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ABSTRACT

Four-year colleges and universities have invested time, faculty, floor space, and monies for software and hardware in teaching introductory courses in Management Information Systems (MIS). Do these resources increase the level of computer literacy (information fundamentals)? This paper reports on the before and after results of a questionnaire on computer literacy given to 143 students taking an introductory MIS course. Differences in the amount of learning are analyzed from the perspective of a variety of demographic factors (age, gender, typing skills, and computer access) and Kolb's Learning Styles Inventory (KLSI).

Success in most businesses today require people who are computer literate. To help meet this requirement in information fundamentals and to make their graduates more marketable, colleges and universities have allocated faculty, hardware, software, and physical space to teach introductory courses in computers.

Many high schools and junior high schools have also introduced courses aimed at raising students' computer literacy. If these schools are successful in raising students' fluency to the same level as those students completing college level courses, the need for introductory college courses in computer literacy would be reduced and perhaps even dropped. For those students who still need the introductory courses, tailoring the instruction to their learning styles could raise computer literacy to even higher levels.

As university professors, our goal was to better understand which factors appear to influence both incoming levels of computer literacy, as well as (possibly) influence the learning process itself. This knowledge could assist administrators and teachers in a variety of ways (e.g., placement of incoming students into higher-level courses based upon a predetermined, validated test score).

The authors surveyed over 500 university students on computer literacy to obtain data on incoming students. That survey produced 436 viable questionnaires. The authors then surveyed the same students upon completion of their first college-level computer class to obtain data on how much the students learned. The latter survey produced 143 viable questionnaires, which provided enough to test our research hypothesis.

This paper discusses (1) an overview of computer literacy and learning styles in the literature; (2) the design, methodology, and nature of the two surveys; and (3) the results, tests, and explorations. Finally (4) we provide conclusions about incoming students finishing their first college-level computer course. Suggestions are offered for future areas of research.

SETTING FOR COMPUTER LITERACY AND LEARNING STYLES

Background to Computer Literacy

At first, "computer literacy" was defined as "the ability to use a computer to perform a task" (Gattiker & Paulson, 1987). Now, however, the term has taken on a variety of meanings and is defined in different ways for specific groups of people (Bjorn-Anderson, 1983; Wynne, 1983). For example, it means far more than a person's ability to work with a microcomputer or terminal. It may describe a worker's ability to use appropriate application software such as spreadsheets, database, or word processing programs (Gattiker & Paulson, 1987).

Computer literacy may even be used to describe people's awareness of the role of computers in their lives (Capron, 1990). This year computer literacy has come to include " . . . the two dozen words or terms [that] are all anyone needs to talk intelligently about computers . . ." (Dvorak, 1991).

In this present study, "computer literacy" exhibits these three levels or definitions of the term:

- Knowledge of what a computer is and of how it works. This requires understanding specific terminology because the terms are unique and descriptive.
- Interaction with a computer. This means the ability to understand and properly use specific types of software for specific purposes.
- Computer awareness. Included in this is an understanding of the importance, versatility, pervasiveness, and potential uses of computers for both positive and negative purposes within society (Capron, 1990).

Background to Learning Styles

Kolb developed a theory and a nine-question instrument that provides a learning style inventory (KLSI). His theory moves a person's learning through a four-stage process in which a person:

1. Starts with a concrete experience (CE),
2. Moves to reflective observation (RO),
3. Goes on to making abstract concepts (AC), and
4. Settles into active experimentation (AE).

Words that describe CE, RO, AC, and AE stages or modes of this learning process are feeling, watching, thinking, and doing. The process is continuing, cyclic, and directed by a person's needs and goals (Kolb, 1984). Thus, the process is highly individualized — and could be influenced by the exigencies of the day.

A nine-item questionnaire, which requires self-description, produces scores for the KLSI. Each item has a set of four words, with which a person rank orders the words so the sequency describes him- or herself. Researchers recently use the questionnaire to analyze the learning style of software end users (Bostrom, Olfman, & Sein, 1990), but it has also had dissenters (Freedman, 1980). The shaded textbox below shows a half-sized version of the questionnaire, modified to reflect the current usage of "best" as being number "1."

Textbox 1. Learning Style Survey (with modified instructions)

Name ______________________________ Student ID ____________

Nine sets of four words listed below characterize learning style. Would you rank-order the words in each set so the order describes you. Keep in mind that there are no right or wrong answers — all choices are equally acceptable.

Assign numbers to the left of the words that characterize your learning style:

1 for the best
2 for the next best
3 for the next to least
4 for the least

Example:

SET

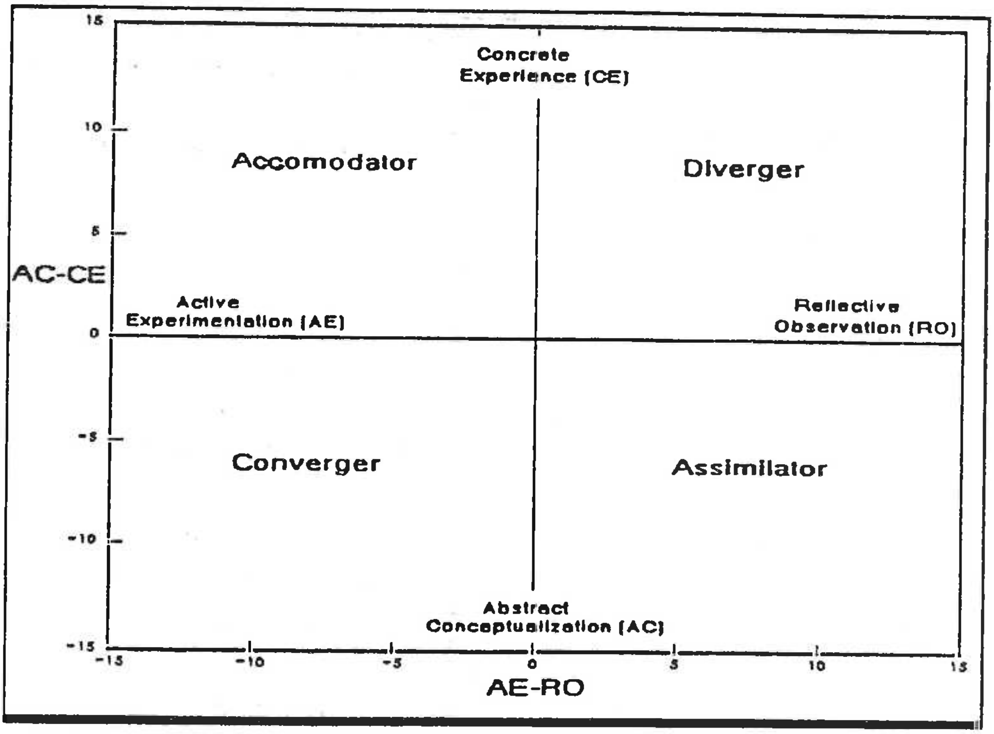
0. _2_ fast, _3_ understanding, _4_ slow, _1_ big picture

The suggested way of ranking is to find the best — 1, the least — 4, and then the next best — 2 and finally the next to least — 3. Be sure to assign a different rank number to each of the four words in each set.

1. ____ discriminating ____ tentative ____ involved ____ practical
2. ____ receptive ____ relevant ____ analytical ____ impartial
3. ____ feeling ____ watching ____ thinking ____ doing
4. ____ accepting ____ risk-taker ____ evaluative ____ aware
5. ____ intuitive ____ productive ____ logical ____ questioning
6. ____ abstract ____ observing ____ concrete ____ active
7. ____ present-oriented ____ reflecting ____ future-oriented ____ pragmatic
8. ____ experience ____ observation ____ conceptualization ____ experimentation
9. ____ intense ____ reserved ____ rational ____ responsible

Tallying the numbers assigned to the four words for the questions in prescribed combinations measures a person's relative preferences for the four learning modes or abilities (CE, RO, AC, and AE). Using these numeric assignments, Kolb made up visual patterns produced by subtracting CE from AC and RO from AE. The plots of these two numbers, AC-CE and AE-RO, allows placement of people on a Learning Style Grid, such as the one depicted in Figure 1. These placements in the quartered grid allow people to be designated as "Converger, Diverger, Assimilator, and Accommodator" (Kolb, 1984). Our interest in this report was the relative positioning of style as related to an increased level of computer literacy. Other studies have allowed categorization of students by their majors (Brown & Burke, 1987) and level of education (Baker, Simon, & Bazeli, 1986, 1987).

Figure 1. Kolb's Learning Style Type Grid



COMPONENTS OF COMPUTER LITERACY

The research problem was to determine the increase in the level of computer literacy (as defined above) of students measured at the beginning and ending of their introductory computer course. The primary reason for this study was to assure that a measurable level of learning was taking place and to establish a step level at which students could hurdle the introductory Management Information System (MIS) course and proceed to the next MIS course. Obviously, students also need to know about computers for other courses (Eyob, 1991). Secondary purposes included the evaluation of a variety of demographic variables and the exploration of learning style types to see how they impact the learning computer literacy.

The researchers created and tested questionnaire items that captured a comprehensive view of the course materials in the introductory MIS course, beyond just a computer language (Cheng, Plake, & Stevens, 1985). The survey included definitional questions (Duffy, 1989; Capron, 1990; Ingalsbe, 1989; Webster's, 1988) from all subject areas covered in the introductory course. The shaded text boxes in the Appendix show the first two pages of the questionnaire. This same questionnaire, first given with a demographic survey and last given with a learning style survey, allowed the researchers to determine the amount of learning taking place in the introductory course.

The hypothesis of this research study was: **exposure to the introductory MIS course would sufficiently elevate students' level of computer literacy,** thus allowing them to proceed to the next required and elective MIS courses. Based on previous testing of students taking sophomore MIS classes, there was a 48 percent increase in the level of computer literacy over the beginning level. Definitions in this hypothesis are:

Exposure to the introductory MIS course—learning the terminology presented in the textbook and in class. In effect, this was the experimental treatment.

Sufficiently elevate—score at a higher level on a questionnaire, equal to or higher than those who completed the course previously. Specifically, the average score had to equal or be greater than 48.1 out of 90 questions.

Level of computer literacy—test score obtained on the questionnaire that had questions on hardware, software, systems operations, computer languages, data and information, and systems analysis. The score was the dependent variable in all but one test and ranged from 0 to 90.

Twelve supporting null hypotheses dealing with demographicss and learning style are shown below. The first one is experimental, 10 deal with demographics, and one is exploratory.

There was NO difference in students' computer literacy for those who:

Ho1: Had completed the college-level introductory MIS course.

There was NO increase in students' computer literacy capacity (learning evidence) for those who:

Ho2: Had exposure (any experience with) to computers;
Ho3: Were of a different gender;
Ho4: Were younger, specifically, less than 21 years old;
Ho5: Were enrolled in less than three courses (part-time students);
Ho6: Had completed previous computer courses;
Ho7: Had access to computers off campus and at home;
Ho8: Owned a personal computer;
Ho9: Could type faster (touch type);
Ho10: Use a non-IBM type computer;
Ho11: Worked greater than 20 hours/week;
Ho12: Had differend learning styles.

METHODS

Questionnaire

The questionnaire was given during the first meeting of the class to nine introductory classes and two follow-on MIS courses. The latter two were used to validate the testing and establish a minimum literacy level. Then during the last two weeks of the semester, the questionnaire was given again to the nine introductory classes. Between the first and last administrations, the construction of the questionnaire was changed only to substitute learning style questions for demographic questions as shown in the above two tables.

The first 10 questions were demographic in nature, and the 90 items which followed involved computer literacy (Appendix). Rather than multiple choice, these 90 questions were constructed as matching questions to reduce the use of space and reading time by the participants. Besides, researchers have found matching questions to reduce guessing by participants and to be easier to construct and score (Sax, 1989).

The nontrivial literacy questions assured the researchers did not capture cursory and chance knowledge, which were also checked for item difficulty level and discrimination indices (ITEMAN, 1986). No student scored perfect on either the beginning or ending test, so an interval scale could be used in testing.

General Procedures

The procedures used in the administration of the questionnaire to all classes were:

1. After the instructor briefed students about the course, the instructor introduced the researcher to the class.
2. The researcher told the students that the survey would take about 20 minutes, and the results in no way affected their grade. They were reminded that answering the survey was voluntary.
3. The researcher then read the questionnaire instructions and passed out the questionnaires. This was not necessary for the second testing.
4. The researcher recorded the time when the students turned in the questionnaire.
5. Data analyses included several precautions geared toward assuring the validity of the data (e.g., eliminating questionnaires that had none of the last 10 questions attempted).

RESULTS AND DISCUSSION

The hypotheses, means, results of t-tests, and levels of significance are shown in Tables 1 and 2. The six hypotheses not testing at significances higher than $p > 0.1$ are shown in Table 2; the other five are shown in Table 1. The range of improvement scores (the difference between questionnaires) was 0 to 46, with 16.5 being the mean and 15 being the median.

Experimental and Demographic Differences

Tables 1 and 2 provide a number of interesting findings concerning the effect (and lack of effect) of demographic variables. As shown in Table 1, the 143 students who answered both the beginning and ending course questionnaire demonstrated a 48 percent improvement in computer literacy, the first hypothesis. Additionally, they displayed a higher level of computer literacy than the students that had previously taken the introductory course. Also, those few who had no prior computer experience learned more computer terms than the students who had been exposed to computers.

Table 1. Significant Results of Hypotheses Tests

HYP	Independent Variables	n	Mean	Std. Error	t-score	Significance
Ho1:	Questionnaire scores:					
	first	143	34.6	13.4	10.53	p > 0.001
	second		51.0	13.1		
	learning/improvement		16.5	11.2		
			Learning Mean			
Ho2:	Computer experience:					
	some	127	15.9	10.8	1.76	p > 0.1
	none	16	21.6	12.4		
Ho3:	Gender difference:					
	male	66	14.1	10.5	2.35	p > 0.05
	female	76	18.3	11.1		
Ho4:	Age:					
	less than 19 yr	23	12.7	9.1		
	19 to less than 22 yr	58	13.8	9.5	-0.49	ns
	22 to less than 29 yr	39	17.8	11.5	-1.79	p > 0.1
	29 to less than 39 yr	15	25.1	13.3	-1.89	p > 0.1
	greater than 39 yr	8	24.5	10.0	0.13	ns
Ho5:	Courses this term:					
	3 or less	36	19.8	12.0		
	more than 3	107	15.4	10.6	1.95	p > 0.1

Interestingly, these findings suggest that female students learned 30 percent more than the male students during the semester. Also, the females have a different learning style than the males, which is discussed in the next section.

Physical age also appears to help students learn computer terms. The learning progression with age is uncanny. An interesting note to this hypothesis is that the students less than 21 years old had a one point higher average score on the first test than those 21 and over. Younger students started with high literacy scores and faded.

Table 2. Non-significant Results of Hypotheses Tests

HYP	Independent Variables	n	Mean	Std. Error	t-score
Ho6:	Computer course(s):				
	one or more	75	15.1	10.0	1.55
	none	68	18.0	12.1	
Ho7:	Access:				
	only on campus	53	16.3	11.2	
	also off campus	90	16.6	11.1	-0.16
	not at home	86	16.5	10.9	
	at home	57	16.5	11.5	0.03
Ho8:	Typing Speed:				
	cannot	5	10.4	8.8	
	less than 20 wpm	13	14.6	13.1	-0.79
	touch, less than 20 wpm	12	17.7	10.8	-0.64
	20 to 50 wpm	95	16.6	11.1	0.33
	greater than 50 wpm	18	18.3	10.6	-0.64
	non-touch	18	13.4	12.0	
	touch	125	16.9	11.0	-1.17
Ho9:	Computer familiarity:				
	IBM	90	15.9	10.9	
	non-IBM	51	16.9	11.4	-0.51
Ho10:	Personal Computer:				
	own	46	17.6	11.6	
	not own	97	16.0	10.9	-0.79
Ho11:	Outisde work:				
	none	42	16.3	10.6	
	less than 10 hr	3	3.7	3.2	5.10
	10 to less than 20 hr	13	15.8	10.3	3.55
	20 to less than 40 hr	65	16.8	11.8	0.31
	greater than 40 hr	20	18.5	10.4	0.63
	less than 20 hr	58	15.5	10.6	
	20 or more hr	85	17.2	11.5	-0.88

Part-time students learned more, but knew a little more to start with. One explanation for this finding is that taking three or less classes allows more "head room" for vocabulary.

As was expected, students that never had a computer course learned more (19 percent), but they did not learn significantly more than those who previously had taken a course. In the pre-course questionnaire, those students that never had a computer course started four points behind those who had a course and never did close the gap.

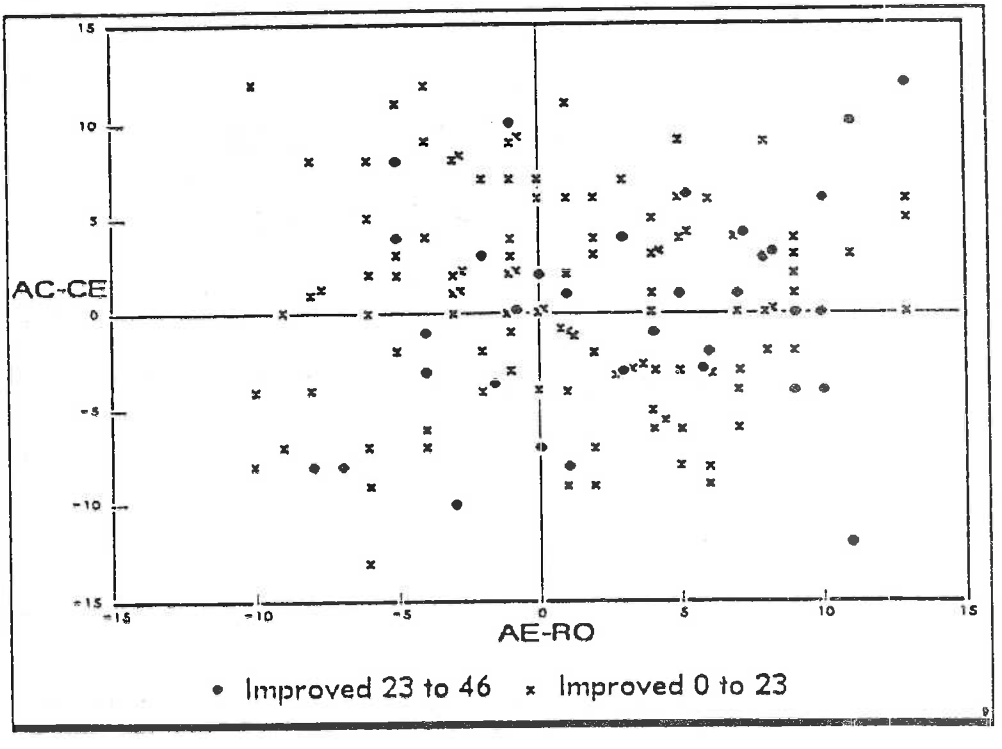
Neither access to a computer, even an IBM, nor owning a computer had an effect on learning. Those students that had a computer at home answered seven percent more questions correctly, but they did not show more improvement over those who did not have one at home. An unexplained factor appears to be *motivation*, and having access to and owning a computer does not appear to indicate motivation.

Finally, a number of factors appear to be related (but not significant) to computer literacy. Computer literacy is not significantly linked to manual dexterity. The ability to type well does appear to help a student learn more, but not significantly more. More hours of outside work does appear to be related to computer literacy, but again not significantly.

Learning Style Type

Exploration. Figure 2 shows a scattergram of AC-CE and AE-RO scores on a learning style type grid. No distinguishable pattern could be seen, except for those 34 students that demonstrated a higher level (23 to 46 point) of improvement. The dark circles represent this group of students' placement on the AC-CE and AE-RO axes. Most of these circles were found to be on the right side of the AE-RO axis, which proved to be a significant finding.

Figure 2. More High Learners on the Right Side of the AE-RO Axis

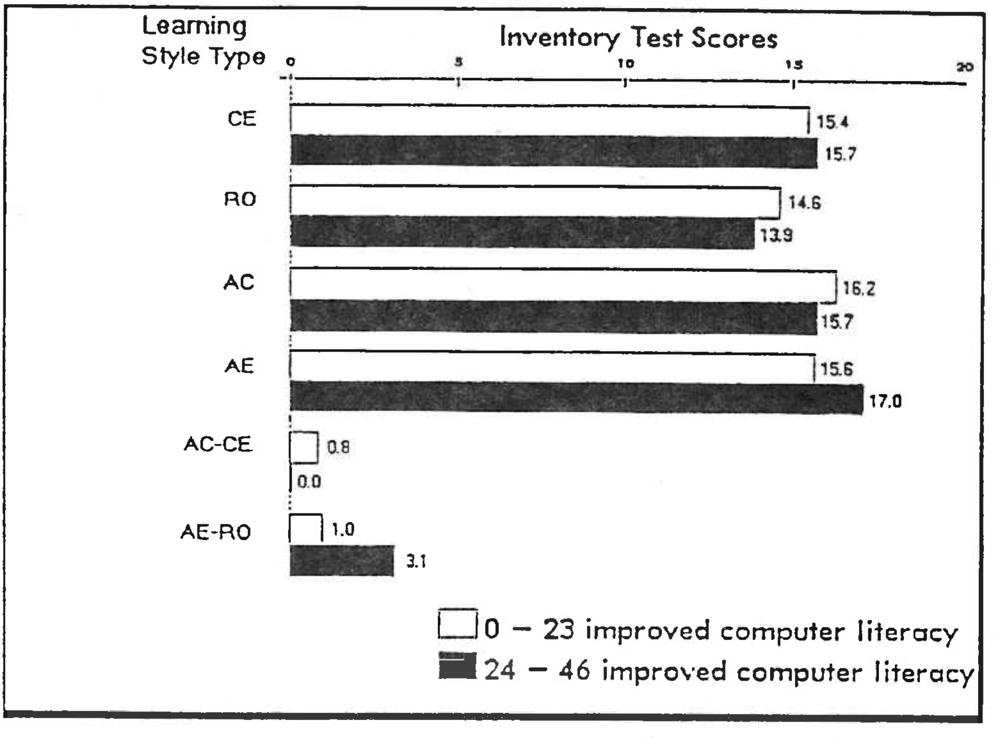


Using the AC-CE and AE-RO as independent variables and those students in the higher learning group and lower learning group as dependent variables, a linear discriminant analysis showed the groups were slightly different (MINITAB, 1989). The categorical split on the dependent variables was again at the improvement level of less than 23 and level of between 23 and 46. MINITAB calculated their proportionality at 0.578 and 0.588. This is near-chance, supported by a further test of polar extremes (scores below 15 and above 30) showed a proportionality of only 0.414 and 0.500.

Gender differences showed more. Again, using AC-CE and AE-RO as the independent variables and the male and female students the dependent variables, their proportionality was 0.612 and 0.605. Both of these discriminant analyses show slight differences in the groups and t-tests verified the differences.

Tests on learning levels. Figure 3 shows the differences in learning groups between the low-scoring students who had an improvement level of less than 23 and high-scoring students who had an improvement level between 23 and 46. Table 3 details the test differences in learning styles scores, confirming that the high-scoring learning group tended to be on the right of the AE-RO axis with the AE (Active Experimentation) factor being the more dominant. Again, this confirms that active learners (AEs) have an advantage over reflective learners (ROs) (Bostrom, Olfman, and Sein, 1990). The learning style tests did not completely agree with Bostrom's, but he did not test students. Also confirming the demographic tests, twenty-two of the 34 high-scoring learners were female students.

Figure 3. Different Learning Style for High Learning Level



To determine whether students who take tests well were in the same learning style categories, t-tests were made on the high and low scorers on the literacy questionnaire. Test takers with high scores (52 to 77) were significantly different from those with lower scores (25 to 51) in CE, AC and AC-CE learning style categories. The high scores group was not the same students that improved the most, indicating that learning computer terminology and learning to take tests well may not be the same talent.

Table 3. Results of Tests for Learning Improvement Levels

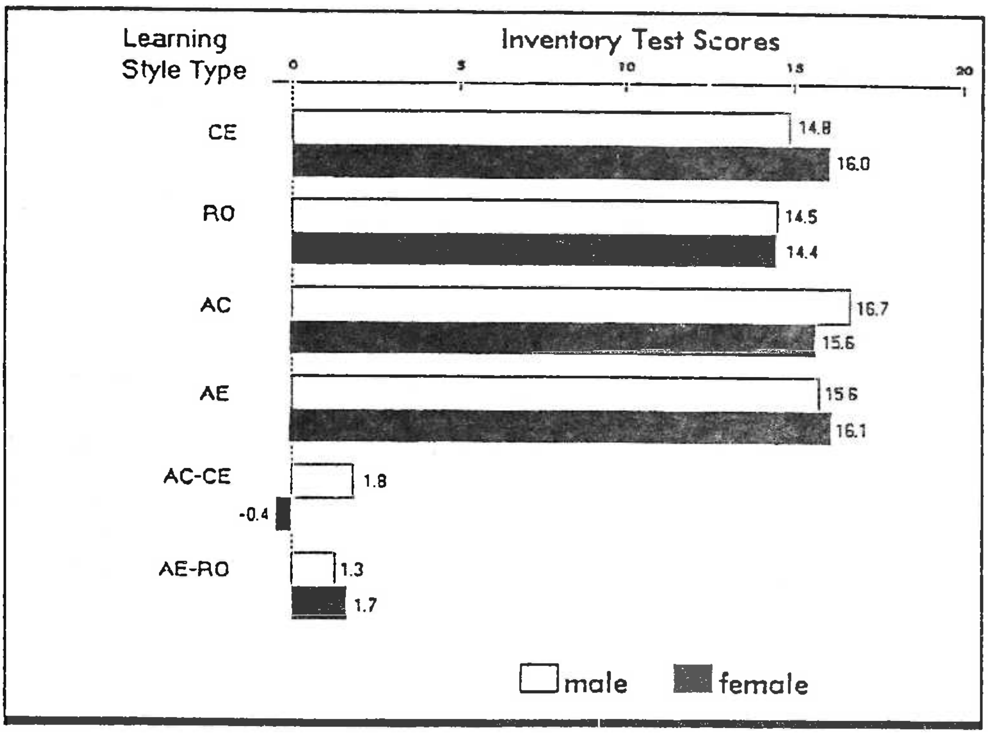
HYP	Independent Variables	n	Mean	Std. Error	t-score	Significance
Ho12a	CE					
	improved 0-23	109	15.4	2.9	-0.52	ns
	improved 24-46	34	15.7	2.9		
	RO					
	improved 0-23	109	14.6	3.4	1.10	ns
	improved 24-46	34	13.9	3.4		
	AC					
	improved 0-23	109	16.2	3.3	0.82	ns
	improved 24-46	34	15.7	3.4		
	AE					
	improved 0-23	109	15.6	2.9	-2.33	$p > 0.05$
	improved 24-46	34	17.0	3.0		
	AC-CE					
	improved 0-23	109	0.83	5.7	0.76	ns
	improved 24-46	34	0.00	6.0		
	AE-RO					
	improved 0-23	109	0.97	5.7	-1.83	$p > 0.1$
	improved 24-46	34	3.1	5.9		

Tests on Gender. The learning style types were different for the male and female students as the numbers in Table 5 demonstrate and Figure 4 shows. With the female students learning an average of 30 percent more than the males, the females' higher AE-RO scores did tend to match the higher AE-RO scores of the more improved group of students. Also, the females' low AC-CE scores tend to match the direction of the more improved group. Any statements beyond those two would be even more speculative. Verifying our numbers, the learning styles inventory scores of female students in this study correspond (no significant differences) to those of an all-female college in New England (Baker, Simon, & Bazeli, 1986).

Table 4. Results of Tests for Gender Learning Styles

HYP	Independent Variables	n	Mean	Std. Error	t-score	Significance
Ho12b	CE					
	male	66	14.8	2.6	-2.53	p > 0.02
	female	76	16.0	3.1		
	RO					
	male	66	14.5	3.2	0.09	ns
	female	76	14.4	3.6		
	AC					
	male	66	16.7	3.1	1.90	p > 0.1
	female	76	15.6	3.5		
	AE					
	male	66	15.8	3.1	-0.68	ns
	female	76	16.1	2.9		
	AC-CE					
	male	66	1.8	5.1	2.39	p > 0.02
	female	76	-0.4	6.1		
	AE-RO					
	male	66	1.3	5.6	-0.52	ns
	female	76	1.7	6.1		

Figure 4. Gender Learning Styles Differ



CONCLUSION

This research study has provided a number of expected and fascinating findings — as well as unforeseen relationships. First, students did learn vocabulary and skills required for a measurable level computer literacy, and those who came into the classroom at a lower level finished the course with a higher level of literacy. One unexpected finding was that older students are not impaired in becoming more computer literate. In fact, being mid-aged, female, or a part-time student may help people in increasing their computer literacy.

Having access to a computer only on campus (in the computer labs) did not affect learning about computers. Owning a computer did help people to get to a higher level of computer literacy, but did not increase the amount of learning significantly over nonowners. Working more hours per week, oddly enough, does not lower learning. Instead, it appears to have increased learning slightly.

These findings provide interesting possibilities and questions for both business firms and institutions of higher education.

- Gender (being female), having lighter course loads, and increasing age appear to increase the learning of computer terminology. Under what circumstances can we increase the learning of males, those under a normal workload, and the young?
- Except for a few high learners, the relationship between learning style and computer literacy learning levels appears to be nonexistent. How can the learning styles be controlled to increase computer literacy and other learning?
- People who have a personal computer start and end at a higher level computer literacy. How do we get a personal computer into the hands of employees and students?

This current study has been only a beginning. Its findings are preliminary and may not be generalizable. However, based upon this we offer the following questions for further research:

- What motivates people to learn about computers?
- What are the differences between learning to use a computer (manually, artistically, and logically) and learning the computer terminology? Further, are there associated gender, aptitude, and age differences?

If computer literacy is needed for success in business and government, we need to know what factors will help and hinder our students in learning today. Our application of those factors in education/training will eventually shorten the time needed to bring about computer literacy.

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Appendix 1. Textbox 2—Demographic Questions in the First Questionnaire

DEMOGRAPHICS

1. How many computer courses have you taken?
   - ☐ A. None
   - ☐ B. One
   - ☐ C. Two
   - ☐ D. Three
   - ☐ E. Four or more
2. How old are you?
   - ☐ A. Younger than 19
   - ☐ B. 19 to 21
   - ☐ C. 22 to 29
   - ☐ D. 30 to 39
   - ☐ E. Over 39
3. How many words per minute (wpm) can you type?
   - ☐ A. None, cannot type
   - ☐ B. Less than 20 wpm using a few fingers
   - ☐ C. Less than 20 wpm using all fingers
   - ☐ D. Between 20 and 50 wpm
   - ☐ E. More than 50 wpm
4. How much computer experience have you had? (MARK ALL THAT APPLY)
   - ☐ A. None
   - ☐ B. Played video games
   - ☐ C. Used one or more word processors (Names ________________)
   - ☐ D. Used one or more spreadsheets (Names ________________)
   - ☐ E. Programmed one or more languages (Names ________________)
5. Have you used any of the following computers? (MARK ALL THAT APPLY)
   - ☐ A. IBM or IBM compatible
   - ☐ B. Macintosh or Apple
   - ☐ C. Commodore
   - ☐ D. Atari
   - ☐ E. Other, SPECIFY ________________
6. Do you have access to a computer off campus?
   - ☐ A. None
   - ☐ B. Yes, at home
   - ☐ C. Yes, at work
   - ☐ D. Yes, at home and work
   - ☐ E. Yes, at friend's
7. Do you own a computer?
   - ☐ A. No
   - ☐ B. Yes, a desktop
   - ☐ C. Yes, a portable
   - ☐ D. Yes, a laptop
8. How many hours per week do you work in outside employment (not course work)?
   - ☐ A. None
   - ☐ B. Less than 10
   - ☐ C. 10 to 19
   - ☐ D. 20 to 40
   - ☐ E. Over 40
9. How many courses are you taking this semester?
   - ☐ A. One
   - ☐ B. More than one (number ________)
10. What major do you plan to take in your college?
    - ☐ A. Undecided
    - ☐ B. Major, SPECIFY ________________

Appendix 2. Textbox 3—First Page of Terms in Questionnaire

COLUMN A Definitions	COLUMN B Terms
____ 11. Has four functional parts: input, processing, storage (programs and data), and output ____ 12. Performs the mathematical operations and any comparisons required ____ 13. Physical parts of a computer.	A. Arithmetic/logical unit B. Computer System C. CPU D. Firmware E. Hardware
____ 14. Standard method of representing a character with a number inside the computer. ____ 15. The base 2 numbering system that uses digits 0 and 1. ____ 16. Number system that uses the ten digits 0 through 9 and the six letters A through F to represent values in base 16.	A. Alphanumeric B. ASCII C. Binary D. Hexadecimal E. Numeric data
____ 17. Process of joining two character strings. ____ 18. Order in which calculations are executed. ____ 19. Indicates how fast a computer can process data.	A. Clockspeed B. Code C. Concatenation D. Documentation E. Precedence
____ 20. Smallest part of a display screen that can be controlled. ____ 21. Standard keyboard arrangement. ____ 22. Uses position of light and a computer screen to record information.	A. Cluster B. Dvorak C. Light pen D. Qwerty E. Pixel
____ 23. File used in building a turn-key application that requires very little input from a user before starting. ____ 24. File used by DOS after the boot process is finished to further set up your computer system. ____ 25. Hidden file in DOS that manages each character that is typed, displayed, printed, received, or sent through any communications adapter.	A. AUTOEXEC.BAT B. CONFIG.SYS C. IBMBIO.COM D. IBMDOS.COM E. DOS
____ 26. High-level language designed for scientists, engineers, and mathematicians to solve complex numerical problems. ____ 27. High-level language oriented toward organizational data processing procedures, particularly in business. ____ 28. High-level language which the user with very little programming knowledge can use.	A. Ada B. BASIC C. COBOL D. FORTRAN E. Fourth Generation