COMPUTER LITERACY AND THE INTRODUCTORY STUDENT: AN ANALYSIS OF PERCEIVED AND ACTUAL KNOWLEDGE OF COMPUTERS AND COMPUTER APPLICATIONS

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Abstract

This study was designed to address the perennial issue of the degree of computer knowledge acquired by students prior to enrolling in an introductory Computer Concepts course. High school students often take a computer course that includes computer applications (word processing, spreadsheets, database management systems and presentation software); for some students, formal instruction in such computer applications begins in middle school and informal instruction may begin much earlier. Despite the increasing prevalence of students who enter universities having completed at least one computing course, instructors of university-level introductory computer courses typically observe wide differences in the computing background and knowledge of students enrolled in their courses. To better assess these differences, 82 students enrolled in a Spring Semester 2003 Computer Concepts course voluntarily completed a computer literacy assessment test in an attempt to earn a high enough score to "test out" of the course. This paper provides an analysis of the students' perceptions of their proficiency with software applications, prior course completed, their frequency and longevity of computer and Internet use, and their results on the "test out" exam.

Keywords: Computer literacy, software proficiency, introductory course

Introduction

The value of the introductory computing course in the IS/IT curriculum has been a long-standing subject of debate. Numerous investigations suggest that computer use and attitudes about computing technology have a significant impact on student performance in computing courses (e.g. Davis, 1989; Harris, 1993; Henry, Stone & Pierce, 1995; Papp, 1996). Other investigators have focused on whether there is a continuing need to include computer literacy components in the Information Systems curriculum (Gordon and Chimi, 1998). The proponents of the IS 2002 Model Curriculum also wrestled with the value of the introductory course in the IS curriculum. While the course was not removed from the last version of the model curriculum, it was relegated to prerequisite status.

The educational implications of the introductory students' computing background are not insignificant. As noted by Bialaszewski, Case, and Wood (1996), student familiarity with information technology is likely to affect the teaching methodology used by instructors as well as instructors' academic expectations about their students' ability and readiness to use collaborative tools such as FTP, electronic conferencing, messaging systems, workflow and document management applications, and other forms of groupware. When students have prior experience with such technologies, instructors' expectations for course outcomes tend to be raised and they are more likely to use instructional approaches that capitalize on their students' experience and knowledge base in order to increase the value of the learning processes included in the course.

Most instructors of university-level introductory computing courses would agree that their courses' ability to significantly contribute (add value) to the curriculum is either enabled or constrained by their students' incoming knowledge and prior experience with computing technology. If the foundation knowledge of incoming students is strong, course content can be focused on extending the depth and/or breadth of their knowledge base in a manner that provides a more significant contribution toward the achievement of IS degree program learning outcomes. A lesser knowledge base for incoming students is likely to cause instructors to have more modest expectations for course outcomes; in such instances, course content is more likely to be focused on ensuring that students leave the course with the minimum knowledge base needed to enter upper-level courses. Needless to say, making appropriate adjustments in course content is contingent on monitoring the extent of knowledge and experience of incoming students.

The potential value of the introductory computing course in the IS/IT curriculum is also influenced by continual changes in the minimal skill sets that employers expect new hires to possess. Over time, the minimum level of computing literacy sought by employers has ratcheted upward. These changes put unrelenting pressure on universities to ensure that their graduates have the foundation skills required to enter the job market. The foundation, however, is a moving target. The increasingly higher expectations of employers influence (or should influence) universities to revise the content of their computing courses to keep pace with changing industry needs. Because curriculum revisions logically begin with the introductory computing course, it is important for universities to assess the computing knowledge and prior use of computers of students enrolled in this course.

Overview of the Current Investigation

This study was designed to assess the computer knowledge of and prior computing experience of students entering an introductory computing course at a medium-sized regional university in the southeast U.S. To minimize the impacts of exposure to course content on assessment test results, data was collected during the second week of the 2003 Spring Semester. Students enrolled in three sections of the university's Computer Concepts course were offered the opportunity to attempt to "test out" of the course by achieving an acceptable score on a 100-item Computer Literacy Assessment Test. More than 800 students were enrolled in the three sections of the course, but only about 1 in 10 chose to take advantage of this "test out" opportunity.

The items on the assessment instrument covered a wide range of concept categories that are commonly addressed in an introductory computing courses and textbooks including:

- Computer hardware (input, output, storage, and processing devices)
- Computer software (application software, system software, user interfaces, etc.)
- Networking technologies (LAN vs. WAN components, communication protocols, wireless communication technologies, etc.)
- Data and databases (DBMSs, relational databases, queries, primary keys, etc.)
- Internet concepts and applications (URLs, search engines, e-commerce, Internet services, etc.)
- Computer security (cryptography, software piracy, data privacy, cybercrime, viruses, etc.)
- Computer system development and programming (systems development processes, programming languages, etc.)

The items on the assessment test were written in textbook-independent language designed to assess the students' understanding of basic concepts rather than the specialized ways in which these might be addressed in different textbooks.

A cover sheet attached to the assessment test captured a variety of data about the students' previous computer courses and experiences (see Appendix). They were asked to indicate:

- Number of previous computer courses completed
- How long (in years) they had been using computers
- How long (in years) they had been using the Internet and WWW
- Frequency of computer use
- Frequency of Internet use
- Self-rated degree of knowledge/proficiency with word processors, spreadsheets, databases, and presentation graphics.

Procedure

The "test out" opportunity and scheduled administration date/time was announced during each of the first three class meetings in each section of the course. It was also placed each section's course calendar in WebCT. When first announced, more than half of the students enrolled in the course indicated that they intended to take the literacy assessment test, however, only 82 actually participated in the study. Each student was required to provide his/her student ID card to receive a copy of the test. Test takers were not allowed to leave the assessment location until they had completed the test and submitted their test forms, their ScanTron answer forms, and their cover sheets.

At the end of the semester, all students in two of the three sections of the course were offered the opportunity to retake the literacy assessment test for extra credit. Each student taking the test was awarded the same number of extra credit points for its completion. This was done to reinforce the promise that their score on this "test" could not have a negative bearing on their composite average for the course. All but a handful of students opted to take advantage of this extra credit opportunity.

The second administration of the assessment test enables us to address two issues:

1. The extent to which the students mastered the range of concepts covered in the course.
2. The extent to which the course adds to the computer knowledge of students enrolled in the course.

The second issue can be tested by comparing the performance of students who participated in both administrations of the test.

Results

Most (92.7%) of the students participating in this investigation had completed at least one computing course prior to entering the Computer Concepts course. More than seventy percent reported that they had completed two or more computing courses; the median number of prior courses completed by the students in this investigation was two. More than one-third (36.6%) of the participating students reported that they had completed at least one university or junior-college computing class in prior enrolling in the Computer Concepts course. More than half (51.2%) indicated that they completed at least one computing course while in middle school and 82.9% reported that they had completed at least one computing course while in high school (see Table 1).

Table 1: Participants' Prior Coursework in Computing

	Number of Prior Computing Courses Completed			
Level	**None**	**One**	**Two**	**Three or More**
Junior College/College	63.4%	25.6%	4.9%	6%
High School	17.1%	37.8%	23.2%	22%
Middle School	48.8%	31.7%	13.4%	6.1%

Table 2 provides a summary of study participants' perceptions of their mastery of productivity software applications prior to entering the Computer Concepts course. Most participants (58.5%) felt that they possessed above average word processing skills; almost all the rest (31.7%) felt that they had achieved an average master of word processing. Seventy-eight percent felt that they had at least an average level of knowledge of spreadsheets. More than seventy percent (72.4%) felt that their knowledge of presentation graphics was at least average. Only 57.1% of our participants felt that their knowledge of database applications was average or better.

Table 2: Participants' Self-Perceived Proficiency with Various Applications

	Self-Perceived Proficiency				
Application	**Excellent**	**Very Good**	**Average**	**Fair**	**Poor**
Word Processing	28.0%	30.5%	31.7%	2.4%	0%
Spreadsheet	4.9%	19.5%	46.3%	22.0%	0%
Database	3.7%	13.4%	40.2%	30.5%	4.9%
Presentation Graphics	15.9%	14.5%	40.8%	18.4%	9.2%

Table 3 summarizes how long (in years) the participants had been using computers and the Internet. More than seventy percent (71.9%) reported that they had been using computers for six or more years. As might be expected, reported longevity of Internet use was less than reported longevity of computer use. Only 39.1% of the students indicated that they had been using the Internet for six or more years.

Table 3: Participants' Use of Computers and the Internet in Years

Information Technology	Years of Use					
	Less than one	1 to 2	3 to 5	6 to 10	11 to 15	More than 15
Computers	0%	2.4%	25.6%	45.1%	20.7%	6.1%
Internet	0%	2.4%	57.3%	35.4%	3.7%	0%

Participants were also asked to indicate how frequently they used computers and the Internet. Table 4 provides a summary of their responses to these questions. More than 90% of participating students indicated that they used computers on the daily basis with more than 70% indicating that they used computers for at least an hour a day. Most participants (87.8%) also indicated that they used the Internet on a daily basis; and 64.6% indicated that they used the Internet for an hour or more each day.

Table 4: Participants' Frequency of Computer and Internet Use

Information Technology	Frequency of Use					
	Do not use	Less than once per week	Multiple times per week	Daily: Less than one hour per day	Daily: 1 to 3 hours per day	Daily: More than 3 hours per day
Computers	0%	0%	9.8%	18.3%	40.2%	31.7%
Internet	0%	0%	12.2%	23.2%	34.1%	30.5%

Literacy Assessment Scores

Only one of the 82 students taking the assessment test obtained a score (77) above the stated minimum of 70 needed to "test out" of the course. The mean score on the test (on a 100 point scale) was 49.51 while the median score was 48.00. The results of the Computer Literacy Assessment Test suggest that the average participant in this study had mastered slightly less than half of the computing concepts addressed in the Computer Concepts course prior to entering the course.

Test Score Predictors

Regression was used to determine whether longevity of computer/Internet use (in years) or frequency of computer/Internet use could be used as predictors of scores on the Computer Literacy Assessment Test. A significant regression model was found [$F(4,76) = 3.48$, $p < .02$] that had an R-value of .393 and a .155 R Square. Frequency of computer use was the only significant independent variable in the model [$t(1,76) = 2.86$, $p < .005$].

A second regression considered whether prior coursework in computing could be used as a predictor of literacy assessment test scores. The predictor variables in this analysis were number of university/junior college courses, number of high school courses, middle (junior high) school courses, and total number of previous courses. A marginally significant regression model was found [$F(4,77) = 2.398$, $p < .06$] that had an R-value of .333 and a .111 R Square. Number of university/junior college courses was the only significant independent variable in the model [$t(1,77) = 2.17$, $p < .04$]. Number of high school courses was marginally significant [$t(1,77) = 1.86$, $p < .07$]. Total number of courses was also marginally significant, but in an opposite direction to expectations [$t(1,77) = -1.90$, $p < .07$]; the negative beta coefficient for this variable in the model suggests that higher prior course totals tend to be related to lower literacy assessment test scores.

A third regression analysis considered whether self-perceived software proficiency could be used to predict literacy assessment test scores. The resultant regression model was not significant and had an overall F-value that was less than one. This finding suggests that there is no predictive relationship between student perceptions of their proficiency with productivity software applications (word processing, spreadsheet, database, and presentation graphics) and scores on the Computer Literacy Assessment Tests.

A final regression analysis including the predictor variables from each of the first two regression analysis (longevity and frequency of computer/Internet use and prior courses) was performed. Stepwise regression was used in order to find the best overall predictive model. It yielded a highly significant single-variable model [$F(1,81) = 12.399$, $p < .001$] that had an R-value of .366 and a .134 R Square. The single predictor variable in the resultant model was frequency of computer use [$t(1,81) = -3.52$, $p < .001$]. This suggests that frequency of computer use is a better predictor of literacy assessment test scores than prior computing courses or mastery of software applications.

Additional Analyses

Correlation analyses performed to date indicate that student perceptions of their proficiency with software applications tend to be directly related to the number of courses that they completed in high school. A significant positive correlation ($r = .225$) has also been found between the number of university-level computing courses and literacy assessment test scores. Correlation analysis also suggests that literacy test scores are directly related to frequency of computer use and frequency of Internet use. Perceptions of software proficiency, however, were not observed to be significantly correlated with increased computer or Internet use.

The comparative performance of participating students who took the literacy assessment test the second time at the end of the semester has not been analyzed at the time of this writing. These results, however, will be presented at the conference. These findings should provide insights into the extent to which the actually course contributes to increasing student knowledge of computers and their applications.

Analyses of student performance on the concept categories identified above (hardware, software, networking, database, Internet, security, systems development) remain incomplete at this point in time. These results will also be presented at the conference. Preliminary results suggest that students perform much better in some content areas than others. They also suggest that there are substantial gaps in student knowledge in most content categories; even in those content areas where student performance is highest, average performance falls short of minimal mastery levels. Further examination of the knowledge level of incoming students across content areas will assist in identifying the degree to which the different concept categories should be emphasized in class.

Discussion

The results suggest that the majority of students enrolling in university-level introductory computing courses do not possess a sufficient prior knowledge or experience base to warrant removal of such courses from the curriculum. While most of the students enrolled in such courses have already completed multiple computing courses, their mastery of fundamental concepts tends to fall short of the minimum proficiency levels required to move into more advance courses in the curriculum. Hence, the introductory course may not be superfluous for most of the students that take it.

Although the introductory course has been relegated to prerequisite status in the IS 2002 Model Curriculum, it may still fulfill an important need at many universities. It may play an especially important role in narrowing the wide diversity in the computing backgrounds of enrolled students. The introductory course may also help to ensure that student mastery of computing concepts extends beyond hands-on experience with productivity software applications. It can assist students in becoming more knowledge consumers and managers of information technologies.

The external validity (generalizability) of the findings of this investigation is limited by self-selection factors. As noted previously only about one in ten of the students enrolled in the introductory computer course chose to take advantage of the “test out” opportunity. This, by itself, suggests that self-selection factors were at work. It is likely that many of the students who participated were above average in computer knowledge and/or experience with computer applications, or perceived themselves to be. This may have skewed much of the data captured by this investigation from self-reported skill and knowledge levels to scores on the assessment test itself. Had data been obtained from a significantly larger percentage of the students enrolled in the three sections of the course ($n > 800$) rather than this self-selected subset ($n = 82$), the average skill and knowledge levels may have been even lower than the levels observed in this investigation.

Overconfidence of participants may also play a role in the pattern of observed results. It is possible that the students who chose to take the test felt that they knew more about computers than their test scores indicate. For example, students who use software applications with confidence may feel that they are above average in their overall knowledge of computers. Future replications of this study should attempt to capture the students’ confidence in their knowledge of computers.

Another factor that may limit the generalizability of the results is the possibility that the students who chose to take the test o saw it as a 'low risk' way to get around having to take the course. Some may have thought that they might 'get lucky' and earn a high enough score to test out of the course.

Another possible limitation may be the difficulty of the test-out exam itself. Participant scores on the second administration of the test will help us gauge test difficulty. If average performance on the second test remains below minimum mastery levels, the test itself may be the main explanation for the observed pattern of findings.

We suspect that the best explanation for our findings may be that prior coursework tended to focus on keystrokes rather than concepts. Many high school courses are applications oriented rather than concepts oriented. As a result, students enhance their ability to use particular applications without ever really having to come to grips with how the program works with the operating system and hardware to accomplish user tasks. If high school courses focused more squarely on fundamental computer operations, rather than computer applications, our results may have been very different.

Despite these limitations, the results of this investigation assist in shedding light on the computer concepts of which entering students are most familiar. This "foundation" information provides a base from which the introductory course can be revised to assist in addressing the changing needs and expectations of employers.

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APPENDIX

CISM 1120: Computer Concepts

Computer Literacy Assessment Test

Name: ____(PLEASE PRINT)

Student Number (SS#): ____________________________ Date: ____________________

Instructor: ____________________________ Class Days/Time: ______________________

<u>Make that the personal information provided above is also written on your Scantron form.</u>

Year (1,2,3,4 etc) _______ Major: ____

Hometown: ____ State: ___________

How many previous computer courses have you taken in:
University _____college ________in high school ___ in junior high school ________

How long have your been using computers?
Less than 1 year ______ 1-2 years ______ 3-5 years _____ 6-10 years _____ 11-15 years _____ more than 15 years _____

How long have your been using the Internet and WWW?
Less than 1 year ______ 1-2 years ______ 3-5 years _____ 6-10 years _____ 11-15 years _____ more than 15 years _____

How frequently do you use computer?
Do not use computers _____ less than once per week _____ multiple times per week_____
Daily, <1 hour/day _____ Daily, 1-3 hours/day _____ Daily, >3 hours/day _____

How frequently do you use the Internet?
Do not use the Internet _____ less than once per week _____ multiple times per week_____
Daily, <1 hour/day _____ Daily, 1-3 hours/day _____ Daily, >3 hours/day _____

Rate your expertise as Expert, **VG** (very good), **G**ood, **F**air, or **P**oor **in:**
Word Processing _____ Spreadsheets _____ Databases _____ PowerPoint or equivalent _____