Distance Learning is Good for the Environment: Savings in Greenhouse Gas Emissions

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Abstract

Distance learning is associated with a variety of benefits such as reduced use of campus facilities, increased accessibility, and control of disease transmission. In this study, we explore an additional benefit: mitigation of anthropogenic carbon dioxide emissions contributing to global climate change. A survey was presented to 500 students enrolled in online courses on three college campuses. Students who commuted by personal car were asked to estimate whether taking the course online resulted in fewer driving trips to campus. The environmental consequences of the estimated reduction in commute trips was assessed by calculating the CO2 emissions savings associated with reduced consumption of gasoline. The results indicate that offering a lower-division class of 100 students with an online format leads to reduced CO2 emissions of 5-10 tons per semester, and knowledge of such an environmental benefit leads to enhanced student satisfaction with distance learning.

Introduction

Evaluation of distance education has frequently involved comparison with face-to-face instruction. Recent meta-analyses indicate that differences in learning outcomes are minimal (there is a small overall difference favoring distance education). Student satisfaction levels are similar for distance and face-to-face instruction (with a slight overall preference for the face-to-face format). Other analyses indicate that satisfaction with distance education is highest for students who like to work independently, who score high on internal locus of control, who are technologically oriented, and who are highly motivated (Allen, Bourhis, Mabry, Burrell, & Timmerman, 2006). With this basic comparison somewhat settled, distance learning has been associated with a number of positive outcomes of interest to campus administrators: among these are accessibility (for nontraditional and disabled students), flexibility (no scheduling conflicts), increased participation in class discussion by shy students (using web-based forums), decreased disease transmission (relevant during flu season), and cost for facilities (no classroom space needed). Findings to be reported here suggest an additional advantage for teaching with an online format – distance learning is good for the environment!

The problem of human impact on the environment and ecological systems is well-established and of major concern within the scientific community. Periodic reports from the Intergovernmental Panel on Climate Change (2007) describe in detail the ecosystem damage to be expected in this century by disturbances associated with climate change (flooding, drought, ocean acidification) and other global change drivers (pollution, land use change). The reports document how human activities have resulted in higher levels of heat-trapping gases in the atmosphere and how this has been a major cause of recent increases in global temperatures.

This is not merely an issue for naturalists and government officials. Human activities that result in release of carbon dioxide and other heat-trapping gases are driven by economic forces, cultural expectations, and personal lifestyle decisions. Changing human activity to mitigate atmospheric impact will require creative and effective applications of the accumulated sociological and psychological research on how people learn, think, and make decisions. We will need to design environmentally-friendly lifestyle models that address existing human beliefs, attitudes, intentions, motives, and thought

processes. Because of their potential for personal and social influence, educational settings are an appropriate place to introduce such models.

Educators and social scientists have begun to acknowledge the need to address the relevance of greenhouse gas emissions and their resulting impact on global climate change. For example, leaders and administrators on university campuses have expressed grave concern over the threat of climate change. At the time of this writing, 674 college and university presidents have placed their signatures on an initiative titled the American College and University Presidents' Climate Commitment. By signing, they have made the following commitment: "We, the undersigned presidents and chancellors of colleges and universities, are deeply concerned about the unprecedented scale and speed of global warming and its potential for large-scale, adverse health, social, economic and ecological effects…We believe colleges and universities must exercise leadership in their communities and throughout society by modeling ways to minimize global warming emissions" (American College, 2011). While this commitment to organizational action is a reasonable first step, challenging work remains to be done on college campuses. Educational institutions need to make significant progress in the direction of organization-wide sustainability and this progress needs to be accompanied by informative evaluation studies. At present, there simply isn't much research available in the social sciences focused on efforts to reduce greenhouse gas emissions through organizational action (American Psychological Association, 2010).

One direction taken by some campuses of higher education is to promote sustainability through capital improvements such as new and remodeled academic buildings (green building) and adjustment in campus operations (sustainability management) (Galbraith, 2009). Another direction, the one addressed in this report, is to encourage faculty to offer more courses using distance learning via online instruction.

It is possible (but by no means certain) that offering an online section of a course results in behavior changes with ensuing environmental consequences. If taking a course via the internet results in fewer driving trips to campus, then the environmental savings can be identified in terms of carbon dioxide savings. Despite efforts to promote use of bicycles and public transportation, many students commute to class using their personal cars and trucks. The combined effect of all these commuters may constitute a significant source of atmospheric CO2 coming from the campus community. If changes can be made in the way course offerings are organized and scheduled so as to decrease the frequency of commuter trips to campus, then the savings in CO2 emissions may be nontrivial. The purpose of this study was to assess the degree of savings in CO2 emissions that can be expected when a course is offered using an online instructional format (as opposed to a traditional face-to-face format).

Hypothesis 1: Offering a course online will result in fewer student commute trips to campus and the reduction in driving will result in less carbon dioxide emitted into the environment.

Hypothesis 2: Knowledge of the environmental benefits of online instruction will elicit positive attitudes regarding this teaching format.

Method

The participants were 500 undergraduate students on three California campuses enrolled in eight online courses. One University of California campus and two California State University campuses were represented. Three disciplines were included (Engineering, Psychology, Child Development). Four lower-division and four upper-division classes were included. Class size varied from 4 to 128 students, however most of the participants (68%) were from separate sections of a lower-division course on Critical Thinking in Psychology. Most of the participants were 18-21 years old and approximately 60% were female.

Several weeks before the end of the semester, the students responded to brief survey (sent via email or provided on the course website) that asked about mode of transportation typically used in getting to campus, miles per gallon used (if drivers), distance from campus, and whether fewer trips were made to campus (in the student's estimation) on account of the online course format. The weighted mean response rate was 71% for lower-division classes and 83% for upper-division classes.

Results

Of particular interest was the estimated reduction in trips to campus for students who commuted by personal car. Total miles *not* driven, total gallons of fuel saved, commute distance, and car efficiency (reported miles per gallon) were used to estimate the savings in gasoline consumption over the semester. This fuel total was used to calculate the resulting savings in CO2 emissions for the class (total) and the mean CO2 for each student enrolled. Each gallon of gasoline consumed results in emission of 19.564 pounds of CO2, based on emission coefficients provided by the U.S. Energy Information Administration (2011).

The results are summarized in Table 1. Percentage of students driving to campus depended on the class level. In the lower-division classes (e.g., the critical thinking sections indicated by "CT" in the column headings), many of the students live in campus dorms and simply walk to class. Upper-division students are more likely to live off-campus and drive to class. However the savings in fuel was greatest for the lower-division classes due to the larger class size and resulting larger number of commuting drivers. Entries for total CO2 mitigation (second from bottom row) show that for one critical thinking class the reduction in personal commuting accounted for close to 10 tons of CO2 that was *not* emitted into the atmosphere because of the online format (and in no critical thinking class was the savings less than five tons). Entries in the bottom row show that *on average*, the CO2 mitigation varies from 103 pounds to 338 pounds per enrolled student in a distance learning class (as opposed to a traditional on-campus class). The weighted mean savings is 148 pounds of CO2 per enrolled student over the course of a semester.

Table 1. *Commuter Fuel Savings and CO2 Mitigation for 8 Online College Classes**

Class	CT-F08	His-F08	CD-F08	CT-S09	Psy-S09	Eng-S09	CT-F09	His-F09
Enrollmt	108	14	29	105	87	4	128	25
% Resp	48	71	79	70	83	100	83	92
% Drive	37	50	91	28	28	100	24	42
RT Dist	17	13	24	15	24	23	18	16
Mi Less	17213	2880	5947	13455	22861	1844	20390	4694
Gal Less	665	124	248	549	922	69	971	200
CO2 Tot	6.5	1.2	2.4	5.4	9.0	0.7	9.5	2.0
CO2/Std	121	173	168	103	208	338	149	157

* Column 1 headings: class enrollment, response rate, percentage who drive to campus, reported reduction in driving trips due to online format (round-trip distance), reduction in miles driven over the semester, gallons of fuel saved, total CO2 mitigation (tons) over the semester for these commuters, savings per enrolled online student (in pounds, averaged over the whole class including nondrivers).

After the CO2 calculation was completed, results were made available to the students by email or (in four classes) on an online discussion forum. Student reactions (by return email or posted to the forum) were reviewed by means of the instructor's subjective appraisal. When presented with the results of this "class demonstration," the students typically responded with surprise and pleasure that their selection of an online class had resulted in positive effects for the environment. The following are representative of comments posted on the discussion forums prompted only by a description of the class results for CO2 emissions:

- I hope that the university starts offering more online classes in the future so that we can continue to help save our environment by cutting down on emissions due to traveling to class. Taking this class saves me about 8 miles of driving per week.

- Wow, this [CO2 savings] is impressive! It certainly makes me feel good about taking this class!!! I must say that part of the reason I decided to take it was because I moved out of town.

- As for the environmental savings, I certainly think that this is a good way to conserve...especially for those of us with a long commute, and considering the enormous cost and energy usage of lighting and temperature regulation in classrooms
.
- I think this course is definitely beneficial in two ways, it helps the environment, and also it really helps us learn how to communicate through the computer which will be beneficial as we enter a more and more digital world.

- It's great that this on-line class saves so much on Carbon emissions and gas. It's also great for people like me who have somewhat hectic schedules.

- I am really surprised that an online course can have such an impact on the environment.

- I think that is a lot, to see gallon after gallon lined up and imagine of a 4 month period of burning it all is amazing.

- I also didn't really think about how it helps the environment; I do think I will be taking more online courses.

- I am totally blown away by the information provided from the results of this survey. I really like the idea of taking online classes and working at your leisure. The idea of saving so much by doing so though is absolutely mind blowing.

- That's very surprising, I would have guessed it be quite a difference but not that much of a savings. I'm very happy then to have taken this course to participate in the CO2 reduction.

- Wow! That is definitely interesting. I would've never guessed that an online course could have an effect on the CO2 emissions.

Discussion

It was hypothesized that offering a course online will result in fewer student commute trips to campus and the reduction in personal driving will result in less carbon dioxide emitted into the environment. If the student estimates of reduced driving can be accepted, the hypothesis received strong support. Close to 30 percent of the students in the lower-division classes reduced their trips to campus by two per week. The proportion of driving commuters was higher in upper-division classes (50-80%). Calculations based on these data suggest that the online teaching format results in a total CO2 emissions savings of 100-340 pounds per student enrolled. Over the semester this adds up to 5-10 tons in reduced emissions for a lower-division class of about 100 students.

Acceptance of the findings in this study rests on the assumption that the self-report estimate of reduced commute driving is reasonably accurate. Clearly it would not be feasible to randomly assign students to online vs. face-to-face sections and place mileage monitors in their cars, so we have to work with the student's estimate of reduced trips to campus. The requested information is probably not personally sensitive and hence unlikely to be subject to a personal-enhancement bias (effort to "look good" to those requesting the information).
The actual question posed to the students was:

- Does taking this course with an online format result in any fewer trips to campus each week (compared with what probably would have been your schedule with Psyc 100 meeting 2-3 times/week on campus)? Make an educated guess: _____ fewer trips per week (on average).

While the first part of the question leaves it open whether to indicate fewer trips or not, the fill-in part appears to prompt for an estimate other than zero. Any attempt to replicate this study should attempt a more-neutral phrasing of this crucial question.

Another assumption is that personal commute driving is the main greenhouse gas–related activity

distinguishing students in the distance-learning class from those taking the class with a traditional format. When students are on campus for face-to-face class meetings, their energy use is minimal. However the instructor will often lecture using a computer and projector which can total well over 1000 watts of power. The campus buildings are generally temperature controlled and lighted whether or not online classes are scheduled. Some students use their laptops or netbook computers when in class but the energy demands of these devices are minimal. These same students working from home on an online course may be using interior light and heat. However given that most college courses are taught in the daytime, many of these students could be expected to use natural light and heating/air conditioning demands would depend on the season and locale. A student working from home on a laptop computer only uses 15-60 watts of energy plus possibly another 10 watts for the modem and router (a desktop computer with monitor might use between 100 and 300 watts of power) (Mallard, 2010; Bluejay, 2011). We made no effort to take on the complex calculations required to factor in use of classroom equipment and lighting vs. home/apartment energy use associated with distance learning. Future studies on the energy demands of in-class vs. distance learning could include careful measurement of the actual energy demands for individual students using each instructional format.

Hypothesis 2 made the prediction that knowledge of the environmental benefits of online instruction would elicit positive attitudes regarding this teaching format. Comments posted to the online discussion forums indicated that this hypothesis was supported. Students reacted with surprise and volunteered positive comments after learning of the environmental benefit associated with their enrollment in an online section. The feedback regarding the CO2 savings associated with the online class format appears to have reinforced positive attitudes regarding distance learning and even helped to mitigate dissatisfaction with the online format.

If data on the positive environmental impact of distance learning can encourage positive student attitudes regarding the form of instruction, one can only wonder about the potential impact upon faculty in general. A report released by the Sloan Consortium, summarizing data from a national survey conducted in 2009, concludes that while the number of online courses continues to grow, acceptance of online learning by faculty has been relatively constant since 2002. None of the chief academic officers cited in the report felt that a majority of their faculty accept online education (Allen & Seaman, 2010).

Clearly the proponents of online learning have yet to achieve full acceptance. The message that distance learning is good for the environment can only help.

References

Allen, M., Bourhis, J., Mabry, E., Burrell, N. A., & Timmerman, C. E. (2006). Comparing distance education to face-to-face methods of education. In B. M. Gayle, R. W. Preiss, N. Burrell, & M. Allen (Eds.), *Classroom communication and instructional processes*. Mahwah, NJ: Lawrence Erlbaum.

Allen, I. E., and Seaman, J. (2010). *Learning on demand: Online education in the United States, 2009*. Babson Survey Research Group. Retrieved from http://www.sloan-c.org/publications/survey/pdf/learningondemand.pdf

American College and University Presidents' Climate Commitment. (2011). Retrieved from http://www.presidentsclimatecommitment.org/about/commitment

American Psychological Association. (2010). *Psychology and global climate change*. Retrieved from http://www.apa.org/science/about/publications/climate-change-booklet.pdf

Bluejay, M. (2011). Saving electricity. Retrieved from http://michaelbluejay.com/electricity/computers.html

Kate Galbraith. (2009, August 20). Sustainability field booms on campus. *New York Times*, p. F4.

Mallard, S. (2010, August). How much electricity does a computer use? Go green to see green. *Bright*

Hub. Retrieved from http://www.brighthub.com/environment/green-computing/articles/9351.aspx

Intergovernmental Panel on Climate Change. (2007). *Fourth assessment report: Climate change 2007.* Retrieved from http://www.pewclimate.org/global-warming-basics/ipccar4.cfm

U.S. Energy Information Administration. (2011). Retrieved from http://www.eia.doe.gov/oiaf/1605/coefficients.html

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