use the online HW do not always perform better in terms of test scores. Chua-Chow, Chauncey, and McKessock (2011) compare the final grades of two classes of students enrolled in an introductory business statistics course in two different years. They find that the group with e-homework gets higher final grades than the group without e-homework. In a comparison of manual versus online HW in managerial economics, Kennelly, Considine, and Flannery (2011) report little evidence that HW (online or offline) prepares students for exams.

Thus, evidence on effectiveness of HW is mixed.

#### 2.3.4 Research Questions and Expected Results

Three questions that emanate from this literature review are as follows:

*Research Question 1*: Does attending class contribute positively to student performance in exams?
*Research Question 2*: Does a Khan Academy requirement contribute positively to performance in exams?
*Research Question 3*: What is the role of HW in performance in exams?

On the basis of the literature review, our combined classroom experience, and common sense we form the following expectations. We expect attendance, HW score, and Khan experience to improve exam performance (i.e., both increase exam score and reduce time spent to complete the exam). We are less certain about time-related variables (such as the role of time spent on HW on exam performance or the expected impact of attendance on time in exam). We look to the data to provide these answers.

## 3. Data

### 3.1 Courses

The average business undergraduate perceives quantitative courses such as business statistics and operations management as challenging. Our dataset comprises two sections of each course. Business statistics is the only statistics course required for business school students and it does not have a mathematics prerequisite. The course catalog description of business statistics reads: "Probability and statistics in a business environment encompassing descriptive statistics, probability theory, hypothesis testing, linear regression, and correlation. *Prerequisites*: Algebraic proficiency and microcomputer proficiency. *Credits*: 3."

Operations management is an introductory course that relies on quantitative methods and has business statistics as a prerequisite. The course catalog description of operations management reads: "Operations strategy and competition, production systems and processes, decision analysis and graphical linear programming, quality management and process control, facility location and layout, work methods and measurement, inventory management and project evaluation review technique. *Prerequisites*: Business Statistics. *Credits*: 3."

For experimental purposes, one section of business statistics and two sections of operations management required Khan Academy exercises as part of the student's grade. Each course had five equally weighted exams. All exams and HW assignments were online, compiled by the professor from MyPearsonLab.

## 3.2 Khan Academy Assignments (All Online)

At the outset of the course, the professor and students create a Khan Academy account for themselves. (The user may choose to create a Khan Academy account with the site or log in with an existing Google or Facebook ID.) After the students log in, they designate the professor as a coach in their profile. The professor chooses the skill-sets and announces them in the course website and the syllabus with a direct link. The professor has access to students' performance records via the progress report.

To facilitate retrieval of the students' performance results in Khan Academy, we enlisted the help of a computer programmer, who developed a program using Application Programming Interface (API) to access the Khan Academy database using student user IDs. The other option is to gather the results manually, which can lead to inaccuracy and, of course, is time-consuming.

Table 1 shows the Khan assignments leading up to each of the five exams. The 19 skill-sets listed in Table 1 were selected on the basis of experience and from studies in the same area (Johnson and Kuennen 2006; Green et al. 2009; Lunsford and Poplin 2011). They are grouped into five Khan Academy assignments to prepare the student for each of the five exams. The assessment tool presents students with algorithmically generated numerical problems, performed by the Khan website so the questions are randomized in subsequent attempts while the substantive nature of the problem does not change. To achieve proficiency, a student must complete 10 problems correctly in a row. For example, for Khan Assignment 1, if a student achieves proficiency in all seven skill-sets, her/his grade for this part of the course is seven; for Khan Assignment 2, if the student achieves proficiency in two skill-sets, her/his grade for this part of the course is two, and so on. Watching the Khan videos is optional for students, because in the professors' experience, mathematics-oriented students find them boring, unnecessary, or frustrating.

**Table 1.** Description of Khan assignments

| Khan Assignment | Skill-Set |
|---|---|
| For Exam 1 | Adding and Subtracting Negative Numbers |
| | Order of Operations |
| | Rounding Numbers |
| | Multiplying and Dividing Negative Numbers |
| | Ordering Negative Numbers |
| | Absolute Value |
| | Comparing Absolute Values |
| For Exam 2 | Ratio Word Problems |
| | Fraction Word Problems |
| | Evaluating Expressions |
| | Linear Equations 1 |
| For Exam 3 | Linear Equations 2 |
| | Linear Equations 3 |
| For Exam 4 | Linear Equations 4 |
| | Solving for a Variable |
| | Percentage Word Problems |
| For Exam 5 | Mean, Median, and Mode |
| | Probability |
| | Dependent Probability |

### 3.3 HW and Exams (All Online)

Pearson Education, Inc. offers many supplements, one of which is the access code that students purchase to have access to online learning aids such as e-books, slides, practice exercises, sample tests, study guides, videos, news, and so on. Professors are free to integrate all or parts of the product into their course. Especially in quantitative courses, where students have varied backgrounds, both students and professors value an interactive, customizable supplement. All four courses in our dataset use HW and exams compiled by the professor from MyPearsonLab.

Each HW assignment comprises 10 to 15 multi-part numerical questions, and each exam has five to eight multi-part questions. Each question requires three to five calculations. The questions are provided by the online system and are closely related to the numerical problems at the end of the chapters in the textbook. Each question uses algorithmic values that are generated when a student accesses the question, so the numerical portion of the question is different in different attempts. In doing the HW, students are allowed three attempts to solve a question and get instant feedback. In exams, only one attempt per question is allowed. The exams have a time limit of 50 minutes (equal to the class period) and the amount of time remaining appears in a window. The online system grades the HW and exams, and provides immediate feedback to the student. The system tracks the time students take to complete the HW and exams in addition to their respective scores.

## 3.4 Sample Characteristics

Our sample consists of multiple observations on 102 (out of a total of 108) students who signed a consent form to participate in the study. The Appendix presents the consent form. Attendance is recorded in class by a simple "present/absent" check. The attendance percentages refer to average attendance up to each exam. Students are free to study Khan assignments at any time, although they are advised to attain proficiency in the assigned skill-sets before each exam. In rare instances, spillovers occur. For example, an eager student may finish more skill-sets than necessary for the first exam or a lagging student may not get to the Khan assignment until after the relevant exam. The variable Time Spent on HW is the total time on the assignments leading up to an exam. HW Score is the average of several HW assignments before an upcoming exam. Table 2 provides descriptive statistics on student characteristics and performance.

**Table 2.** Descriptive statistics

| Variable | Mean | Std. Dev. | Minimum | Maximum |
|---|---|---|---|---|
| *Female Dummy* | 0.32 | | 0 | 1 |
| *Age at the beginning of semester (Aug 29, 2011)* | 21.83 | 3.20 | 19.05 | 42.68 |
| *White Dummy* | 0.85 | | 0 | 1 |
| *Cumulative Credits* | 71.36 | 25.64 | 5 | 143 |
| *GPA* | 2.92 | 0.63 | 1.64 | 4 |
| *Statistics Course Dummy (1 if Business Statistics, 0 if Operations Management)* | 0.56 | | 0 | 1 |
| *Attendance 1 (%)* | 94.08 | 13.64 | 33.33 | 100 |
| *Attendance 2* | 92.16 | 18.27 | 0 | 100 |
| *Attendance 3* | 91.67 | 16.63 | 0 | 100 |
| *Attendance 4* | 88.73 | 21.58 | 0 | 100 |
| *Attendance 5* | 90.52 | 19.55 | 0 | 100 |
| *Khan Academy Dummy (1 if the course requires it, 0 otherwise)* | 0.73 | | 0 | 1 |
| *Khan Academy Assignments 1* | 1.89 | 2.75 | 0 | 12 |
| *Khan Academy Assignments 2* | 1.85 | 2.07 | 0 | 6 |
| *Khan Academy Assignments 3* | 1.15 | 1.59 | 0 | 6 |
| *Khan Academy Assignments 4* | 0.95 | 1.32 | 0 | 6 |
| *Khan Academy Assignments 5* | 1.27 | 1.90 | 0 | 11 |
| *Time Spent on Homework 1 (hours)* | 1.71 | 1.68 | 0 | 14.51 |
| *Time Spent on Homework 2* | 3.23 | 2.02 | 0.33 | 11.17 |
| *Time Spent on Homework 3* | 3.91 | 3.12 | 0 | 18.68 |
| *Time Spent on Homework 4* | 2.56 | 2.07 | 0 | 12.83 |
| *Time Spent on Homework 5* | 2.59 | 1.79 | 0 | 7.41 |
| *Homework Score 1 (%)* | 78.07 | 32.00 | 0 | 100 |
| *Homework Score 2* | 82.42 | 24.54 | 3.5 | 100 |
| *Homework Score 3* | 84.07 | 24.06 | 0 | 100 |
| *Homework Score 4* | 86.65 | 20.41 | 0 | 100 |
| *Homework Score 5* | 90.26 | 19.69 | 0 | 100 |

| Variable | Mean | Std. Dev. | Minimum | Maximum |
|---|---|---|---|---|
| *Time in Exam 1 (hours)* | 0.45 | 0.16 | 0.14 | 0.81 |
| *Time in Exam 2* | 0.50 | 0.17 | 0.23 | 1.04 |
| *Time in Exam 3* | 0.51 | 0.18 | 0.22 | 1.00 |
| *Time in Exam 4* | 0.49 | 0.16 | 0.23 | 0.93 |
| *Time in Exam 5* | 0.43 | 0.15 | 0.15 | 0.95 |
| *Exam 1 Score (%)* | 80.39 | 17.78 | 23 | 100 |
| *Exam 2 Score* | 81.50 | 18.87 | 18 | 100 |
| *Exam 3 Score* | 82.87 | 19.50 | 30 | 100 |
| *Exam 4 Score* | 82.09 | 17.84 | 5 | 100 |
| *Exam 5 Score* | 83.49 | 19.06 | 6 | 100 |

**Notes:** Number of students = 102. Standard deviations of binary variables are not reported by convention.

Slightly over 30% of the students are female, the average age at the beginning of semester (August 29, 2011) is 22, and about 85% are white. Accumulated credits at the beginning of the semester indicate that the average student has completed about five semesters of work. For the average student, the GPA at the beginning of the semester is close to a B.

The classes, on average, have very good attendance (about 90%). The average number of Khan Academy skill-sets for which students achieved proficiency dwindles toward the end of the semester but increases before the last exam. Time spent to complete HW shows an overall increase, with a slight dip around the fourth HW owing to the nature of that particular assignment. HW scores show steady improvement over the semester. The average time spent to complete an exam is about 30 minutes. Students do relatively well on exams and while scores drop slightly in Exam 4, the overall scores appear to be rather stable.

## 4. Methodology

We estimate our models by stacking data on five exams. (We also estimated the models individually on each exam. We present and discuss stacked results for space and scope considerations, with full results available upon request.) The OLS models are as follows.

$$\begin{gathered}(\text{Exam Score})_{ij} = \alpha_1 + (\text{Student Characteristics})_i{}'\boldsymbol{\beta_1} + \\ \beta_2(\text{Statistics Course Dummy})_i + \beta_3(\text{Attendance})_{ij} + \\ \beta_4(\text{Khan Academy Dummy})_i + \beta_5(\text{Khan Academy Dummy*Khan Academy Assignment})_{ij} + \\ \beta_6(\text{Time Spent on Homework})_{ij} + \beta_7(\text{Homework Score})_{ij} + u_{1ij}\end{gathered}$$

$$\begin{gathered}(\text{Time in Exam})_{ij} = \alpha_2 + (\text{Student Characteristics})_i{}'\boldsymbol{\gamma_1} + \\ \gamma_2(\text{Statistics Course Dummy})_i + \gamma_3(\text{Attendance})_{ij} + \\ \gamma_4(\text{Khan Academy Dummy})_i + \gamma_5(\text{Khan Academy Dummy} * \text{Khan Academy Assignment})_{ij} \\ + \gamma_6(\text{Time Spent on Homework})_{ij} + \gamma_7(\text{Homework Score})_{ij} + u_{2ij}\end{gathered}$$

where *i* denotes a student and *j* denotes an exam (*j=1,…5)*. Student Characteristics is a vector that consists of gender, age at the beginning of the semester, racial-ethnic origin, and cumulative credits and GPA at the beginning of the semester.

Although the model presented above is reasonably instructive, the model parameters are susceptible to potential bias stemming from unobserved heterogeneity across individual students. Students may differ in a variety of ways, not only in demographic profiles but also in their ambition, interest, background, intelligence, emotional health, and other factors beyond our control. Accounting for such idiosyncrasies across students can be accomplished with a fixed effects model that assigns a separate intercept to each student $\alpha_{1i}$ and $\alpha_{2i}$ (Chamberlain 1985).

However, estimating a large number of intercepts (in our case 102, corresponding to 102 students) poses a considerable computational burden. Fortunately, multiple observations per student are available owing to multiple exams, and hence we can use the first-differences method. The intercepts as well as the time-constant variables then cancel out of the differenced model:

$$\text{Differenced(Exam Score)}_{ij} = \beta_3\text{Differenced(Attendance)}_{ij} + \beta_5\text{Differenced(Khan Academy Dummy} * \text{Khan Academy Assignment)}_{ij} + \beta_6\text{Differenced(Time Spent on Homework)}_{ij} + \beta_7\text{Differenced(Homework Score)}_{ij} + v_{1ij}$$

$$\text{Differenced(Time in Exam)}_{ij} = \gamma_3\text{Differenced(Attendance)}_{ij} + \gamma_5\text{Differenced(Khan Academy Dummy} * \text{Khan Academy Assignment)}_{ij} + \gamma_6\text{Differenced(Time Spent on Homework)}_{ij} + \gamma_7\text{Differenced(Homework Score)}_{ij} + v_{2ij}$$

where the notation is such that *Differenced(Z)* = $Z_{j+1} - Z_{j,}$ for *j* = 1, 2, 3, 4. We lose one observation per student as a result of taking first differences. The coefficients of the explanatory variables remain and are interpreted as in the OLS model.

## 5. Results and Discussion

The ordinary least squares (OLS) and fixed effects (FE) results for Exam Score appear in Tables 3 and 4, and the OLS and FE results for Time in Exam are presented in Tables 5 and 6, respectively. We find that females, older students, nonwhites, and students with a lower GPA earn lower scores in exams than their counterparts. We find that white students complete exams faster than other students. (Although demographic characteristics may be interesting, we do not dwell on them so as to avoid feeding the common stereotypes. Rather, we treat demographic variables in our OLS models as control variables. A more comprehensive treatment of gender issues appears in Kiefer and Sekaquaptewa (2007). In FE models they cancel out owing to taking first differences, and student heterogeneity—observed and unobserved—is captured by a unique albeit latent intercept.) We find that statistics exams take longer than operations management exams, possibly owing to the greater difficulty of the content in the statistics courses.

**Table 3.** OLS model - Dependent variable: *Exam Score*

| Explanatory Variable | Coefficient | Standard Error | t statistic | *p*-value |
|---|---|---|---|---|
| *Intercept* | 29.4912*** | 7.3034 | 4.0380 | 6.24E-05 |
| *Female* | -6.5259*** | 1.5330 | -4.2570 | 2.48E-05 |
| *Age* | -0.4054* | 0.2334 | -1.7374 | 0.0829 |
| *White* | 6.9988*** | 1.9759 | 3.5422 | 4.34E-04 |
| *Cum Credits* | -0.0004 | 0.0306 | -0.0120 | 0.9904 |
| *GPA* | 9.3724*** | 1.2458 | 7.5234 | 2.51E-13 |
| *Statistics Course Dummy* | -1.0797 | 1.6537 | -0.6529 | 0.5141 |
| *Attendance* | 0.0693* | 0.0385 | 1.8002 | 0.0724 |
| *Khan Academy Dummy* | 3.4093* | 1.9086 | 1.7862 | 0.0747 |
| *Khan Academy Dummy * Khan Academy Assignment* | 0.0962 | 0.3641 | 0.2642 | 0.7918 |
| *Time Spent on HW* | -0.4195(ms) | 0.2934 | -1.4299 | 0.1534 |
| *HW Score* | 0.2731*** | 0.0303 | 9.0250 | 3.92E-18 |
| *F-statistic* | 27.9583*** | | | |
| *Adjusted* $R^2$ | 0.3681 | | | |

**Notes:** n = 510 observations (102 students and 5 exams). ****p*-value < 0.01; ** *p*-value < 0.05; * *p*-value < 0.10; ms =marginally significant as indicated by the corresponding *p*-value in the last column.

**Table 4.** FE model - Dependent variable: *Differenced(Exam Score)*

| Explanatory Variable | Coefficient | Standard Error | t statistic | *p*-value |
|---|---|---|---|---|
| *Differenced(Attendance)* | 0.0448(ms) | 0.0338 | 1.3235 | 0.1864 |
| *Differenced(Khan Academy Dummy * Khan Academy Assignment)* | 0.1679 | 0.3111 | 0.5397 | 0.5897 |
| *Differenced(Time Spent on HW)* | -0.0383 | 0.2396 | -0.1598 | 0.8732 |
| *Differenced(HW Score)* | 0.2380*** | 0.0335 | 7.1036 | 5.52E-12 |
| *F-statistic* | 13.8286*** | | | |
| *Adjusted* $R^2$ | Not Applicable | | | |

**Notes:** n = 408 observations (102 students and 4 differences). Adjusted $R^2$ is not applicable because of the lack of an intercept in the model. *** *p*-value < 0.01; ** *p*-value < 0.05; * *p*-value < 0.10; ms = marginally significant as indicated by the corresponding *p*-value in the last column.

**Table 5.** OLS model - Dependent variable: *Time in Exam*

| Explanatory Variable | Coefficient | Standard Error | t statistic | *p*-value |
|---|---|---|---|---|
| *Intercept* | 0.4693*** | 0.0716 | 6.5523 | 1.42E-10 |
| *Female* | 0.0133 | 0.0150 | 0.8829 | 0.3777 |
| *Age* | 0.0027 | 0.0023 | 1.1639 | 0.2450 |
| *White* | -0.0505*** | 0.0194 | -2.6062 | 0.0094 |
| *Cum Credits* | 0.0002 | 0.0003 | 0.5553 | 0.5790 |
| *GPA* | -0.0139 | 0.0122 | -1.1343 | 0.2572 |
| *Statistics Course Dummy* | 0.0805*** | 0.0162 | 4.9632 | 9.54E-07 |
| *Attendance* | 0.0006(ms) | 0.0004 | 1.4890 | 0.1371 |
| *Khan Academy Dummy* | -0.0231(ms) | 0.0187 | -1.2357 | 0.2172 |
| *Khan Academy Dummy * Khan Academy Assignment* | 0.0021 | 0.0036 | 0.5857 | 0.5584 |
| *Time Spent on HW* | 0.0274*** | 0.0029 | 9.5374 | 6.49E-20 |
| *HW Score* | -0.0017*** | 0.0003 | -5.7223 | 1.82E-08 |
| *F-statistic* | 16.8951*** | | | |
| *Adjusted $R^2$* | 0.2557 | | | |

**Notes:** n = 510 observations (102 students and 5 exams). *** *p*-value < 0.01; ** *p*-value < 0.05; * *p*-value < 0.10; ms = marginally significant as indicated by the corresponding *p*-value in the last column.

**Table 6**. FE model - Dependent variable: *Differenced(Time in Exam)*

| Explanatory Variable | Coefficient | Standard Error | t statistic | *p*-value |
|---|---|---|---|---|
| *Differenced(Attendance)* | 0.0003 | 0.0003 | 0.9341 | 0.3508 |
| *Differenced(Khan Academy Dummy * Khan Academy Assignments)* | 0.0073(ms) | 0.0030 | 2.4552 | 0.0145 |
| *Differenced(Time Spent on HW)* | 0.0236*** | 0.0023 | 10.2832 | 3.47E-22 |
| *Differenced(HW Score)* | -0.0022*** | 0.0003 | -6.9332 | 1.64E-11 |
| *F-statistic* | 39.1675*** | | | |
| *Adjusted $R^2$* | Not applicable | | | |

**Notes:** n = 408 observations (102 students and 4 differences). Adjusted $R^2$ is not applicable because of the lack of an intercept in the model. *** $p$-value < 0.01; ** $p$-value < 0.05; * $p$-value < 0.10; ms = marginally significant as indicated by the corresponding $p$-value in the last column.

Attendance complies with our expectations and with the prior literature in both the OLS and FE models, with respect to its positive impact on exam score. Rochelle and Dotterweich (2007) and Westerman et al. (2011) are among the studies that conclude positive effects of attendance on exam scores.

We find that attendance in the OLS model has a positive sign and is (marginally) significant in the Time in Exam regression. This result can be explained by visualizing an uninterested student, who does not attend class much and rushes through an exam. The coefficient is insignificant once personal idiosyncrasies are accounted for in the FE model. The latent student-specific trait appears to be proxied by the attendance variable in the OLS model and therefore the OLS coefficient of attendance is biased.

With a Khan experience, a student's exam score is likely to improve according to the OLS model. However, the effect vanishes in the FE model. (In OLS models, the effect of Khan Academy is computed from Coefficient of Khan Academy Dummy + (Coefficient of Khan Academy Assignment)*(Mean Value of Khan Academy Assignment)). As in the case of attendance, accounting for individual-specific effects removes the seeming effect of the explanatory variable on the dependent variable.

Using the Khan Academy skill-sets appears to speed up students in exams, according to the OLS model. However, the effect is reversed according to the FE model. Thus, controlling for person-specific effects changes the coefficient estimate. The different result is possibly due to self-selection. For example, a conscientious student achieves proficiency in more skill-sets in preparation for the exam and also may take greater care in the exam, perhaps double-checking her/his answers before clicking the "submit" button.

Students who take longer to complete the HW have lower scores on the exam according to the OLS model. The coefficient is insignificant in the FE model. Possibly, a personal trait, in this case slowness in mathematics, is addressed by the person-specific intercept, thus releasing the coefficient of the explanatory variable from bias.

According to both OLS and FE models, students who spend more time completing HW also spend more time on exams. The reader can picture a struggling student who may be new to quantitative material spending more time on both HW and exams.

We find that students who do well on HW score higher and take less time to complete an exam in both OLS and FE models.

## 6. Conclusion

In this study, we investigate the determinants of performance in quantitative courses by using online databases while recognizing unobserved heterogeneity across students. The main takeaways from the fixed effects model can be summarized as follows.

*Research Question 1*: Does attending class contribute positively to student performance in exams?

> Attendance increases exam score but does not significantly change time in exam. If attendance rises 10 points, exam score increases by 0.4 point, both out of 100. Thus, certain students appear to be helped by attendance. This finding is consistent with the literature on attendance summarized in section 2.

*Research Question 2:* Does a Khan Academy requirement contribute positively to performance in exams?

> Khan experience does not significantly raise the exam score but does increase time in exam. A diligent or a conscientious student may achieve proficiency in more skill-sets and also spend more time completing the exam, perhaps double-checking before clicking the "submit" button. While the reason for increased time may differ from student to student, we let the student-specific intercept capture it. Our mixed result appears to be consistent with the mixed evidence in the literature on the effects of CAI on performance, as summarized in section 2.

*Research Question 3*: What is the role of HW on performance in exams?

> Time spent on HW does not significantly affect exam score but does significantly increase time in exam. A student who struggles with HW also appears to be slow in the exam. HW score significantly increases exam score. If HW score goes up by 10 points, exam score rises by 2.4 points, both out of 100. HW score significantly decreases time in exam. Thus, while the literature reports mixed evidence on effects of HW on academic performance, as summarized in section 2, our results on HW are strongly positive. Hence, we are led to conclude that professors should continue assigning HW, as it plays a key role in academic success.

No study is without limitations. First, the OLS model does not control for time of day effect, because including the time dummy variables results in collinearity with the course dummy and the Khan Academy dummy. Seating, professor's subjective opinion on the student, and whether the student had previously taken a course from the professor may be important but are not controlled owing to data limitations. The omitted variables listed here only confound the OLS results since any unobserved/unmeasurable variable is captured by individual-specific intercepts in the FE models.

Second, our sample consists of over 100 students but is still small. Therefore, some of the results, especially regarding demographics in the OLS models, should not be generalized. Third, currently we model the Khan system as a 0/1 dummy and number of skill-sets successfully finished by the student. Potential variables that can be added include successful completion of a skill-set assignment vis-à-vis exam date, which skill-sets a student has trouble with, and so on.

However, deciphering such data is time-consuming and expensive and requires intensive API programming. We leave these issues to future research.

Keeping in mind the aforementioned limitations, our study has implications for instructors of mathematics-based courses that teach blended courses as well as for those who teach on-ground courses but recommend online teaching aids to students. Some of our findings presented above may appear small in numerical value however, the ones that are discussed are statistically significant, and moreover, a small improvement in numerical grade may make a major difference in letter grade, if the student is on the border of two letter grades.

Students may skip classes if they are unable to grasp the adverse effect of an absence on their performance. Our findings imply that poor attendance lowers final grade and that professors should enforce strict rules for attendance to live lectures. We implement Khan Academy as an online learning aid in order to equalize any differences among students with respect to mathematical skills. In our university students are from varied backgrounds and mathematics is not a prerequisite for courses such as business statistics, economics, marketing research, operations management, and other quantitative courses. Our results imply that this online tool is like a vitamin supplement that does not immediately help but does not have known adverse effects, either. We find that it is empirically hard to attribute exam performance improvement to Khan Academy especially after carefully accounting for student-specific characteristics through fixed effects. (It will be recalled that when we omit fixed effects, Khan effect on exam score appears significant and positive). According to our results, HW serves as valuable practice before the exam and enables students to hone the skills they will be using to answer exam questions. The implication of this result is to supplement the lecture material in a blended course with online HW that prepares students for online exams.

Today, universities increasingly rely on blended or purely online learning environments to accommodate technology-savvy and time-pressed educational customers, as well as to reduce costs. Consequently, teaching faculty face new challenges, especially in mathematics-based courses. In the future, as the competition for online learning aids increases, professors can expect to experiment with more online products that help students cope with mathematics-based courses. This research should lead to future research investigating the role of CAI in teaching and learning quantitative courses in business.

# Appendix – Consent Form

(For space and scope considerations, only excerpts from the consent form are presented.)

**A Test of the Khan Academy in Improving Learning Business Statistics**

The information collected for this research will not affect your grade.
No identifiable information will be released in the research reports.
Your confidentiality will be protected to the extent that is allowed by law.

**Purpose of the study**

Our study plans to measure the effect of using Khan Academy on students' performance, engagement, and course satisfaction. You will be asked to complete an engagement survey and a course satisfaction survey. Your participation is voluntary. If you choose to participate, you may withdraw from the study at any time and no one will hold it against you. Participation in the study will not affect your (grades, standing, etc.) in the (department, program, university). In addition, your participation in the study may be terminated without your consent if the investigators determine it is unsafe for you to continue or you are not able to complete the research.

**Procedures**

In addition to your regular course work, you will be asked to complete an engagement survey and a course satisfaction survey at the end of the semester. Completing each survey should take you approximately 20 minutes. Demographic information, academic standing information, and previous academic performance information will be collected from Academic Records, Summer School and Graduate Studies.

**Confidentiality**

The engagement survey and the course satisfaction survey will collect information in such a way that subjects can NOT be identified, directly or indirectly or through identifiers linked to the subjects. Paper files, will be archived during and up to three (3) years after the research. Then they will be destroyed by shredding.

No identifiable information will be released in the research reports.

Your confidentiality will be protected to the extent that is allowed by law.

**Risks/Benefits**

There is no risk to the students except the ones pertinent to regular classroom activities. The information collected **will not affect your grades**. Individual and/or identifiable information will not be released in accordance to the Family Educational Rights and Privacy Act of 1974 (FERPA).

The study has the potential of benefiting college students at University if it finds a positive correlation between the use of Khan Academy and better student performance, satisfaction, and/or engagement.

**Sources of Information**

We will collect the following information:

- First name
- Last name
- Student ID
- Email
- Sex
- Race
- Age
- Cumulative credits so far
- GPA so far
- Homework performance
- Exams performance
- Attendance
- Khan Academy use (if applicable to your course)

We will by no means report individual student information, but we will report aggregate information for each section.

The demographic information, academic standing information, and previous academic performance information will be used to ensure that the control group and experimental group have homogeneous characteristics.

You will be given a copy of this consent form. Please ask any questions or voice any concerns you may have now or at any time during the study. If you have any questions about the research study, you should contact the researchers at the phone numbers listed at the top of this form. If you have questions about your rights as a participant in this study or the way the study has been conducted, you may contact xxxxx.

**Authorization**

I have read and understand this consent form, and I volunteer to participate in this research study.

I understand that I will receive a copy of this form. I voluntarily choose to participate, but I understand that my consent does not take away any legal rights in the case of negligence or other legal fault of anyone who is involved in this study. I further understand that nothing in this consent form is intended to replace any applicable Federal, state or local laws.

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## References

Beal, C. R., Walles, R., Arroyo, I., and Woolf, B. P. (2007), "On-Line Tutoring for Math Achievement Testing: A Controlled Evaluation," *Journal of Interactive Online Learning*, 6 (1), p43.

Becker, W. E. and Watts, M. (eds.) (1998), *Teaching Economics to Undergraduates: Alternatives to Chalk and Talk*, E. Elgar.

Beldarrain, Y. (2006), "Distance Education Trends: Integrating New Technologies to Foster Student Interaction and Collaboration," *Distance Education*, 27(2), 139-153.

Chamberlain, G. (1985), "Heterogeneity, Omitted Variable Bias, and Duration Dependence," in *Longitudinal Analysis of Labor Market Data*, eds. J. J. Heckman and B. S. Singer, Cambridge University Press, New York, pp. 3-38.

Chua-Chow, C., Chauncey, C. A., and McKessock, D. (2011), "Enhancing the Study of Business Statistics with an E-Homework System," *Journal of Education and Vocational Research*, 1(3), pp. 96-105.

Cooper, H., Robinson, J. C., and Patall, E. A. (2006), "Does Homework Improve Academic Achievement? A Synthesis of Research, 1987 – 2003," *Review of Educational Research*, 76, 1-62.

Dickson, G. W. and Segars, A. (1999), "Redefining the High-Technology Classroom," *Journal of Education for Business*, 74(3), 152-156.

Dillard-Eggers, J., Wooten, T., Childs, B., and Coker, J. (2008), "Evidence on the Effectiveness of on-Line Homework," *College Teaching Methods & Styles Journal*, 4(5), 9-16.

Evans, L. (2010), *Social Media Marketing: Strategies for Engaging in Facebook, Twitter & Other Social Media*, Que Publishing.

Fini, A. (2009), "The Technological Dimension of a Massive Open Online Course: The Case of the CCK08 Course Tools," *The International Review of Research in Open and Distance Learning*, 10(5).

Ganesh, G., Sun, Q., and Barat, S. (2010), "Improving the Marketing Math Skills of Marketing Undergraduate Students through a Unique Undergraduate Marketing Math Course," *Marketing Education Review*, 20, 47-64.

Gonul, F. F. (2005), "Degrees of Education: Demand Is up, and Online Universities' Increased Offerings Raise Questions," *Pittsburgh Post-Gazette*, E2.

Green, J. J., Stone, C. C., Zegeye, A., and Charles, T. A. (2009), "How Much Math Do Students Need to Succeed in Business and Economics Statistics? An Ordered Probit Analysis," *Journal of Statistics Education*, 17. http://www.amstat.org/publications/jse/v17n3/green.pdf

Guo, Y. M. and Ro, Y. K. (2008), "Capturing Flow in the Business Classroom," *Decision Sciences Journal of Innovative Education*, 6, 437-462.

Hall, D. and Lang, T. (2007), "Course Management Systems: Hope or Hype?" *International Journal of Web-Based Learning and Teaching Technologies*, 2(2), 1-20.

Haverty, J. L. (2010), "Using a Web-Based Homework System in a Managerial Accounting Course: Does It Help Students to Learn?" *Academy of Business Disciplines Journal*, 2, 1-11.

Hazari, S. and Johnson, B. (2007), "Perceptions of Business Students' Feature Requirements in Educational Web Sites," *Decision Sciences Journal of Innovative Education*, 5, 357-374.

Hsu, M. (2011), "Does Online Homework System for Business Statistics Improve Learning?" in *Proceedings of the Pennsylvania Economic Association 2011 Conference*, Dickinson College Carlisle, Pennsylvania, pp. 114-116.

Johnson, M. and Kuennen, E. (2006), "Basic Math Skills and Performance in an Introductory Statistics Course," *Journal of Statistics Education*, 14(2). http://www.amstat.org/publications/jse/v14n2/johnson.html

Kennelly, B., Considine, J., and Flannery, D. (2011), "Online Assignments in Economics: A Test of Their Effectiveness," *The Journal of Economic Education*, 42, 136-146.

Khan, S. (2010), "YouTube U. Beats Yousnooze U.," *The Chronicle of Higher Education*, 57.

Kiefer, A. K. and Sekaquaptewa, D. (2007), "Implicit Stereotypes, Gender Identification, and Math-Related Outcomes: A Prospective Study of Female College Students," *Psychological Science*, 18 (1), 13-18.

Kozma, R. (2003), "Technology and Classroom Practices: An International Study," *Journal of Research on Technology in Education*, 36(1), 1-14.

Kyllonen, P. C. and Christal, R. E. (1990), "Reasoning Ability Is (Little More Than) Working-Memory Capacity?!" *Intelligence*, 14, 389-433.

Larwin, K. and Larwin, D. (2011), "A Meta-Analysis Examining the Impact of Computer-Assisted Instruction on Postsecondary Statistics Education: 40 Years of Research," *Journal of Research on Technology in Education*, 43, 253-278.

Lohmann, J. S. (1998), "Classrooms without Walls: Three Companies That Took the Plunge," *Training and Development*, September, 39-41.

Lovett, M. and Greenhouse, J. (2000), "Applying Cognitive Theory to Statistics Instruction," *The American Statistician*, 54(3), 196-206.

Lumsden, K. G. and Scott, A. (1983), "The Efficacy of Innovative Teaching Techniques in Economics: The U.K. Experience," *The American Economic Review*, 73, 13-17.

Lunsford, M. L. and Poplin, P. (2011), "From Research to Practice: Basic Mathematics Skills and Success in Introductory Statistics," *Journal of Statistics Education*, 19. http://www.amstat.org/publications/jse/v19n1/lunsford.pdf

Martin, F. G. (2012), "Will Massive Open Online Courses Change How We Teach?" *Communications of the ACM*, 55, 26-28.

Means, B., Toyama, Y., Murphy, R., Bakia, M., and Jones, K. (2009), *Evaluation of Evidence-Based Practices in Online Learning a Meta-Analysis and Review of Online Learning Studies*, Washington, D.C.: U.S. Dept. of Education, Office of Planning, Evaluation and Policy Development, Policy and Program Studies Service.

Miller, M. (2011), *YouTube for Business: Online Video Marketing for Any Business* (2nd ed.), Que Publishing.

Moore, M. G. and Kearsley, G. (2005), *Distance Education. A Systems View*, Belmont, CA: Thomson Wadsworth.

Nonis, S. A. and Hudson, G. I. (1999), "The Second Course in Business Statistics and Its Role in Undergraduate Marketing Education," *Journal of Marketing Education*, 21, 232-241.

Palocsay, S. W. and Stevens, S. P. (2008), "A Study of the Effectiveness of Web-Based Homework in Teaching Undergraduate Business Statistics," *Decision Sciences Journal of Innovative Education*, 6, 213-232.

Peters, M., Kethley, B., and Bullington, K. (2002), "The Relationship between Homework and Performance in an Introductory Operations Management Course," *Journal of Education for Business*, 77, 340.

Porter, A., Griffiths, D., and Hedberg, J. (2003), "From Classroom to Online Teaching: Experiences in Improving Statistics Education," *Journal of Applied Mathematics & Decision Sciences*, 7, 65-73.

Quillen, I. (2011), "Math Educators See the Right Angles for Digital Tools," *Education Week*, 30, S4-S6.

Ractham, P., Kaewkitipong, L., and Firpo, D. (2012), "The Use of Facebook in an Introductory MIS Course: Social Constructivist Learning Environment," *Decision Sciences Journal of Innovative Education*, 10, 165-188.

Rochelle, C. F. and Dotterweich, D. (2007), "Student Success in Business Statistics," *Journal of Economics and Finance Education*, 6(1), 19-24.

Russo, A. (2011), "Salman Khan," *Scholastic Administr@tor*, Back to School, 18-19.

Sosa, G. W., Berger, D. E., Saw, A. T., and Mary, J. C. (2011), "Effectiveness of Computer-Assisted Instruction in Statistics," *Review of Educational Research*, 81(1), 97-128.

Strang, K. D. (2012), "Skype Synchronous Interaction Effectiveness in a Quantitative Management Science Course," *Decision Sciences Journal of Innovative Education*, 10, 3-23.

Strauss, V. (2012), "How Well Does Khan Academy Teach?" *The Washington Post*.

Thompson, J. J., Tong, Y., and Chauvin, S. W. (2009), "Pace: An Alternative Measure of Student Question Response Time," *Applied Measurement in Education*, 22, 272-289.

Tishkovskaya, S. and Lancaster, G. A. (2012), “Statistical Education in the 21st Century: a Review of Challenges, Teaching Innovations and Strategies for Reform,” *Journal of Statistics Education* 20 (2), www.amstat.org/publications/jse/v20n2/tishkovskaya.pdf

Westerman, J. W., Coffey, B. S., Pouder, R. W., and Perez-Batres, L. A. (2011), "The Relationship between Undergraduate Attendance and Performance Revisited: Alignment of Student and Instructor Goals," *Decision Sciences Journal of Innovative Education*, 9, 49-67.

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