

College in the Information Age: Gains Associated with Students' Use of Technology

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Abstract

Increasingly college students are expected to use computers and technology in their studies. This study estimated the relationship between students' use of technology and self-reported educational gains. These gains range from general learning outcomes to specific outcomes related to computers and technology. Results suggest a modest, but statistically significant relationship between students' use of technology and closely related learning outcomes. Four college activities related to computer use emerged as strongest predictors of gains from college: searched internet for course material, used computer to analyze data, used index or database to find material, and retrieved off-campus library materials. Implications for policy and future research are discussed.

Introduction

Increasingly college students are expected to use computers and technology in their studies. In fact, owning a personal computer is typically a requirement for all entering freshmen at a large majority of colleges and universities today. Student computer uses range from email communication to web research and word processing (Institution for Higher Education Policy, 1999; Wang & Bagaka's, 2002).

Research on student computer use and technology in college can be conceptualized into three categories. A large body of literature focuses on students' use of technology in education (Bento & Bento, 2000; Cartwright, 1993; Green, 1996; Wang & Bagaka's, 2002). Specifically, this line of research sheds light on the extent to which college students use technology in their day-to-day lives. Typical uses range from electronic mail writing, to instant messaging, web surfing, and online research to name a few (Gatz & Hirt, 2000). More recent work explores the use of technology (e.g., computers and internet) among historically underrepresented students such as students of color (Slate, Manuel, & Brinson, 2002).

Still another line of inquiry tends to highlight the relationship between features of various technologies and adoption or use of such technology. Much of the theoretical work in this area emanates from Rogers' (1986; 1995) theory of technology diffusion. Rogers identified five attributes by which innovations are judged: (a) trialability (b) observability (c) relative advantage (d) complexity and (e) compatibility. That is, innovations that can be tried or tested, yield results that can be observed, and have an advantage over current processes are more likely to be adopted and distributed for broader use. The weight of the evidence in this area focuses on the use of technology in traditional and online learning environments (Ali & Elfessi, 2004; Gifford, 1998; Hofman, 2002; Redding & Rotzien, 2001). For example, Redding and Rotzien found that online instruction was associated with higher scores on course examinations when compared to traditional classroom instruction. In contrast, Gifford (1998) and others (Karr, Weck, Sunal, & Cook, 2003) found that online instruction had little or no impact on improving students' performance.

Third, there is a growing body of evidence that contributes to our understanding of how computer use among postsecondary students impacts learning and development (Pascarella & Terenzini, 2005). Much of the evidence demonstrates the impact of general uses of technology and various pedagogical approaches on subject matter acquisition. Some research findings show that use of technology and incorporation of technology in one's teaching is often positively, albeit modestly, associated with content mastery (Cartwright, 1993; Hofman, 2002; Kulik & Kulik, 1991; Marttunen, 1997; Weller, 1997). Still others have found that students' use of technology or forms of computer-based instruction are not significantly related to knowledge acquisition (Smeaton & Keogh, 1999; Taraban & Rynearson, 1998; Tjaden & Martin, 1995). It seems clear that postsecondary institutions have adopted computers and new technologies with rapid abandon, though such adoption and its impact on students is not consistent across all institutional types (Glaudieux & Swail, 1999).

There is little compelling evidence that examines the impact of students' use of technology or computer-based instruction on student learning. Kuh and Vesper (1999) assessed the impact of students' familiarity with computers on self-reported gains. Results suggest a positive, significant association between such inputs and outputs. Flowers, Pascarella, and Pierson (1999) found between-college differences in the effect of computer use on student outcomes. For example, Flowers et al. observed a modest but significant relationship between computer use and cognitive outcomes for students attending community colleges. Conversely, the same was not true of their counterparts at four-year institutions. Others have investigated this connection as well and found a small, positive effect on student self-reported gains, controlling for an extensive array of background and intervening variables (Kuh & Hu, 2000).

Substantially less evidence examines the relationship between general uses and other pedagogical approaches related to technology and cognitive skill development. Indeed, few studies attempt to connect college students' use of technology to general learning outcomes. The current literature is limited in another way as most studies explore the relationship between computer use or mode of instruction and students' performance on exams (Ali & Elfessi, 2004; Karr, Weck, Sunal & Cook, 2003; Redding & Rotzien, 2001). Comparatively fewer studies estimate the relationship between computer use and closely-related outcomes or gains associated with computers and technology. Such information is necessary for college educators and others who are concerned about students' cognitive and technical skill development. The purpose of this study was to measure the relationship between various uses of technology and students' perceived level of learning or self-reported development. Specifically, I used College Student Experiences Questionnaire (CSEQ) data to estimate the relationship between technology use among college students and self-reported educational gains across several domains with particular attention to gains associated with computers and technology.

The following questions guided this research investigation: (a) Are there differences between high- and low-users of technology in their overall gains from college? (b) Are there differences between high- and low-users of technology in their gains with respect to using computers and other information technology? (c) Are there differences between high- and low-users of technology in their gains with respect to understanding new technology? (d) Are there differences between high- and low-users of technology in their gains with respect to understanding the consequences of science and technology? (e) Of the ten technology-related activities measured by the CSEQ, which are the most powerful predictors of students' self-reported gains overall?

Method

Sample

The sample consisted of 712 individuals who were enrolled at a large, Research-1 university located in a mid-Atlantic state. A large majority of the sample consisted of individuals who were between 20 and 23 years of age. Women made up approximately 49% of the sample while 51% were men. Table 1 presents additional results to describe the sample.

Table 1: Description of sample (N=712)

Characteristic/Categories	N	%
Age		
19 and younger	270	38
20-23	413	58
24-29	29	4
30 and older	1	<1
Gender		
Male	371	51
Female	341	49
College classification		
First-year	173	24
Second-year	159	23
Third-year	174	24
Senior	206	29
Race		
White	573	81
Black	26	4
Asian Pacific Islander	49	7
Other	58	8

Data

Data for the present study were collected using the College Students Experiences Questionnaire (CSEQ) developed by Pace (1984; Pace & Kuh, 1998). The CSEQ is a 191-item survey designed to measure the quality and quantity of students' involvement in college activities and their use of college facilities. For example, several items measure students' involvement in a series of college activities that have been shown to contribute positively to college students' learning and development (Astin, 1984, 1993; Kuh, Pace, & Vesper, 1997; Pace, 1990). The CSEQ has been shown to be consistently reliable and valid; it is used widely in college impact studies (Pascarella & Terenzini, 2005).

The data used in this study reflect an institutional sample. Data were collected in the Fall 2003 and 2004 semesters. The sample was varied in that participants were first-, second-, third-, and fourth-year students. Students were selected randomly by the Office of Institutional Research and invited to participate in the study. Participants completed the CSEQ survey and all responses were included in the dataset. However, individuals with missing data on variables of interest to this study were dropped from the final analysis.

Dependent Variable

The dependent variable in this study was a composite gains score, as measured by the CSEQ. To this end, I calculated the criterion variable by adding together each individual's score on 25 items from the "Estimate of Gains" subscale on the instrument. Thus, the dependent variable (GAIN) was calculated accordingly: $GAIN = \sum [gain_1 + gain_2 + \dots + gain_{25}]$

Each gain item was preceded by the following prompt: *In thinking about your college and university experience up to now, to what extent do you feel you have gained or made progress in the following areas?* Gain items ranged from "acquiring knowledge and skills applicable to a specific job or type of work" to "becoming aware of the consequence of science and new technology." Each item is rated on a 4-point Likert scale with scores of "1" indicating "very little" gain and scores of "4" indicating "very much" gain. After adding together all items to calculate the outcome, scores ranged from 25 to 100.

Analysis

To investigate the research questions, several steps were taken to analyze data. First, participants were sorted into two groups: high and low users of technology. Data from 10 items on the CSEQ *college activities* section were used to create groups. Each item is measured on a 4-point scale: 1 equal to "never," 2 equal to "occasionally," 3 equal to "often," and 4 indicating "very often." Descriptions of these items are presented in Table 2.

Table 2: CSEQ College Activities Items

Item	Response values
Used a computer or word processor to prepare reports or papers.	Very often=4, Often=3, Occasionally=2, Never=1
Used email to communicate with an instructor or other students.	Very often=4, Often=3, Occasionally=2, Never=1
Used a computer tutorial to learn material for a course or developmental/remedial program	Very often=4, Often=3, Occasionally=2, Never=1
Participated in class discussions using an electronic medium (email, list serve, chat group, etc.).	Very often=4, Often=3, Occasionally=2, Never=1
Searched the World Wide Web or Internet for information related to a course.	Very often=4, Often=3, Occasionally=2, Never=1
Used a computer to retrieve materials from a library not at this institution.	Very often=4, Often=3, Occasionally=2, Never=1
Used a computer to produce visual displays of information (charts, graphs, spreadsheets, etc.).	Very often=4, Often=3, Occasionally=2, Never=1
Used a computer to analyze data (statistics, forecasting, etc.).	Very often=4, Often=3, Occasionally=2, Never=1
Developed a web page or multimedia presentation.	Very often=4, Often=3, Occasionally=2, Never=1
Used an index or database (computer, card catalog, etc.) to find material on some topic.	Very often=4, Often=3, Occasionally=2, Never=1

Note: Each item in this section was preceded by the following prompt: "In your experience at this institution during the current school year, about how often have you done each of the following?"

All ten items were combined to create a grouping variable, *techgroup*, ranging from 10 to 40. Participants with scores of less than 20 were considered low users and coded a “0” on *techgroup*. Participants with scores of greater than 20 were considered high users and coded a “1” on *techgroup*. The final sample consisted of 83% high users and 17% low users. The operational definitions used in this study are similar to those found elsewhere (DeSousa & King, 1992).

Given the nature of each independent factor, several nonparametric tests of statistical difference were used to examine variance between groups. First, several Mann-Whitney tests were conducted. “The Mann-Whitney *U* test evaluates whether the medians on a test variable differ significantly between two groups” (Green & Salkind, 2003, p. 361). In addition, frequencies were calculated to summarize background information such as age, gender, and race.

To test the magnitude of the relationship between each independent variables and the criterion variable, overall self-reported gains, stepwise multiple regression was selected as the primary analytical procedure (Pedhazur, 1982). Stepwise multiple regression, a variation of the forward solution, is an appropriate technique for discerning the “most powerful” predictors. In this case, the first variable selected for inclusion in the regression model is the predictor that is most highly correlated with the criterion variable (Hinkle, Wiersma, & Jurs, 1998). The next predictor variable selected for inclusion in the model is the one with the “highest partial correlation with the criterion variable, with the effects of the first variable partialled out” (Hinkle et al., 1998, p. 504). Unlike the forward solution that retains all predictors once they have been entered into the equation, stepwise conducts a second significance test to determine if the significance of previously selected variables remains when considered in combination with other predictors.

Limitations

As with all investigations, this study is not without limitations. First, the data used in this study were drawn from a single institutional sample. The institution is best described as a large, public Research-1 university located in a southeastern state. Thus, findings should be interpreted with caution and generalizations may only be relevant to institutions similar in size, control status, and institutional emphasis.

The present study used self-report data and this may be another possible limitation. To the extent that respondents did not know the information being requested or found survey questions to be ambiguous and unclear, the generalizability of these findings may be limited (Pike & Kuh, 2005). Yet, a large number of scholars lend support to the merit of self-reported data (Astin, 1993; Kuh et al., 2001; Kuh et al., 1997; Pace, 1985; Pascarella & Terenzini, 2005; Pike, 1995). As Gonyea (2005) noted, “In reality, all questionnaire surveys, whether locally produced or nationally published, rely on some type of self-reported information” (p. 74).

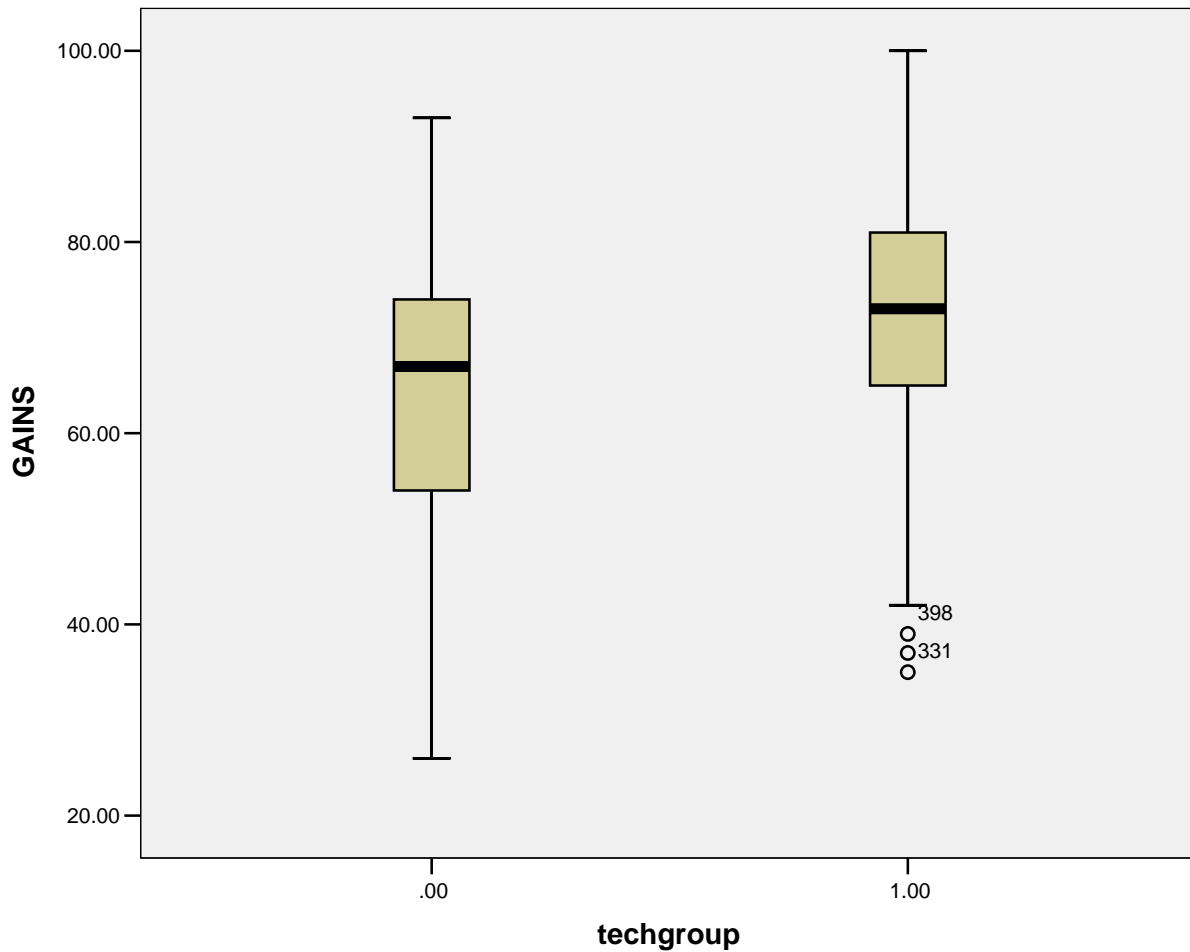
It is also important to note that the sample consists of slightly more men than women. This is noteworthy, given recent enrollment data that suggest women comprise the majority of postsecondary students (National Center for Education Statistics, 2001). Thus, results from the present study should be interpreted in light of this limitation and generalizations may be limited to comparable samples.

Finally, perhaps another limitation relates to the dataset used in the study—the College Student Experiences Questionnaire (CSEQ). Despite its widespread use in college impact studies, the study was limited to factors that could be defined or operationalized using items drawn from the database. It is highly possible that the CSEQ did not measure all of the variables needed to explain the variance in student self-reported gains from college. Likewise, it is plausible that the CSEQ items have a marginal relationship with the constructs (e.g., college activities, opinion, gains, etc.) that they are purported to measure (Pascarella & Terenzini, 2005).

Despite these limitations, this study contributes to our understanding of the potential effect of various uses of technology on students' gains from college. Specifically, it provided information about the association between students' use of technology and self-reported gains from college. In addition, this research provides a foray into group differences that exist between high- and low-users of computers and technology.

Results

This research explored differences between high- and low-users with respect to overall self-reported gains, an independent samples t-test was conducted. The dependent factor was a composite of all 25 items on the CSEQ *estimate of gains* section. Each item was measured on a 4-point Likert scale ranging from “very little” (=1) to “very much” (=4). The independent grouping factor divided the sample into two groups, as described above: high- and low-users. High-users had a higher mean score ($M=72.6$, $SD=12.1$) than low-users ($M=65.1$, $SD=14.5$). The independent samples t-test was significant, $t(45.5) = -3.287$, $p = .002$. The eta square index indicated that less than 2% of the variance in overall gains was accounted for by whether a student was assigned to a high- or low-use condition. Figure 1 shows the distribution for the two groups.

Figure 1: Boxplot of overall gains, by level of technology use

Note: Low users are indicated by “.00” while high users are indicated by “1.00.”

A Mann-Whitney U test was conducted to evaluate the hypothesis that no significant difference exists between high and low users with respect to gains associated with using computers and other information technology. The results of the test were significant, $z = -4.655$, $p < .01$. High users had an average rank of 313.26, while low users had an average rank of 201.42.

A Mann-Whitney U test was conducted to evaluate the null hypothesis that no significant difference was observed between high and low users with respect to gains associated with understanding new technology. The results of the test were significant, $z = -2.03$, $p < .05$. High users had an average rank of 308.42 while low users had an average rank of 255.51.

Another test was conducted to evaluate the null hypothesis that no significant difference exists between high and low users with respect to gains about the consequences of science and technology. Mann-Whitney U test results were significant, $z = -2.228$, $p < .05$. High users had a mean rank of 310.30 and low users had a mean rank of 251.96.

Stepwise multiple regression analysis was conducted to evaluate which of the technology college activities measures were best predictors of students’ self-reported overall gains from

college. Initially, the predictors were the 10 college activity items, described above, that relate to technology and computer use in college, while the criterion variable was the composite gains score.

The linear combination of computer/technology measures that entered the final model was significantly related to the gain score, $F(4,559) = 25.480$, $p < .01$. Four *college activity* measures entered the final model: searched internet for course materials, used computer to analyze data, used index or database to find material, and retrieved off-campus library materials. The sample multiple correlation coefficient was .39, indicating that approximately 15% of the variance in overall gains from college can be accounted for by the four variables that entered the final model.

The regression equation was significant, $R^2 = .15$, adjusted $R^2 = .15$, $F(4, 559) = 25.480$, $p < .01$. Unstandardized beta coefficients were calculated for each independent factor that entered the final regression model: searched internet for course materials ($\beta = 3.53$), used computer to analyze data ($\beta = 1.99$), used index or database to find material ($\beta = 2.34$), and retrieved off-campus library materials ($\beta = 1.05$).

Table 3 presents indices to indicate the relative strength of association between the most powerful predictor variables and the outcome variable, overall gains from college. All of the bivariate correlations were positive and statistically significant ($p < .01$). All partial correlations were positive and statistically significant at the $p < .01$ level except for the item pertaining to retrieving off-campus information ($p < .05$).

Table 3: The Bivariate and Partial Correlations of the Predictors with Gains

Predictor	Correlation between each predictor and gains	Correlation between each predictor and gains controlling for all other predictors
Searched internet for course material	.28**	.19**
Used computer to analyze data	.26**	.19**
Used index or database to find material	.20**	.19**
Retrieved off-campus library materials	.21**	.10*

* $p < .05$, ** $p < .01$

Discussion

Overall, the results of this study suggest that a significant relationship exists between college students' activities that relate to technology/computers and their overall gains from college and in specific technology/computer-related domains.

This study demonstrates that technology and computer related activities in college are related to learning and development in specific domains (e.g., understanding of the consequences of science, using computers and other information technology) and overall self-reported gains from college. Moreover, this study shows that four activities have important ramifications for overall learning and development in college: searched internet for course material, used

computer to analyze data, used index or database to find material, and retrieved off-campus library materials.

Not all technology/computer activities had a significant relationship with overall gains from college, as measured by the CSEQ. In fact, only four variables entered the final model as being the most powerful predictors of overall gains. Findings may raise important questions about the “value added” of other computer/technology uses (e.g., used computer tutorial, created web page, etc.) to students’ collegiate experiences.

All four variables that were selected to enter the regression model are related to using computers/technology to collect information or new understandings. It is reasonable to assume that these activities are closely connected to another learning activity. For example, students may use an index or database to find material for a term paper or writing assignment. Similarly, students may use computers to retrieve off-campus library materials for use in a term paper, essay, or independent research project. Such uses are important and timely given recent demands for college graduates to be skilled at using electronic resources to access, gather, and make judgments about the wealth of information that is readily accessible in the “information age.”

“Searching the internet for course materials” was the most powerful predictor of overall gains from college. That is, using the internet to find course materials was associated with higher overall gain scores. This correlation may not be purely technological or computer-related. It may be correlated with other student characteristics and academic factors. For example, students who search the internet for course materials may have a natural propensity towards using computers, exhibiting independence to search for needed information, and making the most of college. To the extent that this is true, the relationship between this predictor and overall gains may be confounded by individual students’ tendencies.

Findings from this study should prove useful for a number of campus constituents. For faculty members whose goal it is to increase students’ intellectual growth and skills during college, this research identifies several areas for possible intervention. Results suggest that four college activities may have an important association with students’ self-reported gains. Faculty members may consider these findings when designing classroom activities that make use of computers and emerging forms of technology.

Coordinators of undergraduate research opportunity programs may benefit from this study. This study provided data about the impact of computer use on student self-reported gains from college. Findings suggest the plausibility of a significant relationship between using computer to analyze data and learning, as measured by the CSEQ. Coordinators may use this information to design experiences that emphasize student-faculty interactions and use of computers in research investigations.

The results of this study might provide suggestions to administrators and information technology directors who hope to increase the adoption and diffusion of technology in undergraduate education. This study provided useful information about the relationship between frequency of use and cognitive student outcomes. For example, findings suggest that high-users of technology report higher gains, even in computer or technology-related areas, than their counterparts who may use technology less frequently. Administrators may use these findings when designing strategies for increasing the use of technology on campus. In addition, results from this study may prove suggestive of the impact of students’ use of computers and technology on learning and development in college, though causal linkages cannot be drawn from self-reported data.

Results from this study also provide the impetus for future research. Using computers and other forms of technology were associated with higher self-reported gains from college and higher gains in specific domains. In light of prior conclusions about differences by institutional type (Gladieux & Swail, 1999), it is reasonable to assume that the impact of computer use on student growth in college may vary by other factors. That is, not all students will necessarily benefit to the same extent from computer use or the way in which computers are used in college (e.g., independent use, use with peers, use in research/data analysis, etc.). Thus, future research studies should estimate the conditional effect of computer use on students, giving attention to differences by gender, race, age, full-time or part-time attendance.

The present study was conducted to measure differences between high- and low-users of computers and technology. Thus, Mann-Whitney tests and descriptive statistics served as primary analytical techniques. However, given the limitations of correlational studies, non-experimental designs, and significance testing, this topic warrants a more expanded use of research approaches to estimate the impact of use on college students' learning and development. Future studies might use longitudinal designs and an extensive array of controls to model the effect of college students' computer use on learning and development.

Finally, the present study estimated the association of students' use of computers, as measured by the CSEQ, across several learning outcomes. The CSEQ only measures students' use of computers, electronic mail, chat rooms, and websites to name a few. It does not measure students' use of new technologies or sites such as iPods, video chat, facebook, or myspace. Future studies should include these new technologies that are widely used among students.

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