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ABSTRACT

Computer literacy has been identified as one of the most important factors for the effective use of computer-based technology in the workplace. Managers need to know the most efficient methods available to teach computer skills to their employees in a short time. Such methods need to be suitable for all employees, whether academically gifted or weak. A study was conducted to investigate the effectiveness of the methods used in teaching computer literacy to business students at a western Canadian university. Subjects were 128 undergraduate management students taking a required micro-computing course designed to make students computer literate. Classroom methods for the course consisted of traditional lectures and computer-assisted instruction (CAI). Students' grades for the course, grade point averages (GPA), and grades in a BASIC programming course completed by approximately one-half of the subjects were examined. The results revealed that student performance using CAI was predicted by GPA and was affected by completion of the BASIC course. GPA was also found to be a significant predictor of class mark in the micro-computing course. The results suggest that hands-on teaching is superior to traditional classroom lectures, especially for less academically inclined students. Organizations should design training seminars which reflect actual work situations for the benefit or both the end-user and the company. (NB)

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EFFECTIVENESS OF TEACHING METHODS: COMPUTER LITERACY OF END-USERS[1]

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EFFECTIVENESS OF TEACHING METHODS:

COMPUTER LITERACY OF END-USERS

Abstract

Computer literacy has been identified as one of the most important factors for the effective use of computer-based technology at the work-place. Managers need to know the most efficient methods available to teach computer skills to their workers in a short time. Such methods need to be suitable for all employees, whether academically gifted or weak. This paper investigates several approaches used to teach business students about micro-computers. The results show that hands-on teaching is superior to traditional classroom lectures, especially for academically less inclined students. Directions for future research and implications of these findings for management are discussed.

EFFECTIVENESS OF TEACHING METHODS:
COMPUTER LITERACY OF END-USERS

It is expected that by the end of this decade the majority of clerical as well as managerial employees in North America will use computers in their daily work (Giuliano, 1982; Gutek, 1983). The impact of computerization upon job design and work structure has already been substantial, making it an area of considerable interest for human resource management. Most of the relevant research has dealt with such areas as human factors engineering, financing and organizational design (e.g., Carter,1984; Doswell, 1983; Lieberman, Selig & Walsh, 1982, chap. 1 & 2). Unfortunately, while policy and strategy issues related to computer technology have taken most of the limelight in organizational literature (Megaw & Lloyd, 1984; Panko, 1984), education and training aspects have largely been ignored even though additional research in this area is necessary (Hebenstreit, 1985; Kahn, 1981). For example, a comparison of computer-assisted instruction (CAI) versus traditional classroom teaching methods would be useful when trying to determine the effectiveness of these approaches (Amarel, 1983). The amount of technical knowledge (e.g., programming) which may be required when striving for computer literacy has not been determined yet (Hebenstreit, 1983). It might well prove to be minimal. Academic background and individual learning capabilities may also be of consequence (Lepper, 1985). Finally, the type of equipment ultimately utilized (mainframe terminal or intelligent workstation) may dictate certain methods.

This paper investigates the effectiveness of the methods used in teaching computer literacy to business students at a Western Canadian University. Most of the students have previous work experiences, and many continue to work full-time while attending the university part-time. They acquire computer skills with the help of lectures as well as interactive

CAI, which is provided in a micro-computer lab setting. The former teaches technical specifics about computers (hardware) and programming languages, while the latter concentrates on the equipment's use for such job tasks as word-processing, spreadsheets, accounting, database management and programming. The micro-computer course is a requirement for a management degree.

Training of the Office Worker

Much of the organizational literature stresses that only the effective use of technology really warrants its huge financial investment. An assessment of computer literacy in a company's workforce thus becomes the first step in achieving such effectiveness. However, a recent study of employees from several organizations across the Western U.S. showed that hands-on experience and frequent computer use for certain job tasks does not necessarily constitute individual computer knowledge, let alone computer literacy (Gattiker & Larwood, 1986).

Contrary to popular belief, successful use of automated systems is not primarily dependent on technological advances and know-how, but rather on user acceptance of the electronic office (Dierkes & Von Thienen, 1984). Employees need to feel at ease working with the technology. People who interface directly with the computer and other electronic systems must have thorough knowledge of how to use their equipment most effectively. Therefore, organizations should provide sufficient instruction for the end-users within their workforce (Menashian, 1985).

Computer literacy. This is an important construct when assessing possible resistance to computerization (Gattiker, 1984; Dierkes & Von Thienen, 1984). Computer literacy has been defined in different ways for specific groups of employees (Bjorn-Anderson, 1983; Wynne, 1983). In this context, it includes, but is not limited to, the individual s capability to work with computer terminals or intelligent workstations. Such knowledge was usually related to technical aspects, as exhibited by computer scientists and similar professionals who often knew programming languages.

However, today's proliferation of computer-based technology has brought about a radical change of the term computer literacy (Hebenstreit, 1983). In offices, it now describes the worker's ability to use appropriate software programs for certain clerical tasks, including business correspondence, report writing and spreadsheets (Card, Moran & Newell, 1984; Morgall, 1983). Computer knowledge may also mean some familiarity with the data processing capabilities of standard programs. This aspect is reflected more and more in the computer education of future managers (Gattiker, 1986).

Assessing the Effectiveness of Training Alternatives

Traditional computer training methods aimed at achieving computer literacy have included programming skills and knowledge about hardware (Lepper, 1985). Most of today's computer science majors are still taught in this way (Campbell & McCabe, 1984). Yet recent research shows a broader conception of the computer's role in education. For example, Taylor (1980) has described three uses of computers in schools: tutor, tool and tutee. In a tutoring capacity, the computer presents material, evaluates student responses, determines what to present next and keeps records of student progress. The computer serves as a tool when it provides statistical analysis, calculation, or word-processing. For students, the technology may become a calculator in statistics classes, a text editor for writing assignments, an aid to doing spreadsheets when solving accounting/finance problems, or a database management system. Finally, the computer assumes the role of tutee if students communicate in programming languages, such as BASIC and Pascal, which allow manipulation of the "capabilities" of the equipment (Kulik, Kulik & Bangert-Drowns, 1985).

Most of the studies assessing the efficiency of instructing individuals with CAI have been done with grade school students (Kulik, Kulik & Bangert-Drowns, 1985). CAI can provide frequent and highly relevant feedback directly from the student's work (Bork, 1985). Responses can then be carefully analyzed within the common everyday language of the student. However, the question of whether CAI is the best method for adults as well remains unanswered. Furthermore, the training needs for office workers may be quite diverse, depending on whether intelligent workstations, mainframe terminals or computer-aided design systems are used. Training methods for office personnel to acquire the necessary computer skills so far have included CAI and traditional classroom activities, such as lectures and self-study (Menashian, 1985). Clearly, researchers need to evaluate a wider range of educational approaches and their results than ever before (Kulik, Kulik & Bangert-Drowns, 1985).

Evaluation of training results. Obviously, CAI can help individuals overcome resistance to change by providing hands-on experience with the new technology, even if traditional lecturing about computers leaves the potential user awed and somewhat frightened (Hebenstreit, 1985). For instance, some U.S. research indicates that university freshmen who achieved high SAT scores and were near the top of their high school class performed better in computer science courses than their lesser ranked peers (Campbell & McCabe, 1984). Another study by Butcher and Muth (1985) concluded that students with a high grade point average (GPA) fared better in computer science courses than those with lower GPA's. However, since many employees today are being challenged to acquire computer skills, it is important for management to identify those teaching methods which successfully lead to adult computer literacy, regardless of academic competence (Brown, Sawyer & Hitchcock, 1984; Gattiker, 1986; Lepper, 1985).

It would be interesting to know how a student's past academic record explains his/her performance in a micro-computer training course. Would he/she do equally well in traditional classroom tests and exams versus non-traditional "take-home" assignments requiring actual use of the equipment? Answers to these issues and questions would help educators and managers alike to determine the appropriate teaching methods leading to computer literacy for employees who are confronted with technological innovations at the workplace (cf. Bjorn-Anderson, 1983; Kulik. Kulik & Bangert-Drowns, 1985; Menashian, 1985).

Research Issues

In this study, we tried to assess student performance in the acquisition of micro-computer literacy. We hoped to identify the specific techniques which would teach end-users the most useful skills for office settings, that is, facilitate the best man-machine interface (Menashian, 1985).

The following hypotheses were developed:

Hypothesis 1a. Student performance in the CAI section of a micro-computer course is predicted by his/her overall academic performance.

Hypothesis 1b. Student performance in the CAI section of a micro-computer course is affected by his/her grade in a previously completed mainframe computing course teaching BASIC.

Hypothesis 1c. Student performance in the CAI section of a micro-computer course is affected by both his/her overall academic record and successful completion of a mainframe computing course in BASIC.

The models for CAI performance to be estimated here were in the form of linear regression equations:

Hypothesis 1a. CAI = constant + GPA

Hypothesis 1b. CAI = constant + GPBASIC

Hypothesis 1c. CAI = constant + GPA + CRBASIC

The variable CAI is the percentage grade that the student received in the CAI section, which is composed of ten assignments (20% of CAI mark total), two practical exams (20% each of CAI mark total), and two multiple choice exams (also 20% each of CAI mark total). The student's overall academic performance is quantified by his/her 'a priori' GPA and is designated as such. The university presently employs a four-point grade scheme with 4.0 (exceptional performance) resulting in an "A" grade, 3.0 being equivalent to "B", and so on. Below 1.0 ("D"), a failing grade is given with the rationale that the student did not comprehend a sufficient amount of the course material. If the student took the mainframe computing course as an option, the grade received in that course has been coded GPBASIC (i.e., A=4,B=3,C=2,D=1,F=0). A "D" or better in the BASIC course is coded as CRBASIC=1; failure in the course is coded as absence of mainframe experience (CRBASIC=0).

Hypothesis 2a. Student performance in the classroom segment of a micro-computer course is predicted by his/her overall academic performance.

Hypothesis 2b. Student performance in the classroom segment of a micro-computer course is affected by his/her grade in a previously completed mainframe computing course in BASIC.

Hypothesis 2c. Student performance in the classroom segment of a micro-computer course is affected by both his/her overall academic record and successful completion of a mainframe computing course in BASIC.

The models for CLASS overall performance can be expressed using the following linear regression equations:

Hypothesis 2a. CLASS = constant + GPA

Hypothesis 2b. CLASS = constant + GPBASIC

Hypothesis 2c. CLASS = constant + GPA + CRBASIC

The class mark (CLASS in percent) was made up of two exams. One assessed the student's general expertise regarding micro-computer functions, the other tested his/her knowledge about their use in the business world.

Hypothesis 3a. Overall student performance in a micro-computer course is predicted by his/her overall academic record.

Hypothesis 3b. Overall student performance in a micro-computer course is predicted by his/her grade in a mainframe course in BASIC.

Hypothesis 3c. Overall student performance in a micro-computer course is affected by both his/her overall academic record and successful completion of a mainframe computing course in BASIC.

The regression models used to evaluate overall performance in the micro-computing course were:

Hypothesis 3a. GPMICRO = constant + GPA

Hypothesis 3b. GPMICRO = constant + GPBASIC

Hypothesis 3c. GPMICRO = constant + GPA + CRBASIC

The student's overall grade in the micro-computer course is expressed in terms of the grade point that they received (A=4, etc.), and for simplicity is referred to as GPMICRO throughout this study.

Hypothesis 4. Students with superior performance in a micro-computing course are randomly distributed amongst 'a priori' GPA's.

Based on the above hypothesis, we were also interested in testing if 'A" students would fare better with one particular teaching method for acquiring computer literacy than their academically inferior peers. Furthermore, would knowledge about mainframe computers and BASIC programming help academically less inclined students to perform better? The following hypotheses were made:

Hypothesis 5a. Student performance in the CAI section of a micro-computer course is predictable by means of his/her previous academic record and successful completion of a mainframe computing course in BASIC.

Hypothesis 5b. Student performance in the classroom segment of a micro-computer course is predictable by means of his/her previous academic record and successful completion of a mainframe computing course in BASIC.

Hypothesis 5c. Overall student performance in a micro-computing course is predictable by means of his/her previous academic record and successful completion of a mainframe computing course in BASIC.

The models for student performance using different GPA levels were also estimated via linear regression:

Hypothesis 5a. CAI = constant + GPAA + GPAB + GPAC + ACRBASIC + BCRBASIC + CCRBASIC

Hypothesis 5b. CLASS = constant + GPAA + GPAB + GPAC + ACRBASIC + BCRBASIC + CCRBASIC

Hypothesis 5c. GPMICRO = constant + GPAA + GPAB + GPAC + ACRBASIC + BCRBASIC + CCRBASIC

The letter following the acronym GPA refers to the student's grade point average group (note that if a student has a GPA of 3.8 then GPAA=3.8, GPAB=0 and GPAC=0). The prefix of CRBASIC operates in the same manner as for the GPA groupings. "D" grades for the micro-computer course appeared too infrequently to be of consequence here.

Take-home assignments may represent a fairly close parallel to office settings where employees are often asked to perform computer tasks under minimal supervision (Hebenstreit, 1983; Menashian, 1985; Samson, Graue, Weinstein & Walberg, 1984). Consequently, we also looked specifically at assignment performance as a representative variable of the individual's potential work situation.

Hypothesis 6. A student's practical (assignment) performance is predictable by means of his/her previous academic record and successful completion of a mainframe computing course in BASIC.

To model ASSIGNMENT performance, we used the following regression:

Hypothesis 6. ASSIGNMENT = constant + GPAA + GPAB + GPAC + ACRBASIC + BCRBASIC + CCRBASIC

The variable ASSIGNMENT is the student's overall score resulting from the combined total of ten assignments done throughout the micro-computing course.

Method

Subjects and Design

Undergraduate management students must complete a micro-computing course to fulfill one of their graduation requirements. A BASIC programming course on the university's mainframe computer is also available to meet student demand for computer literacy, but may not be substituted for the micro course. Of the 128 students who participated in this project relating to micro-computers, about one half had already taken the mainframe computer class.

The micro-computer course is an attempt to impart computer literacy to management students, enabling them to work effectively with intelligent workstations in an office setting. Classroom methods consist of traditional lectures as well as CAI. Homework includes several assignments on micro-computers requiring the use of different software packages (e.g., Lotus, dBase and Word Perfect). Grading for this course is based on a traditional pencil test for the lecture part, and problem-solving tasks in a hands-on fashion for the CAI portion. In addition, two multiple choice exams relating to both parts are administered. All testing is done with time limits imposed.

Measures

Student grades were determined for the micro-computing course by considering overall performance, laboratory (CAI) performance, classroom performance and take-home micro assignments. The student's 'a priori' GPA and his/her grade achieved in the BASIC programming course (GPBASIC) were also obtained.

In this study, only students who received a passing grade (1.0 or better) in the optional mainframe computing course have been coded for the variable CRBASIC. Grouping variables were used to see if historically high GPA students may achieve GPMICRO=4. Students with 'a priori' GPA's of 3.50 and above were designated as "A" students, those with overall GPA's between 2.50 and 3.49 were classed as "B" students, and those ranging between 1.50 and 2.49 were labeled "C" students. Since no meaningful regressions can be run using such highly correlated variables as 'a priori' GPA and the GPBASIC (i.e., the latter being a part of the former), the use of CRBASIC is necessary. One might expect that students who do well overall would be more likely to have taken the mainframe computing course, but this was not so.

Statistics

All of the analyses for this project were accomplished on micro-computers with the statistical package SYSTAT. Multiple regression was used to determine not only the significance of factors but also the magnitude of the effect they might have on the dependent variable. To see if k independent samples are from different populations, the Kruskal-Wallis one-way analysis of variance by rank was used (Siegel, 1956, pp.184-193). Sample values almost always differ to some degree, and the question is whether the variations among the samples signify genuine population differences or merely represent expected chance variations in random samples from the same population.

Results

In order to facilitate a logical presentation of our results, they will be divided into five sections, according to the relevant hypotheses.

Predicting student performance using CAI. Hypotheses 1a through 1c were supported as follows: A student's 'a priori' GPA indeed proved to be a significant determinant ($p < 0.001$) of his/her performance in the CAI section of the micro-computer course, and it also explained 31% of the total observable variance in his/her laboratory mark. GPBASIC accounted for 23.3% of the population variance in the CAI mark obtained (significance of the independent variable = $p < 0.01$). When taking into account both the student's historical academic performance and also the fact that he/she successfully completed the mainframe computer course (CRBASIC), over 36% of the population variance in the CAI mark can be explained.

Insert Table 1 about here

Predicting student performance in the classroom. CLASS mark was determined almost as well with Hypotheses 2a and 2b as was CAI performance with Hypotheses 1a and 1b. The only important difference between the two groups is that although GPA is a significant predictor of class mark ($p < 0.001$), the other independent variable (CRBASIC) is not acceptable as significant in conjunction with the student's historical performance. The results show that H2a and H2b are supported by the data, whereas H2c can only be accepted with reservations.

Predicting a student's overall performance in the micro-computer course. Hypothesis 3a stated that a strong relationship would exist between the grade point received by a student in the micro-computing course and his/her 'a priori' GPA, which was indeed confirmed. The results also supported Hypothesis 3b, that is, a student's grade achieved in a BASIC course predicts his/her overall performance in a subsequent micro-computer course. Hypothesis 3c held that both a student's historical academic performance and whether he/she had completed a mainframe computing course would be significant indicators of his/her overall performance in the micro-computing course. As shown in Table 1, not only are both of them significant ($p<.001$), but 48.6% of the variance in the final grade received by students is determinable with these two variables. Thus Hypothesis 3c is confirmed as well.

Academic consistency and its effect. With Hypothesis 4, we intended to determine whether or not it was appropriate to treat all students as coming from the same population. Specifically, we tested if a student's rank based on historical academic performance versus the grade received in the micro-computer course was randomly distributed. Table 2 indicates that the rank 'a priori' GPA's of students are not random. In other words, students receiving high grades in the micro-computer course originate from a different population of GPA students than those who received lower grades, refuting Hypothesis 4.

Insert Table 2 about here

Predicting a student's performance with GPA and "traditional" computer literacy. The following three hypotheses are in reality a re-formulation of Hypothesis 3c, taking into account the fact that students with high previous academic performance will tend to perform differently academically weaker peers. As a result, the model to test the following hypotheses treats "A", "B" and "C" students as different groups than was shown to be true using a Kruskal-Wallis test previously.

Hypotheses 5a and 5b stated that a student's performance in the CAI section of the micro-computer course and final class grade are predictable, using the student's historical GPA and the mainframe course grade. However, Table 3 shows that having credit in a mainframe BASIC course is significant to performance in the CAI segment for "B" and "C" students only. For the CLASS section of the micro course, the mainframe BASIC course was not a significant predictor. Therefore, Hypotheses 5a and 5b are only partially supported.

Insert Table 3 about here

According to hypothesis 5c, the predictive model of overall student performance in the micro-computer course (GPMICRO) would be predicted by having completed a mainframe BASIC course and the student's historical GPA. The results indicate that an academically low achiever benefits significantly from a mainframe BASIC course in terms of his/her overall grade in the micro-computer course, while their "brighter" counterparts do not derive much benefit (cf. Table 3). Thus hypothesis 5c can be accepted with reservations only.

Assignment performance. Hypothesis 6 discussed the potentially significant predictors of ASSIGNMENT performance. It can only be partially confirmed because the 'a priori' GPA is indeed a significant predictor ($p < 0.01$), but completion of a mainframe BASIC course is not.

Discussion

This study was designed to assess which of our existing teaching methods would be most effective for students trying to acquire computer literacy. While all methods have merit and should be combined in a complementary manner, one or the other could be expected to emerge as a dominant force. Individual differences in the student population and academic preparation also figure prominently in our ultimate findings.

<u>"Traditional" computer literacy</u>. Different models were tested to see how students would perform in the CAI and CLASS portions of a micro-computer course and what final grade they would receive. As the figures in Table 1 showed, previous completion of a mainframe systems/BASIC programming class was helpful to the student's performance in the CAI section of the course. These results confirm earlier work by Campbell and McCabe (1984) who found that computer science majors with high freshman grades in beginning computing courses performed better and better as they progressed through their academic programs.

On the other hand, credit in a mainframe computer course did not add significantly to the student's GPA for the class section of the micro-computer course. Based on the regression coefficients obtained, it also appears that "traditional" computer literacy helps weaker students (cf. Table 3). Of the students who had previously attended a mainframe computer course, "B" and "C" students did better not only in the CAI section of the micro-computer course but also in their overall class performance. However, this was not true for "A" students. One explanation could be that previous experience with a mainframe computer had made the weaker students less apprehensive, which then helped their performance in tests and traditional class lectures.

<u>Past academic performance</u>. Historic GPA affected the performance of students in all parts of the course, no matter if they were "A" or "C" level students. These findings are not particularly surprising. In earlier research, Butcher and Muth (1985) had found that a student's grade point average achieved in his/her first semester of post-secondary studies predicted his/her performance in subsequent computer science courses. These results support the assumption that student performance is significantly affected by past GPA.

However, an extensive meta-analysis of the literature investigating past academic and current occupational performance was conducted by Samson, Graue, Weinstein & Walberg (1984). They examined about 35 stud'es done since 1950, relating to the connection between academic and occupa..onal performance in various fields. Predictions of occupational performance based on academic achievement were low in magnitude, making the usefulness of our current results questionable for management. Samson, Graue, Weinstein and Walberg (1984) in fact suggested that other measures need to be developed, allowing for better correlations between academic and occupational performance.

Assignment grade and task performance in a "realistic" setting. It has been suggested that hands-on training, including job-simulating tasks, might be the most effective training method (Menashian, 1985). Unfortunately, there is virtually no data testing and supporting this claim. The results of this study may provide a partial confirmation, though. As Table 3 shows, historic GPA affects individual performance on ASSIGNMENTS in the micro-computer course. However, the coefficients indicate that the differences between "A" and "C" students are relatively small. For instance, when multiplying the coefficients with the GPA, the magnitude of difference between the "A" and "B" students is only about .3 out of a possible ten points.

The effect of a student's past performance in a mainframe BASIC course on current assignment performance is not significant. One interpretation could be that traditional methods of teaching computer literacy may not prove helpful fo. business applications. Therefore, effective approaches for teaching office workers require methods that are different from those used in traditional computer science courses (see also Lepper, 1985). Computer education needs to reflect its application in the workplace. Users in office settings usually can draw on commercially available software (Bair & Nelson, 1985). Obviously, knowledge of a programming language and related technical jargon may be required of fewer and fewer employees.

Implications for Management and Future Research

The effective use of computer-based technology assumes a certain level of computer literacy on the part of the operator. He/she thus needs the kind of computer training which allows even the academically less inclined employee to master the required skills. In order to achieve this goal, it is necessary to change not only the current computer education curricula but also the training programs offered in organizations (Cerych, 1985).

This study might be helpful to managers and educators in several ways. For one, it shows that past academic performance might very well determine who should be trained first. Academically gifted individuals can acquire computer skills faster than their peers, making them a resource for their colleagues. The "buddy system" has proven to be effective in encouraging co-workers to increase their computer use in organizational settings (Gattiker & Larwood, 1986).

Furthermore, hands-on work assignments appear to be most helpful for academically less gifted individuals in acquiring computer literacy. Such training also reflects the actual work environment best, where such new skills can then be practically applied (Menashian, 1985). Traditional classroom methods seem better for academically more gifted individuals. However, experience and skills acquired in such settings seldom predict later job performance (e.g., Kulik, Kulik & Bangert-Drowns, 1985; Samson, Graue, Weinstein & Walberg 1984). Based on this study's results, a low-pressure training program for adults using hands-on experience is recommended, including realistic applications in terms of the individual's job as much as possible.

For the researcher, this study raises several issues. It would be of considerable interest to see how much time students spent on doing their assignments. Additional work might show if academic achievers need less time with the computer than their "average" peers. Another area of interest not addressed in this study is gender. Some researchers have found that women are affected differently by computer-based technology, i.e., they have different beliefs about it and show differences in attitudes when compared to their male peers (e.g., Form & McMillen, 1983; Gattiker & Coe, in press). Previous studies have also pointed out that the personality of the instructor may affect student performance (e.g., Brown, Sawyer & Hitchcock, 1984; Eden & Ravid, 1982). This study explains in part which training methods may be more useful when acquiring computer literacy (e.g., Menashian, 1985; Hebenstreit, 1985).

Clearly, the most important result is represented in the fact that academically weaker individuals may profit most from training methods which utilize a hands-on approach. Organizations should design training seminars reflecting actual work situations for the benefit of both the end-user and the company. The overall user effectiveness of new technologies in offices could thus be greatly increased.

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Table 1

Regression Results for Student Performance: GPA and BASIC Course Grade

Dependent Variable		Constant	Independent Variables[1]		d.f.	Adj. R^2
CAI	=	42.459	+ 13.763 * GPA		126	0.309
		(8.55)***	(7.60)***			
	=	70.116	+ 5.267 * GPBASIC		61	0.235
		(23.50)***	(4.45)***			
	=	39.963	+ 13.720 * GPA	+ 5.486 * CRBASIC	125	0.363
		(8.28)***	(7.89)***	(3.42)**		
CLASS	=	36.726	+ 12.738 * GPA		126	0.307
		(7.95)***	(7.57)***			
	=	60.139	+ 5.227 * GPBASIC		61	0.221
		(19.70)***	(4.32)***			
	=	35.484	+ 12.716 * GPA	+ 2.728 * CRBASIC	125	0.319
		(7.66)***	(7.62)***	(1.77)		
GPMICRO	=	-0.347	+ 1.202 * GPA		126	0.419
		(-1.01)	(9.63)***			
	=	2.255	+ 0.369 * GPBASIC		61	0.177
		(9.17)***	(3.79)***			
	=	-0.553	+ 1.199 * GPA	+ 0.453 * CRBASIC	125	0.436
		(-1.70)	(10.21)***	(4.17)***		

[1] *t* ratios are in parentheses beneath estimated coefficients
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

Table 2

One-Way Analysis of Variance for 128 Cases

Dependent Variable GPA
Grouping Variable GPMICRO

Group	Count	Rank Sum
0	1	1.0
1	3	33.5
2	38	1476.0
3	51	3531.0
4	35	3214.5

Kruskal-Wallis test statistic 47.17
$p < .001$ assuming chi-squared distribution with 4 d.f.

Table 3

Regression Results for Student Performance: Different GPA and BASIC Course Grade Populations

Dependent Variable		Constant	Independent Variables[1]							
CAI	=	39.275	+ 14.381 * GPAA	+ 14.262 * GPAB	+ 13.545 * GPAC	- 2.229 * ACRBASIC	+ 4.611 * BCRBASIC	+ 7.949 * CCRBASIC	d.f.	121
		(6.06)***	(6.39)***	(6.28)***	(4.62)***	(-0.36)	(2.15)*	(3.05)**	adj R^2	0.388
CLASS	=	39.816	+ 11.445 * GPAA	+ 11.092 * GPAB	+ 11.398 * GPAC	+ 0.557 * ACRBASIC	+ 3.704 * BCRBASIC	+ 1.303 * CCRBASIC	d.f.	121
		(6.11)***	(5.06)***	(4.86)***	(3.87)***	(0.09)	(1.72)	(0.50)	adj R^2	0.282
GPMICRO	=	-0.329	+ 1.181 * GPAA	+ 1.125 * GPAB	+ 1.109 * GPAC	- 0.154 * ACRBASIC	+ 0.525 * BCRBASIC	+ 0.445 * CCRBASIC	d.f.	121
		(-0.74)	(7.68)***	(7.26)***	(5.54)***	(-0.36)	(3.58)**	(2.51)*	adj R^2	0.496
ASSIGNMENTS	=	5.160	+ 1.187 * GPAA	+ 1.300 * GPAB	+ 1.110 * GPAC	+ 0.171 * ACRBASIC	+ 0.212 * BCRBASIC	+ 0.473 * CCRBASIC	d.f.	121
		(5.81)***	(3.85)***	(4.18)***	(2.76)**	(0.20)	(0.72)	(1.33)	adj R^2	0.232

[1] t ratios are in parentheses beneath estimated coefficients

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$