Student Hits in an Internet-Supported Course: How Can Instructors Use Them and What Do They Mean?

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ABSTRACT

The world of education is changing as Web-based technology and courseware are increasingly used for delivery of course material. In this environment, instructors may need new measures for determining student involvement, and ultimately student performance. This study examines whether hits to a Web site have any value for predicting student performance in a traditional course supported by Web activities. Total Hits at the end of the semester was used as one measure. Hit Consistency, determined by assigning a 0 when no hits occurred between class meetings and by assigning a 1 when one or more hits occurred between class meetings, was another. Hit Consistency was significantly correlated with course average (r = .37, p < .001) for 108 students in two course sections. Hit Consistency started to show a significant relationship with course average by the third week (or class). Total Hits was not found to significantly correlate with course average (r = .08, p > .05) at the end of the semester or during any week. These results suggest that students who consistently access a Web site will perform better than those who do not. When Hit Consistency and Total Hits were entered as independent variables into a stepwise regression with course average as the dependent variable, the model was enhanced by the addition of Total Hits after Hit Consistency was entered (R = .43, p < .001). Hierarchical regression analysis in which cumulative grade point average was entered as the first controlling variable suggested that online access may go beyond the predictive value of achievement alone for predicting course performance with Hit Consistency appearing to be the dominant causal variable.

Subject Areas: Academic Achievement, Courseware, Distance Education, Hierarchical Regression, Hit Consistency, Student Involvement, Student Performance, Total Hits, and Web-Based Technology.

INTRODUCTION

Throughout the 1990s and into the new millennium, thousands of college teachers have taken advantage of a new generation of software designed to create Web sites for courses. In fact, the report of the Web-Based Education Commission (2000) to the president and the Congress of the United States indicated that nearly 40% of all college classes used Internet resources as part of the syllabus in 1999, compared with 15% in 1996. Similarly, two-fifths (42.7%) of college courses now use Web resources as a course component, up from 10.9% in 1995, 33.1% in 1998, and 38.9% in 1999 (Web-Based Education Commission, 2000). Much of this growth is due to
the increasing prevalence of software that makes use of the Internet relatively easy for most instructors (Blackboard, 1997). Such software provides tools for designing functional, interactive sites that facilitate student-teacher communication, deliver course content, and perform administrative tasks (Samuels, 2000).

According to a report prepared by the Institute for Higher Education Policy (1999), there is a relative paucity of original research dedicated to explaining or predicting phenomena related to distance learning. Moreover, much of this writing is in the form of “how-to” papers and essays. Alavi and Gallupe conclude from their case review of the use of information technology in business and management education programs that “few objective assessments of the performance of [technology-mediated education programs] are initially undertaken” (2003, p. 139). Thus, despite the burgeoning use of online mechanisms for delivery of course material (Gubernick & Ebling, 1997), scant research exists that examines the effectiveness of Web-based instruction. Further, the research that does exist compares instruction that is totally Web-based to instruction that is totally traditional, i.e., face-to-face teaching. The majority of research does not represent the more common use of Web technology in the classroom, which, as indicated by the Web-Based Education Commission cited above, is the use of the Web as support (e.g., online announcements, assignment postings, supplementary materials, and discussion boards) in a traditional face-to-face classroom situation.

A significant gap in the research, then, is the lack of studies on the usefulness of Web-based support to improve learning in a face-to-face course and, concomitantly, the development of site utilization measures needed to undertake that research. Our research addresses this gap by studying the value of Web site utilization, measured as the frequency and consistency of Web site hits, for predicting performance in a course supported by Web-based activities.

**REVIEW OF THE LITERATURE**

Theoretical support for our hypotheses has been drawn from literature on the prediction of performance in academic settings. There is, not surprisingly, a large body of extant research on predictors of performance in academic settings and it investigates several types of predictors and measures of success. However, technology and its use in the classroom have advanced quickly in the past decade and the literature becomes sparse concerning the relatively recent phenomenon of Web-based instruction.

We begin the literature review by examining work on the broad relationship of intellectual capabilities and noncognitive measures to academic performance. From there we move to research that focuses on the use of technology in the classroom, looking at various types of technology support as both predictor and dependent variables. Next, we review evidence of the efficacy of Web-based instruction on performance. Last, we look at the research that focuses specifically on the efficacy of “hybrid courses,” i.e., courses that combine traditional face-to-face instruction with Web-based support.

**Predictors of Performance in Academic Settings**

In the research on the prediction of student performance, there is an abundance of studies using quantitative measures of student performance in one level of academe
to predict performance at the next level (Abedi, 1991; Baird, 1975). At the undergraduate university level, the bulk of this research concludes that high school grade point average (GPA), scholastic assessment test (SAT) or achievement test scores, and high school class rank predict academic success with "unsettling accuracy," though these predictors lose their efficacy when college entrance is delayed by several years; then age is a better predictor of success (Merante, 1983). Similarly, at the graduate level, undergraduate GPA, graduate management admission test (GMAT) scores, letters of reference, and work experience have all been used to predict academic success as measured by the first year average or completed GPA or some combination thereof (Deckro & Woundenberg, 1997; Fisher & Resnick, 1990; Gayle & Jones, 1973; Graham, 1991; Wilson & Hardgrave, 1995). Other studies have shown the same measures to be reliable predictors in the context of individual courses, such as accounting (Morgan, Cornick, & Kauder, 1985). However, at least one study shows that SAT scores are not related to success when success is defined as graduation (Tracy & Sedlacek, 1986). In that study, relevant predictors were self-confidence and community service. In another study, Villanova (1996) found GPA to have a much higher correlation with the grade in a mathematics class than SAT total, SAT math, and all other variables considered in the study, with a simple correlation to course grade of .69.

Useful as these general predictors are for certain purposes, they fail to predict the performance of specific groups (Astin, 1975; Fields & Lemay, 1989), e.g., the academic success of minority students (Beasley & Sease, 1974; Clark & Plotkin, 1964; Sedlacek & Brooks, 1976) or specific situations, e.g., success under varying degrees of task complexity (Bolt, Kilough, & Koh, 2001). Consequently, research has also focused on the relationship of noncognitive dimensions to academic success (Messick, 1979; Nelson, Scott, & Bryan, 1984; Pascarella & Chapman, 1983; Pascarella, Duby, & Iverson, 1983; Pruitt, 1973), using such independent variables as gender; family size; income; parent occupation; religion; race and social class (Arken, 1964; Kotler, 1980); self-concept; availability of support systems; preference of long-term goals over short-term needs (Entwistle & Brennan, 1971; Tracy & Sedlacek, 1986); and behavior modeling versus lecture-based training (Compeau & Higgins, 1995).

A characteristic that has received particular attention is self-efficacy (Krueger, 2000; Maracas, Mun, & Johnson, 1989). Self-efficacy can be defined as an individual's belief that he/she can perform a specific behavior to attain a desired goal (Bandura, 1997). Eden (1992) found that high self-efficacy leads to improved initiative and persistence, which lead to improved performance. Research has also documented the role of self-efficacy predicting task performance in educational settings. A meta-analysis by Multon (1991) concluded that self-efficacy is strongly related to student persistence and performance across a variety of subject areas, experimental designs, and grade levels.

Technology Support as Predictor and Dependent Variables in Academic Settings

Distance learning using "low tech" support, e.g., self-paced programmed instruction, has a long history. However, the developments in "high tech" support have considerably broadened the choice and viability of alternative learning contexts.
The use of computers, learning software, and the Internet to support or replace classroom learning is a growing part of education and technology literatures. A number of studies have tested the effectiveness of technology as a support in subject mastery (Rasheed & Cohen, 1990). For example, one study shows that computer-assisted learning software improves subject mastery, retention, and application when compared with traditional teaching practices (Whiting, 1985). In another study, computer-based assessment was found to help improve the long-term recall of key concepts and to result in higher scores than obtained via conventional examinations (Bocij & Greasley, 1999). Interestingly, the same study suggests that students with experience using computers have no advantage over their peers when tested via computer-based assessment. In a study that compared graduate-student satisfaction in a course that was conducted simultaneously for two groups, one getting traditional, face-to-face, instruction and the other using two-way videoconferencing, results showed that performance was the same for both groups but the distance learners were less satisfied with their experience (Marett, Miller, Pearson, & Salisbury, 2002). Measures of success in these studies include examinations as well as observation, group discussions, and questionnaires.

Uncovering the characteristics of students who use and benefit from technology is another stream of this research (Agarwal & Prasad, 1999; Dille & Mezack, 1991; Ehrman, 1990). Self-efficacy has been used to predict the decision to use computers (Compeau, Higgins, & Huff, 1999; Hill, Smith, & Mann, 1987); the perceived usefulness, ease of use, and acceptance of information technology (Davis, 1989); dropout rates (negative relationship) in distance education programs (Osborn, 2001); and performance in an online class (Wang & Newlin, 2002). Attitudes toward new technologies have also been linked to familiarity with technology and higher education levels (Agarwal & Prasad, 1999) and to individual differences with respect to motivation and capabilities (Kwon & Zmud, 1987). A high aptitude in information technology has been shown to predict performance when using computer-based learning packages (Rasheed & Cohen, 1990; Tsai, 1989).

Other, sometimes older, research uses the quantitative cognitive dependent variables ubiquitous in the education literature. However, a study by Tesch (1981) showed that verbal SAT, quantitative SAT, and total SAT scores have little effect in predicting student success in a grammar and usage test when the material is taught using self-paced programmed instruction. Wang and Newlin (2000) have shown that basic demographic characteristics such as gender and age are not reliable predictors of performance in online courses and they assert, in fact, that there are no reliable demographic predictors of performance among college students who choose to take online courses. Rather, they argue, only one global trait, locus of control, is moderately correlated with performance in the virtual classroom. Building on research that found internal locus of control and self-efficacy to be related to a student's success in distance education (Altmann & Arambasich, 1982; Cooper, 1990; Parker, 1999), Wang and Newlin (2002) investigated two types of self-efficacy (self-efficacy for understanding course content and self-efficacy for meeting the technological demands of an online course) and found that both reliably predict performance in distance education.
Use of the Internet in Conjunction with and in place of Face-To-Face Instruction

The literature on teaching and learning, specifically through the World Wide Web is burgeoning, though the development of a body of rigorous research is still embryonic. Research on the effectiveness of the Web as a support for classroom teaching employs many of the same performance outcomes widely used in education research: grades and test scores, self-reports, and observer reports of student satisfaction with and attitudes toward the learning experience (Phelps, Wells, Ashworth, & Hahn, 1991).

There is a growing body of literature that compares Web-based and face-to-face instruction. Studies have found that “cyber learners” learn as well as the face-to-face teams (Navarro & Shoemaker, 2000); that virtual teams make more effective decisions than either individuals or face-to-face teams (Schmidt, Montoya-Weiss, & Massey, 2001); and that there is greater collaboration by students in the virtual classroom (McCullum, 1997). Other studies comparing virtual teams with face-to-face teams suggest that levels of communication effectiveness are similar (Chidambaram, 1996; Warkentin, Sayeed, & Hightower, 1997). There is evidence that Web-based learners have a high degree of satisfaction (Navarro & Shoemaker, 2000) and, conversely, that face-to-face teams report higher levels of satisfaction with their experience (Warkentin et al., 1997). Reviews by Brownson (2000) and Moore and Thompson (1997) of several research studies concluded that learning outcomes of distributed (distance) technology-mediated learning are not significantly different from traditional learning. However, the Moore and Thompson review showed mixed results in terms of student satisfaction.

Wang and Newlin have conducted several studies comparing Web-based to conventional sections of classroom instruction. They have used cognitive-motivation and demographic characteristics as well as class performance and course evaluation measures of students as dependent variables. In one study, Wang and Newlin (2000) compared three Web-based sections to three conventional sections of a psychological statistics course. They found that performance of cyber students on quizzes, homework assignments, and a midterm exam was comparable to that of their counterparts in conventional classes, though the cyber students’ final exam grades were slightly lower. On the other hand, Cheng, Lehman, and Armstrong (1997) compared three groups of teachers participating in three different versions of an in-service microcomputer applications training course: computer-mediated, correspondence course, and conventional classroom. In their study, scores on achievement tests were highest for students taking a correspondence course and lowest for students participating in computer-mediated learning. The latter group was also less positive toward the course than was the conventional classroom group.

On balance, the evidence thus far suggests that there is no difference between the performance of students using technology-based learning and those taught by conventional classroom instruction. Still, we are far from concluding that computer-mediated education will always deliver comparable (much less better) results. More germane to the present study, this research does not provide insight into the more commonly structured college course of today that combines face-to-face and online teaching.
Predictors of Performance in “Hybrid” (Traditional with Web Support) Courses

Within the nascent and thus limited body of research on the pedagogical use of Web-based course delivery is an even sparser subset of research on the efficacy of combined Web-based and face-to-face course instruction. One study, conducted by Goldberg (1997a), a computer science professor at the University of British Columbia, compared students taking a computer science course into three groups: those taking the course using only the Web-based resource (no lectures), those taking the course by attending lectures (no access to the Web-based resource), and those with access to both lectures and the Web-based resource. In this study, students in the combined lecture and Web-based delivery group performed better academically (as measured by exams and assignments) and had better attitudes toward the course than students in the other two groups. (These results led Goldberg to develop a software program of “Web course tools” for use in creating course Web sites.) Another study found that when media-enhanced and fully online classes were matched with traditional sections, media-enhanced versions were superior in having greater numbers of students with an A, B, or C grade, and fewer withdrawals (Hartman, Dziuban, & Moskal, 2000). While these studies do include the hybrid course structure, they still measure success by comparisons with fully Web-based and/or fully traditional courses. An alternative research design, which we have used in the current study, compares student performance to the degree students utilize Web-based support materials in a hybrid course.

Central to measuring the efficacy of Web support in a hybrid course is the ability to measure online activity. The comparison of students making more or less use of Web support is particularly germane in the hybrid class, where Web-based support consists of supplementary materials that enhance learning but are not “required.” In such situations, some students will utilize available Web support more than others. Online activity thus may be an indicator of performance success if such activity indicates interest, involvement, and motivation. Wang and Newlin (2000) investigated the relationship of grades to site involvement by measuring the total number of home page “hits” (a homepage hit was counted as one viewing of the homepage) after the first week of a semester and at the end of the semester for a course taught completely online. They found that the total number of home page visits during the first week predicted the final grades in the course. In other research, Wang and Newlin (2001) found that total number of student comments and frequency of student response to a query by the instructor correlated significantly with final grades in the class.

All Web courseware includes some frequency measure of activity, or “site involvement,” allowing comparison of heavy and light users of available support. However, to the best of our knowledge, there are few studies using Total Hits as a measure, and none that considered Hit Consistency as a predictor of performance in a traditional class using Web-based support.

**RESEARCH QUESTIONS AND HYPOTHESES**

The present study investigates the value of Web-based support by measuring Web site utilization and comparing it to both class performance and overall GPA. We propose three hypotheses.
First, the study considers the value of total Web site hits for predicting performance in a course supported by online activities. We use the measure of Total Hits accrued by students, a measure that has been limitedly researched and supported in the literature (Wang & Newlin, 2000). Based on existing literature that suggests that Web-based instruction is at least as effective as traditional instruction when success is measured as grades and, following Wang and Newlin, using Total Hits as a measure of performance, we offer the following hypothesis:

H1: Total Hits will be positively correlated to course average.

Second, we recognize the possibility that accessing a site on a regular basis may be as important as, if not more important than, the total number of hits accrued. An example of the possible bias of Total Hits is the student who engages in a high frequency of hits to a site just before a final exam near the end of the semester. Such a student might accumulate as many hits in the week before a final exam as a student who regularly visits the site throughout the semester. The former student might have far less interest in the course and greater difficulties with time management than the latter student, who has accrued the same number of hits over the semester, though both would show the same level of online activity if the only measure examined were Total Hits. Hit Consistency has not been used in original research examining course performance, although Goldberg (1997b) counted logons over a 3-month term and related it to student attitudes. However, Powell, Conway, and Ross (1990) did find that success in computer-mediated learning was correlated with a high degree of organization in time management skills. Therefore, our research also tests the relationship between class performance and Hit Consistency, the degree to which hits are consistent across the semester.

H2: Hit Consistency will be positively correlated to course average.

Third, we investigate the comparative value of cumulative GPA and Web site hits for predicting classroom performance. This is of particular interest since cumulative GPA is rarely available to instructors, while hits can be easily observed and measured.

As the literature demonstrates, GPA is one of the best predictors of future success in a class. So it is not unreasonable to expect that GPA plays a role in the relationship between Web site hits and course success. Better students may, for example, engage in regular access to an online site to obtain necessary materials. Moreover, hits are not merely a surrogate measure of GPA. Britton and Tesser (1991) found that certain components of time management were significant predictors of cumulative GPA and accounted for more variance than did SAT scores. If hits are related to skill in time management, it may be that an unusually large number of Total Hits might indicate bad time management and Hit Consistency might indicate good time management.

To the best of our knowledge, no study has considered hits in the context of cumulative GPA. Thus, the question of concern here is: to what extent do hits add to the explanatory value of cumulative GPA in its prediction of classroom performance?

H3: Total Hits will strengthen the positive correlational relationship between cumulative GPA and course average.
H4: Hit Consistency will strengthen the positive correlational relationship between cumulative GPA and course average.

**METHOD**

**Sample**

Participants in the study were 108 undergraduates in two sections of an introductory management class offered in the fall 1999 and spring 2000 semesters at a large university in New York City. The same instructor taught each section. Participants in the fall and spring sections numbered 49 and 59, respectively.

**Course Description**

The introductory management class is entitled Managerial and Organizational Concepts and covers a broad range of topics. Advanced sophomores with 45 or more credits generally take this course, though some juniors also enroll.

The Courseinfo interface (Blackboard, 1997) was used as support for a traditional classroom format. The goal of the Web activities was to support the course by providing class materials that would not ordinarily be available, such as PowerPoint slides of class lectures and additional handouts clarifying course topics. The Web site also provided for greater communication between students and the instructor and opportunities for greater involvement with course topics. In addition, extra credit opportunities involving external links and assignments were posted on the site. No content on the Web site was required for the course. A student could attend class during each weekly meeting and gain all of the content and instructions necessary for a high level of success, though some of the material was much easier to obtain online. A student could also achieve a score of 100 on any graded component without the extra credit options derived from the Web activities. No student was required to access the site.

**Measures of Online Course Activity**

Hit data were derived from frequency measures of online activity provided by version 3.0 of Courseinfo, the courseware program used to support course delivery in this study (Blackboard, 1997). Two measures of online course activity were used: Total Hits and Hit Consistency. Total Hits was operationalized as the total number of hits made to the Web site over the semester. This total was obtained from Courseinfo 1 day before the final exam. In Courseinfo, hits include the number of times a student logs onto the course homepage, as well as the number of times a student clicks on other features of the site after they log on, such as external links, assignments, and course documents.

Hit Consistency is not directly provided by Courseinfo but had to be computed by evaluating the number of hits accrued by students between each class meeting, that is, after one class but before the next class. The time between class meetings was usually 1 week, though it could be 2 weeks when vacations occurred. When students made no hits in the time between class meetings, they were assigned a 0 for that time period. When students made at least one hit to the site during the time
between class meetings, they were assigned a 1 for that time period. Since there were 13 time periods of this type across the semester, this measure could range from 0 to 13.

**Measures of Performance**

Classroom performance was measured as course average, which ranged from 0 to 100 and was computed by determining the average of the graded course components. These included midterm and final examinations, three case study solutions, and several Internet-based problems. The examinations were 15% of the grade and the case study solutions and Internet-based problems made up the other 50%. Course average is the dependent variable used in all regression analyses in this study.

The cumulative GPA of students in the class was used as another measure of performance. This measure could range from 0 to 4.0. As it was not possible to obtain this measure until the end of the semester, the average was adjusted to eliminate the impact of grades assigned to students in this course. Thus, the cumulative GPA used in this study reflects the prior performance of students, as well as their current performance during the semester in which the course was taken, excluding their performance in this particular course.

**Data Analysis**

The zero-order relationships among the predictors of Total Hits, Hit Consistency, cumulative GPA, and course average were examined with correlations. Both measures of online access considered student activity from the beginning of the semester to the day just before the final exam.

A second analysis of the relationship of Hit Consistency and Total Hits was also performed. In this analysis, the cumulative total for each variable was correlated with course average for each of the 13 weeks in the semester. We added this analysis because we felt there was potential value in ascertaining the point at which the impact of online access becomes evident.

A stepwise regression analysis was used to assess the overall predictive potential of online activity for classroom performance. In this analysis, Total Hits and Hit Consistency were entered as independent variables with class average serving as the dependent variable. Cumulative GPA was not entered as a predictor in this analysis as it is not generally available to instructors.

Hierarchical regression analysis (Cohen & Cohen, 1983; Shepperd, 1991; Stone & Hollenbeck, 1989; Wampold & Freund, 1987) was used to evaluate the relative contributions of cumulative GPA, Total Hits, and Hit Consistency to course average. Unlike stepwise regression, this procedure assumes a possible causative order of variables. It is one approach for assessing the contribution of online access to course performance. Two separate hierarchical regression analyses were conducted, as the exact order of causal priority for the measures of online access was not completely clear. In both the analyses, cumulative GPA was entered as the first control variable as it could have a prior or distorting effect on the substantive relationship of online access to course average. In the first hierarchical analysis, Total Hits was entered second and Hit Consistency was entered last (or third). In
the second hierarchical analysis, Hit Consistency was entered second and Total Hits was entered last (or third).

Since one of the goals of this study was to ascertain the predictive value of online access both before and after consideration of cumulative GPA, the last analysis considered both the unstandardized and standardized betas resulting from all relevant regression analyses.

RESULTS

Variable Means and Standard Deviations

Table 1 provides the mean and standard deviation for Total Hits, Hit Consistency, cumulative GPA, and course average. Students showed an average of 222.02 hits over the semester. On average, Hit Consistency was 9.05. The average score of students in the course was 76.98 while their cumulative GPA averaged 2.84 (on the 4.0 scale).

Correlation Analysis

Table 2 shows the intercorrelations among the four measures. Total Hits did not significantly correlate with course average or cumulative GPA, thereby rejecting H1. Hit Consistency did correlate significantly with course average and cumulative GPA, thereby accepting H2. Total Hits and Hit Consistency were significantly correlated with each other as were course average and cumulative GPA.

<table>
<thead>
<tr>
<th>Table 1: Descriptive statistics for Total Hits, Hit Consistency, cumulative GPA, and course average.</th>
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<tbody>
<tr>
<td>Measure</td>
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<tr>
<td>---------------------</td>
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<tr>
<td>Total Hits</td>
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<tr>
<td>Hit Consistency</td>
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<tr>
<td>Cumulative GPA</td>
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<td>Course Average</td>
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<table>
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<th>Table 2: Pearson correlations between Total Hits, Hit Consistency, cumulative GPA, and class average.</th>
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<tr>
<td>Measure</td>
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<tr>
<td>Total Hits</td>
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<td>Hit Consistency</td>
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<td>Cumulative GPA</td>
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<td>Course Average</td>
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</table>

*** p < .001.
Correlation Analysis over Time

Table 3 shows the intercorrelations and descriptive statistics for Hit Consistency and Total Hits for each of the 13 weeks in the semester. Total Hits did not significantly relate to course average at any point in the semester. Hit Consistency started to show a significant relationship to course average by the third week. By the eighth week, it had reached a relationship comparable to the overall relationship shown for it at the end of the semester. This suggests that monitoring Hit Consistency can begin to have some benefit by the third week in a 13-week semester. In contrast, any simple analysis of Total Hits would provide little insight into a student’s potential success even though this measure is provided by many online courseware systems and much easier to obtain than Hit Consistency.

Table 3: Pearson correlation between cumulative Hit Consistency and Total Hits and course average over time and the mean and standard deviation for each online measure of activity over time.

<table>
<thead>
<tr>
<th>Measure/Week</th>
<th>Relationship with Course Average ($r$)</th>
<th>$p$-value</th>
<th>Cumulative Mean</th>
<th>Cumulative SD</th>
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<tr>
<td>Consistency</td>
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<td></td>
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<tr>
<td>Week 1</td>
<td>.15</td>
<td>ns</td>
<td>.16</td>
<td>.37</td>
</tr>
<tr>
<td>Week 2</td>
<td>.17</td>
<td>ns</td>
<td>.80</td>
<td>.64</td>
</tr>
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<td>Week 3</td>
<td>.23</td>
<td>.050</td>
<td>1.53</td>
<td>1.84</td>
</tr>
<tr>
<td>Week 4</td>
<td>.26</td>
<td>.010</td>
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</tr>
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<td>.30</td>
<td>.010</td>
<td>2.80</td>
<td>1.27</td>
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<tr>
<td>Week 6</td>
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<td>.001</td>
<td>3.41</td>
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</tr>
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<td>.31</td>
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<td>4.13</td>
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<td>8.08</td>
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<td>Week 13</td>
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<td>Total Hits</td>
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</tr>
<tr>
<td>Week 8</td>
<td>.06</td>
<td>ns</td>
<td>137.3</td>
<td>80.2</td>
</tr>
<tr>
<td>Week 9</td>
<td>.07</td>
<td>ns</td>
<td>148.4</td>
<td>84.2</td>
</tr>
<tr>
<td>Week 10</td>
<td>.08</td>
<td>ns</td>
<td>159.3</td>
<td>90.7</td>
</tr>
<tr>
<td>Week 11</td>
<td>.08</td>
<td>ns</td>
<td>173.9</td>
<td>99.9</td>
</tr>
<tr>
<td>Week 12</td>
<td>.08</td>
<td>ns</td>
<td>195.3</td>
<td>105.2</td>
</tr>
<tr>
<td>Week 13</td>
<td>.08</td>
<td>ns</td>
<td>222.0</td>
<td>109.1</td>
</tr>
</tbody>
</table>
Stepwise Regression Using Total Hits and Hit Consistency as Predictors

In order to assess the possible value of Total Hits and Hit Consistency for predicting course average, both were entered as independent variables into a stepwise linear regression that treated course average as the dependent variable (DV). Results appear in Table 4.

As might be expected in light of its simple correlation with course average, Hit Consistency was the first variable entered in this model yielding an $R$ of .37 and $R^2$ of .138. However, the addition of Total Hits did provide a significant change to $R^2$ ($F(1, 105) = 5.26, p < .05$) leading to an $R$ of .42 and $R^2$ of .179. While Hit Consistency appears to be the dominant variable, there does appear to be some value to combining Total Hits into the prediction, even though it did not significantly correlate with course performance on its own.

Hierarchical Regression Analyses

The dependent variable of course average was predicted with three hierarchical steps in two separate analyses, shown in Table 5.

Cumulative GPA was entered first in both analyses. In the first analysis, Total Hits was entered second and Hit Consistency was entered third. In the second analysis, this order was reversed. The impact of each predictor in accounting for variance in course average was reflected by the increment in $R^2$ and its significance. In both the analyses, cumulative GPA is by far the most significant predictor of

Table 4: Stepwise regression analysis with course average as the dependent variable and measures of Hit Consistency and Total Hits as predictors.

<table>
<thead>
<tr>
<th>Predictor/Step</th>
<th>$B^*$ at Step</th>
<th>$B'$ at Final</th>
<th>$R$</th>
<th>$R^2$</th>
<th>$F$</th>
</tr>
</thead>
<tbody>
<tr>
<td>DV: Course Average</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Hit Consistency</td>
<td>$.371^{***}$</td>
<td>$.538^{***}$</td>
<td>.371</td>
<td>.138</td>
<td>16.95^{***}</td>
</tr>
<tr>
<td>2. Total Hits</td>
<td>$-.262^{*}$</td>
<td>$-.262^{*}$</td>
<td>.423</td>
<td>.179</td>
<td>11.45^{***}</td>
</tr>
</tbody>
</table>

*p < .05; ***p < .001.

*aStandardized regression coefficients.

Table 5: Hierarchical regression analysis with cumulative GPA as the first control variable and order of entry varying for the measures of Total Hits and Hit Consistency.

<table>
<thead>
<tr>
<th>Predictor/Step</th>
<th>$B'$ at Step</th>
<th>$B'$ at Final</th>
<th>$R$</th>
<th>$R^2$</th>
<th>$R^2$ Change</th>
<th>$F$ for Increment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysis One: DV: Course Average</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Cumulative GPA</td>
<td>$.724^{***}$</td>
<td>$.658^{***}$</td>
<td>.724</td>
<td>.524</td>
<td>.524</td>
<td>116.847^{***}</td>
</tr>
<tr>
<td>2. Total Hits</td>
<td>$-.007$</td>
<td>$-.167^{*}$</td>
<td>.724</td>
<td>.524</td>
<td>.000</td>
<td>.011</td>
</tr>
<tr>
<td>3. Hit Consistency</td>
<td>$.265^{**}$</td>
<td>$.265^{**}$</td>
<td>.750</td>
<td>.562</td>
<td>.038</td>
<td>8.913^{**}</td>
</tr>
<tr>
<td>Analysis Two: DV: Course Average</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Cumulative GPA</td>
<td>$.724^{***}$</td>
<td>$.658^{***}$</td>
<td>.724</td>
<td>.524</td>
<td>.524</td>
<td>116.847^{***}</td>
</tr>
<tr>
<td>2. Hit Consistency</td>
<td>$.153^{*}$</td>
<td>$.265^{**}$</td>
<td>.739</td>
<td>.545</td>
<td>.021</td>
<td>4.872^{*}</td>
</tr>
<tr>
<td>3. Total Hits</td>
<td>$-.167^{*}$</td>
<td>$-.167^{*}$</td>
<td>.750</td>
<td>.562</td>
<td>.017</td>
<td>3.918^{*}</td>
</tr>
</tbody>
</table>

*p < .05; **p < .01; *** p < .001.
course average ($p < .001$). In the first analysis, Total Hits provides no additional predictive power over that provided by cumulative GPA and accordingly H3 is rejected. However, Hit Consistency does provide a significant improvement after both cumulative GPA and Total Hits are entered as control variables ($p < .01$). Therefore, H4 is accepted.

As the final betas in both analyses show, Total Hits appears to have a negative relationship with course average even though it showed no significant relationship with course average or cumulative GPA in the correlational analysis. Moreover, the order of entry of the two measures of online access is informative. In the second analysis, both Hit Consistency and Total Hits act as potential predictors of course average even when the potential moderating influence of cumulative GPA is extracted from the relationship. In the first analysis, Total Hits does not add anything when it is entered as the second variable in the analysis following cumulative GPA.

From an analytical perspective, it may be best to think of Total Hits and Hit Consistency as different aspects of online access. If at the end of the semester one could look back at cumulative GPA, Total Hits, and Hit Consistency as predictors of course average, Hit Consistency would stand on its own as a predictor. In contrast, Total Hits does not materialize as a predictor until consistency is known. In fact, Total Hits might be viewed as a suppressor variable in the traditional predictive sense, as it is not correlated with course average but it is correlated with Hit Consistency, and thus may be suppressing the relationship of Hit Consistency to course average. This is not necessarily surprising. Too many hits, beyond those necessary to keep up to date, may actually waste time that could be better allocated to study.

### Comparison of Regression Coefficients

Table 6 summarizes both the unstandardized regression coefficients ($B$) and the standardized coefficients ($B'$) from the prior regression analyses as a means of

<table>
<thead>
<tr>
<th>Analysis/Stepa</th>
<th>$B$ at Step</th>
<th>$B$ at Final</th>
<th>$B'$ at Step</th>
<th>$B'$ at Final</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: No Control for GPA. DV: Course Average</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Hit Consistency</td>
<td>1.39</td>
<td>2.02</td>
<td>.371</td>
<td>.538</td>
</tr>
<tr>
<td>2. Total Hits</td>
<td>−.02</td>
<td>−.02</td>
<td>−.262</td>
<td>−.262</td>
</tr>
<tr>
<td>2: Control for GPA. DV: Course Average</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Cumulative GPA</td>
<td>12.71</td>
<td>11.56</td>
<td>.724</td>
<td>.658</td>
</tr>
<tr>
<td>2. Total Hits</td>
<td>−.0006</td>
<td>−.02</td>
<td>−.007</td>
<td>−.167</td>
</tr>
<tr>
<td>3. Hit Consistency</td>
<td>.99</td>
<td>.99</td>
<td>.265</td>
<td>.265</td>
</tr>
<tr>
<td>3. Control for GPA. DV: Course Average</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Cumulative GPA</td>
<td>12.71</td>
<td>11.56</td>
<td>.724</td>
<td>.658</td>
</tr>
<tr>
<td>2. Hit Consistency</td>
<td>.58</td>
<td>.99</td>
<td>.153</td>
<td>.265</td>
</tr>
<tr>
<td>3. Total Hits</td>
<td>−.02</td>
<td>−.02</td>
<td>−.167</td>
<td>−.167</td>
</tr>
</tbody>
</table>

a All final coefficients significant at .05 level or greater.
conveying both the practical impact of understanding online access and its relative importance.

It appears that it is possible to predict a gain of about one point in the course average for each week of consistency. Without knowing cumulative GPA, one might predict a gain of about two points. Over 13 weeks, this could add up to a significant amount in both cases.

It would seem worthwhile to reconsider the Total Hits variable in light of this finding. Given that students averaged 222 hits over the semester, Total Hits could be an important factor, especially when student hits increase relative to their level of consistency. Total Hits might also be viewed as a suppressor variable in the traditional predictive sense (Byrne, 1973; Cohen & Cohen, 1983), as it is not correlated with course average but it is correlated with Hit Consistency. Thus, it may add irrelevant variance to the measure of consistency and be a moderator (or suppressor) of the relationship of Hit Consistency to course average.

CONCLUSIONS AND DISCUSSION

Hit Consistency and Total Hits examine different aspects of online activity. A large number of hits can accrue from inconsistent access for various reasons, such as an upcoming final exam or poor time management skills. Conversely, a student can consistently access a site, but not engage in many hits on the site once there. This study hypothesized that both types of online course activity would be related to student performance. However, of the two measures, only Hit Consistency was found to relate to course success. Its importance as a predictor was found to be evident by the third week of the 13-week semester.

The other measure of online activity, Total Hits (as measured at the end of the semester), did not significantly correlate with performance nor did it correlate with performance during any individual week of the semester. This finding differs from the results of Wang and Newlin (2000), who found that Total Hits at the beginning and end of the semester predicted performance. One explanation for this difference may lie in the fact that, in the present study, Web access was supplementary to classroom instruction. Students attended regular classroom sessions, where they could obtain all content necessary for successful performance in the course. In contrast, students in the Wang and Newlin study were taught completely online, with face-to-face meetings occurring only at an orientation meeting at the beginning of the semester and for the final exam. Another difference lies in how hits were measured in the two studies. In the present study, hits accrued both when a student hit the homepage and when he/she moved to other site features. In the Wang and Newlin study, hits accrued only from hits to the home page.

Results of the hierarchical regression analysis indicate that Hit Consistency remains a potential predictive or causal variable in understanding course average even after the potentially biasing impact of achievement, as measured by cumulative GPA, is removed from the relationship. Given the prominent position of GPA in the literature on academic success, this finding is particularly intriguing, as it suggests that Hit Consistency is a potential new research measure.

Hit Consistency, having maintained its relationship in both hierarchical analyses, appears to be the more important measure of online access. At the same time,
it is important to note that Total Hits may also hold some predictive or even causal value even though results showed it to have no significance as a predictive variable once cumulative GPA is considered. Certainly a student must hit at least once in a week to score a 1 for that week in terms of consistency. However, when the full range of hits possible was extracted from the relationship of consistency to course average, consistency became a stronger predictive variable. Thus, there is a suggestion in this analysis that at some point students may accrue more hits than are necessary and that hits may obscure or suppress the apparent relationship of consistency to success.

While causal relations cannot be demonstrated by this kind of study, it does appear that students who engage in irregular access may be in need of additional encouragement and attention. For traditional classes supported by Web activities, a high number of hits between any two classes may be misleading if not followed by hits between subsequent pairs. The accumulation of hits or totals provided by most courseware will be of little use in identifying students in need of attention, especially as the semester moves forward and all students show a number of hits. Thus, instructors should examine the hits between each class and track students who are not regularly hitting the site over time. This is much more likely to lead to useful information about potential poor performers than the total or accumulated hits shown by most Web courseware systems. This model will be especially useful in courses that have a heavy reliance on quantitative methods. Instructors in these courses will need to be vigilant in distance-based study to assure that students are keeping up with the problem-based work. Faculty who monitor hit consistency will be better able to assure that students are working towards course goals.

To reiterate, those instructors moving to online offerings, especially for courses supported but not solely offered online, should consider the potential value of consistent access to a site for predicting student performance and the possible negative impact of too much access or too many hits. Unfortunately, no courseware provides a consistency measure for access, while most, if not all, courseware systems track Total Hits. The development of a measure of consistency in online activity would appear to be a fruitful innovation for Web courseware.

That consistent involvement with coursework throughout the semester produces better performance results than intensive involvement at one point—such as a final exam period—is an intuitively appealing idea to most of us who teach. The present study provides some quantitative support for this conventional wisdom, at least in the context of optional rather than required workload. It behooves us to pursue this area of study with additional research. The Hit Consistency measure needs more testing both in situations like that of the current study, in which Web content was supplementary to classroom instruction, and in other situations, most prominently in courses taught completely online.

Our study provided only a limited understanding of the Total Hits measure. In addition to the contradiction in findings between the present study and the earlier study by Wang and Newlin, regarding the relationship of Total Hits to performance, the possibility that Total Hits may be a moderating variable in the relationship of consistency to success needs further study.

Our own research plans include further testing of this model in the MBA e-business operations curriculum that is planned for implementation in the near
future. This curriculum is designed to use Web-based instruction and action learning (Varanelli, Baugher, & Hall, 2001). Faculty will be trained to use this model and data will be collected to allow further study of this promising predictive technique. [Received: August 15, 2001. Accepted: June 7, 2003.]

REFERENCES


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