Using Technology to Fix Education: Enhancing Engagement and Performance

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Abstract. This paper reports results of the effects of faculty research videos and games on performance in a required upper division empirical methods course. We find that the amount of time students spend viewing the videos has a positive impact on the course grade regardless of GPA. The finding holds in online and face-to-face classes. Preliminary evidence on the use of games suggests a positive impact in online courses.

Introduction. Responsibility for teaching undergraduate research methods courses often rotates among faculty with strong backgrounds in research methods, but sub-field specialties supply more examples of some research techniques than others. This limitation applies regardless of sub-field specialty. For example, international relations may offer relatively many longitudinal studies but few surveys, while comparative politics may offer relatively many case studies but few experiments. Textbooks often provide abbreviated examples, or links to published research demonstrating a technique. Abbreviated examples may generate questions from students, especially in traditional classroom settings, and these questions provide an opportunity for expanding an example. Providing a proper theoretical framework for that example may be more difficult, especially when it is outside an individual's subfield. And the alternative approach, providing links to published work demonstrating techniques, is useful only when students actually follow the link and read through and understand the example. Add to this setting, the course material in research methods is often described as "dry" and enrollments continue to increase pushing up class sizes, there is reason to be concerned about student learning and engagement.

We posited that increasing student exposure through video of faculty discussing their research interests would (a) make research methods more interesting, (b) increase student engagement, (c) increase (and perhaps improve the quality of) student interactions with faculty, (d) provide online students with exposure to a wider range of faculty than their coursework might typically offer, thus providing them with some of the intangible benefits we believe accrue to traditional students, and (e) raise course grades. We also thought that giving students additional practice opportunities through games would likely increase engagement and performance.

Theory. The media-integration model dominates the theoretic literature and research (Bailey and Cotlar, 1994; Greco, 1999; Kim, et. al., 2011; King and Sen, 2013; Mayer, 2003). Research indicates that streaming video and audio explanations of complex concepts and formulas are more effective than textbooks (Klass, 2003; Reed, 2003), and that video adds an interactive dimension to textbooks (Michelich, 2002). Video streaming delivers content "interactively" to all students, even those who are not campus-based (Hartsell and Yuen, 2006). Video may offer upper division instructional faculty an additional tool as they search for ways to encourage students to stay through graduation, and it may help faculty address problems associated with the online environment (e.g., Dickey, 2004; Doherty, 2006; Rovai and Wighting, 2005; Russo and Benson, 2005; Simpson, 2004).

Video is only one tool available to faculty, however. Given our interest in improving performance, we also considered games. The data regarding their use in online environments is unequivocal. Yip and Kwan (2006), studying drill and practice with online vocabulary games, found that students who played retained and recalled vocabulary longer than those who did not play. Investigations into the use of Quizlet report that grades increase as time spent with online drill and practice increases (Kolitsky, 2013), and students using Quizlet achieve higher scores than students using a more traditional classroom approach, e.g., graphic organizer (Vargas, 2011).

There are differences across instructional modes. Social-presence theory leads us to expect differences in the experience of traditional and online students, at least for novice online learners (e.g., Short, Williams and Christie, 1976; Gunawardena, 1995; Kim et. al., 2011; Rice, 1993; Walther, 1992). Courses delivered online may lack the cueing system available in traditional settings; at a minimum we expect that the online environment requires attention be paid to establishing cues. There are no hard and fast rules for creating, or improving, social presence (e.g., Tu and McIssac, 2002). We know that in the most limited online setting, that of text-only interactions, people develop impressions of others (Gunawardena and Zittle, 1997). Nonetheless, it did seem that improving social presence would move us closer to our goals with online students.

In general, we expect a media-rich environment will increase student engagement, and that engaged students will learn more and have higher satisfaction levels than less engaged students. Some may opt for "brick-and-mortar" experiences because they are seeking a sense of community (Boling, et.al. 2012), but it is possible that a sense of community is important for those for whom traditional face-to-face enrollment is not an option. Neumann (1998), for example, reports that distance learning can result in social isolation. Delivering the same types of educational experiences to the growing online student population is important, though it may require innovation. We examined both learning environments.

Method. Our online sections merge traditional campus-based students with students pursuing degrees through the online college; interactions between the latter group and the university are all (or nearly all) mediated by computer systems. All students meet the same admissions requirements. Yet, with fewer opportunities for interaction, online-only students may take the same courses from the same faculty but receive a slightly different education than traditional students. Adding to the complexity of the situation, online courses follow a 7.5-week format while face-to-face courses follow the more traditional 15-week semester format.

We know of face-to-face instructional settings (particularly in large introductory courses) in which faculty contribute lectures or weeks to a course; this situation provides students with exposure to a range of faculty and permits faculty to teach to their strengths, rather than asking that they appear to be experts across an entire field. We adapted the idea to meet our needs of an advanced course with a growing online student population.

Working with the online college, we invited Political Science faculty to create 10-20 minute videos in which they presented a research project, described their method, explained the reason they chose this question, and summarized their findings. Faculty participation was strictly voluntary. Videos would be kept in a repository, and although the impetus for the project was the growing demand for research methods online, it was clear to all participants that the videos would be made available for use at the discretion of the instructor in online, face-to-face, and blended sections of the course.

Faculty developed a dozen research videos. The videos supplement textbook material; they give students access to different applications of the same method and to cases in which a single question is asked in different environments. Videos served as a basis for classroom discussion, online using Discussion Board, and quiz questions. The amount of time that students spent watching the videos was tracked and is used here as an independent variable.

The video repository does not dictate material; it does not require specific texts or topics. Rather, it provides instructional faculty a 'mini-net' with material that has been screened and organized and is ready for export. (See classifications in Table 1.)

A set of games was developed as well. These games typically meet the Kay and Knaack definition of "… web-based tools that support the learning of specific concepts by enhancing, amplifying, and guiding the cognitive process of learners" (2007). Our games fell into the category of drill and practice in which the learning objectives emphasize memory, repetition and retention (Dondi and Moretti, 2007). The games were created to help students practice vocabulary; terms and phrases such as "intervening variable, ecological inference, cross-sectional design over time, and discriminate validity" can be intimidating to undergraduate students. The games give students access to many variations on the drill and practice theme with each game taking approximately five to 10 minutes.

The full data set uses three sections of research methods; two sections were taught online in a 7.5-week format, while the other section was taught in the traditional face-to-face format over the course of a 15-week semester. All sections used the same text; all were taught by full-time faculty; all required written assignments, quizzes and participation. Enrollments were uneven, but no section was small; the fall 2012 semester face-to-face class enrolled 174 students, while its online counterpart enrolled 87, and the spring 2013 semester online class had 107 students.

When possible, we treat these three courses as a single dataset. The two online sections are nearly identical. The one potentially significant difference was the inclusion of games as study guides in one of these sections. In order to capture the similarities and allow for the differences in the data subsets, we opted for two primary models in our analysis. The first model uses data from the online sections only; the second model merges data from all three classes. Missing data reduced each cohort by a handful of observations.

We identified two control variables and two independent variables for the online sections. The controls are 'type of student' (online or e-college student vs. regularly-registered student taking an online course) and past performance (measured by GPA). The variable "online" takes the value of 0 when the student is a regular student taking an online class, and the value of 1 for online-only (or e-college) students. GPA is taken from students' records at the end of the semester in which they took research methods. The independent variables are (a) time spent watching the videos (video, available for the online sections only), and (b) time spent in discussion boards (Discussion Board). In the face-to-face section our only control variable is GPA and our only predictor variable is time spent watching faculty videos. Our dependent variable is course grade.

Data Analysis. Online students spent just over a fifth (21 percent) of their online time viewing faculty research videos. The correlation between video viewing time and course grade was 49 percent, the same as the correlation between course grade and GPA (50 percent). We expected the relationship between GPA and course grade to be strong, but were surprised to find the relationship between video viewing and course grade equally strong. The correlation between viewing the research videos and GPA was .24 percent. The more important question is, 'What is the effect of video viewing on course grade, when the effect of GPA is controlled'? The partial correlation coefficient between faculty video viewing and course grade is 0.73, considerably higher than the zero order correlation between course grade and video viewing. It appears that both GPA and the faculty research videos have independent effects on course grade; they do not substitute for each other. Moreover, within "GPA groups" video viewing has a strong, positive influence on course grades.

We tried three statistical techniques to ensure that violations of assumptions were not driving the results. A comparison of OLS, beta regression analysis, and a Bayesian generalized linear model is presented in Tables 3 and 4. Each model has benefits; beta regression is useful given that our dependent variable is a proportion (Cribari-Neto and Zeileis, 2010), and the Baysian model satisfies those who argue that the data represent the 'universe' of students in each of three sections of a course (Berk, Western and Weiss, 1995). Regardless of the method used, tests of statistical significance and the signs associated with the correlations are consistent. We discuss the OLS data because the model is familiar to a large audience.

As Table 2 indicates, the amount of time students spend viewing the faculty research videos is positively associated with course grade. Video viewing time remains statistically significant even after GPA is added to model. Not surprisingly, GPA is the single strongest predictor of course grade. In the full model, Model 3, one unit of increase of GPA is associated with approximately 17 percent increase in final grade. One minute of increase in video time is associated with 0.03 percent increase in final grade. At first sight, the effects of GPA and faculty videos on course grade appear vastly disparate, but this is largely a measurement artifact. GPA is measured on an interval scale that varies from 0 to 4 – and clearly some numbers are unlikely to occur. Alternately, viewing time is a continuous variable measured in minutes. So unit of GPA has far greater weight by definition than unit of time. (See diagnostics in Charts 1 and 2.)

The time students spend viewing faculty videos is positively correlated with the amount of time they spend in discussion boards (55 percent). This high correlation is likely attributable in part to the fact that some discussion boards were dedicated to the faculty research videos. Creating a single variable (online time) merging the faculty video and discussion board variables did not alter our findings.

There is anecdotal evidence indicating that students found the videos useful and enjoyable. They wrote, "the videos were fantastic and ….fun to watch. …..as an online student the videos are essential to making me feel a connection to the faculty"; "(the videos) were indeed informative". Other students wrote that the videos "were extremely helpful" and "keep you engaged". One student wrote, "I found the faculty videos to be helpful in learning and processing course material. Frequently, the faculty members mentioned some aspect of their research that tied well into the fundamentals of political science research methods that we were reviewing throughout the course. This helped to make the abstract concepts a bit more concrete and easier to grasp. I think the videos were …..a good addition to the course." Another student identified a benefit beyond the scope of the project when he wrote, "I quite enjoyed the videos and found them useful not only as a tool to explain course concepts and research examples but also, and probably more importantly, as an opportunity to sort of 'sample' other professors. The videos provided a kind of mini course from a few professors which helped in selecting classes for the following semesters." One enthusiastic student posted a note referencing a video that he wanted to share. His note read, "I just wanted to share a fantastic video of a social experiment on diversity." Still another wrote, "I thought the videos were great! They provided different views from people and give real-world issues and approaches. You should keep them in up coming (sic) classes." Some online students reported that the exposure to faculty and research made them feel more a part of the community.

Our project has one more element. The spring 2013 online section of the course had all the elements of the fall 2012 online course, and it had games associated with the course material for each week. The inclusion of "mini-games" or "learning objects" into the course, while not measured, appeared to, at least anecdotally, increase student satisfaction. On anonymous course evaluations students wrote, "I liked the different learning games, the use of available technology for course content and the links to outside sources and videos;" "this instructor went out of her way to make it easy for distance-learning students. She ….tied the different elements of the course together in a manner that made learning much easier (textbook, homework quizzes, discussions, and games.);" and "the many sources of media that were used brought diversity to the course material."

Conclusions. The data indicate the project was successful. Many of the faculty who made videos reported that students made reference to the videos in conversation; this was an unanticipated consequence, but one entirely consistent with the project goal of making students more comfortable with research. Videos are being integrated into nearly every section of the course. We have only positive student comments regarding the videos. Course grades improved.

The use of video and games in online instruction engages students with the material, connects students with the "brick-and-mortar" world, and improves understanding of course content. Faculty research videos guide students as they become reviewers and evaluators of research instead of passive consumers. Students respond positively to the range and richness of content. As students come to appreciate the material, teaching becomes easier and more rewarding. Course material that students often viewed as dry becomes engaging.

The online environment requires that faculty quickly engage students. Our videos support that effort. Moreover, they appear to work in face-to-face settings as well. This project provided material suitable to both online and traditional environments. We see the face-to-face environment as one that can provide clues about online environments, but here we actually found that material created for online students helped in traditional settings as well. We make note of this because we agree with those who believe that, In comparisons of online and face-to-face settings, face-to-face learning is typically viewed as the "benchmark" (see Kim and Bonk, 2006). We sympathize with Kim and Bonk, who ask, "What if institutions took the opposite stance and measured face-to-face courses based on whether they could accomplish all that online instruction can?" (28). We encourage asking how technology can improve instruction in all settings.

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Table 1

Course Resources and the Objectives They Were Designed to Support

	Resource Type				
Objective Supported	Research Video	Video Lecture	PP – Audio Files	Films	Web-Sites
Discussion Board	XX			XX	XX
Reinforce Text	XX	XX	XX	XX	XX
Expand on Text	XX	XX		XX	XX
Relate to Other Courses	XX	XX		XX	XX
Relate to "Real" World	XX			XX	XX
Explore P.S. as Science	XX	XX			XX

Table 2

The Effects of Faculty Videos

Variable	*Model 1*	*Model 2*	*Model 3*	*Model 4*
Online v traditional	-0.091*		-0.080*	
GPA	0.222		0.168*	0.193*
Video		0.0005*	0.0003*	0.003*
Discussion Board		0.003*	0.002*	
N	189	194	189	361
R^2	0.471	0.374	0.603	0.474
Adjusted R^2	0.465	0.368	0.594	0.471

* Indicates statistical significance no greater than α = .001

Table 3

Comparison of OLS and Beta Regression Models

Variables	*Model 1*		*Model 2*		*Model 3*	
	OLS	Beta	OLS	Beta	OLS	Beta
Online v traditional	-0.01	-0.09			-0.02	-0.02
GPA	0.20*	0.90*			0.16*	0.71*
Video			0.00*	0.00*	0.00	0.00*
Discussion Board			0.00*	0.00*	0.00*	0.00*
N	102	102	103	103	102	102
R^2	0.57	0.56	0.31	0.30	0.62	0.59
Adjusted R^2	0.56		0.30		0.60	

* Indicates statistical significance no less than α = .01

Signs and statistical significance are consistent regardless of the model used. Beta regression is often used for a ratio level dependent variable where there are restrictions on the unit interval, i.e. $0 < y < 1$. Percentages, proportions, fractions and rates are all suitable for beta regression estimation. Although an option for these data, there is no improvement over OLS.

Table 4

Comparison of OLS and Bayesian Models

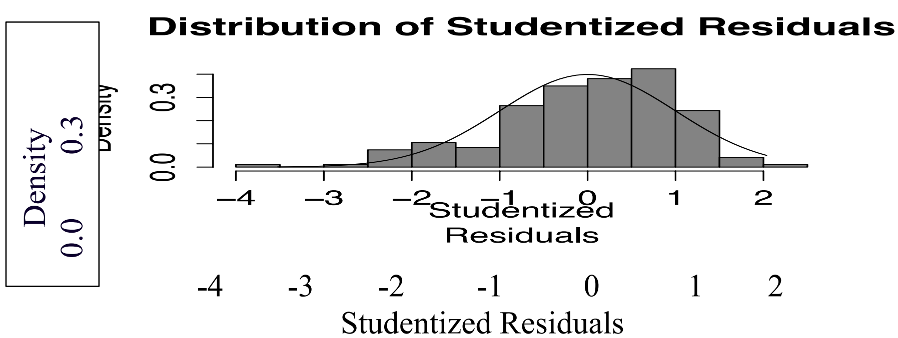
Variables	*Model 1*		*Model 2*		*Model 3*	
	OLS	Bayes	OLS	Bayes	OLS	Bayes
Online v traditional	-0.76	-0.75			-2.36	-2.36
GPA	19.65*	19.63*			16.36*	16.34*
Video			0.03*	0.03*	0.02*	0.02*
Discussion Board			0.02*	0.02*	0.01	0.01
N	102	102	107	107	102	102
R^2	0.57		0.33		0.62	
Adjusted R^2	0.56		0.32		0.60	

* Indicates statistical significance no less than α = .01

Another option for our analysis was a Bayesian generalized linear model. Some would argue that our data is not a sample (or even a set of samples), but rather that our data represent the population (or populations). To see if the assumption would matter, we reviewed a Bayesian model which, if the sample vs. population debate were relevant here, should have provided more reliable estimates than OLS. In fact, Bayesian and OLS regression provided nearly identical results.

Chart 1

Studentized Residual Distribution for the Dependent Variable

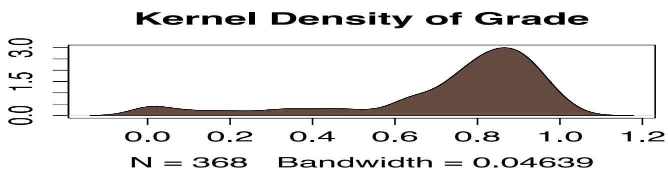


The display in Chart 1 shows that the dependent variable is not normally distributed. It is single peaked, and the majority of the cases lie closer to the center than to either tail, so we treat the variable as though it were normal and continuous. From a purely measurement perspective, we note that there is no reason to expect final course grades at a major research university to be normally distributed; these students have achieved all of their lives, and the data indicate that their performance is still strong. We were, however, interested to see the negative tail. In an effort to explain its existence, we examined the kernel density plot in Chart 2 below.

Chart 2

Kernel Density for Course Grade

Density 0.0 1.5 3.0



0.0 0.2 0.4 0.6 0.8 1.0 1.2

N = 368 Bandwidth = 0.04639

The vast majority of course grades fall between 0.07 and 0.95; the vast majority of students passed the course. In fact, most of them did quite well. That said, our dependent variable cannot be normally distributed.