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ABSTRACT

Many colleges of business now assume incoming freshmen arrive on campus possessing high levels of computer skill and ability. Students are frequently offered the opportunity to take and pass a computer proficiency exam (CPE) in lieu of a freshman information technology (IT) course. While promoted as an efficient alternative, our analysis of the implementation of a CPE as a replacement for the freshman IT course at a small, Midwestern university revealed mixed results. As expected, we found those students who took and passed the CPE generally scored higher in their follow-on, sophomore IT course than those who passed the prerequisite, freshmen IT course. However, the CPE pass rate proved to be significantly lower than that of the course it replaced. This created an unexpected backlog of students unable to enroll in the sophomore IT course, delaying their program of study. Furthermore, over time the CPE highlighted patterns of weakness in students' Excel skills, proving it to be a valuable diagnostic tool. Finally, while the original objective of the CPE had been to replace the freshman IT course, it instead supported the need to reinstate at least some portion of it. This suggests that a hybrid approach may be most effective in ensuring that freshman enter their sophomore year with those IT skills needed most for follow-on course success.

Keywords: Computer Proficiency Exam, Computer Skill Assessment, Prerequisite Course Requirements, Computer Skill Development, IT Course Success

1. INTRODUCTION

The majority of U.S. business schools require freshman and sophomore students to demonstrate proficiency in information technology (IT) as part of their program of study. Students commonly take one or two IT courses during their business core. When two IT courses are required, the first often serves as a prerequisite to the second, higher-level course. While the exact content of these IT courses may vary by university, they commonly incorporate standard IT knowledge such as word processing, spreadsheet modeling, database design, web development, and IT management concepts (Johnson, Bartholomew, and Miller, 2006; Martin and Dunsworth, 2007).

Most undergraduate students enter their first year of college equipped with at least basic email, Internet browsing, and word processing skills, as well as a basic understanding of spreadsheets (McEuen, 2001; Olsen, 2000). However, students' experience with and knowledge of computers may vary widely across and within universities (McDonald and Viscelli, 2008; Olsen, 2000; Trkman and Baloh, 2003). Further skills are commonly obtained through the successful completion of IT coursework, although many students attain computer skills informally through self-education and the help of peers (Davis, 1999). Among these students, the popularity of computer proficiency exams (CPE) has grown as has their frustration and displeasure with being required to

take a basic IT course whose content they believe they have already mastered (Cardell and Nickel, 2003).

As the scope of material taught at U.S. business schools has increased, so too has the pressure to reduce or eliminate introductory courses, including the freshman IT course. In fact, many of Colleges of Business no longer require basic, lower level computer skill courses (McDonald and Viscelli, 2008; Tesch, Murphy, and Crable, 2006). When universities choose to eliminate a freshman IT course, they frequently do so in favor of non-credit IT workshops or computer proficiency exams designed to assess students' computer skill and ability (Johnson et al., 2006; McDonald, 2004).

At the private, Midwestern university that is the subject of this research, it was hypothesized that the implementation of a CPE would provide numerous benefits. First, the elimination of the freshman IT course was projected to reduce both instructor and administrative costs. Second, this would provide room for another, more advanced business core course to be added to the curriculum. Third, it was hoped the adoption of a CPE would ensure greater uniformity in students' computer proficiency prior to their enrollment in the sophomore IT course. This would eliminate the need for a review of basic, freshman IT concepts at the start of the sophomore IT course and insure all students possessed the same IT foundation skill set.

This research therefore seeks to investigate: 1) the impact of the use of a CPE as a surrogate measure of students' IT proficiency (as compared to the freshman IT course) and a gateway to admission to a higher-level IT course, 2) the impact of students' overall academic ability (assessed by their cumulative GPA prior to enrollment) on higher-level IT course performance, and 3) the role gender plays in IT course performance. In addition, we will explore some potentially negative consequences, experienced by the College of Business, which may be attributed to the elimination of the freshman IT course in favor of the new CPE.

Through this study, we hope to develop a clearer picture of the potential role of the CPE as a measure of student IT competence and a predictor of future IT course performance. To test these relationships, we conducted our analysis using data collected from four years of student records involving 713 undergraduate business students. Approximately 60% of these students took the freshman IT course and the remaining 40% took the computer proficiency exam. Finally, we discuss the longer-term impact of the CPE (including CPE pass rates) and revised approach to freshman IT proficiency testing that was adopted by the College of Business as a result of its experience with the CPE.

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

In most IT courses, proficiency assessment is normally spread over a semester where students learn, apply, and then are tested on the subject material (Martin and Dunsworth, 2007; Vincent, Meche, and Ross, 2002). A common challenge faced by universities is therefore to insure that all students achieve some minimum level of IT competency upon course completion (McDonald, 2004). Even when IT instructors use the same course materials and exams, it is possible for different sections of the same course to experience variation in student learning outcomes (Gill and Hu, 1999; Stephens and O'Hara, 2001; Watson, Sousa, and Junglas, 2000). This can be problematic when the course in question serves as a prerequisite, intended to provide the necessary foundation knowledge and skill to insure follow-on IT course success.

One alternative is for Colleges of Business to implement standardized computer proficiency exams that serve as a gateway to follow-on IT courses. These exams test software skills and have traditionally taken the form of multiple-choice exams, simulations (of a hypothetical task), and concurrent tasks (i.e., tests requiring students to solve realistic business problems) (Roberts, 1993). Exams may be self-administered, multiple choice tests or may be administered in the form of objective computer simulations or applied software skill tests (McCourt Larres, Ballantine, and Whittington, 2003). While multiple-choice exams may be the simplest to administer and simulations may allow immediate computer-based scoring and feedback, concurrent (or applied) tests are considered the best from a content validity perspective (Roberts, 1993).

Prior research indicates students frequently overestimate their IT-related abilities when taking self-administered, multiple choice IT proficiency exams (Ballantinea, Larresa, and Oyelereb, 2007; Easton and Easton, 2003; McCourt Larres et al., 2003). It should be noted this trait is often attributed to the new millennial generation (MG) of students entering college today. MG students have been characterized as high achievers, possessing a sense of entitlement, a desire for personal attention, and a hands-on orientation, who are technologically savvy multitaskers (Beard, Schwieger, and Surendran, 2007). They are inductive learners who prefer to do rather than study and often engage in a trial-and-error approach versus sitting through formal instruction (Kraft, Kakish, and Steenkamp, 2007). Thus, it is not surprising that the millennial generation would embrace the introduction of a computer proficiency exam versus sitting through a freshman IT course.

At the university that is the subject of this study, all College of Business students were initially required to take two information technology courses. The freshman IT course served as a foundation skill builder, teaching students common Microsoft Office applications (i.e., Word, PowerPoint, and basic Excel) and Windows utilities. While basic in nature, mastery of this content by students was considered critical by the instructors of the sophomore IT course. This allowed sophomore IT instructors to instead focus on teaching more advanced concepts such as web development, complex Excel spreadsheet modeling, relational database design, and IT management. Most instructors therefore viewed the introduction of the CPE as a positive replacement for the freshman IT course as it was perceived to be a more comprehensive measure of freshman IT proficiency. In short, they believed the implementation of a CPE would more consistently predict future performance in the sophomore IT course.

The administration of the College of Business viewed the introduction of the CPE as an opportunity to eliminate a large number of sections of the freshman IT course. Many of the students who enrolled in the freshman IT course were not

business majors and did not later enroll in the sophomore IT course. As such, it was clear that the projected cost of implementing and administering the CPE each semester would easily be offset by the cost reduction associated with the elimination of 10-12 sections per year of the freshman IT course in favor of the CPE. In addition, the administrative time required to schedule these class sections was also reduced. The introduction of the CPE was therefore supported by the College of Business.

In this study, we hypothesize that students' sophomore-level IT course success (i.e., their final course grade point) will vary by freshman IT computer proficiency (i.e., grade point), IT proficiency source (i.e., freshman IT course or CPE), cumulative GPA (prior to sophomore IT course enrollment), and student gender. Sections 2.1 through 2.5 of this paper discuss these variables and relationships of interest in greater detail. Section 3 of this paper will discuss the data collection, research methods, and results of this research and Section 4 will discuss our post-CPE implementation findings. Section 5 will present our final discussion and conclusions, including study limitations and future research opportunities.

2.1 Sophomore IT Course Performance

The dependent variable of interest in this study is the student's final, sophomore IT course grade point (GP) earned. A student's course grade point, as defined by the university's registrar, can be expressed as a standardized measure of student performance. In this study, sophomore IT course performance utilizes the same scale (i.e., grade point) as that used to report students' computer proficiency and their cumulative grade point average. Therefore, for all grade point values reported in this study, the measurement scale ranges from a low of zero (i.e., a grade of "F") to a high of four (i.e., a grade of "A"). See Table 1 for the exact CPE conversion scale used to calculate freshman IT proficiency grade point.

Exam Score (%)	Letter Grade	Grade Point
0-59	F	0.00
60-62	D–	0.67
63-67	D	1.00
68-69	D+	1.33
70-72	C-	1.67
73-77	C	2.00
78-79	C+	2.33
80-82	B-	2.67
83-87	B	3.00
88-89	B+	3.33
90-92	A-	3.67
93-100	A	4.00

Table 1. Conversion of Computer Proficiency Exam Scores to Course Letter Grade and Grade Point

2.2 Freshman IT Proficiency

Monroy (2000) summarizes the impact of computer proficiency when he answers the question, do you really know enough to get the job done? Freshman students entering college have much greater computer experience than did their predecessors from just a few years ago (Karsten and Schmidt, 2008). They are quite comfortable surfing the Internet, using email, downloading music, playing games, and using Microsoft Word (Baugh, 2004). While they may perceive themselves to be well prepared, key differences between students' abilities remain along with significant variation in their IT skill sets (Shannon, 2008). Assessments of these students reveal many to be quite deficient in their IT-related abilities (Tesch et al., 2006), especially their database and spreadsheet skills (Easton and Easton, 2004).

In this study, the computer proficiency of students who took the freshman IT course is assessed via their actual course grade reported as a standard university grade point. In the case of students who took the computer proficiency exam, their CPE scores have been converted to a standard university grade point. It is important to note that students passed either the freshman IT course or the computer proficiency exam, but not both. This approach yielded an equivalent measure of freshman IT proficiency (i.e., a standard grade point) that was used to represent students' base level of computer skill and knowledge before entering the sophomore IT course. Students were also classified as belonging to either a low or high freshman IT proficiency group.

Basic computer skills must be accumulated before follow-on computer skills may be learned. For example, before advanced Excel modeling may be taught it is required that students first understand the principles of equation definition in Excel as well as basic Excel functions. This enables students to develop a fundamental understanding of how to apply these functions in the proper sequence to create solutions to problems. The greater students' experience is in doing so, the more effective they should become. Therefore, we hypothesize that students' level of freshman IT proficiency (classified as low or high), will impact their performance in the sophomore IT course, also measured as a standard grade point.

H1: Students' freshman IT proficiency level (i.e., low or high) will positively impact their sophomore IT course performance.

2.3 Freshman IT Proficiency Source

The two ways students could demonstrate freshman IT proficiency, as stated previously, include the successful completion of the freshman IT course or by passing the CPE. Freshman IT proficiency source captures the basis by which each student's computing skill and ability are assessed, allowing comparisons between sources to take place. Students were therefore divided into two groups, the freshman IT course group and computer proficiency exam group. This permitted the evaluation of freshman IT proficiency and sophomore IT course performance by proficiency source (i.e., the freshman IT course or CPE). As such, we expect that study results should validate the College of Business' decision to adopt the CPE or refute it in favor of a return to the freshman IT course.

Within the College of Business it was believed that the introduction of the CPE would provide a more consistent and

reliable measure of freshman IT proficiency. Anecdotal evidence indicated freshman IT proficiency was higher for those students who passed the freshman IT course than those who passed the CPE. Discussion among the MIS faculty identified multiple possible reasons for this difference, including: 1) the semester long freshman IT course format allowed students multiple opportunities to "catch up" if they fell behind, 2) students were required to demonstrate only a subset of their IT skills and abilities at any one time, and 3) students could use supporting resources to assist them in the completion of graded projects, homework, and cases. This could theoretically provide significant advantage to these students over those who took and passed the CPE.

In contrast, the CPE is comprehensive in nature and must be completed in one sitting with all students taking the exam under uniform conditions. Anecdotal evidence indicated sophomore IT course performance was higher for those students who passed the CPE than for those who passed the freshman IT course. Again, discussion among the MIS faculty identified multiple possible reasons for this difference, including: 1) the CPE was believed to provide more consistent results (i.e., differences due to instructor teaching style, methods, and assessment were removed), and 2) the CPE was believed to provide more reliable results (i.e., exam conditions did not vary by student and were relatively stable from one exam administration to the next).

Thus, differences in freshman IT proficiency and future sophomore IT course performance were expected to emerge according to whether the student took the freshman IT course or the CPE. Therefore, we hypothesize that students who take and pass the freshman IT course will demonstrate higher freshman IT proficiency than those students who pass the CPE. We further hypothesize that students who pass the CPE will demonstrate higher sophomore IT course performance than those who take and pass the freshman IT course.

H2a: Students who pass the freshman IT course will demonstrate higher freshman IT proficiency than those who pass the CPE.

H2b: Students who pass the CPE will demonstrate higher sophomore IT course performance than those who pass the freshman IT course.

2.4 Cumulative GPA

A student's cumulative GPA has long been associated with higher follow-on course success and is a well-documented precursor to follow-on course performance (Brookshire and Palocsay, 2005; Evans and Simkin, 1989; Marcal and Roberts, 2000). Students' performance record in previous college courses indicates how likely they are to perform better in future courses. To achieve a high cumulative GPA, students must consistently perform well semester after semester, regardless of the challenges they may face. While students may or may not possess strong computer skills when they enter an IT course, their demonstrated study skills and dedication to task allow them to persevere and achieve greater success than those students possessing a lower cumulative GPA. Therefore, we hypothesize that students' cumulative GPA earned prior to their enrollment in the sophomore IT course will positively impact their sophomore IT course performance.

H3: Students' cumulative GPA (prior to enrolment) will positively impact their sophomore IT course performance.

2.5 Student Gender

Prior assessments of the impact of student gender on individuals' computer-related competency have found it to be a significant variable of interest (Alshare, Al-Dwairi, and Akour, 2003; Geissler and Horridge, 1993; Harrison and Rainer, 1992). While older studies report that females tend to be less committed and less proficient in learning and applying computer technologies than males (Kay, 1992; Smith and Necessary, 1996; Wilder, Mackie, and Cooper, 1985), more recent studies indicate that females may actually be more positive and proficient than males in using computers (Beyer, 2008; Chen, 2005). Across business disciplines the research results have been mixed with some finding gender differences and others finding no gender differences related to IT use and proficiency (Anderson and Benjamin, 1994; Karsten and Schmidt, 2008; Wallace and Clariana, 2005).

At the College of Business, instructor observations of both IT and non-IT courses appeared to indicate that female freshman and sophomore students may perform better than do male students. If true, this could indicate that some sort of remedial intervention may be necessary to mitigate these differences to insure that all students are equally prepared to utilize information technology in follow-on courses, both IT and non-IT related. We believe it is important that we test this assumption to insure that the effects of gender related to students' cumulative GPA, freshman IT proficiency, and sophomore IT course performance are better understood.

Therefore, we hypothesize that female students will demonstrate higher levels of freshman IT proficiency, sophomore IT course performance, and will have a higher cumulative GPA than will male students. If female students do indeed perform better than male students as hypothesized, additional research and corrective actions may be warranted to insure male students are equally prepared to succeed in the follow-on sophomore IT course.

H4a: Female students will possess a higher cumulative grade point average than will male students.

H4b: Female students will demonstrate higher freshman IT proficiency than will male students.

H4c: Female students will demonstrate higher sophomore IT course performance than will male students.

3. DATA COLLECTION AND HYPOTHESIS TESTING

To collect student performance data, the university student records database was queried to select four years of freshman and sophomore IT course results for business students. This timeframe included the transition period from the freshman IT course to the CPE, which took place during the middle two years. From this dataset we excluded students who had not yet completed the sophomore IT course or who had this course waived. This yielded an initial dataset of 914 business

students that included gender, cumulative GPA, freshman IT course grade (if taken), and final sophomore IT course grade data. This data was then matched to student scores on the computer proficiency exam (if taken). Cumulative GPA data were collected from the timeframe immediately following the conclusion of students' successful pass of either the freshman IT course or the CPE, but before beginning the sophomore IT course.

Certain student records were excluded from this study, primarily because no freshman IT course grade or CPE score was recorded for them. There were multiple possible reasons why this may have occurred. First, a student could have received a prerequisite requirement waiver for equivalent academic experience. For example, students may have been allowed to make a course substitution after changing their major to business or transferring to the university later in their academic career. In some cases, students may have also received a course wavier for appropriate work-related experience. However, in many cases it was not possible to identify the specific reason why a freshman IT course grade or CPE score was not recorded for them. This reduced the potential study group to 734 business students.

Finally, it was necessary to account for differences in the freshman IT proficiency level considered passing for those students who had taken the freshman IT course versus those who took the CPE exam. Students who earned a 60% proficiency level (i.e., a "D-" grade) or better in the freshman IT course were considered to have passed while students taking the CPE were required to demonstrate at least a 70% proficiency level (i.e., a "C-" grade). To enable a valid comparison between groups, it was necessary to remove those students from this study who had taken the freshman IT course and demonstrated a freshman IT proficiency level of less than 70%. This yielded a final study group of 713 business students, whose makeup consisted of 52.9% males and 47.1% females. Table 2 provides the final statistical attributes for the grade point variables included in the dataset.

3.1 Hypothesis Testing Procedure

Before proceeding with our analysis it was necessary to first group the data by freshman IT proficiency level (i.e., low versus high) and cumulative GPA (i.e., low versus high). To construct these sub-groupings, variable means were calculated and observations split on the mean into low or high subgroups for each variable. Observations below the mean were classified as being in the "low" subgroup while observations at or above the mean were classified as being in the "high" subgroup. Students' freshman IT proficiency source (i.e., freshman IT course versus CPE) and gender (male versus female) were also captured during the data collection process. No transformations of the later variables were required before conducting further analysis. A series of t-tests were then conducted using SPSS to explore our seven hypotheses of interest.

3.2 Results

The results of our hypothesis testing are summarized in Table 3. For each t-test conducted, the seven hypotheses, their t-values and significance levels are provided. In addition, for each variable subgroup (e.g., low versus high, males versus females, etc.) their size, mean, and standard deviation are provided. For all hypotheses, except hypothesis H2a, the t-test results were significant ($p=0.037$), highly significant ($p<0.01$), or better. These results provide reasonable support for six of the seven hypotheses developed earlier in this paper.

Variable	Minimum	Maximum	Mean	S.D.
Cumulative GP	1.00	4.00	3.19	0.50
Freshman IT Proficiency	1.67	4.00	3.07	0.73
Sophomore IT Course Performance	0.00	4.00	3.16	0.74

Table 2. Statistical Attributes of the Grade Point Variables

Hypothesis H2a sought to provide support for the assumption that a significant difference in freshman IT proficiency levels existed that could be explained by student's IT proficiency source (i.e., freshman IT course or CPE). However, the t-test ($t=0.91$, $p=0.36$) for this hypothesis failed to find evidence in support of this assumption. As was discussed during hypothesis development, freshman IT performance was hypothesized to be higher for those students who took the freshman IT course. It was important to test this hypothesis because a significant finding could indicate that the IT proficiency of these students had been overstated. Had this proved true, it may have raised concerns regarding grade inflation or possible problems related to course rigor. The non-significant finding for hypothesis H2a provides some evidence that the students completing the freshman IT course do not exhibit greater freshman IT proficiency than do those who pass CPE.

From the results of hypotheses H2a, one could logically assume that both freshmen IT proficiency groups should therefore earn similar sophomore IT course grades. From an educational and administrative point of view, we would have been content to find that the means of demonstrating freshman IT proficiency (i.e., freshman IT course grade or CPE results) had no effect on students' subsequent performance in the sophomore IT course. However, the results of hypothesis 2b were very highly significant ($t=4.76$, $p<0.001$), indicating students who demonstrated freshman IT proficiency via the CPE actually perform better in the sophomore IT course than those who completed the semester-long, freshman IT course. This was surprising, but as we discussed earlier, there are reasonable, plausible explanations.

Compared to the freshman IT course, the computer proficiency exam has several advantages in truly reflecting proficiency. The content of the CPE cannot be divided and conquered in pieces. It is a comprehensive exam requiring students to demonstrate mastery of all IT material in a single sitting. In contrast, as discussed previously, assessments for

Research Hypothesis		Group	N	Mean	Std. Dev.	*t*-Value	Signif.
H1	*Students' freshman IT proficiency level (i.e., low or high) will positively impact their sophomore IT course performance.*	Low	405	2.83	0.67	15.47	< 0.001
		High	308	3.59	0.59		
H2a	*Students' who pass the freshman IT course will demonstrate higher freshman IT proficiency than those who pass the CPE.*	Freshman IT Course	422	3.05	0.72	0.91	0.36
		CPE	291	3.10	0.75		
H2b	*Students' who pass the CPE will demonstrate higher sophomore IT course performance than those who pass the freshman IT course.*	Freshman IT Course	422	3.05	0.72	4.76	< 0.001
		CPE	291	3.32	0.73		
H3	*Students' cumulative GPA (prior to enrollment) will positively impact their sophomore IT course performance.*	Low	317	2.69	0.71	18.10	< 0.001
		High	396	3.53	0.52		
H4a	*Female students will possess a higher cumulative grade point average (prior to enrollment) than will male students.*	Males	377	3.11	0.52	4.62	< 0.001
		Females	336	3.28	0.46		
H4b	*Female students will demonstrate greater freshman IT proficiency (prior to enrollment) than will male students.*	Males	377	3.02	0.76	2.08	0.037
		Females	336	3.13	0.70		
H4c	*Female students will demonstrate greater sophomore IT course performance than will male students.*	Males	377	3.08	0.77	2.87	0.004
		Females	336	3.24	0.71		

Table 3. Hypothesis Testing Results

the freshman IT course may be spread over the duration of a semester and conquered in smaller components (e.g., multiple exams, quizzes, projects, assignments, etc.). Because the freshman IT course was divided into modules (e.g., internet technologies, Excel, etc.), it was therefore possible for some students to pass the course via their short-term mastery of smaller skill sets. However, at the conclusion of the semester, these same students may find it difficult to recall and apply the skills and lessons learned in the follow-on, sophomore IT course.

In addition, there is likely much more subjectivity in a course grade than in a single comprehensive exam such as the CPE, which is largely objective by design. During the time frame for which data were captured for this study, there were five different course instructors assigned to teach the freshman and/or sophomore IT courses. Without common assessment materials and standards, variation in instructor testing style, approach, and content emphasized may result. To summarize, the CPE is a single measure, comprehensive in nature, providing less room for subjectivity to influence the outcome. Not only are students required to demonstrate mastery of the freshman IT material in a single sitting, but differences in results due to course instructors are removed from the assessment process. The CPE may therefore provide a superior indication of freshman IT proficiency than performance in a semester long course.

4. POST-CPE IMPLEMENTATION FINDINGS

Soon after its implementation, it became apparent to the College of Business that the CPE had achieved the objectives it was originally intended to serve. First, the MIS faculty perceived the CPE to be a successful replacement for the freshman IT course. It was clear that those students who had taken and passed the CPE possessed the necessary foundation skills and knowledge to succeed in the sophomore IT course. This allowed sophomore IT course instructors to greatly reduce the time spent reviewing freshman IT course concepts at the start of each semester, enabling them to advance quickly to new IT concepts such as web development, complex spreadsheet modeling, relational database design, and IT management concepts.

Second, the administration of the College of Business was able to eliminate ten to twelve sections per year of the freshman IT course in favor of a CPE only assessment format. The projected cost of the administration of the CPE each semester was easily offset by the cost reduction associated with the elimination of freshman IT course. It also reduced the administrative time needed to schedule these class sections. Third, this opened up three credits in the College of Business core to allow for the addition of more advanced course options. Fourth, this provided more time for the MIS faculty to develop and offer new courses in support of the MIS major and minor. Finally, students applauded the elimination of the freshman IT course which most students generally regarded as a burden and of little value to them. The introduction of the CPE was therefore initially viewed as being successful.

Within a year it became apparent that CPE pass rates had fallen off substantially. While the CPE pass rate had initially been around 70%, it dropped dramatically over the CPE's first two years to a low of 40%. It was clear an intervention

was needed. Further analysis of recent exams found that students most commonly failed the CPE due to insufficient Excel experience in modeling more complex problems. While students had been provided a study guide instructing them how to prepare (including what materials to read and practice problems to do), later discussions revealed that the majority of students who had failed the CPE underestimated its difficulty and did not thoroughly prepare before taking the exam. During one interview a student stated, "I am pretty good with computers so I thought I didn't need to study too hard and could 'kinda' figure it out, but I ran out of time."

The high failure rate was viewed as being a serious problem because the CPE functions as a gateway exam within the College of Business. In addition to the sophomore IT course, it also serves as a prerequisite for the sophomore statistics course. These courses in turn serve as prerequisites for many other courses. As such, a growing number of students who failed the CPE now found they were behind in their program of study because they had not met this prerequisite requirement. This was especially problematic for those students who failed the CPE multiple times as they risked delaying their expected graduation date by an additional year to complete their degree requirements. Although the CPE had achieved its initial goals, it was now clearly perceived to be a roadblock to student progress.

While the MIS faculty agreed that it was not necessary to reinstate the entire freshman IT course, it was evident that a short freshmen Excel modeling course was required. In response, the MIS faculty developed a four week, one credit, pass/fail Excel modeling course, primarily staffed by part-time adjunct instructors to address this issue. All business students are now required to take this course along with the CPE immediately at its conclusion, with their entire course grade based on their pass or failure of the CPE. During the spring of 2007, the College of Business piloted two sections of this course with students who had previously failed the CPE multiple times. The initial results of this pilot demonstrated a dramatic improvement in CPE scores with approximately 85% of students passing the new freshman Excel modeling course. Today, the CPE pass rate has stabilized with 92.5% of students having passed the exam during the 2008 exam administrations.

5. DISCUSSION AND CONCLUSION

The IT curriculum is an essential component of business students' overall program of study, greatly impacting their preparation for tomorrow's workforce after graduation (Silva and McFadden, 2005). One lesson learned from this study is although students may complete various IT courses during their undergraduate studies, this does not insure that they fully comprehend and can apply these IT course materials. In IT courses that do not require students to pass a comprehensive final exam, the use of a computer proficiency exam may impress a greater degree of urgency upon students to develop, retain, and maintain their computing skills and knowledge. Thus, linking IT-related learning across multiple information technology courses may enhance students' ability to apply what they have learned in other courses.

This research provides empirical evidence for the important role that computer proficiency exams may play in curriculum design. It seems that a proficiency exam may be a better measure of student proficiency and thus a better predictor of future performance than a prerequisite course grade. Students who pass a proficiency exam may not only perform better in follow-on IT courses, but may also retain their knowledge and skills longer to better insure long-term career success in their chosen field of study. Perhaps there should be more use of proficiency exams, particularly in subject areas in which the mastery of prerequisite material is crucial. Where the use of a proficiency exam is not possible, requiring a comprehensive final exam at the conclusion of a prerequisite course may serve this same end.

Another curriculum design implication has to do with the content and skills which faculty deem necessary for future business success, but perhaps not deserving of university level credit. For example, taking that perspective on the basic IT knowledge and skill set covered in the freshman IT course is certainly what led the College of Business to discontinue that course and replace it with the proficiency exam. The larger business faculty felt that foundation information technology skills are necessary for business people, yet was hesitant to continue to award university level credit for learning basic Microsoft Word, PowerPoint, Excel, and Internet research skills. The introduction of a computer proficiency exam was one way to insure that students mastered these skills outside the mainstream college curriculum.

However well intentioned, it was clearly a mistake to eliminate the freshman IT course in favor of the CPE without first conducting a more thorough assessment of its impact. It was assumed (in error) that students would be capable of mastering this material on their own. Faculty members' comfort in implementing the CPE was due to students' high confidence in their ability to master new information technologies independently. Later discussions with students revealed they viewed learning Excel to be the same difficulty as learning Microsoft Word or PowerPoint. In practice, it quickly became clear that Excel demanded much more from students, including how to quantitatively model a business problem, apply the proper sequence of functions, and select the best method for data presentation.

Finally, the implementation of the CPE was done without first creating an exam audit and diagnostic processes. There was initially no process in place to identify, assess, and track both the nature and quantity of students' errors. In addition, it would have been productive to have developed an exam performance diagnostic process before CPE implementation. Better tracking of student exam errors may have revealed error patterns sooner, allowing the College of Business to detect and identify the causes of these errors on a timely basis. This would enable curriculum improvements to be designed and implemented more rapidly.

5.1. Research Limitations

Due to the implementation of a new student course records and registration records system, certain limitations resulting from the conversion of data from the old to new systems were identified. For example, course instructor data was not fully converted for all students. This meant that additional analysis related to the potential impact of instructor differences was not possible. It would have been preferable to include this variable in our analysis. Other data were never

fully captured or are not routinely captured in our student registration and records system. As stated previously, the exact reasons why a number of students did not take the freshman IT course or the computer proficiency exam were not available for use in this study.

5.2. Future Research

Additional research into the role gender plays in IT-related student performance is warranted. In this study, female students demonstrated somewhat greater freshman IT proficiency and sophomore IT performance. However, it is not clear why this occurred. These results could simply indicate that female students took the IT course material more seriously and applied themselves effectively. Male freshman and sophomore students may simply be less mature at this stage of their college career and will catch up in later years. It may also indicate that today's female MG students are more interested and engaged in learning new information technologies than are male students. The emphasis to engage women in the sciences and information technology over the past decade may be paying off.

A second opportunity for future research is the impact of increasing computer proficiency exam standards on sophomore IT course grade point. Would an increase in the required computer proficiency exam score also result in higher sophomore IT course performance? Another opportunity may be to review whether or not adjustments to the computer proficiency exam may provide a better evaluation of computer proficiency. In other words, are we emphasizing the right content in our assessment? Additional variables could be added for future analysis. Course instructor is obviously one such variable. However, other variables including SAT score, students' level of access to IT prior to university enrollment, and students' years of IT experience are three such possibilities.

Finally, the general approach used in this paper could be modified for use in most IT-related courses and some non-IT disciplines. It would be interesting to see this study replicated by other business faculty, especially those teaching courses in disciplines where it is necessary for students to master specific technical knowledge in stages before proceeding from one course to the next.

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