 doi: 10.2304/elea.2006.3.4.534

How Learning Styles Impact E-learning: a case comparative study of undergraduate students who excelled, passed, or failed an online course in scientific/technical writing

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ABSTRACT Online classes appear increasingly popular, making it critical in each discipline to study the advantages and disadvantages of learning online. Following up on anecdotal impressions that scientific/technical writing students appeared to do either better or worse in an online course than an offline equivalent (unpublished data), it was decided to study the impact of learning style and experience in using the Internet on grades. The 60 students who participated in an online course on scientific/technical writing were emailed post-course evaluations which included questions on learning styles. Of these, 37 (62%) returned the evaluations, revealing a clear and significant pattern of results. While the groups did not differ in hours spent studying online, or in total hours spent online, students who excelled in online learning reported spending significantly more hours per week online for work, and less hours online contacting families/friends than students who passed or students who failed. Students who excelled differed significantly from other students in their learning strategies and study habits and frequency with which they contacted the instructor. Students who excelled in this online class appear more experienced both in working online and have study habits conducive to the online environment. Curiously, students who performed marginally or failed were more likely to rate themselves as making good use of study time, and may spend significantly longer online on assignments than the moderate students. The need to design courses that elicit specific habits or to teach students study habits specific to online learning appear critical tasks to improve the success and retention rates in online courses.

Introduction

Within the past 20 years, as institutions have turned to online resources to expand their teaching base and now offer distance learning courses along with their traditional face-to-face courses, much scholarly research has focused on the learning effects of these new trends. The earliest research used a variety of different evaluation methods (surveys, standardized test scores, frequency of student–teacher interaction etc.) to establish if a significant difference could be demonstrated between how well students learn in online environments versus offline equivalents. Thomas L. Russell's (1999) book, *The No Significant Difference Phenomenon*, reviews 355 studies, papers and summaries of studies that looked for statistical differences between the two learning environments. The lack of identified statistical differences from these early studies led Russell to conclude that students who work online typically perform as well as their face-to-face counterparts. This conclusion has generated much debate, and resulted in an online and updated version of the bibliography, which is now available at the International Distance Education Certification Center website. This version now reviews more recent studies, including some showing online

environments to be less effective learning spaces (e.g. Brown & Liedholm, 2002), while the majority of online instruction leads to better student performance than traditional instruction.

Understanding why the early studies yielded no significant difference, some later studies showed inferior results in online learning, while most later studies showed superior performance, is a matter of continued debate. In examining the difference, Pouget & Pym's (2000) literature review focused on questions of measurement and whether qualitative or quantitative measures should be used. Thomas Ramage's (2001) review questions how 'no significant differences' should be interpreted, and questions the claim made by researcher Richard Clark (1994) that media plays a small, if not negligible role compared to method when 'measurable learned outcomes' are 'replicable using different media.'

Twigg (2001), of the Pew Learning and Technology Program, suggests that it is time to move beyond the debate whether there are significant differences in online versus traditional learning. Instead, she recommends that research in this area should address the challenges of higher education: 'improving quality, increasing access, and reducing costs,' through a better understanding of what makes for effective online course design. Specifically, she calls for research to address two questions: (a) what needs to be done to improve online education; and (b) what are the important variables that create a rich online learning experience, one that makes real improvements in academic practice?

The theoretical background to our investigation includes Bandura's (1986) Social Cognitive Theory. This states that knowledge of behavior, such as learning, is impacted by three variables: person characteristics (typically intra-individual state/trait characteristics such as intelligence or motivation), behavior (study habits) and environment (e.g. online or offline learning). Bandura's principle of reciprocal determinism predicts that each characteristic is symbiotically altered by the other two. Thus, when a university offers an online option for a class, it should not be surprising that online and offline courses may attract different types of students, and students may behave differently in online and offline courses. Bandura predicts that the outcome of passing the course will be a function of the student's abilities, behavior and relationship to the environment.

Preliminary Studies

Mindful of Bandura's theory, when we started offering an undergraduate course in scientific/technical writing both online and offline, we recognized an ideal opportunity to study the differences in students choosing either the online ($n = 20$) or the offline ($n = 20$) option. We noted that the small sample sizes of our classroom courses creates potential difficulties in detecting all but large differences (inadequate sample size being a potential explanation for at least some of the early published findings of 'no significant difference' outlined above). We had observed that the online students appeared to receive substantially higher grades, and we confirmed this impression by having an assignment blindly graded. Assignments from the online and face-to-face sections had all personal identifiers removed prior to grading. The online assignments averaged half a grade above the face-to-face assignments. We speculated that online courses might be attracting students who were older (more mature), brighter (had better grade point averages), or were more experienced in higher learning (closer to graduation). We speculated that any of these might provide insight into why our students in the online course appeared to fare better. Instead, we were surprised to find that the impression of students doing better told only one half of the story, and indeed, when we revisited the course grades, were surprised to observe that in the offline (traditional classroom) class, students' grades reflected a negatively skewed curve consistent with a few students excelling, many students scoring above average to average, and a few students failing. By contrast, the online curve reflected more a flat line, showing that many students excelled, about the same number received average grades, and a similar number either performed marginally, failed or failed to complete (dropped out). As importantly, no significant differences were apparent in either the demographic characteristics or Internet experience of students who took the course online or offline (although the small number of students in each class is an important caveat).

Based on our initial impressions, we next decided to study the differences between students who excel, pass or perform marginally in the online course. We hypothesized that if person characteristics were critical, the students should differ significantly in demographic characteristics;

specifically that students who were younger, had lower GPAs, or less years at the university should be more likely to fail than other students. If behavior characteristics were critical, we hypothesized that greater experience on the Internet, more hours studying for the course, and more hours spent in online courses should significantly predict success. Alternatively, if there was an interaction between the variables then some person-behavior difference such as learning style should play a critical role in success in online classes. Thus, we proposed a study examining demographic, Internet use and learning style differences between students who excelled, passed or performed marginally in an online class on scientific/technical writing.

Methods

Participants

Participants in this study were students who participated in an online undergraduate course in scientific/technical writing developed by the senior author. A posteriori, students were divided into three groups based upon their success in this course. Excelling students were defined as the top third of the class, moderate students were those who achieved passing or adequate grades, and about a third of the class were those who performed marginally, failed or dropped out. As shown in Table I, the demographic characteristics of the sample reflect a typical junior class, with the average age of the participants being 24 years (standard deviation [SD] = 6; range: 19-51 years), their average grade point average (GPA) was 3.1 (SD = 0.4; Range: 2.4-4.0), most were juniors (mean = 3.1; SD = 0.4; range: sophomores–seniors), enrolled full time (mean = 15.5; SD = 3.5; range 4-20); who reported an average of 19.4 hours per week (SD = 15.0) at work, and 18.0 hours per week (SD = 11.1) studying. In terms of background, 4 (11%) students reported living in a rural community (<5000), 3 (8%) a small town (5000-50,000), 11 (14%) a medium-sized city (50,001-200,000), 14 (38%) in the suburbs, and 5 (14%) downtown of a primary metropolitan area. Two (5%) graduated from inner-city public schools, 21 (57%) from suburban high schools, and 7 (19%) each from rural public schools and private schools, respectively. Ten (27%) reported living with friends, 9 (24%) each with boy/girlfriends or 9 (24%) with spouses/significant others; 6 (16%) reported living alone, and 3 (8%) reported living with parents. Sample size precluded analysis on these latter three variables.

Variable	ANOVA*			Total			
	F	df	*p*	Minimum	Maximum	Mean	SD
Age	0.71	2	NS	19.0	51	23.64	6.0
Grade point average	1.43	2	NS	2.4	4	3.10	0.4
Years at the University	0.11	2	NS	0.8	5	2.90	1.0
Hours per week during the last semester spent working	0.18	2	NS	0	70	19.40	15.0
Hours per week during the last semester spent studying	0.83	2	NS	2.0	55	18.00	11.1
How do you rate your computer skills	2.31	2	NS	2.0	5	3.60	0.7
Number of credits enrolled this semester	0.42	2	NS	4.0	20	15.50	3.5

*Differences between students who excelled, passed, or failed the course were examined using one-way ANOVAs, but as no significant differences were found, only the mean and standard deviation for the total are reported.

Table I. Demographic characteristics of students completing an online course in scientific writing (n = 37).

Measures

Demographic data were collected by asking participants to complete the form regarding their 'age,' 'grade point average,' and so forth. Questions about Internet use were taken from items developed by the second and fifth authors on another Internet study (Rosser et al, forthcoming 2007). We chose 'number of hours in the past week spent' as our primary measure of time spent online, asked

separately for the workplace, at home and at other places. These three measures were then totaled together to produce an estimate of total hours spent online in the last seven days. To check the reliability of this measure, we also asked for number of hours in the last seven days spent online working, studying, and emailing friends/family. While not an exhaustive list, a strong correlation ($r = .84$, $p < .001$) confirmed that the hours estimated online were reliable. A full list of Internet use items appears in Table II. To measure learning styles, items were taken from Pintrich et al's Motivation Strategies for Learning Questionnaire (MSLQ, 1991). Ten questions were selected from MSLQ and modified for the online environment. Content and face validity were established by a group of 20 students in a technical writing course who conducted usability testing on the questions. Good and bad study strategies were investigated using a series of 10 questions which ask students to rate how typical a particular study strategy is of them on five-point Likert-type scales (1 = not at all typical of me; 5 = very typical of me). Examples include 'try to find the most important ideas from the readings,' 'give up on the difficult parts and study the easy ones,' and 'memorize key words of important concepts.' 'Study habits' refers to the frequency with which students report performing a particular study habit. Seven questions investigated study style using five-point Likert-type scales (1 = none of the time; 5 = all of the time). Examples include 'read the text,' 'communicate with classmates via the chatroom' and 'contact instructor to clarify problems.' A full list of the exact questions on learning styles appears in Table III).

Variable	ANOVA			Total				a. Top third excelling students (n = 15)		b. Middle third passing students (n = 15)		c. Lowest third failing students (n = 7)	
	F	df	p	Min	Max	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Year first started using Internet	3.42	2	.045	1990	2000	1995.6	2.6	1994.4 ab,ac	3.0	1996.6 ab	1.8	1995.7 ac	2.6
How do you rate your computer skills	2.31	2	ns	2	5	3.6	0.7						
Hours spent last 7 days on the Internet in the workplace	0.87	2	ns	0	20	6.3	6.2						
Hours spent last 7 days on the Internet at home	1.22	2	ns	1	40	12.2	9.6						
Hours spent last 7 days on the Internet at other places	0.31	2	ns	0	10	1.5	2.4						
Hours spent last 7 days on Internet, work related	3.35	2	.048	0	27	3.6	6.1	6.5 ab, ac	7.5	2.1 ab	4.4	0.5 ac	4.4
Hours spent last 7 days on Internet, homework	0.99	2	ns	1	40	9.4	7.9						
Hours spent last 7 days on Internet, friends/family	2.87	2	.071	0	15	4.0	3.9	2.3 ab,ac	2.7	4.7 ab	3.9	6.3 ac	5.5
Hours spent last 7 days on Internet, personal	2.30	2	ns	0	20	5.8	6.7						
Hours spent last 7 days on the Internet (at work, at home and at other places)	1.09	2	ns	2	50	19.7	11.0						
Hours spent last 7 days on Internet (reliability estimate: doing study, work related, and emailing friends and family)	0.45	2	ns	32	54	17.1	10.1						
Hours spent studying assignments for this course	2.69	2	.083	1	81	17.2	20.3	16.9	22.2	11.3 bc	12.3	34.6 bc	26.0

Table II. Internet characteristics of students who excel, pass or fail an online course in scientific writing (n = 37).

Procedures

In order to evaluate how the Internet class performed, a priori it was decided to divide the class of 60 students into tertiles based on eventual performance. Thus, the 20 students who received the highest grades would be defined as excellent, the next 20 as average, and the bottom 20 as those who either performed marginally, did not complete or failed. Evaluation rates differed significantly across the thirds, with the top two-thirds returning 16 of 20 evaluation forms each, while in the lowest group, only 7 of the 20 returned completed evaluations.

Analyses

To compare the three groups on continuous variables, for internal data, one-way analyses of variance (ANOVAs) were employed, with least square difference (LSD) used to identify where any differences lay. ANOVA enabled us to simultaneously investigate two critical questions: on what variables do those who excel in this online class differ from others; and, on what variables do those who do badly in this online course differ from others? For categorical data, because small numbers in some cells precluded analysis, cells were collapsed into meaningful categories. A priori, an alpha level of .05 was identified as indicating a significant difference and $p < .1$ as evidence of trend.

Variable	ANOVA (df = 2)		Total				a. Top third excelling students (*n* = 15)		b. Middle third passing students (*n* = 15)		c. Lowest third failing students (*n* = 7)	
	F	*p**	Min	Max	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Q16. Finding most important ideas from readings	10.58	.000	1	5	3.6	1.0	4.3 ab,ac	0.8	2.9 ab	0.9	3.4 ac	0.8
Q17. Memorize key words of important concepts	1.07	ns	2	5	3.6	1.0						
Q18. Try to relate to what I know already	.27	ns	2	5	3.6	0.1						
Q19. Determine concepts I don't understand well	8.19	.001	2	5	3.6	1.0	4.3 ab,	0.9	3.0 ab	0.8	3.5	0.8
Q20. Connect the readings and concepts	5.29	.010	2	5	3.8	0.9	4.2 ab	0.9	3.3 ab	0.7	3.5	0.8
Q21. Read notes over and over again	0.34	ns	1	5	2.8	1.1						
Q22. Relate my ideas to what I am reading	0.42	ns	2	5	3.4	1.0						
Q23. Decide what I am supposed to learn from this course	0.42	ns	2	5	3.3	1.0						
Q24. Make good use of study time	3.13	.057	2	5	3.8	1.0	3.7 ac	1.0	3.5 bc	1.1	4.6 ac,bc	0.8
Q25. Give up the difficult parts and study the easy ones	2.85	.071	1	4	2.4	0.9	2.0 ab	0.8	2.7 ab	0.9	2.7	0.8
Q26. Check points of assignment	3.21	.053	2	5	3.8	0.8	4.1 ab	0.6	3.4 ab	.74	3.6	1.0
Q27. Read assignment material	5.23	.011	2	5	3.9	1.0	4.5 ab,ac	0.7	3.5 ab	1.1	3.4 ac	0.8
Q28. Read text	5.74	.007	2	5	3.7	0.9	4.3 ab,ac	0.9	3.3 ab	0.8	3.3 ac	0.8
Q29. Communicate with classmates via chat room	1.98	ns	1	5	3.6	1.2						
Q30. Interact with instructor	12.00	.000	1	5	3.5	1.1	4.5 ab,ac	0.7	3.1 ab	1.0	2.4 ac	0.5
Q31. Reread text to clarify problems	3.09	.059	2	5	3.3	0.9	3.7 ab	0.7	3.0 ab	0.8	3.1	1.1
Q32. Contact instructor to clarify problems	7.54	.002	1	5	3.3	1.0	4.0 ab,ac	0.9	2.8 ab	0.9	3.0 ac	0.6
Use of 'good' strategies	2.60	.090	9	23	18.2	2.6	19.2 ab	1.7	17.1ab	3.2	18.1	2.4
Use of 'bad' strategies	0.27	ns	12	20	15.7	2.1	16.0	2.0	15.4	1.9	15.8	2.8
Good study habits	18.46	.000	17	32	25.5	3.9	28.6 ab,ac	2.2	23.9 ab	2.9	21.7 ac	3.3
Overall superior strategies and habits	8.58	.001	44	66	58.2	5.7	61.9 ab,ac	3.2	55.5 ab	5.9	54.2 ac	4.6

Qns 16-25: 1 = not at all typical; 5 = very much typical. Qns 26-32: 1 = None of the time; 5 = all of the time.
*Only those results that are statistically significant ($p < .05$) or show evidence of trend ($p < .01$) reported with means and standard deviations for each group.
Note: When the one way ANOVA indicated significant differences, the method of least square differences (LSD) was used to detect where the significant ($p < .05$) difference(s) lay, i.e. between 'ab,' the top and middle thirds; 'ac,' top and lowest thirds; and 'bc,' the middle and lowest thirds.

Table III. Learning strategies and study habits of students who excel, pass or fail an online course in scientific writing ($n = 37$).

Results

Demographic Differences

No evidence was found of any demographic differences between the excelling, passing and failing students on age, grade point average, credit load, years at university, hours spent working, hours spent studying, or their background in community (rural–urban), school (private, public or inner city), or with whom they live (see Table I). With the critical caveat that sample size is small and, hence, differences may be masked, no evidence was found that the students in the top, middle, and lower tertiles differed, demographically.

Internet Use Differences

Data on Internet use is analyzed in Table II. Students who excelled in the class reported first using the Internet on average two years earlier than the average students and one year earlier than the

failing students. Similarly, excelling students reported spending significantly more time on the Internet specifically on work-related business. Conversely, there was evidence of a trend that students who excelled in the course spent less time on the Internet communicating with friends and family. Curiously, those who failed also reported spending more time online studying assignments for the course (than the average students). However, total hours spent on the Internet did not differ across the groups, and neither did their rating of their computer skills.

Learning Style Differences

Table III reports the differences in learning style. Here, on 8 out of 21 questions (38%) significant differences were found, and on a further 6 (29%), evidence of a trend was also reported. Thus, major differences in how students study online appeared consistently across the groups, with 13 differences separating the students who excelled from the students who were average, 8 distinguishing the excelling students from the failing students, and 1 separating the average student from the failing student. The top third were significantly more likely than the middle third to state that the following strategies are typical of them: 'trying to find the most important ideas from the reading' (q16), 'determine the concepts s/he doesn't understand well' (q19), and 'connect the concepts s/he doesn't understand well' (q20). Conversely, the top third were significantly *less* likely to rate themselves as: 'make good use of study time' (q24), and 'give up the difficult parts and study the easy parts' (q25). Conversely, the bottom third were significantly less likely to report 'trying to find the most important ideas from the readings' (q16) but more likely to report 'making good use of study time' (q24) than either the moderate group or the top group.

In terms of frequency in study habits, there were also many more significant differences than expected by chance. The top third report doing the following skills significantly more frequently than the middle third: 'check points of assignments' (q26), 'read assignment materials' (q27), 'read the text' (q28), 're-read the text to clarify problems' (q31), 'interact with the instructor' (q30), and 'contact the instructor to clarify problems' (q32). Similarly, the top third reported spending significantly more time than the bottom third to: 'read assignment materials' (q27), 'read the text' (q28); 'to interact with the instructor' (q30), and to 'contact the instructor to clarify problems' (q32).

To investigate what type of study habits coalesce in an online class, we studied the intercorrelations between items on typical study strategies (good or bad), and study style (see Table IV). Item-total correlations inform on what particular study habits correlate strongly with a good overall study strategy. As shown in Table IV, in descending order of strength of correlation, having good study habits ($r = .85$; $p < .001$) and using good study strategies ($r. = 74$; $p < .001$) were most strongly correlated with overall good study, while bad strategies did not significantly correlate. The strongest individual items which correlated with an overall good study strategy were finding the most important ideas from the readings ($r = .69$; $p < .001$), interacting with the instructor online ($r = .67$; $p < .001$), reading the assignment material online ($r = .65$; $p < .001$), and contacting the instructor to clarify problems ($r = .61$; $p < .001$). Moderately correlated items included not giving up on the difficult parts and studying the easy parts instead ($r = -.56$; $p = .001$) and rereading the online text to clarify problems ($r = .45$; $p = .009$). Weakly correlated items that were still significantly related to overall good study strategy included connecting the readings and concepts ($r = .39$; $p = .026$), communicating with classmates via chat rooms ($r = .37$; $p = .034$); checking the points of assignments ($r = .36$; $p = .037$); relating ideas to what the student knows already ($r = .36$; $p = .040$); and relating the student's ideas to the readings ($r = .25$; $p = .047$). Study habits that were not significantly correlated included reading the text ($r = .26$), memorizing key words of important concepts ($r = .20$), making good use of study time ($r = .19$), deciding what to learn from the course ($r = -.18$), determining concepts that the student doesn't understand well ($r = .07$) and reading notes and readings over and over again ($r = -.04$). Regarding inter-item correlations, a measure of what strategies tend to go together, the strongest correlations were between using time well and (a) contacting the instructor to clarify problems ($r = .76$; $p < .001$), (b) interacting with the instructor online ($r = .70$; $p < .001$), (c) reading the assignment material ($r = .68$; $p < .001$), and (d) rereading the text to clarify problems ($r = .60$; $p < .001$). Reading the assignment material was strongly correlated with rereading the text to clarify problems ($r = .60$; $p < .001$) and contacting the instructor to clarify to clarify problems ($r = .61$; $p < .001$). Not surprisingly, interacting with the

instructor was also correlated with contacting the instructor to clarify problems ($r = .60$; $p < .001$), and finding the most important ideas from the reading was strongly correlated with overall good strategies ($r = .66$; $p < .001$). Other weaker associations are presented in Table IV.

		Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Good Strat	Bad Strat	Good Time	Total
Q16. Finding most important ideas from readings	r	.16	.19	.39	.43	.10	.05	-.21	.04	-.45	.21	.51	.27	-.12	.54	.27	.36	.66	.04	.47	.69
	p	.	.	.019	.009	.	.	.	.	.006	.	.002	.	.	.001	.	.029	.000	.	.000	.000
Q17. Memorize key words of important concepts	r	.	.26	-.09	-.07	.10	.23	-.06	-.18	-.44	-.13	.26	.27	.15	-.05	-.01	-.03	.21	.24	.18	.20
	p		.	.	.	.	.	.	.	.007	.	.	.	.	.	.	.	.	.	.	.
Q18. Try to relate to what I know already	r		.	-.28	-.09	.18	.21	-.10	.02	-.19	.06	.46	.05	.08	.10	.13	.17	.47	-.04	.16	.36
	p			.	.	.	.	.	.	.	.	.006	.	.	.	.	.	.005	.	.	.040
Q19. Determine concepts I don't understand well	r			.	.49	.21	-.15	.09	-.08	-.23	.35	.26	-.27	-.20	.31	.29	.26	.13	.55	.29	.07
	p				.003	.	.	.	.	.	.038	.	.	.	.067	.083	.	.	.001	.	.
Q20. Connect the readings and concepts	r				.	.36	-.10	.20	.00	-.14	.18	.46	.27	.02	.22	.30	.29	.46	.42	.47	.39
	p					.037	.	.	.	.	.	.006	.	.	.	.075	.090	.005	.015	.005	.026
Q21. Read notes over and over again	r					.	.053	.03	.16	-.23	.08	.05	.24	.04	-.24	.49	-.07	.31	.59	.05	-.04
	p						.	.	.	.	.	.	.	.	.	.003	.	.076	.000	.	.
Q22. Relate my ideas to what I am reading	r						.	.15	.31	-.18	.23	-.11	.07	.36	-.01	.25	.04	.58	.03	.18	.35
	p							.	.066	.	.	.	.	.033	.	.	.	.000	.	.	.047
Q23. Decide what I am supposed to learn	r							.	.06	.16	-.09	-/06	.10	.24	-.15	.16	.32	.03	.60	.12	-.18
	p								.	.	.	.	.	.	.	.	.061	.	.	.	.
Q24. Make good use of study time	r								..	-.16	.23	-.13	.15	.07	-.05	.12	.05	.51	-.03	-.08	.19
	p									.	.	.	.	.	.	.	.	.002	.	.	.
Q25. Give up the difficult parts and study the easy ones	r									.	-.17	-.31	-.02	-.14	-.38	-.24	-.42	-.41	.03	-.40	-.56
	p										.	.072	.	.	.020	.	.010	.014	.	.018	.001
Q26. Check points of assignment	r										.	.17	-.28	-.03	.24	.23	.40	.34	.01	.38	.36
	p											.	.091	.	.	.	.013	.049	.	.023	.037
Q27. Read assignment material	r											.	-.06	.09	.60	.26	.61	.44	.10	.68	.65
	p												.	.	.000	.	.000	.010	.	.000	.000
Q28. Read text	r												.	.08	.26	.05	.10	.11	.18	.31	.26
	p													.	.	.	.	.	.	.075	.
Q29. Communicate with classmates via chatroom	r													.	.07	.45	.18	.13	.07	.51	.37
	p														.	.006	.	.	.	.001	.034
Q30. Interact with instructor	r														.	.26	.60	.26	-.17	.70	.67
	p															.	.000	.	.	.000	.000
Q31. Reread text to clarify problems	R															.	.46	.37	.46	.60	.45
	p																.004	.030	.006	.000	.009
Q32. Contact instructor to clarify problems	r																.	.29	.10	.76	.61
	p																	.091	.	.000	.000
Use of "good" strategies	r																	.	.15	.46	.74
	p																		.	.007	.000
Use of "bad" strategies	r																			.12	-.22
	p																			.50	.
Good study habits	r																			.	.85
	p																				.000
Overall Superior strategies and habits (Total)	r																				.
	p																				

Table IV. Intercorrelational matrix of learning style and study habit questions.

Discussion

In this online study of students completing an online course in scientific writing, there were clear and consistent differences found between students who excelled, students who passed with an average grade, and students who failed. Placed in Bandura's social cognitive learning theory, students' behavior in two areas, rather than student characteristics or environmental characteristics, predicted success.

First, in terms of Internet use, the students who excelled in this online course appeared more experienced using the Internet, reported using the Internet more on work-related activities, and spent significantly less time socializing on the Internet (see Table II). We speculate that students who work more online are more accustomed to not using the Internet for other purposes, and hence are more focused and efficient in their use of the Internet, while students who work more offline may be more easily distracted by online communications with family and friends.

Second, while no differences were found on demographics and few differences on Internet use, the study habits and strategies of online students consistently differentiated the students who excelled in the course from average students and students who failed.

Students who excelled were more likely to report specific 'good' study habits as typical of them, than either average students or failing students (see Table III). Individual strategies and habits significantly predictive of success include finding the most important ideas from the readings, interacting with the instructor, contacting the instructor to clarify problems, determining the concepts that one does not understand, reading the text, reading the assignment materials, and connecting the readings and concepts. Other habits that may be important to success in an online course include checking points of assignments, rereading the text to clarify problems, not believing

that one is making good use of study time, and not ignoring the difficult parts to study the easy parts.

When added together, both good study strategies and good study habits predicted success, while no difference was found in the use of bad or ineffective strategies. This suggests that the students who are failing are not actively sabotaging their study program, but have inferior study habits while believing they are making superior use of study time.

Taking the results of Internet use and study habits together, students who excel appear more experienced in working online, and have study habits better suited for the online environment (especially identifying and clarifying key ideas, points of assignments, and problem-solving either by rereading the text or contacting the instructor). Second, by interacting with the instructor, it may be easier for a student to contact the instructor as soon as problems are identified.

Students who excelled in the course appeared to use learning strategies which clarify the *process*, help them *focus*, and then *read selectively* what they need to succeed. By contrast, the students who failed possibly spent more time doing assignments, and adopted ineffective strategies such as rereading the easy parts of the text. Thus, they appeared more focused on the *content* rather than the *process* of learning, less likely to ask for help, and less likely to problem solve. Together this could be interpreted as less efficiency in their study habits.

As important as the differences is recognizing what was not found. Since no differences were found between the students in total number of hours worked, total number of hours studied, or total number of hours online, the differences found have to be explained by how students are spending their time online. Marginal/failing students appear to believe they are making good use of study time, but give up on the difficult parts of assignments to study the easy ones.

No evidence was found that memorizing key words or important concepts, relating new concepts to what they know already, relating ideas to the readings, communicating with classmates via chat rooms, determining the key learning objectives, and reading and rereading notes predicted success. It is not possible to determine from this study whether these strategies were simply less appropriate to the content area of the course (scientific writing), to the way the course was graded (primarily on online assignments and chatroom participation), were habits that in a larger study sample might be found to be significant, or indeed, may in reality be less viable strategies for online courses.

The results suggest that students who are successful in online courses study differently and employ different study habits from students who fail. Confirming the successful study habits for online courses is a logical next step to advance research in this area. Teaching students how to use the Internet to *process* the information and to use the online environment efficiently would appear helpful in increasing success in online classes.

There are at least two major weaknesses in this study. First, while the 75% return rate of students who excelled and those who passed is adequate, the differentially low return rate of 35% by the students who failed is problematic. We simply do not know how they are similar to, or different from, the students who did not return evaluations, and, hence, generalization of results is difficult. It is possible that those in the failing group who did not return evaluations significantly differed from those who did, in which case our results only reflect part of the picture.

Second, because of the large number of variables investigated relative to a small class size, any significant findings should be taken as promising areas to investigate further and to be confirmed through replication. These are precisely the type of study results vulnerable to overgeneralization. Hence, we caution other course directors in online scientific writing classes and curriculum developers in other disciplines not to assume that these results are generalizable to their students or courses. Currently, we are conducting a follow-up study of the same course provided to different populations of students (e.g. undergrads, dentistry, nursing and public health students) which may further inform our investigation whether the results presented here are replicable, and the degree of generalization across students that is warranted.

For others considering research of online classes we have several suggestions for future research. First, if we were conducting this study again, we would seek IRB (Institutional Review Board for the Protection of Human Studies) permission to follow up all students, including those who failed and/or dropped out. Second, as an end-of-course evaluation, we collected our data anonymously, with students only identifiable by which third of the grades they accomplished. Collecting the demographic characteristics early in the course and learning styles at multiple times

in the course would permit comparison of those who completed the course with those who dropped out. However, this may also decrease anonymity, which in turn risks biased results. Third, in larger samples, differentiating drop-outs from failing students would be helpful, as these two groups may differ in learning styles and other key variables. Finally, qualitative research, including focus groups of students who excelled, passed, and failed (conducted separately) may be invaluable in providing student perceptions as to why students appear to fare differently in courses online, than offline.

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