Assessing Technology Skills of Business Students

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ABSTRACT

Assessment has become an imperative in higher education, especially with schools seeking reaccreditation with AACSB. This research summarizes how, given learning objectives, a computer-mediated exam for assessing business students' technology skills was developed, administered, and used to determine if certain measures might be effective in improving those skills. In the process, potential factors were identified from the literature for explaining variation in student technology skills, and statistical analysis was used to determine which of those factors were significant.

INTRODUCTION

For many involved in various fields of education, the question "Are we doing any good?" continually looms. That is, conscientious instructors are concerned about whether or not they are effective. While item scoring and course grades provide some insight into this, standardized objective-based assessment can also help considerably (Eder and Martell 2008). Furthermore, the latter will tend to shed light less on whether or not the student learned effectively and more on whether or not the course and/or curriculum is doing what was intended.

While individual instructors can be expected to care about teaching effectiveness, more and more external constituents are now becoming concerned. At publicly funded schools, taxpayers and legislators are raising questions about whether or not their money is being spent in a worthwhile manner (Martell and Calderon 2005). Similarly, privately funded schools must compete based upon the effectiveness of the instruction being provided. To assist both types of educational institutions, as well as to provide certification to external constituencies, accrediting bodies have also become involved with program assessment.

For business programs within higher education, the AACSB (Association to Advance Collegiate Schools of Business) is the most highly regarded such accrediting agency, and assessment is currently a major concern. Accrediting standards for the AACSB require all member schools to determine objectives for their respective programs and assess the effectiveness of those programs per those objectives (Popper 2005). Taking the feedback provided by assessment results, the schools are then expected to make programmatic adjustments as appropriate. Consequently, regardless of whether individual instructors or their schools have undertaken assessment on their own or not, the AACSB has mandated that each adopt a culture of assessment. In other words, assessment is no longer optional.

Ultimately, both instructors and program directors must be able to ascertain what proportion of students meet expectations, as well as what proportion exceed, fall slightly short of, or fall substantially short of expectations. Based upon this knowledge, adjustments can be made to the curricula, and the effects of those adjustments can be determined (Redle and Calderon 2005). In the process, success factors can be identified so that programs can be developed accordingly.

This research involves a three-phase case study that addressed the assessment of technology skills among business students. The initial phase involved the identification of learning goals and the design and implementation of an assessment exam. Based upon the results of the assessment exam, a statistical analysis of a number of potential success factors was undertaken. Finally, several approaches to improving technology skills were examined, a followup exam was administered, and a statistical analysis of the results was conducted. These three phases are further addressed below, but, prior to that, background for the case study, as well as the factors leading to success with technology – in particular, microcomputer applications – are discussed.

TECHNOLOGY SKILLS AMONG BUSINESS STUDENTS

The College of Business (CoB) at a midsized state university (11,500 students) offers the Bachelor of Science (BS) degree at the undergraduate level. In response to the AACSB imperative, that CoB identified six major areas of learning within its BS program: business knowledge, critical thinking, ethics, oral communication, technology skills, and written communication. For each of these areas a set of goals was established, along with a rubric for assessing achievement of those goals.

Technology, along with leadership, ethics, entrepreneurship, and economic development, has been identified as an emphasis area by the CoB and is correspondingly recognized in the CoB mission statement. As part of this emphasis on technology, any undergraduate student choosing one of the nine Business majors is required to demonstrate proficiency with the standard productivity software applications prior to enrolling in the core Statistics course, which is in turn a prerequisite for all junior level coursework. The requisite proficiency can be demonstrated through coursework, such as the Microcomputer Applications course offered by the CoB or an equivalent course offered elsewhere, or by a satisfactory score on a four-hour comprehensive hands-on exam developed by the CoB. Consequently all upper level Business students should not only have developed basic computer proficiency but they should also have had the opportunity to have reinforced that proficiency.

Technology skills that were identified as critical for business graduates consist of proficiency in database, presentation, spreadsheet, and word processing applications. In the development of an assessment rubric, the CoB defined five levels of proficiency, and these are:

1. Does not meet expectations
2. Needs improvement
3. Meets expectations
4. Exceeds expectations
5. Substantially exceeds expectations

For each of the four applications software categories at least one representative skill corresponding to each of the proficiency levels was identified. For example, for database software, students who can define relationships among tables are considered to have “met expectations”. In contrast, students who can do nothing more than generating simple forms and reports are considered to “need improvement”.

FACTORS AFFECTING TECHNOLOGY COMPETENCE AMONG STUDENTS

The literature provides a number of factors associated with students' technology skills, in addition to factors associated with how well students perform on computer-based assessments. In early studies that explored student computer aptitude, predictor variables included (1) student demographic information, (2) past academic achievement, (3) prior computer training and experience, and (4) cognitive style. Evans and Simkin (1989) found all four of these factors to be significant; however, none were described as “strong” predictors of computer proficiency. In a similar study, Houle (1996) found significant variation in computer self-efficacy, computer anxiety, and computer attitude based on prior computer training and experience (i.e., completion of high school courses in application software, computer ownership, and on-the-job use of computers). This finding is confirmed by Havelka (2003) that found differences in software self-efficacy related to student computer experience.

The literature on the relationship between perceived computer experience and computer self-efficacy and computer anxiety is extensive; however, there is less research on the relationship between perceived computer experience and performance (i.e., tested proficiency). Although research in this area has produced mixed results, Ballou and Huguenard (2008) found perceived computer experience to positively impact student performance on exams in an introductory IS course.

In a study on computer proficiency among Internet users, Bradlow, Hoch and Hutchinson (2002) found education and self-report level of technology familiarity to be positively related to computer proficiency, such that higher levels of education and the belief that one is "technology savvy" resulted in greater computer proficiency. Additionally, these researchers explored the difference between self-perception of computer knowledge (estimated proficiency) and measured knowledge (tested proficiency) to conclude that self-rated computer knowledge was not aligned to tested knowledge (i.e., respondents were overconfident of their knowledge of the Internet) (Bradley et al., 2002). Similar findings are reported by Hilberg and Meiselwitz (2008), who found a substantial gap (nearly 20 percentile points) between perception of fluency and assessed fluency.

In research that focused on computer-based assessment, Schneberger, Amoroso, and Durfee (2007) found performance improvement in a microcomputer applications course to be positively related to class section and instructor, and negatively related to level of computer skill. In that study, students with lower initial computer skills showed greater improvement on computer-based assessments.

Thus, the factors summarized below in Table 1 being considered with respect to how they may influence technology skills among students.

RESEARCH DESIGN

Two broad research questions are addressed here through the use of three sets of hypotheses. First (and the initial driving force behind this research), it is important to know *whether or not the CoB's students are meeting technology skills expectations*. To be more specific, this question (or concern) is subdivided to address each of the four applications software areas. In addition, related to this question is the desire to identify which factors explain the variation in technology skills among business students. A second research question addresses *if and how students' technology skills might be improved*. In particular, will incorporating technology skills material into other classes to reinforce and/or enhance the basics improve students' abilities with computer software, and, if so, what treatments are effective?

Meeting CoB Skill Expectations

As no benchmark parameters were involved for the basic assessment of technology skills, no formal hypotheses seem relevant for addressing the primary portion of the first research question. Nevertheless, for this research question's secondary portion – explaining variation in

Table 1: Factors influencing technology competence

Prior computer training, experience, access	Computer access Prior computer experience Amount of formal computer training	Evans & Simkin (1989)
	Completion of high school courses in application software On-the-job use of computers	Houle (1996)
	Number of years of computer use Number of computer courses taken Number of application software packages learned	Havelka (2003)
	Computer ownership	Houle (1996)
Belief that one is technology savvy	Self-report level of technology familiarity	Ballou & Huguenard (2008) Bradlow et al. (2002) Hilberg & Meiselwitz (2008)
Instructional format	Class section and instructor	Schneberger et al. (2007)

student skills – let ρ_i represent the correlation between y, the overall level of proficiency across all four applications (database, etc.), and the i^{th} explanatory variable, x_i (e.g., age, ethnicity, major, etc.). Then the hypothesis

H$_1$: $\rho_i \neq 0$ for some i

or

H$_1$: Overall software applications proficiency is related to one or more of the suggested explanatory variables

addresses this set of research questions. The proficiency represented by the y variable was measured ia a technology skills assessment exam, discussed below. The x_i are the variables listed in Table 1 above.

Similarly, let **H$_{1a}$** through **H$_{1e}$** be represented in the same manner but referring to specific y variables, one for each of the four applications plus integration across applications. Then, referring to database proficiency for example, these hypotheses would then be stated in a manner similar to

H$_{1a}$: $\rho_{ai} \neq 0$ for any i

or

H$_{1a}$: Proficiency with database software is related to one or more of the suggested explanatory variables

These hypotheses were tested using the data from the technology skills exam, and results are addressed in the appropriate section below.

Improvement of Technology Skills

Associated with the second research question, regarding the improvement of technology skills, another set of hypotheses have been formulated. To examine whether or not improvement took place during the semester, let

H_2: $\mu > 0$

or

H_2: Overall average proficiency with computer applications increased during the semester

In addition, let **H_{2a}** through **H_{2e}** represent hypotheses that proficiency with each of the four individual applications has increased and that the ability to integrate across applications has improved. For example, referring to database skills

H_{2a}: $\mu_a > 0$

or

H_{2a}: Average student proficiency with database applications (e.g., Access) increased during the semester

summarizes the hypothesis being tested. Note that all **H_2** can be stated alternately as

H_2: $\mu_{After} > \mu_{Before}$

or

H_2: Average proficiency at the end of the semester is better than at the beginning

Consequently, the research associated with this set of hypotheses involved what was essentially a blocked ANOVA design, where the blocking factor was each student and the treatment was the collection of activities involved over the course of a semester. "Before" and "After" refer, respectively, to the assessment exam taken before those activities and that exam taken again at the end of the semester.

Testing the Hypotheses

In order that these hypotheses might be addressed, an assessment exam (described below) was administered, and the students who took the exam were asked to complete a questionnaire. The purpose of the questionnaire was to gather data associated with the factors believed to be influential in technology skill acquisition. The assessment exam is discussed in the next section.

ASSESSING TECHNOLOGY SKILLS

Based upon the rubric described above, a hands-on self-grading exam was developed. The SimNet XPert software package, developed by Triad Interactive and published by McGraw-Hill, was used for this purpose. This platform, which provides tutoring and assessment for Microsoft (MS) Office XP/2003, was chosen because it is currently in use for students who seek to "test-out" of the Microcomputer Applications class. Given the time limitations, as well as the somewhat different purpose of the assessment testing, the set of tasks on the assessment exam represent a smaller subset of the proficiency exam.

The assessment exam consisted of five independent modules and was designed to require a total of approximately one hour. The modules corresponded to database software (Access), presentation software (PowerPoint), spreadsheet (Excel) software, word processing (Word) software, and software integration skills. Each module was comprised of 12 tasks, each representing one of the five proficiency levels described above. Since the integration skills module addressed working across the software applications (e.g., importing an Excel table into Access), the results of this module were subsequently reassigned to each of the applications being integrated, typically as level 5 tasks.

The core Management Information Systems class, taken by all CoB students sometime in their junior or senior years, was chosen for administering the technology skills assessment exam. This course was offered in five sections on the main campus, via compressed video to sections on each of two remote campuses (synchronous with one of the main campus sections), and as an online class, associated with three different campus locations. Each section was assigned to one of four instructors, of whom three are tenured and one is not. During the first half of the semester, the exam was made available on the main campus in the CoB's open computing lab, which is accessible via student ID card-swipe access Monday through Friday from 7:00 am until 10:00 pm. In addition, the exam was made available in at least one lab at each the three remote campuses.

Because two research questions – one dealing with basic skill levels and the other addressing skills improvement – are being addressed, the assessment exam was administered twice. These herein are referred to as the *pretest* and *posttest*. Out of 167 students registered for the course, 122 took the pretest, during the first half of the semester. Of those students, 87 took the posttest, which was administered at the end of the semester.

BASIC ASSESSMENT RESULTS

For each of the 12 tasks contained in the five modules of the assessment exam the percentage of students performing the task correctly was calculated. The results for the 12 tasks in the integration module were then incorporated into the results for the other four modules. So as to reflect relative importance of the proficiency levels, a weight was assigned to each task according to an inverse scale. (That is, Level 1 tasks were weighted at 5, Level 2 at 4, and so on.) For each of the four modules a weighted sum was calculated and then divided by the sum of the weights for that module, resulting in an aggregate measure by which to compare performance across the four software applications.

Relative to the learning goals, students taking the pretest scored best on the word processing module (aggregated score of 73%) and worst on the spreadsheet module (55%). Scores on the database module were slightly better (58%) than those for spreadsheets, and scores on the presentation module were mediocre (63%). Essentially, students for the most part not only met but surpassed expectations for the word processing assessment but fell substantially short on spreadsheet skills. Table 2 below summarizes performance on the pretest, where *Qn* indicates the question number for the given application program, *Rubric* the ability level according to the assessment rubric, and *Wt* the weight assigned to the rubric level.

Table 2: Proportion of students answering correctly on assessment exam

Database				**Spreadsheet**				**Presentation**				**Word Processing**			
Qn	***Rubric***	***Wt***		***Qn***	***Rubric***	***Wt***		***Qn***	***Rubric***	***Wt***		***Qn***	***Rubric***	***Wt***	
1	1	5	84%	1	1	5	98%	1	1	5	73%	1	1	5	99%
2	1	5	75%	3	1	5	71%	4	1	5	91%	3	1	5	98%
3	1	5	52%	5	1	5	95%	8	1	5	54%	7	1	5	42%
6	1	5	80%	2	2	4	71%	5	2	4	93%	2	2	4	76%
7	1	5	64%	9	2	4	81%	6	2	4	94%	4	2	4	98%
8	1	5	89%	10	2	4	35%	7	2	4	85%	5	2	4	66%
9	3	3	38%	6	3	3	16%	2	3	3	42%	6	3	3	97%
10	3	3	59%	7	3	3	2%	3	3	3	1%	8	3	3	77%
12	3	3	5%	8	3	3	19%	9	3	3	18%	9	3	3	81%
4	4	2	42%	4	4	2	54%	10	4	2	82%	10	4	2	84%
5	4	2	0%	11	4	2	0%	11	4	2	75%	11	4	2	89%
11	4	2	4%	12	4	2	33%	12	4	2	82%	12	4	2	36%
i10	5	1	37%	i1	5	1	98%	i6	5	1	66%	i1	5	1	22%
				i3	5	1	71%	i7	5	1	13%	i2	5	1	32%
				i4	5	1	54%	i8	5	1	20%	i3	5	1	68%
				i5	5	1	95%	i9	5	1	8%	i4	5	1	17%
				i8	5	1	19%	i12	5	1	31%	i5	5	1	20%
				i9	5	1	81%					i7	5	1	13%
				i10	5	1	35%					i11	5	1	58%
				i11	5	1	0%								
				i12	5	1	33%								
Weighted Avg:			**58%**				**56%**				**63%**				**73%**

For each student, the score on any of the assessment modules could range between zero and 12 points, inclusive, and the maximum possible overall score was 60 points (the sum of the scores for the five modules). Univariate analyses of the pretest scores are presented below in Table 3. Of note is the discontinuous nature of the data (values of 1, 2, 3, etc. but not 2.3, for example) and the consequently poor fit to a normal distribution, as evidenced by the observed significance of the Shapiro-Wilk value for each type of score. This somewhat limited further analysis and dictated that nonparametric procedures be used.

In addition, prior to an analysis of the factors that may explain variation in the pretest scores, as summarized in hypothesis $\mathbf{H_1}$, a univariate analysis was conducted on the questionnaire data associated with those factors. As with the pretest data, values for the numeric variables were generally not normally distributed, and several of these are more appropriately treated as ordinal.

Table 3: Pretest score statistics

	DB	***Int***	***Pre***	***SS***	***WP***	***Overall***
Obs:	121	120	121	120	120	115
Mean:	5.99	3.87	7.93	5.83	9.57	33.48
StdDev:	2.08	2.69	2.25	2.04	1.80	8.26
Median:	6.00	4.00	8.00	6.00	10.00	34.00
S-W:	0.0007	0.0001	0.0001	0.0097	0.0001	0.0435

Ordinarily, using multiple regression to model and analyze the relationship between the skills addressed and the potentially explanatory factors would be appropriate. Nevertheless, because of the nature of the data and, consequentially the need to use nonparametric methods, no regression analysis was employed. (Nonparametric regression methods do exist, but their primary purpose is for prediction, rather than addressing the relationships between variables.) The research hypotheses $\mathbf{H_1}$ (as well as $\mathbf{H_{1a}}$ through $\mathbf{H_{1b}}$) have thus been stated in terms of simple correlations, and subsequent testing was done via Spearman's ρ, a nonparametric measure based upon ranks. Table 4 summarizes those correlations between assessment test performance and some of the more significant candidates for explanatory factors. As can be seen from the table only *Off Campus*, *Grade*, and *Lapse* can considered as statistically significant at the 5% level or better. (The observed significance levels are one-tailed, since the *a priori* analyses based upon the literature, along with researcher expectations, suggests either positive or negative relationships.) These variables represent, respectively, whether a student has access off-campus to computing facilities, the grade received if a microcomputer applications course has been taken, and the time since such a course had been completed.

Perceived abilities with the various applications cannot be considered explanatory variables. Nevertheless, but not surprisingly, these perceived abilities are positively related to exam scores and are generally significant. This holds not only for scores on a given application and perceived ability with that application but also across applications.

SKILLS IMPROVEMENT RESULTS

Analysis of the difference between pretest and posttest scores showed an observed average overall improvement on the 60 point exam (five modules at 12 questions each) of 3.35 points. A paired *t* test with 77 degrees of freedom produced a *t* score of 6.072, which corresponds to an observed significance of better than 0.001. Although the data, which are limited to integer values, are not truly continuous, the approximation to a normal distribution was sufficiently close (χ^2 of 17.9, df=7; p=0.21) that the paired *t* test can be considered valid. Consequently, the null hypothesis for $\mathbf{H_2}$ was rejected, and a significant overall improvement of

Table 4: Correlations and significance levels of factors vs performance

	DB	*Int*	*Pre*	*SS*	*WP*	*Overall*
Age	-0.019	-0.092	-0.072	-0.059	0.074	0.199
	0.8460	0.3335	0.4515	0.5371	0.4384	0.0357
Grade	0.256	0.125	0.232	0.207	0.336	-0.031
	0.0145	0.2280	0.03	0.0449	0.0009	0.7687
Lapse	-0.216	-0.178	-0.129	-0.211	-0.193	-0.095
	0.0368	0.0809	0.2062	0.0378	0.0569	0.3535
Female	0.075	0.012	0.044	0.045	0.091	0.114
	0.4237	0.8941	0.6353	0.6208	0.3253	0.2168
Black	-0.013	-0.202	-0.040	-0.163	-0.052	0.099
	0.8971	0.0320	0.6771	0.0848	0.5828	0.3011
Off Campus	0.335	0.187	0.231	0.248	0.364	0.221
	0.0004	0.0489	0.0148	0.0084	<0.0001	0.0198
Major	-0.028	-0.094	-0.043	-0.055	0.025	0.094
	0.7720	0.3218	0.6509	0.5600	0.7966	0.3201
Course	-0.014	-0.062	0.040	0.033	-0.028	0.070
	0.8839	0.5201	0.6748	0.7296	0.7694	0.4688
Employed	-0.205	-0.315	-0.14	-0.058	-0.178	-0.061
	0.0358	0.0008	0.1499	0.5446	0.0645	0.5276
On Job	0.024	-0.099	0.027	0.077	0.022	0.040
	0.8119	0.3046	0.7806	0.4216	0.8241	0.68
DB Ability	0.196	0.225	0.181	0.095	0.151	0.036
	0.0463	0.0184	0.0593	0.3271	0.1200	0.7117
Pr Ability	0.265	0.238	0.228	0.324	0.218	0.092
	0.0062	0.0125	0.0164	0.0006	0.0228	0.3434
SS Ability	0.244	0.184	0.270	0.176	0.411	0.008
	0.0121	0.0549	0.0044	0.0655	<0.0001	0.9377
WP Ability	0.175	0.176	0.178	0.113	0.222	0.198
	0.0748	0.0666	0.0628	0.2381	0.0205	0.0389
Ability	0.311	0.283	0.291	0.245	0.372	0.125
	0.0013	0.0029	0.0022	0.0103	<0.0001	0.1985

software skills among the CoB students was concluded.

As with overall software skills, CoB student proficiency with four out of the five individual software applications showed significant improvement. Since none of the five data sets (one for each type of software) were normally distributed, the conditions needed for the use of a paired *t* test were not met. Consequently, the sign test, which is generally less powerful than a paired *t* procedure, was used to determine if the average improvement were greater than 0.

Table 5 below summarizes the results, where the *S-W* value is the observed significance of the Shapiro-Wilk test for normality, and the *Sig* value indicates how significantly the observed median differs from zero improvement (smaller values represent greater observed significance). The values in the table show that the greatest improvement was with database software and integration across applications. For database skills, both the observed average and median improvement were close to one point (around 8%) for the 12 point exam. Presentation skills also showed reasonable improvement – somewhat over half a point on average – but the improvement of spreadsheet and word processing skills were minimal, at well under half a point each. Overall improvement (approximately 5% on average) was highly significant.

Table 5: Statistics for technology skills improvement (points)

	Obs	*Average*	*StDev*	*S-W*	*Median*	*Sig*
Database:	87	1.02	1.70	0.0017	1	0.0001
Integration:	87	0.82	1.96	0.0100	1	0.0003
Presentation:	87	0.63	1.86	0.0039	1	0.0008
Spreadsheet:	87	0.28	1.65	0.0026	0	0.0193
Word	87	0.14	1.58	0.0002	0	0.1144
Overall:	79	3.06	4.61	0.0996	2	0.0001

In summary, the data supported $\mathbf{H_{2a}}$ through $\mathbf{H_{2e}}$ (i.e., that database, integration, presentation, and spreadsheet skills each improved on average), for which the null hypotheses were consequently rejected. On the other hand, there was not sufficient evidence to support $\mathbf{H_{2e}}$ (i.e., that students' word processing skills improved), so the corresponding null hypothesis could not be rejected. It is not surprising that the improvement of word processing skills was not better, as there was essentially no deficiency there in the first place. The fact that improvement of spreadsheet skills, although statistically significant, was not stronger is nevertheless disappointing.

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