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ABSTRACT

On-line courses have become an important component of the delivery of courses in all areas of education. The validity of online delivery is challenged if Web students perform poorly in subsequent major courses. This paper investigates the effect of mode of delivery and other factors on the level of success, failure, potential, and limitations of web delivery in course sequences. This study was conducted on a two-course sequence in the Computer Information Systems Department at Metropolitan State College of Denver. The result of this research identifies important factors impacting student success in this two course sequence.

INTRODUCTION

During the last decade research and statistical analyses of student grades consistently pointed to equality between classroom and the Web courses. The social aspects of online student behavior have been researched. Some research has found that students participate more in class discussions when the course is delivered electronically than they would in a traditional class (Burgstahler, 1997). Time and again, no significant differences were found in final grades between Web and classroom delivery of courses. Differences in final grades between Internet students and classroom students have been found not to be statistically significant by numerous researchers (Bowman, 1995; Marold, 2003; Mawhinney, 1998; Schulman, 1999). Differences in performance were found when students were broken into categories based on ability as measured by GPA (Marold, 2002). Specifically the mid-level students were most affected by the delivery mode. The credibility of courses completed online as opposed to the classroom has also been analyzed (Moreno, 2000). However, the general consensus was that Web courses were working, and that colleges were justified in forging ahead with plans to put entire curricula online.

The first courses to be put online in Information Systems departments were generally the lower level service courses or courses which were Level 1 or Level 2 in Bloom's Taxonomy (Bloom, 1956). These on-line courses were enthusiastically received by students and faculty alike. When higher level courses that concentrated on problem solving and analytical ability (Bloom's Level 3 through Level 5) were put online, faculty began to notice that students taking subsequent courses who had taken the Web-delivered version of the prerequisite had difficulty applying concepts and developing a solution to a problem. Perhaps the Web-delivered CIS courses requiring this higher level of problem solving were not as successful as the earlier courses which taught students more basic skills. When faced with putting courses that involve problem solving and higher analytical reasoning on the Web, there was concern that the initial success of the first

Internet courses was not being repeated. It was time to re-examine the validity of claims of Web course success, and move to examine the delivery mode and other factors that affect student performance in CIS course sequences.

RESEARCH QUESTION

The authors of this study are professors of Information Systems courses at a large (20,000 students) urban state college in Denver, Colorado. Sections of CMS 2010 Computer Applications for Business have been offered online since 1996. This course is required for all School of Business majors, whether they will pursue a major in CIS or not. CIS majors are required to take CMS 2110 — a problem solving and logic course — which requires CMS2010. CMS2110 has been offered on the Web since 1999. The investigation and data analysis of this study stemmed from the authors' observations of student performance in the CMS 2110 course. In the early semesters of students fulfilling the prerequisite for the course by taking the online version, the authors noticed numerous egregious errors by students in the application of theory on tests, homework, and projects. The practical work submitted by the online students demonstrated lack of understanding of crucial topics. Could this be attributed to the fact that some of these students had taken the prerequisite course online? Were there other factors as well such as time elapsed between the two courses, that might explain the differences in student progress in the CMS 2110 course?

The authors determined that a robust analysis was necessary to examine the effect of Web delivery in course sequences. Although the lack of true understanding of concepts appeared to be a problem, it was not certain how widespread this problem was, or whether the mode of delivery was a factor. A study was designed and tested to address these questions. As a result of this effort, factors such as delivery mode were examined to determine their effect on student performance in the second course in a two-course sequence.

LITERATURE REVIEW

While there are a myriad of studies on Internet courses and their success, there is not enough on the more subtle aspects of the success or failure of these courses in relation to preparation for subsequent courses. In 1998, Mawhinney and Morrell recommended putting reliable mechanisms in place for predicting success in the first required CIS major course. Students successes in their IS major often are directly impacted by how well prepared they are for their first major course. Therefore investigating if performance in an online version of a prerequisite course was a predictor of success in the subsequent first major course (CMS 2110 in this case) was warranted.

A wealth of research has already been done on final grades, design of Web courses and delivery of hybrid courses. Research has reported the advantages and disadvantages of Web courses, for both students and faculty (Presby, 2001; Mawhinney, 1998; Dager, 1998) found that online training and Web-based training can have greater value today because the courses can be much more interactive, and the results can be tracked automatically. Student demand for complete degrees and certificates of training was found to be increasing significantly by Nixon (1998).

Kroder (1998) reported that 8 out of 10 students who responded to a survey of Web course satisfaction said they would take another Internet-based course even though it took more time than a classroom course. The differences in performance and achievement among Web students and classroom students have also been analyzed. Achievement, as evidenced by testing was found to be higher in the Web students; however, performance on projects and homework submissions was found to be higher in classroom students and lower in Web students (Marold, 2002.) The attrition rates and failure rates for online courses, and all distance education courses in general, have always been higher than in the classroom. Terry (2001) found that the attrition rates for online MBA courses not only were higher than in the classroom, but as the courses became more analytical and theoretical, the attrition rates increased. A preliminary study found that students who took a prerequisite (CMS 2010) online fared worse in the subsequent course (CMS 2110) than students who took the prerequisite in the classroom (Pence, 2003).

Widespread research on the success of Web delivered courses at all levels continues. This research compares student performance in a sequence of courses, based upon whether the students had taken the prerequisite course online or in the classroom. College records were analyzed from 1999 to 2003 to see if they could reveal a relationship between mode of delivery and performance in the subsequent required CIS classes.

METHODOLOGY

Data Collection

Data was collected from the college's database for students from Fall 1999 to Fall 2003 in two courses: CMS 2010 (Computer Applications for Business) and CMS 2110 (Business Problem Solving: A Structured Programming Approach). CMS 2010 is a prerequisite for CMS 2110. One of the predictors of success for students in CMS 2110 is the mode of delivery for the prerequisite CMS 2010; therefore, data was captured for the delivery mode for both courses. Another predictor is the abilities of the student as measured by GPA. Both the GPA before taking CMS 2010 and before taking CMS 2110 was captured. Table 1 shows the data captured for each student.

Variable Description	
Student ID	CRN for 2110
Student name	Delivery method for 2110
Gender	Year/semester 2110 last taken
Student's major	when2110 minus when 2010
Major	Semesters between 2010/2110
Delivery method for 2010	GPA just prior to 2110
Year/semester 2010 last taken	Number of times 2110 attempted
GPA just prior to 2010	Number of credits transferred
Number of times 2010 attempted	Grade in 2110 [last attempt]
Grade in 2010 [last attempt]	Transfer student status

Table 1: Data Captured For Each Student

Sample Characteristics

The merged files for these two courses resulted in 1,387 usable records. There was one record per student, each record representing the student's last attempt at either course. Thirty-eight percent of the students were females. Fifty-four percent of the students were declared Computer Information Systems majors. Thirteen percent were undeclared majors. The remaining thirty-three percent were declared as majors in 45 different academic programs.

The grade data for the two courses were converted into equivalent numeric scores (A = 4, B = 3, etc.). For purposes of this analysis, I (incomplete) and NC (no credit) grades were treated as being equivalent to F, since these represent students who did not successfully complete the courses. Figures 1 and 2 depict the letter grade distributions for these courses. An EX grade represents a student who received credit for CMS 2010 through an exemption exam (minimum score of 80 required). When the NC grades are added to the F grades in CMS 2110, the resulting distribution is bi-modal, which is not uncommon at our institution. The mean grade in CMS 2010 was 3.13 and the mean grade in CMS 2110 was 2.46. Although the mean grade in CMS 2110 was significantly lower, there are several things which must be pointed out before drawing the conclusion that CMS 2110 is the more difficult course. CMS 2010 is the prerequisite to CMS 2110 and must be passed prior to taking CMS 2110. The CMS 2010 students in this sample are a subset who have chosen to take CMS 2110. The majority of students who take CMS 2010 do not take CMS 2110. CMS 2110 does not require a minimum grade of C to count toward the CIS major, but CMS 2010 does require a minimum grade of C to count for all students majoring in Business programs (including the CIS major).

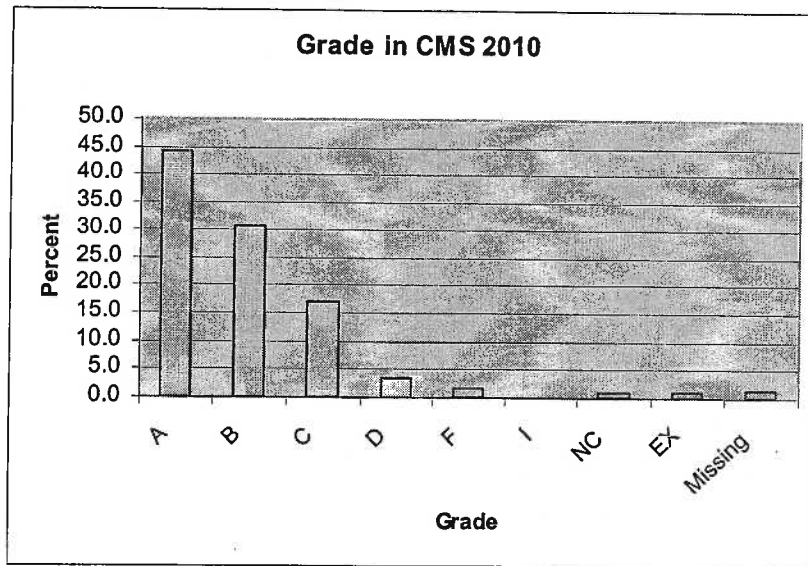


Figure 1: Grade in CMS 2010

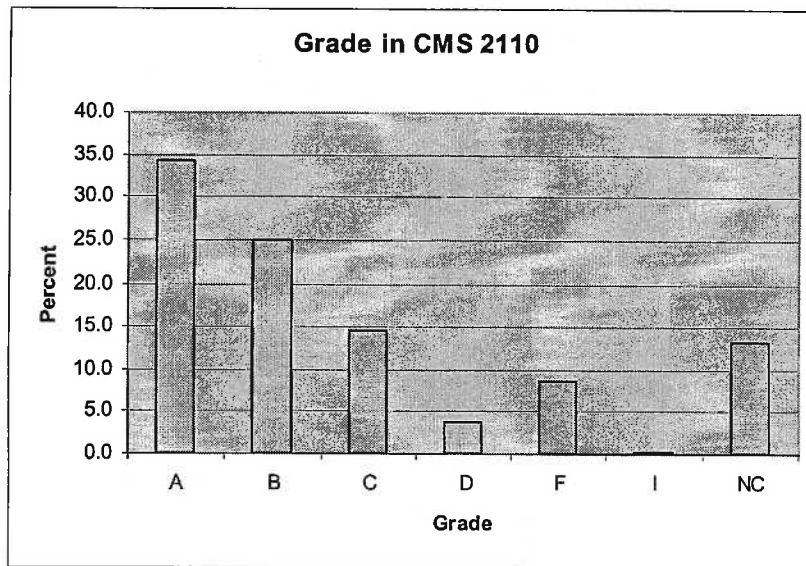


Figure 2: Grade in CMS 2110

Figures 3 and 4 depict the GPA distribution of the students just prior to taking CMS 2010 and just prior to taking CMS 2110. A fairly large proportion (23%) of the students had a GPA of zero prior to taking CMS 2010. This was not consistent with the aforementioned pilot study where the data were retrieved manually, suggesting that the data retrieval methodology may have erroneously reported zero-GPAs instead of blanks for students who had transferred just prior to taking CMS 2010. This anomaly has yet to be verified.

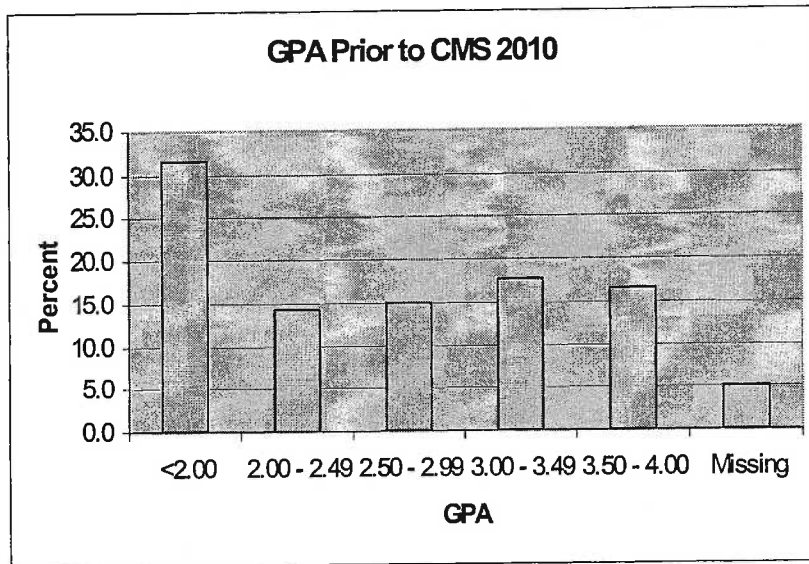


Figure 3: GPA Prior to CMS 2010

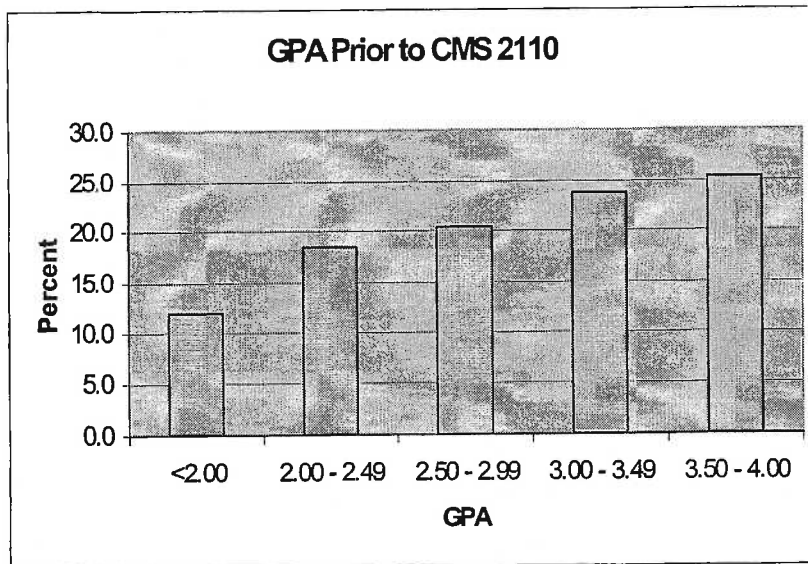


Figure 4: GPA Prior to CMS 2110

Figure 5 depicts the distribution of transfer credits. More than sixty percent of students in the sample had transferred one or more credits from another institution. This is consistent with college data which indicate that the majority of our students are transfer students from community colleges and other four year institutions.

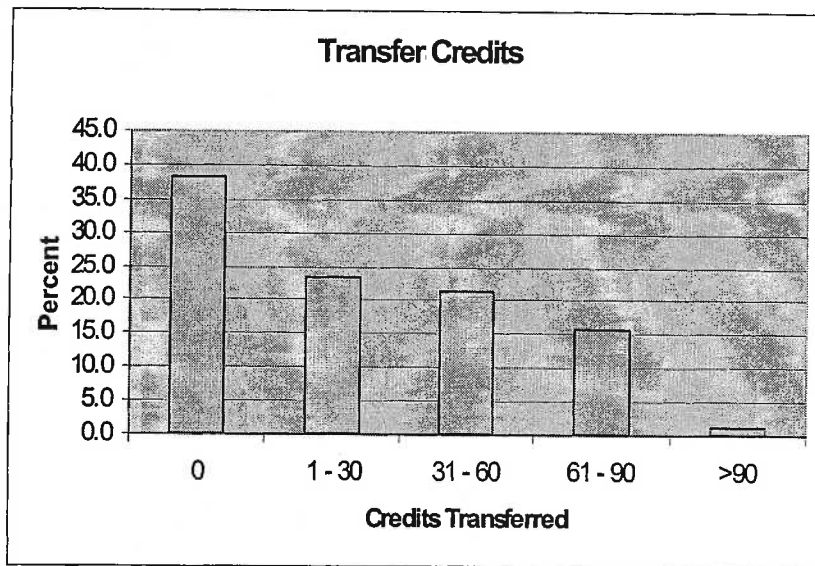


Figure 5: Transfer Credits

Figure 6 depicts the distribution of the time lag between the two courses. A value of zero indicates the two courses were taken concurrently, while a value of one indicates the two courses were taken in immediate succession. The “missing” values reflect students who apparently took the two courses out of sequence. The CMS 2010 grades of these students were not included in the analysis (although the concurrent ones were.) Some of the students who took the two courses out of sequence, were in fact students who had previously taken CMS 2010 but had not achieved a grade of at least C.

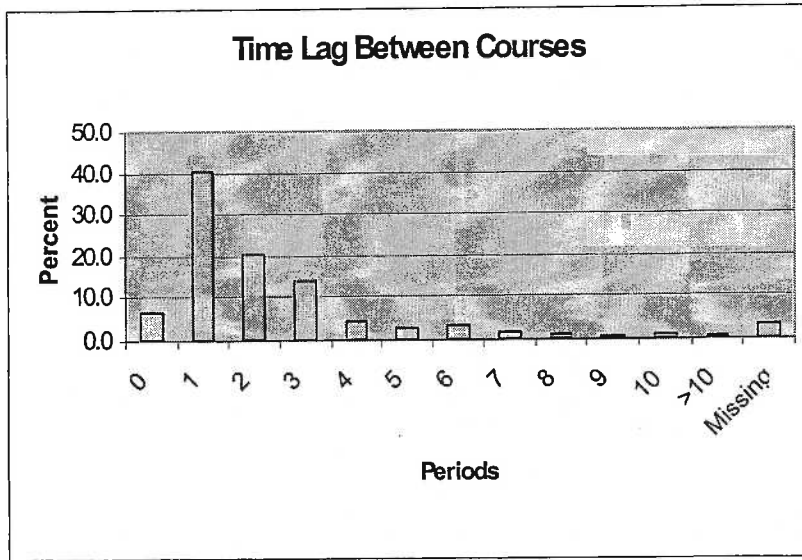


Figure 6: Time Lag Between Courses

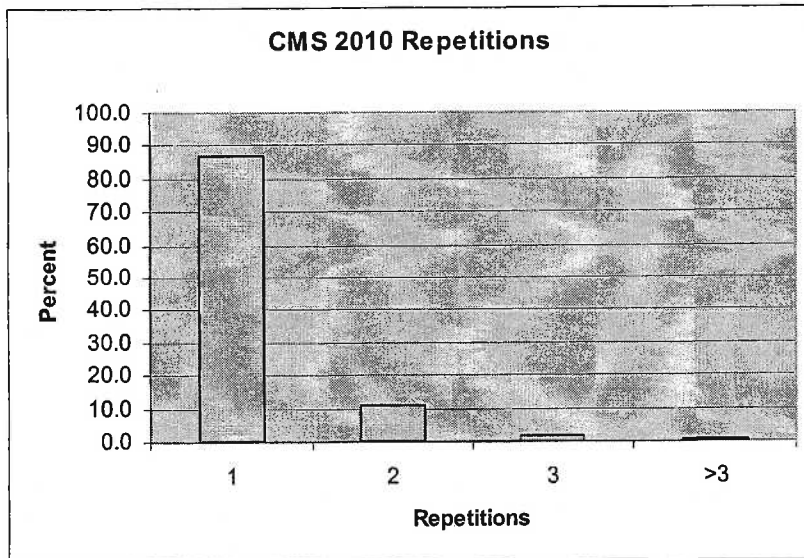


Figure 7: CMS 2010 Repetitions

Figures 7 and 8 depict the number of times students repeat these two courses. The profiles are very similar and more than 85% of the students who take either course do not take it more than once.

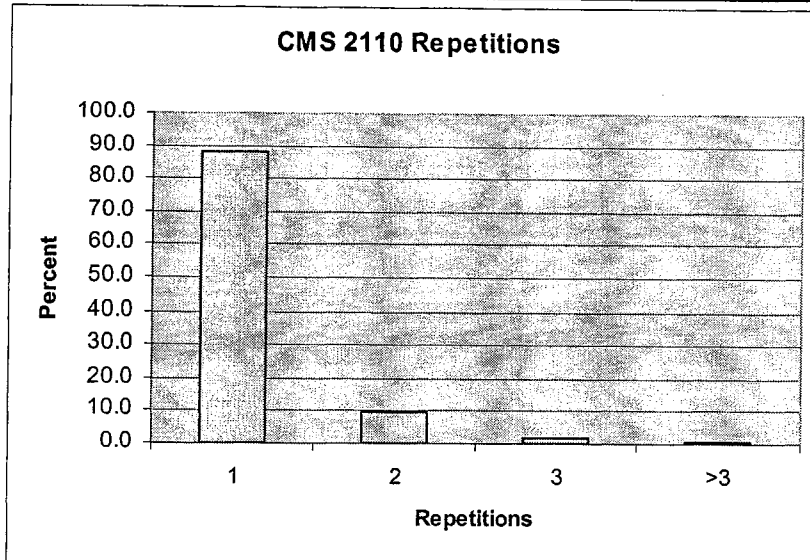


Figure 8: CMS 2110 Repetitions

ANALYSIS

The data were analyzed using the SPSS/PC for Windows statistical package. The correlation of each of the predictor variables with the grade in CMS 2110 was determined using Pearson coefficients (Anderson, 1994; Norusis, 1993).

Table 2 identifies and describes the variables used in this analysis.

The correlation analysis of the predictor variables is shown in Table 3. Of the 15 pair-wise correlation values, all but four were statistically significant at $p \leq 0.05$.

Name	Description	Comment
Gendern	Gender (numeric)	f = 0, m = 1
majorn	Major (numeric)	cis = 1 (for 1 st or 2 nd major), others = 0
gpa2010	GPA just prior to 2010	
rep2010	No. times 2010 attempted	
grd201n1	Grade in 2010 [last attempt] (numeric)	A = 4, B = 3, C = 2, D = 1, F/NC = 0, EX = disregarded
grd201n2	Grade in 2010 [last attempt] (numeric)	A = 4, B = 3, C = 2, D = 1, F/NC = 0, EX = 3
facst0n	Instructor status in 2110 (numeric)	1 = fulltime, 0 = parttime
delv201n	Delivery method for 2010 (numeric)	classroom = 1, online = 0
delv211n	Delivery method for 2110 (numeric)	classroom = 1, online = 0
semlag	Semesters between 2010/2110	0 = concurrent, 1 = previous semester, etc.
gpa2110	GPA just prior to 2110	
rep2110	No. times 2110 attempted	
tranhr	No. credits transferred	
grd2110n	Grade in 2110 [last attempt] (numeric)	A = 4, B = 3, C = 2, D = 1, F/NC/I = 0
transfer	Transfer student status	Non-transfer = 0, transfer = 1
facst1n	Instructor status in 2110 (numeric)	1 = fulltime, 0 = parttime

Table 2: Key to Variable Names

<u>Variable</u>	<u>Pearson</u>	<u>Coefficient</u>	<u>p-value</u>	<u>Significancen</u>	
semlag	-.146		.000	***	1341
gendern1	-.070		.010	**	1385
majorn	.118		.000	***	1386
trahhrv	.121		.000	***	1386
transfer	.083		.002	**	1386
facst1n	-.032		.236		1386
gpa2110	.343		.000	***	1386
rep2110	-.163		.000	***	1386
delv211n	.170		.000	***	1386
grd201n1	.353		.000	***	1356
grd201n2	.350		.000	***	1367
facst0n	.036		.186		1374
gpa2010	.021		.452		1317
rep2010	-.114		.000	***	1386
delv201n	.003		.904		1374
*** Correlation is significant at the 0.001 level (2-tailed).					
** Correlation is significant at the 0.01 level (2-tailed).					
* Correlation is significant at the 0.05 level (2-tailed).					

Table 3: Correlation of Predictor Variable with CMS 2110 Grade

The following predictor variables had statistically significant ($p < .05$ 2-tailed) correlations with course grade in CMS 2110:

- Time Between Courses: students who waited longer after completing the prerequisite CMS 2010 did worse in CMS 2110.
- Gender: females did better than males in CMS 2110.
- Majors versus Non-majors: CIS majors did better than non-majors in CMS 2110.
- Transfer Students: Transfer students did better than non-transfer students in CMS 2110. Students with a higher number of transfer credits did better in CMS 2110.
- Grade Point Average (GPA): Students with higher GPAs just prior to taking CMS 2110 did better in CMS 2110.
- Course Repetitions: students with a higher number of repetitions of CMS 2010 did worse in CMS 2110. Students with a higher number of repetitions of CMS 2110 did worse in CMS 2110.
- Delivery Mode: students who took CMS 2110 in classroom did better than online students in CMS 2110.
- Grade in Prerequisite: students with higher grades in CMS 2010 did better in CMS 2110.

The following predictor variables did not have a statistically significant correlation with course grade in CMS 2110:

- Grade Point Average (GPA): GPA just prior to taking CMS 2010 did not have a significant correlation with performance in CMS 2110. This is contrary to what was found in the aforementioned pilot study and may be due to possibly misreported zero GPA values described above.
- Delivery Mode of Prerequisite: it did not seem to matter in CMS 2110 whether the prerequisite was taken online or in the classroom. It also did not seem to affect the CMS 2010 grade itself whether CMS 2010 was taken online or in the classroom, which is contrary to what we have seen in other courses.
- Faculty Status: whether the faculty member who taught the course was full-time or part-time seemed to have no effect on the CMS 2110 course grade. This was true for both the CMS 2110 instructor and the instructor of the prerequisite CMS 2010

DISCUSSION

An interesting finding is that delivery mode (online or classroom) for the course (CMS 2010) did not affect the student's performance in CMS 2010 nor the student's performance in the subsequent course (CMS 2110). While the delivery mode of the prerequisite did not affect student performance, the delivery mode of the second course, CMS 2110, did make a difference in performance. Students taking this course in the classroom performed better than those students taking the course online.

Perhaps the reason that the delivery mode of CMS 2010 did not make a significant difference in either the student's performance in CMS 2010 or CMS 2110 is that it is a course designed for business majors in general and not geared specifically to CIS majors. Most of the data analyzed came from sections of CMS 2010 prior to Fall 2002. Prior to Fall of 2002, CMS 2010 had no enforced prerequisites, and much of the course was basic computer terminology and basic hands-on skills in word processing and electronic spreadsheets. Even after the course was updated to cover topics more in-depth and a computer literacy prerequisite added, there is still a minimal amount of higher level logic, analysis, and problem solving required. Exams are entirely multiple-choice, requiring a lower level critical thinking. The fact that it was found that the delivery method of CMS 2010 had no effect on performance in 2010 is consistent with research that has shown that students perform as well in online courses when the level of critical thinking and analysis is at a lower level.

It is also possible that the benefit students obtain from learning to work on computer problems on their own instead of relying on an instructor leading them through such topics as Electronic Spreadsheets and Database offsets any disadvantage in not having an instructor to explain, emphasize, and reinforce key points. Learning on their own to do lower level problem solving setting up electronic spreadsheets and databases could possibly give students a head start on the types of problems that they must learn to solve in CMS 2110. As an example, students must learn to write a simple IF statement in EXCEL in CMS 2010. Further, it is possible that the self-selecting population of students taking CMS 2010 online is to some extent students that enjoy working with computers and excel at problem solving and other skills needed to be successful in CMS 2110.

The fact that there was a significant difference found in performance in CMS 2110 based on delivery mode is consistent with previous research that has shown that students perform worse in online classes when the course requires higher level analytical thinking and problem solving.

Another important finding was that grade in the prerequisite course and the time between taking the prerequisite course and CMS 2110 course were significant. Together, this would seem to validate that while the delivery mode of CMS 2010 is not important, it is important for CMS 2010 to be a prerequisite. It was found that especially after a four or more semester lag between courses, grades in CMS 2110 were much lower. It was also found that students that took the courses out of sequence performed worse.

Transfer students outperformed non-transfer students, and the more credits they transferred in, the better they performed. The authors believe this can be explained by the characteristics of our transfer students. Many students transferring into the CIS program are second-degree students, who already hold a degree from another institution and are coming back for retraining in the IS field. Others are transferring in one or more computer programming courses that cover some, but not all the topics covered in CMS 2110, so they end up taking the course. The prior experience they gained in their transfer classes gives them an advantage over students that have only taken the prerequisite CMS 2010. Finally, transfer students at this institution are typically older students than non-transfer students and have a higher maturity level and commitment to succeed. Many have also had some work experience related to the IS field.

Other research findings confirm what one would expect. Students majoring in Computer Information Systems (and thus hopefully more interested and dedicated to the topic) performed significantly better in CMS 2110 than other majors. Both courses are very tightly coordinated in terms of exams and assignments, so as expected there was no significance found based on whether the courses were taught by full-time or part-time instructors. Students with higher GPAs prior to taking CMS 2110 performed better. Students that did not complete CMS 2010 successfully on the first attempt performed worse in CMS 2110.

CONCLUSIONS

The research indicates that student who take a prerequisite course in an online delivery perform just as well in a subsequent course in a CIS sequence as do students who take the prerequisite in the classroom. This is not what most of the authors expected. However, the result could be due to poor coupling between the courses in terms of course content. A more tightly coupled sequence needs to be examined to verify the findings in this research. Sequences such as CMS 2110 and one of the departments 3000 level programming language courses will likely produce different results. Additional sequences such as an introduction to Database Management Systems and Database Development, Web Development and Web Site Administration, and Statistics I and II will be examined in the near future.

The research validates that the material covered in CMS 2010 is important to have prior to taking CMS 2110. Students who have taken CMS 2010 several years ago should perhaps be advised to consider retaking the course.

Finally, the research indicates that further study regarding the online delivery of CMS 2110 is warranted. It was found that students generally performed worse in the online delivery version of the course. How will this affect performance in subsequent courses in the students CIS program? Do all types of students perform more poorly in the online version of the course, or are there certain characteristics of students who perform poorly that can be identified? Could these characteristics then be used to identify the students who should be advised not to take the online version of the class? Research on factors that impact student performance in a course sequence continues.

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