Comparison of Student Outcomes for a Classroom-based vs. an Internet-based Construction Safety Course
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Project Description and Outcomes
The overall objective of the present study was to compare examination performance across examination items that represent the first three levels of Bloom's taxonomy. Specifically, the study was designed to determine if there are differences in performance with knowledge-based, comprehension-based, and application-based examination items in the traditional classroom version and the Internet version of a *Construction Safety* course.

Our study shows that student outcomes from the Internet version of the course are comparable to classroom version outcomes, except for the performance on application-based examination items.   Students in the Internet version of the course scored statistically higher in the application scores ($p = 0.036$). Multiple regression analysis was used to eliminate possible confounders of the study results, including: student personality type (as revealed by the Myers-Briggs Personality Type Indicator[®]), prior academic background, including high school grade-point average, and standardized admissions test score.

Methods Used in the Study
 Design of the course
 We have applied criteria for the evaluation of web sites (Ferguson, L. and K. Wijekumar 2000; Sternberger, C.S. 2002; Sorg, S., B. Truman-Davis, C. Dziuban, P. Moskal, J. Hartman, and F. Juge, 1999; Dillon, A. and E. Zhu, 1997) to the *Construction Safety* course web site to identify potential design features that can increase the quality of learning for both the classroom-based and Internet-based student populations. These include a logical, hierarchical design to all supporting materials for a particular topic, making it easy for the student to take charge of their own learning.

The *Construction Safety* course learning objectives and performance measures were designed to enable students to begin by extracting knowledge from a series of lessons, assigned readings, and corresponding PowerPoint™ summaries accessible through the Internet or through classroom interaction and instruction. Lessons were designed to foster comprehension of the knowledge-based information, often showing relationships between various elements in factual parameters. The lessons were also designed to give the students practice in applying the knowledge-based information towards *best-practice* solutions to problems drawn from the construction industry. *Best-practice* solutions are emphasized in the course because of the construction industry's recognition of the benefits (to productivity and schedule) that are gained by going beyond the minimum required by government standards.

Finally, the four course examinations were designed to assess student performance across the first three levels of Bloom's taxonomy (Bloom, B.S., T. Hastings, and G.F. Nadaus 1971) of cognitive learning: knowledge, comprehension, and application.   Application-

type questions tested students' ability to apply knowledge and comprehension skills to real-life scenarios. It is upon these examination performance data that the results described in this paper are based.

Statistical Analysis of Examination Results
All statistical analyses were conducted using SPSS 12.0 for Windows (SPSS, Inc., Chicago). A critical value of p 0.05 was used for all statistical significance tests. The statistical analysis is divided into three parts. The first part examines student demographics and academic background information. The second part compares the student outcomes (scores on application, knowledge, comprehension, as well as overall exam score) between classroom-based and Internet-based instruction. The third part of the analysis examines potential confounding variables.

In the first part of the analysis, a frequency table is used to summarize categorical variables. Means and standard deviations are used to analyze continuous variables. In the second part of the analysis, a Student's t-test was conducted on difference of test scores between the Internet and traditional classroom students. In the third part of the analysis, academic/demographic variables that demonstrated a significant association with instruction type were evaluatedone at a timefor confounding of the relationship between instruction type and student outcome variables. To examine the bivariate association with instruction type, categorical variables such as gender were analyzed using the chi-square test. Continuous variables were evaluated using the student's t-test. Confounding was defined as a dramatic change in the beta and p-value for instruction type when the potential confounder was added to the regression model.

Compilation of student warehouse information
To support multiple regression analyses that were aimed at identifying potential confounders, student demographic information was gathered from student warehouse data, using Query Management Facility (QMF) for Windows, which is supplied by Rocket Software, an IBM partner. QMF for Windows is a graphical application tool that assists in building queries. QMF allows query capability with Administrative Information System (AIS) DB2 ("Database 2") tables and warehouses. It is used to create detail and summary reports as well as to export data to other functions. It is primarily a tool for data retrieval and has limited use for sorting or display. QMF is available for multiple platforms. QMF allows two types of queries, Prompted Queries and Standard Query Language (SQL) Syntax. Prompted Queries are graphical representations of existing components, as opposed to SQL Queries, where the query statement is written in standard query language syntax. *Tables, "join" conditions, columns, sort conditions,* and *row* conditions are selected from the DB2 and warehouses. The data for the present study were gleaned using a Prompted Query.
The query parameters were selected by the research team. QMF was then used to retrieve the data and export it to Microsoft Excel™, where it was sorted, grouped, and manipulated for comparison and study.

The Myers-Briggs Type Indicator® Student Form G (Bayne, R. 1995) was administered to all students within the cohorts to generate data on personality type. This information,

along with other demographic and student warehouse data, was tested through regression analysis to identify potential confounders.

Discussion/Conclusions
Results from this study suggest that Internet-based student performance across the four examinations of the course with specific reference to application-type examination items may be significantly higher than the classroom-based student performance.   Though there are many factors that could contribute to this observation, the increased "student-centeredness" of the Internet-based version of the course may contribute to better preparation for dealing with these types of examination items.   Currently, efforts are underway to develop teaching strategies to increase the student-centeredness of the classroom-based version of the course, such as use of group exercises that foster application-type thinking.

Another interesting finding is that average age of the cohort is not a confounder, based on the results of the multiple regression analysis.   Had there been a direct correlation between age and maturity, we would expect the regression analysis to identify age as a positive performance factor when the populations are normalized. The current data set does not suggest this outcome.

Based on these results, future revisions to the course will incorporate instructional methods specifically designed to enhance performance in application-type examination items.   The conclusions drawn from this study will drive continuous improvement of the *Construction Safety* course, and may also have general applicability to web-based instruction applications in other disciplines.

The results of this research may assist the Department's advising staff as they counsel students regarding selection of classroom-based vs. Internet-based courses.   As the Safety Program adds additional Internet-based courses, subsequent assessments of performance with respect to delivery mode will be undertaken.