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The Emerging Profile of the On-line Learner: Relating Course Performance with Pre-tests, GPA, and other Measures of Achievement

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ABSTRACT

In a continuous improvement research project aimed at identifying the students who are best suited for Web-delivered programming courses, the authors gathered data from five online and five classroom sections of Visual Basic programming at Metropolitan State College of Denver and compared it. All sections of the course used the same syllabus and assignments, and were taught from a centralized, standardized process by the same instructor. Internet students in the midrange of achievement level were affected more by delivery method than those at either the high end, or the low end of their achievement level, as measured by GPA. The research culminates a three-year study on delivering higher level CIS curriculum via Web courses. The authors conclude that more study is needed, but are convinced that the mid-level B or C student is most affected by Web delivery, and design and delivery of programming courses via the Web need careful attention.

INTRODUCTION

Web-delivered courses are here to stay. Students like them, instructors like them, and administrators like them—all for different reasons. Nevertheless, earning legitimate college course credit via the Internet is now firmly established. The common problems present in higher level, critical thinking courses delivered via the Web is also well researched by now. There are problems and significant issues, as was noted in earlier research by ourselves and by others trying to measure the success of online learning [10], [14], [7, [11],[12],[13], [19]. The first courses to be put online in Information Systems departments were generally the lower level elective courses, and courses which were survey or retention-oriented courses. When faced with putting courses that involve problem solving and higher analytical reasoning on the Web, the initial success of the first Internet courses would not be repeated. *All* Web courses were not working. The attrition rate was higher for upper level, more analytical courses, and the failure rate was greater. The performance, as measured by projects completed, was not equal to classroom sections, even though final grades were often not significantly different.

Results of several research projects over the last five years were inconclusive. Yet it was evident that for some students the method of delivery of course curricula made a difference in their learning. Most certainly, in both delivery methods, there were those students at the high end who would succeed regardless of the delivery, and likewise, there was the group at the bottom level that would not succeed in either environment. However, the middle tier might be more vulnerable to delivery method, and for them the difference in mastering concepts might be related to whether they took their programming class online or in the classroom. In an attempt to separate out those students who would be most affected by mode of delivery, a pretest on the prerequisite knowledge for the Business Application Development with Visual Basic course was administered during the first three weeks of class to students in both the online sections and the classroom sections. The authors were motivated to validate through this research what they most certainly were seeing in the two populations—classroom and Internet. What they knew to be true had eluded them in the two phases of research prior to this final project.

RESEARCH QUESTION

The authors of this study had recently offered sections of CMS 3145 Business Application Development with Visual Basic on the Web. A study was done in 2000 examining data from two courses—Telecommunications Systems and Visual Basic. Although results were interesting, they were inconclusive [7]. The authors decided to re-examine the question the following year when there were more data available on Web students; the sample could be drawn from just one course instead of a combination of the two. The authors suspected the level of learning in other 3000 level classes delivered on the Web was not at the 2 or 3 (apply, relate, analyze) level of Bloom's taxonomy [1]. They suspected from observation and grading of assignments and tests that there may be significant differences in student ability to apply IS theory when students took a course online. Does the delivery mode in upper level classes make a difference or not?

LITERATURE REVIEW

A wealth of research has already been done on final grades, design of Web courses and delivery of hybrid courses [16]. Research has reported the advantages and disadvantages of Web courses, for both students and faculty [12]. The social aspects of online student behavior have been researched [13]. Burgstahler found that students participate more in class discussions when the course is delivered electronically than they would in a traditional class [4]. Dager 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 [6]. Student demand for complete degrees and certificates of training was found to be increasing significantly [15]. Kroder 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 [8]. Differences in final grades between Internet students and classroom students have been found not to be statistically significant [17] [11] [3] [12]. The differences in performance and achievement among Web students and classroom students have even 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 [10]. The credibility of courses completed online as opposed to the classroom has been analyzed [14]. Research on the levels of computer literacy by students taking Web courses showed that most students were at a competent level on the Bodker [2] scale, but not at either extreme on the scale—the novice or proficient level. [10]. Web literacy and computer literacy in general did not seem to be a barrier to taking an upper level course online.

The attrition rates and failure rates for online courses, and all distance education courses in general, have always been higher than in the classroom [9]. Terry 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 [19]. The attrition rate in Quantitative Analysis was 33%, and in Statistical Methods in Business was an astounding 43%. The natural conclusion was that courses requiring extensive mathematics and problem solving were more difficult to convert to an Internet format. The course that was the subject of this study requires a higher degree of analytical and problem solving ability. The authors investigated the differences in ability of Internet and classroom students to apply the theory contained in the programming course, finding limited differences [10]. It was obvious that after the initial early "honeymoon" reportings of Web course successes, there were some more serious issues to consider than simply whether Web courses were successful. Not all students benefit equally from online Web courses. The question becomes, "*Which* students are more affected by delivery modes? "

RESEARCH PLAN

The authors' original plan was to use the screening pretest as a means of separating the low achieving, middle achieving, and high achieving students. It was thought that the high-achieving students would do well in the programming course, regardless of whether they were in the classroom or online. Likewise, the low-achieving students—those who would fail to complete the course, drop it, or receive an F would be more likely to fail regardless of the delivery mode. There are always a larger percentage of the latter students in Web courses. Those students are often characterized by a lack of realization of limitations; they believe that if they take the course on the Web, it will be easier to complete than it is in the classroom. They equate convenience and lack of formal classroom meetings with success [20]. The middle tier, those students with B and C, grades are the ones for whom the delivery mode would be most crucial. The authors initially gathered data from two groups of online and classroom sections of a programming course.

In the first two phases of this three-phase research project, grades from projects and application portions of tests were gathered and analyzed. The plan was to compare (one tailed t-test) grades on application of theory , both on tests and on project assignments turned in to see if there were differences in student ability to apply concepts learned. The initial results of that research were reported in 2002 [10]. In this final phase of the research project with expanded and more complete data, the concentration shifted to identifying the student who was most likely to be affected by Web delivery versus classroom delivery of the Visual Basic programming course.

The research questions then could be phrased as follows:

Null Hypothesis$_1$: Students taking a programming course via the Internet who are low achievers, as measured by GPA, will be able to apply IS theory learned as well or better than students taking a programming course in a traditional classroom, as evidenced by grades on projects and applied test problems.

Alternate Hypothesis$_1$: Students taking a programming course via the Internet who are low achievers, as measured by GPA, cannot apply IS theory learned as well as students taking a programming course in a traditional classroom, as evidenced by grades on projects and applied test problems.

Null Hypothesis$_2$: Students taking a programming course via the Internet who are mid range achievers, as measured by GPA, will be able to apply IS theory learned as well or better than students taking a programming course in a traditional classroom, as evidenced by grades on projects and applied test problems.

Alternate Hypothesis$_2$: Students taking a programming course via the Internet who are midrange achievers, as measured by GPA cannot apply IS theory learned as well as students taking a programming course in a traditional classroom, as evidenced by grades on projects and applied test problems.

Null Hypothesis$_3$: Students taking a programming course via the Internet who are high achievers, as measured by GPA, will be able to apply IS theory learned as well or better than students taking a programming course in a traditional classroom, as evidenced by grades on projects and applied test problems.

Alternate Hypothesis$_3$: Students taking a programming course via the Internet who are high achievers, as measured by GPA above 3.5 cannot apply IS theory learned as well as students taking a programming course in a traditional classroom, as evidenced by grades on projects and applied test problems.

Methodology

The authors developed a plan to collect data for four semesters from student scores on applied portions required of all students in the Business Application Development with Visual Basic course.

The authors were surprised that an analysis of the aforementioned pre-test data with exams scores and project scores showed that the correlations were very low. The correlation between the pre-test score and the exams was significant (p=.044) but was only (.317). More shocking was the fact there was absolutely no correlation (.064, p=.686) between the pre-test score and the projects. The authors' only guesses as to why there was little correlation was that 1) The students did not make a serious effort at the pre-test since it was not counted in their grade and/or 2) The pre-test itself did not measure students' ability to solve logical problems. Given the low correlations, the authors abandoned any further attempt to analyze the data by using the pre-test scores to attempt to group the students.

After much discussion, it was decided to gather additional data by looking up each student's GPA, and see if that was highly correlated to performance on exams and projects. Using GPA had been considered before devising the pre-test, but was dismissed due to the fact the students GPA would be highly dependent on what types of courses they had taken prior to the programming course (not to mention the hours that would have to be spent looking up each student's GPA). It was found that GPA was indeed highly correlated to both exams scores and project scores. The authors then decided to make use of two additional semesters worth of data that was available, without the pre-test scores. With this additional data and increased sample size, the correlation between GPA and exams scores was .610 (p=.000), and the correlation between GPA and projects was .560 (p=.000)

It was decided to consider students with a GPA>3.5 to be the high-achievement group of students, students with a GPA<2.5 as the low-achievement students, and the remainder the middle-achievement group of students. Although a GPA from 2.0-2.5 is acceptable for graduation in most majors, it was felt that a student with a GPA below 2.5 would have a very difficult time in a course requiring a very high level of problem solving and logic abilities as well a much larger time commitment compared to most courses Of a total of 133 students, 34 fell into the high-achievement group, 76 fell into the middle-achievement group, and 23 fell into the low-achievement group. The number of classroom students versus the number of Internet students in each category was almost equally divided (13 versus 10 for the low-achievement group, 38 versus 38 for the middle achievement group, and 15 versus 19 for the high achievement group.) It should be noted that if students withdrew from the course, or they did not complete at least 2 exams, or 2 projects, they were not included in the study. (If the latter had not been done, there would most likely have been many more students in the low-achievement group.) The fact that these groups were split almost equally added to the concern that the authors had in that students appear to not be making the decision to choose an Internet versus a classroom delivery mode based on their achievement level. One would think that the Internet sections would have a much higher proportion of high-achievement students, and a much lower proportion of low-achievement students.

This characteristic of Web course populations is reported in other research as well [20], [5], [18].

Data Analysis

The data were entered and analyzed with the *MINITAB* software program. In the Visual Basic programming course, the major student assignment was to submit three phases of a semester-long project. Each phase covered four or five chapters of programming concepts. Students were required to apply concepts from each chapter by designing, coding, and debugging functions and subroutines to process forms. Three exams were given, with each exam covering the same material as the three phases of the project. Part II of each of these exams consisted of five essay/coding problems. The average of the three phases of the project was calculated, as was the average of the applied portions of the three exam scores (weighted at 50% of the exam.). For the purpose of this analysis, it was decided that students would be graded only on work attempted, assuming at least two of the three scores were available. Thus the average for a project score or exam score could be based on either two or three scores. No average was calculated for students completing only one of the three scores. A one-sided t-Test was then used to compare the difference between classroom and Internet students, for each of the three achievement-level groups on both the projects and exams.

The data for the high-achievement group is summarized in Table 1. The mean scores for exams were identical between the two groups (85% versus 85%). The null hypothesis was not rejected, with a p-value of .49. Classroom students slightly outperformed Internet students on projects (88% versus 84%), but this was also not significant with a p-value of .23. Despite the relatively small sample size, the results seemed to confirm the authors' sense that high-achieving students can learn and apply difficult programming concepts in both an online and classroom environment.

The data for the low-achievement group is summarized in Table 2. Results were mixed, with Classroom students outperforming Internet students by 58% versus 47% on exams (p=.078), but actually scoring lower on projects 54% versus 57% (p=.60). Again although the sample size was small, the low scores seemed to agree with the authors' belief that lower-achieving students will likely be unable to learn and apply difficult programming concepts regardless of whether they take the course in an online and classroom environment.

Table 2: CMS 3145 Results – Low-Achievement Group

Delivery (n1, n2*)	Exams	Projects
	Mean (st dev)	Mean (st dev)
Classroom (13, 11)	.58 (.12)	.54 (.23)
Internet (10, 8)	.47 (.20)	.57 (.27)
t-Test (p-value)	1.5 (.078)	-0.27(0.60)

*n1= number of students attempting at least two of the three exams
n2= number of students attempting at least two of the three projects

The data for the middle-achievement group is summarized in Table 3. Students in the classroom sections outperformed students in the Internet sections on exams by an average of 75% versus 69%. This was significant at p=.052. Classroom students also outperformed Internet students on projects, 80% versus 68%. This was highly significant (p=0.004). This data provided the strongest evidence of what the authors believed, that middle "B" and "C" students benefit the most from a traditional classroom setting in a difficult problem solving type of course.

Interpretation of Results

This culmination of a three year study of Web courses and their successes or failures has resulted in a shifted emphasis: the focus turned to the student that is affected the most by an online environment. The first two stages of research focused on the course itself. Findings from the second phase pointed to serious problems with upper level, more analytical problem solving courses. Findings were somewhat inconclusive, but they showed when comparing performance across classroom and Internet students that some Internet students were seriously affected by delivery mode. This research shows the traditional classroom still works, and it appears to work better for the mid-level achiever. The profile of the online learner is still emerging, but the triadic division of achievers allows us to focus on the majority of all students—those at the mid-level.

We conclude that at least within the realm of online programming classes, the mid-range student is more apt to have difficulty applying the theory of programming problems than his/her classroom counterpart. The vast majority of students seeking a college degree in information systems are at the mid-range level; therefore these findings are extremely important. There are students at the high-achievement level in Web courses that may have trouble applying programming concepts, too, but not an alarming amount. Good students are resilient in all types of environments. For these students, online Web courses are truly a blessing. They are motivated, independent workers who are able to progress beyond where they might in a traditional classroom.

Table 1: CMS 3145 Results – High-Achievement Group

Delivery (n1, n2*)	Exams	Projects
	Mean (st dev)	Mean (st dev)
Classroom (15, 15)	.85 (.17)	.88 (.13)
Internet (17, 17)	.85 (.11)	.84 (.19)
t-Test (p-value)	0.02 (.49)	0.73(.23)

*n1= number of students attempting at least two of the three exams
n2= number of students attempting at least two of the three projects

Table 3: CMS 3145 Results – Middle-Achievement Group

Delivery (n1, n2*)	Exams	Projects
	Mean (st dev)	Mean (st dev)
Classroom (38, 38)	.75 (.14)	.80 (.17)
Internet (38, 38)	.69 (.18)	.68 (.20)
t-Test (p-value)	1.65 (.052)	2.73(0.004)

*n1= number of students attempting at least two of the three exams
n2= number of students attempting at least two of the three projects

Likewise, the preponderance of low achieving students in Web courses is a reality, but those students have difficulty in any environment. Perhaps their choice of online courses is unwise, but the situation does not warrant mass hysteria over the failure of Web courses. However, the mid-achievement group—the majority in both Web and classroom courses—are at significant risk when attempting a Web version of a programming course.

CONCLUSIONS

The authors stress that these findings do not indicate that we should stop delivering higher level courses on the Internet. However, an awareness of the risks with Web delivery is the first step toward correcting the weaknesses. While the ideal profile of a successful online student would reveal a self-directed, interested, active learner, the population of students who actually choose to enroll in online courses may include passive learners and individuals who are not particularly suited to the delivery mode. Conscious efforts to discourage inappropriate enrollment in online versions of courses seems to have little impact. The president of The Canadian Association of University Teachers, Tom Booth, notes that these students "are the least able to deal with the frustration and isolation of Web-based distance education" [5]. There are optional "suitability" evaluations and even WBTs (Web based training) modules instructing students how to take Web courses and succeed. Whether or not they are suited for online learning is not one of student's major considerations when signing up for a Web course—convenience, independent learning, freedom from driving to campus, and flexibility are. This is unlikely to change. However, the knowledge that extra effort is indicated when one takes a Web course can inspire us to increase our efforts in designing and delivering Web courses. More explicit emphasis on the actual application of theory or content could be included in the online course delivery materials. Materials that in some way duplicate the use of examples and questions in the classroom might improve on the application aspect once the problem is appropriately recognized. Application of smaller content elements can be required before major projects are presented. Frequent interactive elements in course materials could be especially effective. More interactive exercises and presentation of examples of application of theory might be indicated, rather than a collection of static pages.

It must also be noted that GPAs and traditional grading practices may not focus sufficiently on student ability to apply learned content, leading to grades based more on recognition and recall than on application or analysis. Often, at least a minimal level of application is assumed rather than measured. Measuring higher level learning objectives is considerably more difficult than measuring recognition and recall. Assessment and evaluation of students is complex and educators have long recognized the need for better testing. Roger Shank notes that America is "test obsessed", but it is reluctant to change the methods of testing [18]. Perhaps inappropriate testing and grading methods everywhere contribute to a false outcome when examining the success of Web courses.

The authors remain committed to Web delivery of department courses. They also justifiably remain concerned about the reality of developing critical thinking skills and analytical reasoning online. Most importantly, they remain concerned for the mid-level student for which there is a recognized risk in choosing online programming classes.

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