



An evaluation of web enhanced instruction in college level biology courses

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Websites that accompany science courses typically aim to provide easy access to learning materials, and to facilitate student-instructor communication. We tested whether these aims were achieved in two web enhanced, lower division undergraduate biology courses in an Israeli college. We collected data on the students' attitudes through pre- and post-course questionnaires, monitored their usage of the course websites, and related these data to the students' final course grades.

The students ($n=96$) accessed the websites frequently and regularly, and regarded them as important sources of information. About 47% of the students reported an increased level of general interest in the courses due to the websites. Students mainly downloaded lecture slides and exercise forms from the websites, but did not use the sites to communicate among themselves, or with the instructor. Final course grades were not correlated with the frequency of usage of the website. Female students had a more positive pre-course attitude towards the websites as compared with male students. However, there was no difference between men and women in usage of the course websites, and in achievement levels.

We conclude that the website component of the courses in our study facilitated delivery of learning materials and individual study, but not the social aspects of learning. We suggest that effective design of web enhanced courses can overcome this limitation by stressing social interactions and group learning during face to face sessions.

Introduction

The rapid advance of Internet technology is creating exciting opportunities and challenges for teachers at all levels (Bates, 1999; Levenberg & Major, 1998; Schifter, 2000; Van Dusen, 1997). Web enhanced instruction has become standard practice in most institutions of higher learning in Western

countries (Allen & Seaman, 2003; Waits & Lewis, 2003). Courses that are completely online are relatively rare, however, particularly in the natural sciences (US Department of Education, 1999). This tendency may be due to several reasons. First, many science courses include laboratories and/or field trips that cannot be easily replaced by distance learning. Secondly, these courses are typically very discipline oriented, and do not aim to train students in distance learning skills. Instructors may feel that spending time on teaching such skills is not a top priority in science courses. Finally, many instructors and administrators value the social interaction in learning communities, and believe that it cannot be adequately achieved through distance learning (Guri-Rosenblit, 2003). Therefore, many college level science courses are based on classroom teaching, but are enhanced by some form of Internet instruction.

Web enhanced teaching takes a variety of forms, ranging from a few items of information about the course to complete modules for online learning (eg, Riffell & Sibley, 2005 for an introductory biology course). Course websites are expected to facilitate student access to study materials, reduce student reliance on handouts, and provide convenient tools (such as email and discussion groups) for communication among students, and between students and instructors. The prevalence of web enhanced teaching is increasing rapidly. For example, at Tel Aviv University (Israel), the number of courses that included Internet instruction increased from a handful to about 1000 (50% of all courses) during 1998-2003. Only 1% of these courses were completely online, while most remaining courses enhanced face to face teaching with a course website (Nachmias, 2002). Ninety five percent of the course websites were used for posting of study materials (such as lecture slides and reading materials), and one half of the websites were also used for course administration (posting of messages, grades, etc) (Nachmias et al., 2003).

As a further example, in a survey conducted at three universities in the UK, 67% of the responding lecturers reported that they delivered course material electronically, mainly reading material and lecture notes (Wilson, 2003). Thus, course websites have become the working standard for much of college teaching. Do students actually access the websites, even if the course structure does not require them to do so? If yes, what learning needs do websites facilitate?

In the present study we ask whether, and how, college students use course Internet sites to enhance their study. In particular, we investigate whether (a) the course websites are accessible to students; (b) students expect course websites to improve their achievement; (c) students primarily view course websites as sources of information or as tools for communication; (d) frequent use of the course websites correlates with higher achievements.

Distance learning may reflect gender related differences in learning styles, as women may be under represented in online interactive learning, due to inferior levels of access and technology literacy, and dominant male behavior (Barrett & Lally, 1999; Blum, 1999; Gunn et al., 2003). It has been suggested that women value social interaction while studying more highly than men, and may therefore use websites for communication, and social support, more frequently than men (Barrett & Lally, 1999; Kirkup & Von Prummer, 1990; King, 2000). In a traditional biology course female students accessed the course website more frequently than their male classmates (Sanders & Morrison-Sheltar, 2001). A minor aim of our study was to assess whether gender differences in web enhanced learning also occurred in our sample of students, which contained 66% women.

Many studies evaluate distance learning programs by comparing student attitudes and achievement in classes that receive face to face instruction versus distance learning classes. Ideally, both classes are taught by the same instructor, with identical syllabi and study assignments (eg, King & Hildreth, 2001; Tucker, 2001). Distance learning increased student and instructor satisfaction, and improved student achievements in some such studies (Shachar & Neumann, 2003), but was as effective as classroom teaching in many others (eg, Russell, 1999; Ramage, 2002; Zeiler, 2003; Mottarella et al., 2004). The drawback in the design of these studies is that the quality of instruction may differ between the traditional and the distance learning class, due to the instructor's experience and/or preferences for the two teaching modes. In the present study, we tried to reduce this difficulty by focusing on the variation in the usage of Internet resources between students within the same course. Our investigation further differs from previous work by focusing on websites that augment traditional classroom teaching, rather than replacing it. We attempt to identify components of course websites that are most useful to the students taking the course, based on student reports and monitoring of website usage.

Methods

Students and courses

Ninety six students participated in the study in 2002-2003. Fifty two of them were first year students, and the remaining 44 were second year students, all majoring in biology. Background data on the student sample, based on their statements in pre-course questionnaires, are provided in Table 1.

The first year students took a course in Invertebrate Zoology. The second year students took a course in Introductory Ecology. Both courses included

a weekly lecture and either laboratories or exercise sections. All courses were taught by the same instructor, and were accompanied by Internet sites. The language of instruction was Hebrew.

Table 1: Characteristics of the students who participated in the study (n=72), based on pre-course questionnaires. Mean values are listed with their standard errors.

	Students who entered college in		All students
	2002	2003	
Sample size	44	52	96
Percent men	38	30	34
Age	23.55±0.41	22.33±0.32	22.90±0.26
College entrance examination score*	596.73±11.84	604.00±12.71	599.89±8.61
Percent born in Israel	75.7	78.8	77.1
Percent with one college educated parent	17.6	25.0	19.4
Percent with two college educated parents	44.1	25.0	33.9

* A standard national exam, which is required for college admission in Israel. Scores range 400-800.

Course websites

The course websites contained the following study materials: course syllabus, lecture slides, laboratory manual or exercise questions, sample exams or quizzes, review questions, and links to course related websites elsewhere. Some of the items on the websites were required for the course, while other items were not compulsory, but could be used as enrichment for interested students. The courses were designed so that students could complete them even if they did not use the websites at all. For example, there were no assignments that had to be submitted through the Internet sites. The websites also enabled written communication among students and between students and instructors in the course. The communication functions included discussion groups for the reading assignment and home assignments, options for online submission of assignments, and an email service provided by the learning management system. Additional communication channels in the courses included the face to face session, telephone and the regular college email platform.

Monitoring website use

The websites were implemented using the learning management system *Highlearn* [<http://www.britannica-ks.com/Products/Edu.asp>]. Students were instructed in the use of *Highlearn* during the first week of each course. This system requires an individual login for each user, and allows the

course instructor to monitor the usage of the website by individual students. The monitoring tool provides a list of course items accessed by each of the users, together with date and time of access. It also provides a record for each course item, which lists the dates and times of access to the item, and the identity of the users who accessed it. Using these data, we scored how many items each student in our sample accessed during the whole course period. We also divided the course items in the sites into groups (syllabi, lecture slides, discussion groups, etc), and recorded the total number of visits by students to each group of items.

Questionnaires

Questionnaires were administered to students in the first week of the course, and after the final exam. The students were not required to hand in the questionnaires. Introductory questionnaires (completed and returned by 72 students) contained questions on personal details, and about the students' expectations regarding web enhanced learning. Summary questionnaires contained questions regarding the students' use of the website during the course, and their attitudes towards it. Some of the questions are based on a questionnaire developed by Sanders & Morrison-Sheltar (2001). The questionnaires were validated by six independent experts, and were modified according to their comments. Students were asked to provide their names in both questionnaires, to enable individual comparisons between their attitudes, usage of the websites, and academic achievements. Forty four students returned the identified summary questionnaires. The use of identified questionnaires may have introduced biases in the students' responses. To test for this possibility, we asked 90 additional students, who took Invertebrate Zoology and Introductory Ecology in 2003-2004, to anonymously answer the same post-course questionnaire. Seventy four of the anonymous questionnaires were returned. We expected to reveal possible biases through differences between responses to identified and anonymous questionnaires.

Results

Students' access to the Internet

Fifty five percent (55%) of the students in the study had access to the Internet from home. A further 30% accessed the Internet from the college computer classrooms, while the remaining 15% could access the Internet at the homes of friends or relatives. Only 20% of the respondents used the Internet daily.

Pre-course expectations and post-course attitudes

At the beginning of the course, most of the students expected the website to increase their interest in the course subject. A lower proportion of respondents reported that the website enhanced their interest in the course topic in the post-course questionnaire. The difference between the distribution of pre-course and post-course attitudes on this issue was statistically significant (Table 2, $\chi^2=18.09$, $df=2$, $p<0.01$). Similarly, the website affected the respondents' class attendance less than they expected at the beginning of the course. The difference between the distribution of pre-course and post-course student attitudes on this point was significant as well (Table 3, $\chi^2=6.75$, $df=2$, $p<0.05$).

Table 2: Website effects on the students' interest in the course subject. Frequencies of questionnaire responses are reported. Sample sizes were 72 for pre-course questionnaires, and 118 for post-course questionnaires. We pooled identified ($n=44$) and unidentified ($n=74$) responses to the post-course questionnaires.

	Pre-course expectation	Post-course statement
Increased	0.67	0.47
Unchanged	0.33	0.53
Reduced	0	0

Table 3: Website effects on the students' tendency to attend lectures. Frequencies of questionnaire responses are reported. Sample sizes were 72 for pre-course questionnaires, and 118 for post-course questionnaires. We pooled identified ($n=44$) and unidentified ($n=74$) responses to the post-course questionnaires.

	Pre-course expectation	Post-course statement
Increased	0.20	0.13
Unchanged	0.77	0.87
Reduced	0	0

Use of the website and academic achievements

Ninety percent of the respondents expected the use of the website to improve their achievements in the course to a very large or large extent. We tested whether this expectation was fulfilled by recording the total number of visits to the website for all students. We then tested whether website usage correlated with the students' course grades. Contrary to the students' expectation, the correlation was not statistically significant ($r_{96}=0.12$, $p>0.05$). We also found that students who did not visit the

website at all ($n=11$) did not differ in their academic achievements from website users (students who accessed the website at least once during the course).

Patterns of web site usage

The websites were used frequently and regularly throughout the courses. The frequency of visits was 4.45 ± 0.60 (mean \pm SE) visits/ student/ week for Invertebrate Zoology, and 4.12 ± 0.55 visits/ student/ week for Introductory Ecology. The students regarded the Internet sites as an important source of information (Figure 1). They reported that they used the websites mainly to access learning materials and course assignments. The records of items that were actually accessed validate the reports: lecture slides were accessed most frequently, followed by assignment sheets, review question sheets, and practice exams. The websites' communication possibilities (with other students and with the instructor) were hardly used at all.

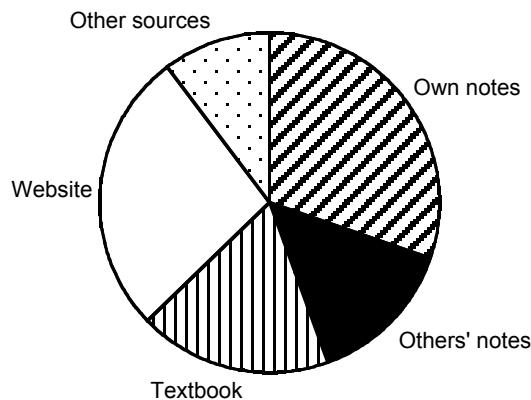


Figure 1: Relative importance of various sources of information, according to respondents' reports. Data are based on 44 identified and 74 anonymous responses.

Gender effects

The distribution of locations of Internet usage (home, college, friends, none) did not differ between men and women ($\chi^2=5.95$, $df=3$, $p>0.05$). Gender differences were not found for the frequency of Internet usage ($\chi^2=10.68$, $df=3$, $p>0.05$). Women had significantly higher pre-course expectations from the websites as compared to men (Table 4, $\chi^2=16.89$, $df=3$, $p<0.01$). However, usage records showed that men and women

accessed the website at similar frequencies ($t_{58}=0.27$, $p>0.05$). Males and females did not differ significantly in their course grades ($t_{68}=0.86$, $p>0.05$). Both males and females regarded the websites mainly as sources of information: they were ranked most useful as sources of exercise forms, lecture slides, and course related Internet resources. The websites were considered least useful for student-student and student-instructor communication by both men and women.

Table 4: Male (n=15) and female (n=47) pre-course expectations regarding the importance of the website in improving their course achievements. Frequencies of questionnaire responses are reported.

Response	Male	Female
Very important	0.40	0.49
Important	0.13	0.47
Somewhat important	0.33	0.04
Unimportant	0.14	0

The students' questionnaire responses revealed a slight gender related difference in learning style. Both men (44% of respondents) and women (47% of respondents) stated that their preferred way of studying was taking notes in class. Men's second preferred mode of studying was listening to the lecture (17%), while the women's second choice was studying the textbook (20% of respondents).

Identified versus anonymous questionnaires

The responses of the anonymous students (collected in 2003-4) were similar to the identified respondents (collected in 2002-3): About one half of the participants in both groups stated that the course website increased their interest in the course, and the majority of students in both groups reported that the website did not affect their class attendance. Students in both groups viewed their own lecture notes as their most important learning resource, followed by the course website. In both groups of students, the information content of the Internet sites, rather than their communication features, were considered important. The agreement between identified and anonymous replies suggests that identified responses can be regarded as reliable.

Freestyle comments in the questionnaires

The post-course questionnaires invited the students to comment on the Internet component of the courses, and in particular on problems associated with it. Nineteen participants responded. Eight respondents noted that they were not always able to log into the website. Three other

users reported additional technical difficulties (difficulty obtaining a user name; slow response rate of the server). The remaining respondents commented that lectures slides were not accompanied by explanatory notes (n=1); no solutions were provided to review questions (n=2); learning materials were not updated frequently enough (n=1), or did not match the lecture materials (n=1); course related websites were not helpful (n=1); printing of website materials was complicated or costly (n=2); and that communication with the teaching staff via the website was difficult (n=1). Thus, most responses addressed technical aspects of distance learning or the content of the posted learning materials. Only one comment dealt with the communication aspects of the website.

Discussion

Internet assisted instruction has become the standard in college level science education in recent years. The question is no longer whether lecturers ought to accompany their face to face teaching with websites, but how to do so most efficiently. It is time consuming to set up and maintain websites. Given that this large effort is almost expected in college level instruction, how can it be allocated most efficiently? What features of course websites are most useful to learners (these features should receive most attention during website development)? Which course objectives can be attained through the websites? Which objectives can be better attained in face to face sessions? Our study tried to address these questions for two course websites, used by a small sample of students, who also attended face to face classes. Despite the small scale of our study, we think that some insights can be gained from our results regarding effective development of web enhanced science courses:

- Students in our study visited the website regularly although they were not required to do so. They considered the website an important source of information, second only to lectures delivered by the course teacher. This suggests that the information contents of the websites are viewed as important learning resources by students, probably helping them to prepare for lectures and/or review lecture material. It is well worth the instructor's effort to maintain course website updates with respect to learning materials.
- Class attendance was not mandatory in the courses studied, and lecture materials were posted on the websites prior to each lecture. Nevertheless, most students reported that the availability of learning materials did not decrease their tendency to attend lectures. We conclude that students perceived face to face instruction and e-learning as complementary, rather than interchangeable modes of learning. Face to face learning likely provided the social experience of learning, while

the e-learning component provided opportunities for self paced study and review.

- Students did not use the website for communication with other students or with the instructor, presumably because they perceived face to face communication as easier and more effective. This trend emerges from the students' self-reports in the questionnaires, from the topics raised in their freestyle comments, and from their actual patterns of website usage. The development of written communication skills is explicitly defined as a learning goal in many distance education courses that are completely online. In traditional science courses, on the other hand, it is often not defined as a goal *per se*. It would therefore seem advisable for instructors to allocate more time to face to face communication with their students than to written communication via the course website in these circumstances.

Our results concur with many previous studies that report no significant effect of teaching technology on student's academic achievements (Russell, 1999). This is hardly surprising, because students did not differ in their exposure to face to face instruction, which comprised a major part of the course. Nevertheless, the course website increased interest in the course in about one half of the students, suggesting that this teaching technology may affect learners' attitudes.

In agreement with recent analyses of web based learning (Lu et al., 2003; Astleitner & Steinberg, 2005), we found only few gender related differences in usage patterns of the websites or in achievement levels. Women did not report greater difficulties in accessing and using the websites than men. If anything, female students had higher initial expectations from the Internet technology as compared with male students. These findings contrast with some earlier studies, which found an under-representation of female students in Internet learning environments (Barrett & Lally, 1999; Blum, 1999; Gunn et al., 2003).

A possible explanation for the difference between these findings and ours is that gender related differences usually surface in Internet forums and discussion groups. Women tend to value group study more highly than men (Kirkup & von Prummer, 1990), but are often under-represented in online discussions (King, 2000). In our study, however, students met each other regularly, and did not utilise the Internet for group study and discussions. It seems likely that gender differences were more evident in the students' face to face interactions, as these provided their social learning environment. Zuga (1999) suggests that designers of e-learning environments ought to consider differences in learning styles between men and women to accommodate the needs of both genders. This

recommendation does not seem to apply to web enhanced learning as described in our study, since male and female students seem to handle information retrieval from websites equally well.

Our study suggests that students regard course websites as important sources of information, but not as important means of communication. Obviously, student use of the website's communication functions can be enhanced if defined as course requirements. Such assignments can include compulsory participation in discussion groups, or in online collaborative projects. But does this kind of interaction provide any advantage over traditional group learning in science courses? Our subjective view is that the communication technology is not yet advanced enough to successfully replace traditional group study. An additional aspect of college level science education, which was not explored in our study, is the usage of public access Internet databases and software. The role of science course websites in directing students to these resources, and in training student to use them, is a promising topic for further research.

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