

PREDICTION OF LEARNING AND SATISFACTION IN WEB-BASED AND LECTURE COURSES*

RUTH H. MAKI
WILLIAM S. MAKI
Texas Tech University

ABSTRACT

We investigated variables that affect learning and satisfaction in Web-based and lecture versions of introductory psychology courses. Student characteristics, including year in college, college major, and personality characteristics, predicted performance equally well in Web-based and lecture courses. Differences among instructors predicted performance more strongly in lecture courses than in Web-based courses. Enjoyment of class discussion was negatively related to performance in Web-based courses. Several variables increased course satisfaction in both course formats, including lower workload, better scores on examinations, preference for working independently, and knowing what to expect on tests. Instructor and enjoyment of class discussion influenced satisfaction with lecture courses but not Web-based courses. None of the variables that we studied influenced satisfaction in Web-based but not lecture courses. These results suggest that commonly-used readiness questionnaires may not be useful in selecting students who will do well in and be satisfied with technology-mediated courses.

Courses deployed over the World Wide Web (“Web”) are becoming more frequent for both distance education and resident instruction on college campuses. Relative to traditional lecture-test methods, how effective are these Web-based

*The project was supported by a grant from the National Science Foundation to Ruth H. Maki and William S. Maki, “Using Technology to Transform Instruction and Improve Learning in Introductory Psychology” (NSF DUE-9752349).

courses? What individual differences mediate learning and satisfaction in Web-based and lecture courses? Both these questions have been the subject of recent research.

The few studies that have compared the effectiveness of Web-based and lecture formats have resulted in differing outcomes. Sankaran, Sankaran, and Bui (2000) recently reported a study of amount learned in Web-based and lecture versions of an undergraduate business computer course. No significant difference in learning gain from pretest to final examination was found. Wang and Newlin (2000) compared Web-based and lecture sections of a statistical methods course. They found that the Web-based students scored more poorly on the final examination than did lecture students. Hiltz (1993) compared Web-based and lecture versions of several courses (computer science, sociology, mathematics, and statistics). She found equal learning for Web-based and lecture sections in most courses and superior learning in the Web-based computer science course. In our own previous research (Maki & Maki, 2002; Maki, Maki, Patterson, & Whittaker, 2000), we found that students in a Web-based introductory psychology course learned more than students in a standard lecture-test course.

A review of the variations in the designs and implementations of these Web-based courses led to the conclusion that the design of the course (the instructional technology), and not the computerized delivery, produced the differences favoring the Web-based courses (Maki & Maki, 2002; cf. Clark, 1994a, 1994b). We believe that the use of the Web allows instructional designers to produce better learning experiences than possible in traditional lecture classes because deadlines can be easily enforced, students can receive immediate feedback, and learning can be made active. For example, we know that the grading contingencies encourage students to interact more with course material in Web-based than in lecture courses (Taraban, Maki, & Rynearson, 1999).

Level of student satisfaction in Web-based courses (again relative to lecture courses) also varied across the cited studies. Hiltz (1993) found that satisfaction was high in the Web-based courses (but she did not compare satisfaction of Web-based and lecture courses). Wang and Newlin (2000) found fairly equivalent satisfaction. Maki et al. (2000) found lower satisfaction in the Web-based than in the lecture version of introductory psychology, a finding replicated by Maki and Maki (2002). The lower levels of satisfaction in the Web-based course may have occurred because students had to keep up with regular weekly assignments in order to earn course points; students in the Web-based course reported that they worked harder and spent more time on course material than did students in the lecture course (Maki & Maki, 2002). So, like learning, satisfaction probably depends upon the types of activities required in the course.

Learning and satisfaction may also depend upon the characteristics of students enrolled in the Web-based and lecture courses. Hiltz (1993) conducted a series of regression analyses to predict grades and satisfaction in Web-based courses. Higher final grades were received by students who were high in verbal ability (as

measured by the SAT verbal score) and by students who rated the course as convenient. However, with 12 predictor variables, only 14 percent of the variance in grades was explained. Greater satisfaction with the course was predicted by higher convenience ratings, higher ratings for access to the professor, and higher ratings for course involvement. Hiltz (1993) was able to explain 67 percent of the variance in satisfaction ratings with 18 predictor variables. However, she did not examine how well the same variables predicted learning and satisfaction in traditional lecture classes. Wang and Newlin (2000) reported that three variables predicted final grade in the Web-based course: total homepage hits; need for cognition (Cacioppo & Petty, 1982); and locus of control (Rotter, 1966). Students who had a high level of Web-based course activity, who displayed a high degree of inquisitiveness, and who believed that they were responsible for outcomes scored the highest in the Web-based course. However, Wang and Newlin did not report whether inquisitiveness and professed responsibility were also important in the lecture course.

Maki and Maki (2002) investigated the importance of a cognitive variable, namely comprehension skill, in learning and satisfaction in Web-based versus lecture versions of introductory psychology. Maki and Maki first removed variance due to year in college and college major, which may have differed between the two course formats as a result of self-selection. After this variance was removed with regression analyses, comprehension skill interacted with course format. Maki and Maki found the students who were medium or higher in comprehension skill benefited from Web-based courses relative to similar students in lecture courses.

The present study is similar to that of Maki and Maki (2002) except that we were particularly interested in whether student characteristics and prior experience affect satisfaction and performance in Web-based courses. In the first study, predictor variables were instructor and characteristics of students, including college major, year in college, and personality variables. In the second study, we used variables related to questions that are frequently asked on distance-learning readiness questionnaires. We expected that these more specific questions might predict performance and satisfaction differentially for Web-based and lecture courses.

GENERAL METHOD

Design

During each semester for three academic years (1998-1999, 1999-2000, and 2000-2001), we conducted lecture sections and Web-based sections of introductory psychology. During the first two academic years, we had four different instructors, two who taught each semester during 1998-99, and two who taught each semester during 1999-2000. Each instructor taught two Web-based sections

(of about 25 students each) and one lecture section (of about 50 students) in each of two semesters. During 2000-2001, one of the 1999-2000 instructors taught two Web-based sections and one lecture section during fall semester. In Spring 2002, a fifth instructor taught two Web-based sections and one lecture section. All instructors were doctoral students at Texas Tech University. The Web-based sections were marked in the printed schedule by an asterisk indicating that the course included homework to be done on the Web.

In our second study, we used data from the 1999-2000 and 2000-2001 academic years. Because we did not find any clearly different patterns for Web-based and lecture sections in the first year, during the second and third years we added some questions specifically related to variables that are queried on distance readiness questionnaires.

Participants

All participants were enrolled in General Psychology at Texas Tech University. Across the three years, a total of 479 students originally enrolled in the lecture sections and 437 originally enrolled in the Web-based sections. A total of 29 students dropped the lecture sections and 51 students dropped the Web-based sections. Thus, the overall drop rates were 6.1 percent for the lecture sections and 11.7 percent for the Web-based sections.

Procedure

The primary material in all sections was a standard introductory psychology textbook (Kalat, 1996, 1999). Students read approximately one chapter per week. In the lecture sections, classes met three times a week, and the graduate student instructors gave lectures. The graduate students offered review sheets and review sessions for examinations. In the Web-based course, students were required to participate in four types of weekly activities: 1) a preview of the week's chapter via an outline, frequently asked questions, and vocabulary words, all followed by a Web-based quiz over the preview material; 2) Web-based, interactive multiple-choice mastery quizzes, two of which had to be passed at 80 percent or better each week (Maki & Maki, 2001); 3) interactive experimental demonstrations or searches for chapter-related material on the Web; and 4) a weekly class meeting led by the graduate teaching assistant. Activities in the weekly meeting varied during the first year: formal study groups for which students wrote questions and discussed answers; review sessions based on student questions sent via e-mail to the instructors; or demonstration classes in which data from the week's assignment were pooled and discussed. These class activities did not produce learning differences in 1998-1999, and the demonstration classes were the most highly rated, so all Web-based sections in 1999-2001 participated in one mandatory demonstration class each week. Lecture and Web-based students followed the same course calendar and took the same examinations based on the same textbook

material on the same days. Examination questions were taken from the test bank accompanying the textbook. Questions were nominated by the teaching assistants and selected by the faculty instructor. Teaching assistants were instructed to suggest questions that were related to material they had covered in their lectures. The main difference between the formats was in the activities designed to supplement learning from the textbook. In the lecture sections, the supplement was three weekly lectures. In the Web-based sections, this supplement consisted of activities delivered via the Web, plus one weekly class session.

A questionnaire including the predictor variables was given to students in both types of courses during the first week of classes. A second questionnaire including the outcome variables was given during the last week of classes. For additional procedural details, see Maki and Maki (2002).

STUDY 1: ANALYSIS OF 1998-2000 DATA

Data from the 1998-99 academic year were combined with data from the 1999-2000 academic year. First, we investigated differences in predictor variables in order to determine whether different types of students sign up for Web-based and lecture courses. Wang and Newlin (2000) reported that the Web-based students had a more external locus of control than lecture students, so we expected that we also might have different types of students in the two course formats. Next, we used regression analyses to predict variance in examination performance, learning as measured by increases in performance on difficult content questions, and satisfaction. Predictor variables included course format (Web-based vs. lecture), course instructor, year in college, college major, and personality characteristics.

Participants

A total of 302 students completed the Web-based courses, and a total of 357 students completed the lecture courses in 1998-2000.¹ Not all students completed both the pre-course and the post-course questionnaire. For each analysis reported below, we used data from all students for whom we had values for each variable used in the analysis. The number of subjects used in each analysis is given at the bottom of each table.

¹The results published in Maki et al. (2000) were from the 1998-99 offerings of the course. In that article, we investigated differences in performance and satisfaction between lecture and Web-based sections, but we did not attempt to identify individual difference variables that might have predicted such differences. For the present first study, we have reanalyzed the data from 1998-1999, along with data from the 1999-2000 academic year. Combining the data across two years gave us more participants and also allowed us to use four rather than two instructors in regression analyses.

Dependent Measures

Examination Scores

In each lecture and Web-based section, students took four midterm examinations, each covering about 3-4 textbook chapters. During each semester, the examinations were the same for lecture and Web-based students. Examinations consisted of about 40 multiple-choice questions, mostly selected from the test bank associated with the textbook. None of the questions used on examinations had occurred in the mastery quizzes for Web-based sections (Maki & Maki, 2001), although those questions were selected from the same test bank that accompanied the textbook.

Content Questions

We used post-course scores on 40 difficult multiple choice questions (3-4 questions related to each textbook chapter) to measure learning of general psychology content. These questions are publicly disclosed practice questions from previously administered GRE tests (Educational Testing Service, 1994). Students answered these questions twice, once at the beginning of the course and once at the end.

Satisfaction

At the end of the course, students responded to “I would recommend the section of introductory psychology that I took to a good friend” and “If I were to sign up for introductory psychology again, I would sign up for the same section.” They answered each of these questions on a 5-point scale ranging from 1 = *strongly disagree* to 5 = *strongly agree*. We averaged responses to create a satisfaction score for each student.

Predictor Variables

The predictor variables for Study 1 are shown in Table 1. First, we asked whether students who signed up for the Web-based and lecture sections differed on these variables. Table 2 shows the distribution of majors in the two class formats. A chi-square indicated that the distribution of majors was significantly different in the Web-based and lecture sections, $\chi^2(5) = 22.92, p < .05$ (the significance level used for all statistical tests). Majors that were over-represented in the Web-based sections were business, humanities, and science and technology. Majors that were over-represented in the lecture sections were pre-professional and undecided. Table 3 also shows the distribution by college class. There were more freshmen in the lecture sections than in the Web-based sections, $\chi^2(1) = 15.79$.

Next, we conducted analyses of variance (ANOVAs) on the means for Big Five factors for the lecture and Web-based classes to determine whether different

Table 1. Predictor Variables for the Regression in Study 1

Variable	Description	Coding for regression
Pre-course content	40 publicly disclosed multiple-choice questions from the practice test for the Psychology Graduate Record Examination (GRE; Educational Testing Service, 1994).	One continuous variable
Course format	In each of 4 semesters in 1998-2000, students signed up for one of 4 Web-based sections of 25 students each or one of 2 lecture sections of 50 students each.	One dichotomous variable ^a
Semester/Section time	Fall or spring semester; instructor's first or second Web-based section that semester. With instructor, removes class cohort variance.	Two dichotomous variables (time coded as 0 for lecture)
Instructor	Four instructors, one male and one female in each academic year. Each taught 2 Web-based and 1 lecture section per semester.	Three dichotomous variables: academic year, instructor 1 vs. instructor 2, instructor 3 vs. instructor 4
Year in college	Taken from official class lists. Categorized as freshman and above because there were few students at each level above freshman.	One dichotomous variable
Student major	Identified from official class lists. Six categories: humanities (English, history, languages); <i>social sciences</i> (mass communication, exercise and sports sciences, human development, psychology, and elementary education); <i>pre-professional</i> (pre-medical, pre-dental, pre-physical therapy, other health professions, nursing, architecture, and pre-law); <i>science and technology</i> (biological and physical sciences, engineering, math, and computer science); <i>business</i> (College of Business Administration, agribusiness and agricultural economics); and <i>undecided</i> .	Five dichotomous variables (major) vs. other: Humanities Social sciences Pre-professional Science/technology Undecided
Big Five	Taken from the International Personality Pool (Goldberg, 1999). <i>Extraversion</i> , <i>agreeableness</i> , <i>conscientiousness</i> , <i>emotional stability</i> , and <i>intellect or imagination</i> [similar to openness to experience in McCrae and Costa's (1987) Big Five descriptors]. Students indicated the accuracy of 10 phrases (e.g., am the life of the party) as descriptors of themselves on a 5-point scale (very inaccurate to very accurate) for each factor.	Five continuous variables
Workload	Response on a 5-point scale of agreement to "I had to work harder in this class than in my other classes." Response to number of hours per week spent on the class with responses varying from 1 to 10.	Two continuous variables

^aAll dichotomous variables were coded as +1 and -1.

Table 2. Percent of Students Classified by Major Areas and Year in School in Web-Based and Lecture Sections in the 1998-2000 Sample

	Web-Based Sections	Lecture Sections
College majors		
Business	14.80	10.20
Humanities	8.22	6.91
Pre-professional	23.68	34.54
Psychology/Social Science	26.32	26.97
Science/technology	17.10	10.20
Undecided	9.87	19.41
Year in college		
Freshmen	53.62	69.00
Sophomore and above	46.38	31.00

types of students signed up for the two types of courses. Data were analyzed with class as the unit of analysis to remove any class cohort effects, following the recommendation of Peckham, Glass, & Hopkins (1969).² Table 3 shows mean scores for each of the Big Five characteristics. None of the differences between lecture and Web-based sections was significant, $F(1, 22) \leq 3.19$, $MSE = 0.040$, suggesting that students who signed up for Web-based and lecture sections of introductory psychology were similar on Big Five personality characteristics.

The last two rows of Table 3 show that students in the online sections reported working harder in the online course than in the lecture class, as measured at the end of the semester. An ANOVA using class means showed significantly higher agreement ratings to the statement "I had to work harder in this course than in my other courses" for Web-based than for lecture students, $F(1, 16) = 11.95$, $MSE = .076$. A similar analysis with estimated time spent on the course showed a similar trend, although the longer estimates for the Web-based than for the lecture course were short of conventional significance levels, $F(1, 16) = 3.60$, $MSE = .338$, $p < .10$.

²In contrast to the recommendation of Peckham et al. (1969), Hopkins (1982) recommended that individuals be used as the unit of analysis with classifying variables included in the analysis. We report each analysis involving class sections using class means as the unit of analysis. However, we also conducted each analysis using participants as the unit of analysis, including semester and instructor, and we found similar results. These variables uniquely identify each class for the lecture sections. However, because each instructor taught two smaller Web-based classes each semester, semester and instructor do not uniquely identify classes for the Web-based sections. In the regression analyses, we extracted the variance due to specific classes for both Web-based and lecture sections.

Table 3. Mean Scores and Standard Deviations for the Predictor Variables for Students in Web-Based and Lecture Sections, 1998-2000

Predictor variable	Web-based sections		Lecture sections	
	Mean	SD	Mean	SD
Big Five Scales^a				
Extraversion	3.42	0.17	3.39	0.14
Agreeableness	4.01	0.20	4.06	0.15
Conscientiousness	3.61	0.23	3.50	0.12
Emotional stability	3.36	0.23	3.20	0.13
Intellect	3.68	0.16	3.64	0.06
Perceived workload				
Worked harder ^a	3.25	0.29	2.78	0.24 ^b
Time spent, hours/week	3.89	0.62	3.34	0.49

^aMeans on a 5-point rating scale of agreement with 1 = "Strongly disagree" and 5 = "Strongly agree."

^bWeb-based sections gave significantly higher ratings than lecture sections.

Results and Discussion

In order to understand what variables influenced performance and satisfaction of students in the Web-based and lecture sections, we conducted regression analyses. A description of the coding for each variable is given in the right column of Table 1. Because we were specifically interested in whether each of these variables predicted differentially for the Web-based and lecture sections, we created an interaction term for each predictor variable with course format. In order to ensure that interactions were interpretable, we followed the recommendation of Aiken and West (1991) to center each predictor variable around zero by subtracting the mean for the variable from each score. We then multiplied these centered scores by the code for course format. If a variable predicted variance differentially for the lecture and Web-based courses, we expected to find that the interaction between course format and that variable would produce a significant change in R^2 .

The rationale for the order of variables for the hierarchical regression was as follows. Pre-course measures of the dependent variable, if available, were entered first to equate students at the beginning. Variance related to course format was removed to verify differences in the Web-based and lecture courses. Next, variance due to semester, class time, and instructor was extracted to control for class cohort effects. Instructor was also of interest because Williams and Ceci (1997) showed that students had more favorable opinions about all aspects of a

course when they preferred the instructor. Furthermore, Stringer and Irwing (1998) concluded that teaching quality explained 42 percent of the variance in overall course evaluations. We also entered the interaction of course format and instructor, expecting instructor to play a larger role in lecture sections than in Web-based sections. Variance related to year in college and major was removed next, each followed by its interaction with course format. Finally, we entered scores on the Big Five scales and their interactions with course format. We hypothesized that conscientiousness might be particularly important in the Web-based course because doing work on time is so important for success in this type of course.

Examination Performance and Learning

The results of the hierarchical regression for the mean score on four midterm examinations are shown in the left side of Table 4 with significant effects in bold. Each row shows the R^2 for the model, the R^2 Change for the added variable, the standardized beta coefficients (when they are meaningful), and the degrees of freedom for R^2 Change. Scores on the content questions at the beginning of the course were entered first to control for pre-course psychology knowledge.

The variables explained about 29 percent of the variance in examination scores, with each Model R^2 explaining significant variance. Course format accounted for significant variance in the examination scores, although the amount was small (about 2 percent). The unadjusted means for the two types of courses were 71.92 percent correct in the Web-based course and 68.93 percent correct in the lecture course. Neither instructor nor the interaction of instructor and course format added significant variance to the model. Year in college yielded a significant increment in R^2 with more advanced students performing better than freshmen, but this did not interact with course format. Major accounted for about a significant amount of variance in performance. Students who were majoring in humanities and science and technology performed better than other students. Again, however, this effect did not interact with course format. The Big Five personality scales added a significant increment in variance. The beta weights show that introverted students and those who were more intellectual and imaginative did better on examinations, but this was not differential for the two types of course formats.

A similar regression analysis (shown on the right side of Table 4) was conducted for learning as measured by performance on the difficult content questions at the end of the course. The same variables were entered in the same order as in the analysis of examination performance. The variables predicted 30 percent of the variance. Performance on the difficult content questions at the beginning of the course predicted significant variance. Course format also explained significant variance with students in the Web-based courses performing better ($M = 34.53$ percent) than students in the lecture courses ($M = 30.73$ percent). Again, neither

instructor nor the interaction of instructor and course format predicted significant variance. In contrast to the analysis with the class midterm examinations, year in college and major did not explain a significant amount of variance. The Big Five scores predicted learning showing the same pattern as for examination scores. Introverted students learned more and students who are higher in intellect and imagination learned more, but, again, this did not interact with course format.

Satisfaction

We conducted a similar regression analysis for course satisfaction. We collected satisfaction data anonymously during the Fall 1998, so we were unable to use those data in the regression analyses. The 341 students for whom we had identifiable pre-course and post-course data were used in the analysis, shown in Table 5. Overall, we explained about 25 percent of the variance. First, we extracted a significant amount of variance related to course format. Satisfaction ratings in the Web-based courses ($M = 3.49$) were lower than ratings in the lecture courses ($M = 3.99$). Next, variance associated with specific class, with specific instructor, and with the interaction of course format and instructor was removed. Instructor accounted for significant variance. Although instructor and course format did not interact overall, the two instructors during the second academic year did produce an interaction with course format. Instructor produced a significant change in R^2 (.069) in the lecture sections, but not in the Web-based sections (R^2 Change = .028).

At the next step, we extracted variance associated with workload because Greenwald and Gillmore (1997) found that satisfaction ratings were influenced by perceived workload although these were mediated by expected grade. Marsh and Roche (2000) argued that grades are much more important than workload. We entered the variables in two orders: perceived workload followed by midterm examination scores; and examination scores followed by perceived workload. If grades mediate the effects of perceived workload, then workload should have an effect on satisfaction when workload is entered before examination scores, but not when examination scores are entered before workload. As can be seen in Table 5, workload accounted for a significant increment in variance when it was entered before examination scores. Specifically, students who thought they had to work harder in the course relative to other courses were less satisfied than those who thought they had to work less hard, but this did not interact with course format. Examination performance also added a significant increment in variance in satisfaction scores with students who performed better on examinations being more satisfied than students who performed less well. When workload was entered after examination scores, it did not produce a significant increment in variance (R^2 Change = 0.006), but examination scores produced a significant increment in R^2 (0.100) when they were entered before workload. None of the other student

Table 5. Prediction of Satisfaction in the Web-Based and Lecture Courses, 1998-2000

Predictor	R^2	R^2 change	df change	Beta
Course format	.033	.033^a	1	-.183^b
Semester/(Class time)	.034	.001	2	
Instructor	.057	.023^a	3	
Instructor X format	.073	.015	3	
Workload	.105	.032^a	2	
Worked harder				-.180^b
Time spent				-.020
Workload X format	.108	.003	2	
Examination performance	.182	.074^a	1	.302^b
Performance X format	.188	.006	1	
Year in college	.193	.005	1	.077
Year X format	.194	.001	1	
Major	.212	.018	5	
Major X format	.222	.011	5	
Big Five	.242	.019	5	
Big Five X format	.252	.010	5	

$N = 341$

^aSignificant increment in variance, $p < .05$.

^bSignificant *beta* in model at each step, $p < .05$.

Note: **Bold** signifies significantly different from 0, $p < .05$.

characteristics added significant increments in variance, and these variables did not interact course format.

We predicted significant amounts of variance in satisfaction. Course format influenced satisfaction, with students preferring the lecture course. Instructor influenced satisfaction, but there was some suggestion that it was more influential in the lecture sections. Both perceived workload and examination scores influenced the satisfaction supporting Marsh and Roche (2000), but workload was mediated by examination scores (and, presumably, expected grade). However, Marsh and Roche reported that the correlation between perceived workload

and satisfaction is generally positive; we found a negative relation. Students who thought the courses were more work were less satisfied.

Summary of the 1998-2000 Regression Analyses

Students learned more in the Web-based sections than in the lecture sections, but they were less satisfied, replicating Maki et al. (2000). Instructor played some role in both learning and satisfaction, and there was some evidence that instructors were more influential in satisfaction in lecture courses than in Web-based courses. Students who were more advanced than freshmen, who were humanities or science and technology majors, who were introverted, and who were more intellectual did better than other students on examinations, but this was not differential for Web-based and lecture courses. Those variables did not affect satisfaction, although scores on examinations and workload, mediated by examination scores, did influence satisfaction. Our goal of being able to prescribe which type of student should enroll in which type of course was not attained with this set of predictor variables.

STUDY 2: ANALYSIS OF 1999-2001 DATA

During the second and third academic years (1999-2001), we included some questions on our pre-course and post-course surveys that were designed to discriminate between Web-based and lecture sections. These questions were adapted from distance-readiness questionnaires that can be found on distance learning Web sites (e.g., University of Washington, Texas Tech University). We thought that we might increase differences in predictability between Web-based and lecture courses by using specific questions that are presumably related to success in Web-based classes. In addition, we added a question about satisfaction to both the pre-course and post-course questionnaires. Satisfaction has been consistently higher in our lecture than in our Web-based courses (Maki et al., 2000), but students who enroll in our lecture sections may be generally more satisfied with all their courses than those who enroll in Web-based sections. If this is true, then removing the variance associated with expected satisfaction in the beginning of the semester from satisfaction ratings at the end of the semester should eliminate the Web-based and lecture difference. Thus, we collected pre-course and post-course ratings of expected and actual liking for the class.

Participants

A total of 258 students completed the Web-based sections in 1999-2001 and 276 students completed the lecture courses.³ Not all students completed the

³About one-third of the students in this study participated in the Maki and Maki (2002) study. A total of 94 students in the lecture courses and 95 students in the Web-based courses had volunteered to come to the laboratory to be tested on a comprehension test. Maki and Maki (2002) used this measure of comprehension skill to predict the same outcome measures as in the present study.

pre-course and post-course surveys. We used subjects from whom we had complete data in each regression analysis. Number of subjects included is at the bottom of each table.

Dependent and Predictor Variables

During the second and third academic years, we conducted two regression analyses. The first used the mean grade on the four midterm examinations as the dependent variable. The second used responses on a 5-point agreement scale to the question "I liked my psychology class."

The predictor variables are described in Table 6. Pre-course content knowledge, as measured by scores on the difficult GRE practice questions (Educational Testing Service, 1994), and expected course liking, as measured by agreement with "I will like my psychology class," were the first predictor variables. Next, course format (Web-based vs. lecture) was entered into our regressions. The three instructors, as described in Table 6, were the next predictors. Each instructor taught about an equal number of students in Web-based and lecture courses each semester. The remainder of the predictor variables, described in Table 6, was modeled on questions that are commonly used in distance-readiness questionnaires. Enjoyment of class discussion might be important because face-to-face discussion does not occur in Web-based courses. To tap into commonly asked questions about students' comfort levels with computers, we asked students to respond to a computer anxiety scale (Cohen & Waugh, 1989) and to report their frequency of e-mail and Web use. Other questions that are common on distance-readiness questionnaires ask about organization ability and the ability to work independently. We included the four questions described in Table 6 to tap into these characteristics. Finally, at the end of the semester, we asked students whether they knew what to expect on tests. A complaint in earlier versions of the Web-based course was that students didn't know what to expect on tests. Some students wanted more interaction with a lecturer, not because they learned better from lectures, but because lectures guide their test expectancies. For these offerings of the Web-based course, students received an e-mail review of topics before each test, so they should have known what to expect. In addition, the mastery quizzes in the Web-based sections were taken from the same test bank as the test questions (although they were different questions). Web-based students and lecture students actually reported fairly similar agreement with the statement "I knew what to expect on tests" ($M = 3.80$ for Web-based students and $M = 3.65$ for lecture students). Using class means as the unit of analysis, this difference was not significant, $F < 1$.

Results and Discussion

Regression analyses were conducted on the Web-based and lecture data for the mean performance on the four examinations and for the satisfaction measure

Table 6. Predictor Variables for the Regression in Study 2

Variable	Description	Coding for regression
Pre-course content or expected liking	40 multiple-choice questions (GRE; Educational Testing Service, 1994) or agreement with "I will like my psychology course."	Continuous variable
Course format	Same as Study 1	Same as Study 1
Instructor	Three instructors, one male and one female (instructors 3 and 4) taught fall and spring semester in 1999-2000. The male also taught fall semester of 2000-2001. A third male instructor taught in spring semester 2000-2001. Each instructor taught 2 Web-based and 1 lecture section per semester. Because variance due to instructor was confounded with semester and year, we removed this variance before the semester/section time variance.	Two dichotomous variables: instructor 3 vs. instructor 4; instructor 5 vs. 3 and 4 combined.
Academic Year/Semester/Section time	Fall or spring semester; instructor's first or second Web-based section that semester. With instructor, removes class cohort variance.	Two dichotomous variables (time coded as 0 for lecture)
Class discussion	Responses on a 5-point scale of agreement to "I enjoy class discussions."	One continuous variable
Computer experience	Computer anxiety—Responses on a 5-point scale of agreement to 16 items, such as "I feel anxious when working with computers." E-mail use—Response to "How much have you used e-mail" on a 5-point scale varying from "Never" to "Very Often." WWW-use—Responses to "How often have you used the World-Wide Web to find information" on a 5-point scale varying from "Never" to "Very Often."	Three continuous variables
Organization	Responses to "How would you rate your organizational abilities?" on a 5-point scale varying from "Much worse than average" to "Much better than average."	One continuous variable
Independence	Responses on a 5-point agreement scale to "I am comfortable working independently," "I need to have instructors remind of assignments," and "I am willing to ask for help when I need it."	Three continuous variables
Expect tests	Responses on a 5-point agreement scale to "I usually knew what to expect on tests in this course."	One continuous variable

^aAll dichotomous variables were coded as +1 and -1.

(liked course). Variables were entered in the following order: pre-course measure, instructor, year/semester/specific class time (to remove class cohort variance), preference for class discussion, computer experience, organization, independence, knowledge of what to expect on tests, and examination scores (for the satisfaction measure).

Examination Performance

The regression analysis for the mean scores on the four midterm examinations is shown in Table 7. We were able to explain about 46 percent of the variance. Beginning knowledge explained significant variance. Course format also explained significant variance with higher examination scores in the Web-based than in the lecture sections. Instructor did not explain significant variance, but its interaction with course format produced a significant increment in variance. For the lecture sections, instructor produced a significant increment in variance, but the increment was not significant in the Web-based course. The interaction of enjoyment of class discussions and course format was also significant. Students who enjoy class discussion *less* did significantly better than those who enjoy it more in the Web-based course, but the opposite was true in the lecture courses (although this effect was not significant). Computer experience related to course performance in that students who were less anxious and those who used the Web less did better than more anxious students and those who used the Web more. These effects did not interact significantly with course format, so they must have more related to general characteristics of students than to specific skills needed in the Web-based course. Student independence was related to performance; students who like to work independently performed better in both course formats than those who prefer less independent work. Finally, students who knew what to expect on tests performed better than those who rated this item lower, but this was true about equally for Web-based and lecture sections.

Liking the Course

The regression for how much students liked the course is shown in Table 8. First, we entered the ratings for how much students expected to like the course. Then, we entered the same variables as for the analysis of examination scores. Finally, we included scores on examinations and their interaction with course format as predictor variables. We were able to explain about 34 percent of the variance. Expected liking accounted for significant variance. Course format produced a significant increment in variance with the Web-based course being liked less than the lecture course. Instructor added a significant increment in variance, but it also interacted with course format. Instructor produced a significant increment in variance in the lecture course, but not in the Web-based course. Liking class discussion interacted with course format, such that liking class discussion produced a significant increment in variance in the lecture course, but

Table 7. Prediction of Examination Scores for the 1999-2001 Sample

Predictor	R^2	R^2 change	df change	Beta
Beginning content scores	.149	.149^a	1	.386^b
Course format	.181	.032^a	1	.178^b
Instructor	.190	.009	2	
Instructor X format	.224	.034^a	3	
Lecture		(.075^a)		
Web-based		(.011)		
Year/Semester/(Class time)	.263	.039^a	3	
Class discussion	.264	.001	1	-.040
Class discussion X format	.276	.012^a	1	
Lecture		(.007)		.085
Web-based		(.019^a)		-.153^b
Computer experience	.308	.031^a	3	
Computer anxiety				-.148^b
E-mail use (pre-course)				.081
WWW use (pre-course)				-.170^b
Comp. Experience X format	.318	.010	3	
Organization ability	.324	.006	1	.076
Organization X format	.324	.000	1	
Independence	.317	.048^a	3	
Work Independently				.236^b
Ask for help				.061
Instructor remind me				.039
Independent X format	.384	.012	3	
Expect tests	.462	.078^a	1	.314^b
Expect tests X format	.462	.000	1	

N = 344

^aSignificant increment in variance, $p < .05$.^bSignificant beta in model at each step, $p < .05$.**Note:** **Bold** signifies significantly different from 0, $p < .05$.

Table 8. Prediction of "Liked Class" for the 1999-2001 Sample

Predictor	R^2	R^2 change	df change	Beta
Expected course liking	.064	.064^a	1	.253
Course format	.099	.035^a	1	-.189
Instructor	.144	.045^a	2	
Instructor X format Lecture Web-based	.166	.022^a (.202^a) (.006)	2	
Year/Semester/(Class time)	.176	.010	3	
Class discussion	.187	.011^a	1	.114
Class discussion X format Lecture Web-based	.206	.019 (.095^a) (.001)	1	.315^b -.009
Computer experience	.215	.009	3	
Comp. Experience X format	.221	.005	3	
Organization ability	.222	.001	1	-.038
Organization X format	.222	.000	1	
Independence Work Independently Ask for help Instructor remind me	.248	.026^a	3	.152^b .028 -.068
Independent X format	.262	.014	3	
Expect tests	.319	.058^a	1	.267^b
Expect tests X format	.322	.003	1	
Examination scores	.335	.013^a	1	.147^b
Exam scores X format	.336	.001	1	

N = 344

^aSignificant increment in variance, $p < .05$.

^bSignificant *beta* in model at each step, $p < .05$.

Note: **Bold** signifies significantly different from 0, $p < .05$.

not in the Web-based course. Students who like class discussion liked their lecture class more than did students who like class discussion less. Computer experience and organization ability did not explain significant variance. Students who like to work independently, those who knew what to expect on texts, and those who did better on tests liked their class more than did other students. However, none of these variables interacted with course format.

GENERAL DISCUSSION

In the present research, we inquired about student characteristics that may be related to differential learning and satisfaction in Web-based relative to lecture courses. In the introduction to this report, we noted that previous studies produced conflicting results, possibly because of methodological problems (e.g., measurements taken in one type of course but not in the other). To provide a more definitive answer to the question about student characteristics, we collected data on student characteristics in both Web-based and lecture versions of a general psychology course. In Study 1, we examined academic variables (major, year in school), perceived workload, and personality variables (extraversion, agreeableness, conscientiousness, emotional stability, and intellect or imagination). In Study 2, we examined characteristics often thought to be related to success in distance learning: computer experience (computer anxiety, Web use), preferences for class discussion, preferences for working independently, and self-rated organizational ability.

For the most part, we discovered that many of the variables we studied are correlated with learning and/or satisfaction in *both* Web-based and lecture courses. Indeed, the variables in our regression analyses accounted for significant percentages of variance in learning and satisfaction (ranging from about 25 percent to over 45 percent). However, with few exceptions, these variables did not differentially predict learning and satisfaction in the two types of course. The variables that were significantly associated with better learning and greater satisfaction are listed in Table 9. The specific instructor tended to be associated with both better learning and greater satisfaction but only in the lecture course. Enjoyment of class discussion was related to greater satisfaction in the lecture course, but related negatively to better learning in the Web-based course. Otherwise, all the variables listed in the left column of Table 9 did not differentially predict learning and satisfaction.

The general lack of interactions between course format and student characteristics stands in sharp contrast to the interactive effects of measured comprehension skill and course format on learning and performance outcomes. Maki and Maki (2002) found that students in the Web-based course who scored highly on a test of multimedia comprehension skills learned more and performed better than did students who scored less well in terms of comprehension skill. Students' learning and performance in the lecture course were both poorer than in the

Table 9. Variables Associated with Learning and Satisfaction in Web-Based and Lecture Courses

Both lecture and Web-based	Lecture only	Web-based only
Associated with better learning		
More initial knowledge	Specific instructor (varied depending upon instructor)	Don't enjoy class discussion
Sophomore or higher		
Humanities or science/ technology major		
Introverted or intellectual		
Lower computer anxiety		
Less use of WWW at course beginning		
Preference for working independently		
Knowing what to expect on tests		
Associated with greater satisfaction		
Lower workload	Specific instructor	[No variables predicted satisfaction in Web-based but not lecture courses]
Better scores on exams	Enjoy class discussion	
Expected liking of course		
Preference for working independently		
Knowing what to expect on tests		

Web-based course and were not influenced as much by comprehension skill. Importantly in the present context, the same results were not obtained when self-reported comprehension skill was used as a predictor variable.

We perceive two implications of the present findings. First, self reports, be they personality tests or estimates of one's abilities or expressed preferences for work styles, appear to do little to distinguish between course formats with respect to student learning and satisfaction. It remains an open question as to whether this appraisal generalizes to other self-reports (e.g., of thinking, learning, and cognitive

styles; Sternberg & Zhang, 2001). But at present there appears to be little reason to use the self-report measures considered here to advise students about their likelihood for success in different course formats. The present readiness surveys on distance learning Web sites may measure student characteristics generally associated with academic success while failing to measure abilities and experiences specifically associated with success in a technology-mediated course. Thus, the second implication of our findings (as contrasted with those from Maki & Maki, 2002) is that measuring cognitive abilities is likely to be more fruitful than measuring self-reported preferences in identifying students who benefit more from one course format than another.

REFERENCES

- Aiken, L. S., & West, S. G. (1991). *Multiple regression: Testing and interpreting interactions*. Newbury Park, CA: Sage Publications.
- Cacioppo, J. T., & Petty, R. E. (1982). The need for cognition. *Journal of Personality and Social Psychology*, *42*, 116-131.
- Clark, R. E. (1994a). Assessment of distance learning technology. In E. L. Baker & H. F. O'Neil, Jr. (Eds.), *Technology assessment in education and training*. Hillsdale, NJ: Lawrence Erlbaum Associates.
- Clark, R. E. (1994b). Media will never influence learning. *Educational Technology Research & Development*, *42*, 21-29.
- Cohen, B. A., & Waugh, G. W. (1989). Assessing computer anxiety. *Psychological Reports*, *65*, 735-738.
- Educational Testing Service. (1994). *GRE: Practicing to take the psychology test* (3rd ed.). Princeton, NJ: Educational Testing Service.
- Goldberg, L. R. (1999). A broad-bandwidth, public-domain, personality inventory measuring the lower-level facets of several five-factor models. In I. Mervielde, I. J. Deary, F. De Fruyt, & F. Ostendorf (Eds.), *Personality psychology in Europe* (Vol. 7, pp. 7-28). Tilburg, The Netherlands: Tilburg University Press. [Web-based]. Available: (<http://ipip.ori.org/ipip/appendixa.htm#Appendix A>).
- Greenwald, A. G., & Gillmore, G. M. (1997). No pain, no gain? The importance of measuring course workload in student ratings of instruction. *Journal of Educational Psychology*, *89*, 743-751.
- Hiltz, S. R. (1993). Correlates of learning in a virtual classroom. *International Journal of Man-Machine Studies*, *39*, 71-98.
- Hopkins, K. D. (1982). The unit of analysis: Group means versus individual observations. *American Educational Research Journal*, *19*, 5-18.
- Kalat, J. W. (1996). *Introduction to psychology, 4th edition*. Pacific Grove, CA: Brooks/Cole.
- Kalat, J. W. (1999). *Introduction to psychology, 5th edition*. Pacific Grove, CA: Brooks/Cole, Wadsworth.
- Maki, R. H., Maki, W. S., Patterson, M., & Whittaker, P. D. (2000). Evaluation of a Web-based introductory psychology course: 1. Learning and satisfaction in Web-based versus lecture courses. *Behavior Research Methods, Instruments, & Computers*, *32*, 230-239.

Maki, W. S., & Maki, R. H. (2001). Mastery quizzes on the Web: Results from a Web-based introductory psychology course. *Behavior Research Methods, Instruments & Computers, 33*, 212-216.

Maki, W. S., & Maki, R. H. (2002). Multimedia comprehension skill predicts differential outcomes of Web-based and lecture courses. *Journal of Experimental Psychology: Applied, 8*, 85-98.

Marsh, H. W., & Roche, L. A. (2000). Effects of grading leniency and low workload on students' evaluations of teaching: Popular myth, bias, validity, or innocent bystanders? *Journal of Educational Psychology, 92*, 202-228.

McCrae, R. R., & Costa, P. T., Jr. (1987). Validation of the five-factor model of personality across instruments and observers. *Journal of Personality and Social Psychology, 52*, 81-90.

Peckham, P. D., Glass, G. V., & Hopkins, K. D. (1969). The experimental unit in statistical analysis. *Journal of Special Education, 3*, 337-349.

Rotter, J. B. (1966). Generalized expectancies for internal versus external control of reinforcement. *Psychological Monographs, 80* (1, Whole No. 609).

Sankaran, S. R., Sankaran, D., & Bui, T. X. (2000). Effect of student attitude to course format on learning performance: An empirical study in Web vs. lecture instruction. *Journal of Instructional Technology, 27*, 66-73.

Sternberg, R. J., & Zhang, L. (Eds.) (2001). *Perspectives on thinking, learning, and cognitive styles*. Mahwah, NJ: Erlbaum.

Stringer, M., & Irwing, P. (1998). Students' evaluations of teaching effectiveness: A structural modeling approach. *British Journal of Educational Psychology, 68*, 409-426.

Taraban, R., Maki, W. S., & Rynearson, K. (1999). Measuring study time distributions: Implications for designing computer-based courses. *Behavior Research Methods, Instruments, & Computers, 31*, 263-269.

Wang, A. Y., & Newlin, M. H. (2000). Characteristics of students who enroll and succeed in psychology Web-based classes. *Journal of Educational Psychology, 92*, 137-143.

Williams, W. M., & Ceci, S. J. (1997, September/October). "How'm I doing?" Problems with student ratings of instructors and courses. *Change, 29*, 12-23.

Direct reprint requests to:

Dr. Ruth H. Maki
 Department of Psychology
 Texas Tech University
 Lubbock, TX 79409-2051
 e-mail: ruth.maki@ttu.edu