

DISTANCE LEARNING INSTRUCTION: AS EFFECTIVE AS FACE-TO-FACE INSTRUCTION?

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Abstract *This paper presents the results of an analysis of the performance of two groups of computer engineering students who enrolled in a course in computer architecture. The first group took the course in a traditional classroom in face-to-face mode while the other group took the course in distance learning mode using an asynchronous learning network. Students were placed in the groups according to their wish, thus making the mode of learning self-selective. Both versions of the course cover the same material and were taught by the same instructor. The analysis tracks the performance of students, both in this course, and in a computer engineering design laboratory course for which this course is a prerequisite.*

The researchers tested the hypothesis that mode of instruction (face-to-face or distance learning) does not make any difference in students' performance in the computer architecture course. Data analysis found very little (.12) correlation between mode of instruction and students' grades in the computer architecture course. When analyzed separately for each mode of instruction, course grades showed moderate correlation with SAT scores. Students who took the computer architecture course in distance learning mode had higher math and verbal SAT scores and higher school rankings than students who took the same course in the face-to-face mode. However, those students who were taught in face-to-face mode outperformed distance learning students in the design laboratory course. The difference between the groups' grades in the design laboratory course was statistically significant. Further analysis showed that students who were taught in face-to-face mode had a slightly higher cumulative GPA. The reasonable explanation of the discrepancy between the SAT scores and course grades can be given by analyzing the ratio of attempted and earned credits. Both groups have the same average number of earned credits but the distance learning group failed to pass an average of 13 credit hours more.

Index Terms *Assessment, distance learning, outcomes assessment.*

INTRODUCTION

There are several studies of the performance of students in traditional, face-to-face courses offered in distance learning

mode, for example [1]. In general, these studies show no significant difference in student performance between the two modes of instruction. However, they are typically limited to student performance in individual courses. They do not assess how well students retain the knowledge gained in these courses and how well they perform in subsequent courses that use this knowledge. In this study, we assess the performance of students in a computer engineering design laboratory course after they had taken a prerequisite course in computer architecture, some in distance learning mode and others in face-to-face mode.

CoE 353, Advanced Computer Architecture, is a required course for computer engineering undergraduate junior students at the New Jersey Institute of Technology (NJIT). Students minoring in computer engineering may also take this course as a technical elective. It covers several topics in computer system design; of these, Central Processing Unit (CPU) design and microsequencer design are used in the follow-up laboratory course. For the students in this study, the course used [2] as its textbook (although the course now uses [3]). This course is offered three times annually in face-to-face mode, and once per year in distance learning mode.

After successfully completing CoE 353, computer engineering students take CoE 485, Computer Engineering Design Laboratory, typically during the following semester. This course incorporates five open-ended multi-week design experiments, and uses a laboratory manual developed at NJIT [4]. Of the five experiments, the last two require the design of two CPUs, one with a hard-wired control unit and the other having a microcoded control unit. These two experiments comprise more than half of the course meetings and directly rely on the material covered in CoE 353. This course is offered only in face-to-face mode.

The content of the distance learning version of CoE 353 is identical to that of the face-to-face version of the course; only the mode of delivery varies. The face-to-face version meets twice per week for 1 1/2 hours per meeting. The distance learning students view videotaped lectures in lieu of class meetings. These students also communicate with the instructor and with each other using the Virtual ClassroomTM [5], an asynchronous learning network designed for educational use. Students decided whether to take the course in face-to-face mode or distance learning mode. The course

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sections covered in this study were all taught by the same instructor.

The rest of this paper is organized as follows. The hypothesis and research design are presented next, followed by a description of the data collection and analysis procedures. Results are then given and discussed. A summary and recommendations for future work conclude this paper.

HYPOTHESIS AND RESEARCH DESIGN

The researchers compared the performance of two groups of students who took Advanced Computer Architecture (CoE 353) and Computer Engineering Design Laboratory (CoE 485) courses; the former is a prerequisite for CoE 485. The first group took CoE 353 in face-to-face mode and the second group took CoE 353 in distant learning mode. Due to the fact that both courses are closely linked, the researchers were testing whether one mode was preparing students for the next level course better than the other. The study was designed to test the hypothesis that mode of instruction (face-to-face or distance learning) does not make any difference in students' performance in either the Advanced Computer Architecture course or the Computer Engineering Design Laboratory course.

PROCEDURES

The researchers compared groups' demographic and educational characteristics to see if there were any differences between them. Then, correlation analysis was conducted to see if there was a correlation between students' demographic or academic characteristics and their scores on CoE 353 and CoE 485. Finally, T-tests were performed to see if there were any statistically significant differences in the groups' performance in CoE 485 and in CoE 353.

LIMITATIONS OF THE STUDY

The study had a few limitations. First, students were not randomly selected to the groups; the selection was based only on their willingness to be in distance learning or in face-to-face course. Such self-selection was explained by non-academic reasons, such as a conflict of scheduling with other courses or a part-time job, or the level of familiarity with on-line education, thus self-selection could not have had any impact on the academic performance. A second limitation was the number of participants, which was not big enough for the study to have significant external validity. At the time when this research was conducted, CoE 353 and CoE 485 were the only courses which were taught by the same instructor, so teaching and grading were the same for all. The researchers will continue their studies using larger populations.

DELIMITATIONS OF THE STUDY

Although CoE 353 is a lecture course and CoE 485 is a laboratory course, the authors assumed that students' learning styles did not have a significant effect on the outcomes of CoE 485.

RESULTS

The analysis showed that both groups have similar racial, ethnic and age characteristics. When groups' SAT scores were compared, it was found that the group that took CoE 353 in face-to-face (FTF) mode had lower SAT scores (586 math and 476 verbal) compared to the group which took CoE 353 in distance learning (DL) mode (594 math and 507 verbal). The difference in math SAT scores between two groups is not statistically significant; the difference in verbal SAT scores is statistically significant at .05 probability level. The researchers did not find any correlation between student verbal SAT scores and their performance in the two courses. A moderate correlation (Pearson Product Moment correlation) of $\rho = 0.53$, was found between students' scores on math SAT and performance on CoE 353. The correlation between math SAT and CoE 485 was also moderate, $\rho = 0.47$. The students who took CoE 353 in FTF mode performed better in this course than those who took this course in DL mode; subsequently, FTF students performed better in CoE 485. (See Table I). The study found very little correlation, $\rho = 0.14$, between the mode of teaching, FTF or DL, and student performance in CoE 353, and an even smaller correlation, $\rho = 0.12$, between the mode of teaching in CoE 353 and performance in CoE 485.

TABLE I
STUDENT BACKGROUND INFORMATION AND PERFORMANCE IN CoE 353 AND CoE 485

Mean Values	FTF Group (N=49)	DL Group (N=44)
HIGH SCHOOL ACADEMIC PERFORMANCE		
Math SAT	586	594
Verbal SAT	476	507
High school ranking	42	39
COLLEGE ACADEMIC PERFORMANCE		
Grade Point Average	2.85	2.75
Attempted credits	121	134
Earned credits	112	113
CoE 353 grade	2.05	1.70
CoE 485 grade	2.87	2.55
CORRELATION ANALYSIS		
Math SAT and CoE 353		0.53
Math SAT and CoE 485		0.47
Learning mode and CoE 353		0.14
Learning mode and CoE 485		0.12

DISCUSSION

The research was limited to 93 students only and it was impossible at the time of the study to find any advantages of the distance learning over face-to-face or vice versa. Judging by the math SAT scores one could assume that students in the study who took a DL course came to college better prepared than those students who took CoE 353 course in FTF mode, and thus would perform better on both computer engineering courses. However, the results showed the opposite; FTF student outperformed DL students in both courses, even though a correlational analysis found a positive correlation between math SAT scores and performance in CoE 353 and CoE 485. Other NJIT studies [6] confirm that math SAT scores cannot be used as predictors of student achievement at the college level. It is also important to mention that correlational analysis points to the fact that there is a relation between two variables but it cannot prove that one variable is the cause and the other is an effect. Other NJIT studies [6] confirm that math SAT scores cannot be used as predictors of student achievement at college level.

As noted earlier, the authors assumed that students' learning styles did not have a significant effect on the outcomes of CoE 485. Although this may be perfectly valid, it has not been proved here. For instance, it is possible that some students may perform particularly well in lecture courses, but not so well in hands-on laboratory courses, or vice versa. It will be necessary to study more sequences of courses, some consisting solely of lecture courses, and others containing a mixture of lecture and laboratory courses, to test whether or not this assumption is correct.

SUMMARY

This study has used an outcomes based assessment to analyze the effect of the mode of instructional delivery on student performance. Specifically, it examined how students who took a computer architecture course in either face-to-face mode or distance learning mode performed in a subsequent computer engineering design laboratory course. Although the mode of instruction had no significant effect on student' grades in the computer architecture course, students who took this course in face-to-face mode performed significantly better in the subsequent design laboratory course than students who took the architecture course in distance learning mode.

This study has probably raised more questions than it has answered. If this result is typical of most or all courses, it is possible that the mode of instruction has an effect on the long-term retention of knowledge and the students' ability to apply knowledge to new situations. However, given the limitations of this study, this result cannot be completely verified. More studies like this, across a broad range of courses and having larger numbers of students, are needed before any definitive conclusions can be made.

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