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AUTHOR	Snelbecker, Glenn E.; And Others
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ABSTRACT

This study was conducted to examine the extent to which one's demographic characteristics, previous experience aptitudes, and attitudes may be indicative of probable success in learning about computers. Information was derived from two National Science Foundation (NSF)-funded programs designed to retrain experienced teachers to become K-12 computer science teachers. In these programs, employed teachers, certified in other areas, took a series of courses to become qualified to teach computer science and to serve as computer resource persons at either the elementary or secondary level. Subjects in the current study are high school teachers (N=42) and elementary school teachers (N=47), who completed the NSF program and the Computer Attitude Scale, the Computer Aptitude, Literacy and Interest Profile, and a series of questionnaires. Results indicate that some kind of previous experience with computers is predictive of successful achievement, but which experiences are most important is not clear. (LL)

Demographic Variables, Experience, Aptitudes and Attitudes as Predictors of Teachers' Learning About Computers

Glenn E. Snelbecker, Nina Bhote-Eduljee, Robert M. Aiken,
and Judith D. Wilson, Temple University

Paper presented at the Annual Meeting of the American Educational
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ABSTRACT

It's generally recognized that teachers in general, not only a select few, will need to learn more about computers. Despite a need for many different kinds of teachers to learn about and to use computers effectively, some suggest that certain people will have more difficulty than others when learning about computers --e.g., that gender or math background or previous experience with computers will indicate who will, or will not, be successful. This paper reports the extent to which demographic, experience, aptitude and attitude variables appear to be related to success in two NSF-funded programs designed to retrain experienced teachers to become K-12 computer science teachers. Results are considered with regard not only for the preparation of computer science teachers but also for teachers in general who need to learn about and to use computers.

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Objectives, Perspective, and Importance of This Study

The assertion that computers represent an important influence today (and, even more of an influence in the future) on life in classrooms is something that few people are likely to question (cf Aiken & Snelbecker, 1991; Devlin, 1991; Palumbo, 1990; Roblyer, Castine, & King, 1988). But there are a number of issues and questions about which people can and do disagree, such as: How are teachers to learn about computers? Which teachers actually need to know about computers -- i.e., only "computer science" teachers, teachers using computer-supported instruction, all teachers, etc.? To what extent should we focus on computer science as "subject matter" for all students? To what extent should we only view computers as providing helpful (usually!) resources for classrooms and for society in general? Is it realistic to expect that most (if not all?) teachers will to need to know about computers, (broadly defined)? If such a wide range of teachers need such knowledge, what are the implications of views -- often implicit if not explicitly stated -- that people with certain backgrounds and characteristics are more likely to be successful in such learning ventures than will be people in general (Evans & Simkin, 1989; Roblyer, Castine & King, 1988)

This study focused on one aspect, namely, the extent to which people's demographic characteristics, previous experience, aptitudes and attitudes may be indicative of their probable success in learning about computers. This study derives information from two projects in which employed teachers who were certified in other areas were taking a series of courses to become qualified to teach computer science and to serve as computer resource persons at either the high school level or the elementary school level. (Actually, the latter group was comprised of elementary and middle school teachers, but -- for brevity -- they will be identified collectively as elementary school teachers.) Findings from these projects are considered not only with regard to preparation of computer science teachers but also with regard to teachers in general who may need to learn about computers.

The authors of this study have conducted two projects, both of which have been funded by the National Science Foundation to develop model programs for retraining teachers to teach about and to use computers in K-12 classrooms (Aiken & Snelbecker, 1985 & 1988; also, see Wilson, et al., 1991). The first project was for high school teachers; the second project was for elementary school teachers. Both projects required that participants were certified and experienced as teachers. The high school teacher retraining program involved four graduate courses: #1. BASIC, #2. Pascal, #3. Pascal data structures, and #4. an instructional design emphasizing critical thinking strategies (hereafter abbreviated as the Instruct. Design course). The elementary teacher retraining program involved five courses: #1. Computer applications programs with an emphasis on Appleworks (identified hereafter as the Computer Applications course or simply "Applications"), #2. introduction to LOGO, #3. advanced LOGO, #4. BASIC (a course that, for many reasons, was quite similar to the BASIC course in the high school teacher retraining program), and #5. resources and methods for teaching computer science at the elementary school level (identified hereafter as #5. Computers and Society course). Despite the intense, demanding nature of these courses and the fact that participants had to complete each course at the one time that it was being offered for each group (i.e., there was no opportunity for arranging alternate times nor courses), 75% of the high school teachers and 90.4% of the elementary teachers completed their respective retraining programs and many have already assumed responsibilities as computer science teachers.

It is noteworthy that participants in both projects were deliberately selected so that, in each project, about half had had little or no experience with computers, that they had diverse educational backgrounds leading up to their teacher certification, and that they had diverse personal and professional characteristics as a group.

The purpose of this study was to examine the extent to which demographic characteristics, previous computer-related explorations and experiences, aptitudes and attitudes regarding computers might be correlated with the extent of their success in these teacher retraining courses. Specifically, the following research questions were addressed:

1. Which attributes collectively account for variations in achievement, as measured by course projects, course exams, and overall course grades?
2. What portion of the variance in achievement is accounted for by the respective collective predictors?
3. To what extent are predictors of one type of achievement evident as predictors of other types of achievement within a given course?
4. To what extent are predictors for one course likely to be predictive of achievement in other courses?
5. To what extent are there similarities and differences in the patterns of predictors for the high school vs. the elementary teachers?

Previous studies (e.g., Snelbecker, et al., 1991) have shown that the elementary and high school teachers are generally similar in their collective attitudes and aptitudes regarding computers, and that there are some similarities regarding predictors of achievement for these two teacher groups. The present study goes well beyond our previously reported findings by (a) examining the potential relevance of demographic and "computer-related experience" variables, and by (b) considering the extent to which these and other variables (especially, aptitudes and attitudes) form different sets of collective predictors of achievement.

Methods, Instruments and Data Sources

Subjects in this study were 42 high school teachers and 47 elementary teachers who completed an intensive series of graduate courses on computer science and technology. The high school teachers were selected from an initial group of 253 applicants; the elementary teachers were selected from a group of 457 applicants. Whereas there was an equal number of males and females in the high school teacher group (i.e., 21 of each), as one might expect (from the larger number of female teachers in elementary schools) there were 12 males and 35 females in the elementary teacher group. Minority representation in the high school group was about 27%, and about 29% in the elementary teacher group.

Data were collected in several ways, as follows: All participants completed the Computer Attitude Scale (CAS) (Loyd and Loyd, 1985), the Computer Aptitude, Literacy and Interest Profile (CALIP) (Poplin, Drew, & Gable, 1984), and a series of questionnaires constructed by the authors specifically for the NSF projects. From these data sources, the following predictor variables (listed in the same order in Table 1 and in Table 2) were obtained: Age, Gender, computer Interest (from the CALIP), computer Literacy (from the CALIP), CAQ Total ("Computer Aptitude Quotient") (a summary score of CALIP aptitude scales not including either the Literacy scale or the Interest scale), CAS average (the Loyd and Loyd scale noted above). Computer-related experience variables, collected from participants' written responses in a section of the CALIP, were: self-reported interest in computers, typing speed in number of words per minute, whether they've taken any computer-related classes, level of class achievement in those classes (if any). Self-reports of their level of participation in these computer-related activities: Played games, used packaged programs, wrote programs, operated a mainframe, repaired computers, sold computers, designed computer hardware, managed computer personnel/systems. Self-reports of proficiency with computer programs, namely: Statistical package, word processing, graphics, music, accounting/financial, engineering/architectural, and medical. Undergraduate major for high school teachers (math vs. not math); undergraduate GPA (available only for elementary teachers).

Criterion variables consisted of Project grades, Exam grades, and overall course Grades (a simple average of overall Project and Exam grades) for each course. Thus, the high school group had 12 criterion variables, and the elementary school group had 15 criterion variables.

Results and Discussion

Table 1 contains correlations between predictor and criterion variables for the high school teachers, and Table 2 contains similar results for the elementary school teachers. To aid in interpreting the data, correlation coefficients are only indicated when relationships for the respective pairs reached statistical significance at a .05 probability level. Asterisks indicate the level of significance for these correlation coefficients. Results first will be discussed in terms of the "best" predictor variables, and then with regard to the criteria of achievement.

For the high school teachers, the most prominent predictor variables were CALIP Literacy and CAQ Total (significant relationships with seven criterion variables, each), followed by Word Processing and undergraduate Major (non-math major = 1, math major = 2) (six significant relationships, each), Gender (Male = 1, Female = 2) with five relationships, and "Used packaged program" and Graphics with four statistically significant relationships.

For the elementary teachers, the most prominent predictor variables were CAQ Total with eleven statistically significant relationships, Accounting/Financial with six relationships, both Used packaged program" and "Repaired Computers with five relationships, and Managed Computer Personnel and Systems with four statistically significant relationships.

Among the high school teachers' achievement criterion variables, comparatively the "most predictable" (though far from being highly predicted) were BASIC grade with ten statistically significant predictors, BASIC Exam and Pascal I Exam with eight predictors each. There were seven predictors for Pascal II Exam, and six predictors (each) for three criterion variables -- BASIC Project, Pascal I Grade, and Pascal II Grade.

Among the elementary school teachers' achievement criterion variables, comparatively the "most predictable" were Computers and Society Project with ten predictors, followed by LOGO I Project and LOGO II Project (each) with seven predictors. LOGO I Grade and LOGO II Grade each had five predictors.

One pattern that can be discerned is that, with the predictor variables included in this study, achievement appears to be somewhat more likely to be predicted for courses on computer languages than on applications courses. (One obvious exception is the fifth course completed by the elementary school teachers, "Computers and Society.") This was evident for both teacher groups. Perhaps this may partly account for the fact that the high school teachers' achievement seems to be more predictable (e.g., high school criterion variables had more predictors) because they had proportionally more computer language courses than the elementary school teachers (three out of four courses, compared with three out of five courses for the elementary teachers).

To take into account intercorrelations among variables and to explore the potential predictive power of these variables collectively, data were then submitted to a series of Variable Selection procedures, Stepwise Regression procedures, and ANOVAs using BMDP's "SOLO Statistical System" (version 3.1). Using the same statistical system, results were examined by means of Robust Regression procedures to minimize likelihood of distortions by outliers.

Tables 3 and 4 provide information regarding the first two research questions posed above. Data for the high school teachers are provided in Table 3; data for the elementary school teachers are in Table 4.

The first research question was: Which attributes collectively account for variations in achievement, as measured by course projects, course exams, and overall course grades (which was the arithmetic average of course project grades and course exam grades)? The main portion of both tables indicates results of the stepwise regression analysis. For each criterion variable, predictors are identified that were most influential collectively. An "X" indicates those predictors which were detected in stepwise regressions that were stopped when the per cent of change fell below .02; an "***" provides overlapping but slightly different results by indicating those variables that were included in the highest five predictors in the stepwise analyses. Predictors will be discussed if they met either of these two conditions.

For the high school group, 10 out of 12 achievement criterion variables (i.e., all except Pascal II Project and Instructional Design Exam) had statistically significant multiple correlations with predictor variables at the .05 level. The overall "best" predictor was CAQ Total, with significance found in nine of the twelve multiple regression analyses. Next were Gender and "Wrote Programs" with involvement in seven multiple regression analyses. The predictors found in six analyses were CAS Average, "Played Games," "Used Package," and Major (Math vs. Non-Math undergraduate major).

For the elementary school group, 11 (plus one more that just missed) of the 15 achievement criterion variables (i.e., all except Applications Course Grade, BASIC Project, BASIC grade, and Computers and Society Exam) had statistically significant multiple correlations with predictor variables at the .05 level. The overall "best" predictor was "Used Package" with significance found in ten out of fifteen multiple regression analyses. Next was Literacy (on the CALIP), with nine, followed by Interest (on the CALIP), CAQ Total and "Statistics Programming" experience, with eight (each) multiple regression analyses. "Wrote Programs" was found in seven multiple regression analyses.

The second research question was: What portion of the variance in achievement is accounted for by the respective collective predictors? In the bottom section of Tables 3 and 4, regression results are reported for each criterion, in terms of R-Squared and Adjusted R-Squared.

For the high school teachers, variance accounted for was highest for Pascal I Exam, with an Adjusted R-Squared of .6635, followed by Pascal I Grade at .6325, BASIC Course Grade at .5210, Pascal II Grade at .4571, and Pascal II Exam at .4437.

For the elementary school teachers, variance account for was highest for Computers and Society Grade at .5696, followed by LOGO II Grade at .5504, Computers and Society Project at .5492, LOGO II Project at .5365, LOGO I Project at .5177, and BASIC Exam at .4641.

All four tables provide useful information in addressing the final three research questions posed above. 3. To what extent are predictors of one type of achievement evident as predictors of other types of achievement within a given course? 4. To what extent are predictors for one course likely to be predictive of achievement in other courses? 5. To what extent are there similarities and differences in the patterns of predictors for the high school vs. the elementary teachers?

In brief, it can be seen that the collective predictor sets differed across achievement measures (project, exam, course grade), types of courses and -- apparently -- the make-up of the overall set of predictors. The latter (make-up of the predictor set), of course, reflects intercorrelations among predictor variables.

Concluding Comments

What might one conclude from these and other researchers' results? Here are a few general observations. Rather than talking about "the predictors" of achievement in learning about computers, it seems necessary to take into account the kind of achievement that one has in mind (what kind of course) and the type of measure being used to assess progress (measures for that course, including global vs. specific indicators, for example). For the high school teachers, the predictor variable that was quite prominent was CAQ Total; to a somewhat lesser extent CAQ Total also was a prominent predictor for the elementary school teachers. Not surprisingly, it seems clear that some kind of previous experience with computers is predictive of successful achievement, but which experiences are "most important" is not at all clear. Part of the problem in drawing conclusions here is the great variability among people in the kinds of experiences that they have had.

Two matters that could not be addressed as readily with the elementary school teachers as with the high school teachers are the relevance of undergraduate Major (specifically, a Math major vs. a "non-Math" major) and Gender. This type of distinction about majors is not applicable for elementary school teachers. Studying Gender effects is hampered by the fact that there are so many more female than male elementary school teachers. Dealing only with the high school teacher group, it appears that Major was important for those courses that tended to emphasize math examples (e.g., Pascal). Somewhat consistent with previous discussions about male vs. female differences, especially that females are more likely to take a utilitarian approach to computers (cf. Devlin, 1991; Sutton, 1991), the present results are noteworthy. In the present research, there was some tendency for males to do better in the BASIC programming course, and for females to do better on Projects in the Instructional Design course. Although not addressed in this study, it well may be that the sequence of the measures and the sequence of the course experiences may influence one's conclusions about predictions of computer course achievement.

These results raise some interesting questions about the manner in which teachers who have virtually no computer expertise might be enticed and aided to become computer literate. For example, having used some type of computer package appears to be related to some achievement measures. Could it be that teachers in general might first be given an opportunity to see and experience what computers can do for them before addressing more minute details about how computers work (just the opposite of what is often presented to novices)? The results from this study and related research should be considered not only with regard to preparation of "computer science/computer support" teachers (or, teacher technologists) but also, much more importantly, with regard to teachers in general who need to know more about computers and their effective use.

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Table 1: Correlations between Predictor and Criterion Variables for High School Teachers

	BASIC			PASCAL 1			PASCAL 2			INSTRUCT. DES.		
Predictors ?	Proj	Exam	Grade	Proj	Exam	Grade	Proj	Exam	Grade	Proj	Exam	Grade
Age		.334 *										
Gender	.389 **	.306 *	.307 *							.376 **		.401 **
Interest CALIP												
Literacy, CALIP	.398 **	.532 ***	.605 *****		.596 *****	.531 ***	.346 *		.433 **			
CAQ Total		.333 *	.343 *	.341 *	.495 ***	.525 ***		.437 **	.487 ***			
CAS Average												
Interest Comput					.324 *							
Words Typing												
Computer Class	.341 *											
Class Achievement					.372 **			.349 *	.299 *			
Played Games	.373 **	.303 *	.507 ***									
Used Package					.575 ****	.586 ****		.483 ***	.456 **			
Wrote Programs		.372 **	.543 ***									
Main frame comp												
Repair Computers												
Sold Computers												
Design Hardware												
Manager, Comput												
Statistics Prog	.411 **	.308 *	.494 ***									
Word Processing		.374 **	.442 **		.426 **	.376 **		.338 *	.360 *			
Graphics			.361 *		.394 **	.391 **		.310 *				
Music												
Accounting / Fin	.347 *		.406 **					.306 *				
Engr/Architect												
Medical												
Major Math?			.297 *	.390 **	.476 ***	.529 ***		.461 **	.402 **			
Undergrad GPA												

* $p < .05$ ** $p < .01$ *** $p < .001$ **** $p < .0001$ ***** $p < .0001$

Table 2: Correlations between Predictor and Criterion Variables for Elementary School Teachers

Predictors ?	APPLIC Proj	APPLIC Exam	APPLIC Grade	LOGO 1 Proj	LOGO 1 Exam	LOGO 1 Grade	LOGO 2 Proj	LOGO 2 Exam	LOGO 2 Grade	BASIC Proj	BASIC Exam	BASIC Grade	COMP. & SOCIETY Proj	COMP. & SOCIETY Exam	COMP. & SOCIETY Grade
Age															
Gender						293*					384**				
Interest, CALIP															
Literacy, CALIP		355**				309*									
CAQ Total		374**	301*		507***	387**		558*****	446***	320*	531****	439**		365**	390**
CAS Average		287*					284*								
Interest Comput				326*			345**						303*		
Words Typing											400**	382**	338*		
Computer Class													364**		
Class Achievement				350**			423**						287*		
Played Games													378**		
Used Package	310*	286*		505***			485***						594*****		
Wrote Programs															
Main frame comp															
Repair Computers				369**		307*	411**		394*				384**		
Sold Computers							294*								
Design Hardware				315*									308*		
Manager, Comput					322*	368**				465***		287*			
Statistics Prog									282*	316*		287*			
Word Processing															
Graphics															
Music															
Accounting / Fin	283*		300*				358**	384**	16***	300*					
Engr/Architect				420**									316*		
Medical				368**											
Major Math?															
Undergrad GPA									337*				334*		

* p < 05 ** p < 01 *** p < 001 **** p 0001 ***** p < 0001

Table 3 Multiple Regression Results, and Listing of Variables Predicting Project, Exam and Course Grade Results for High School Teachers

Notes: 1. Respective predictor variables are further identified in accompanying text.

2. "X" = predictor included in stepwise regression analysis stopped when % change went below .02.

3. "**" = predictor included in first five predictors included in a stepwise regression analysis (NOT necessarily included in the final group, identified in #2, above).

4. Multiple regression results for stepwise regression analysis as noted in #2, above

	A	B	C	D	E	F	G	H	I	J	K	L	M
1			High School Teachers										
2		#1 BASIC			#2 Pascal 1			#3 Pascal 2			#4 Instruct. Design		
3		Proj	Exam	Grade	Proj	Exam	Grade	Proj	Exam	Grade	Proj	Exam	Grade
4	Predictors?												
5													
6	Age		X **		X								
7	Gender	X **			X **	X **	X				X **	X **	X **
8	Interest , CALIP									**	X **	X	X **
9	Literacy, CALIP		X **	X **		X **	X **						
10	CAQ Total		X	**	X **	X **	X **	X **	X **	X **	X **		
11	CAS Average	X **	X		X		X	X **				X	
12	Interest: Comput	X **	X **		X					X			X
13	Words Typing	X							X **	X **		X	
14	Computer Class						**	X	X **			X **	
15	Class Achievement				X								
16	Played Games	X **		X		X			X		X	X **	
17	Used Package		X **	X		X **				X **	X **		X **
18	Wrote Programs		X	X **		**	**		X **	X **		X	
19	Main frame comp	X **						X **			X	X **	
20	Repair Computers							X **				X **	X **
21	Sold Computers			X **				X **			**		X
22	Design Hardware												
23	Manager, Comput										X		X **
24	Statistics Prog.							X				X	
25	Word Processing				**						X		
26	Graphics												X
27	Music				**	X	X						
28	Accounting/Finan			X	X								
29	Engr/Architect.												
30	Medical												
31	Major: Math?		**		X **	X	X **		X **		X		
32	Undergrad GPA	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
33													
34													
35	Results of Regression Analyses, Using "= > .02 change" rule												
36	F-Ratio	3.54	5.03	9.5	3.84	12.27	12.48	1.8	6.18	7.57	2.5	1.76	4.02
37	Probability Level	0.007	.000	.000	0.003	.000	.000	0.122	.000	.000	0.029	0.113	0.002
38	R-Squared	0.3409	0.4681	0.582	0.4978	0.7224	0.6877	0.2824	0.5293	0.5267	0.428	0.3781	0.5094
39	Adjusted R-Squared	0.2445	0.375	0.521	0.368	0.6635	0.6325	0.1254	0.4437	0.4571	0.2568	0.1637	0.3829

Table 4 Multiple Regression Results, and Listing of Variables Predicting Project, Exam and Course Grade Results for Elementary and Middle School Teachers

Notes: 1. Respective predictor variables are further identified in accompanying text.
2. "X" = predictor included in stepwise regression analysis stopped when % change went below .02
3. "**" = predictor included in first five predictors included in a stepwise regression analysi (NOT necessarily included in the final group, identified in #2, above).
4. Multiple regression results for stepwise regression analysis as noted in #2, above

	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	/E
1			Elementary & Middle School Teachers													
2		#1 Applications			#2 LOGO 1			#3 LOGO 2			#4 BASIC			#5 Computers & So		
3		Proj	Exam	Grade	Proj	Exam	Grade	Proj	Exam	Grade	Proj	Exam	Grade	Proj	Exam	Grade
4	Predictors?															
5																
6	Age	X		X **					X		X **					
7	Gender				**	X **	X					X **				
8	Interest , CALIP	X			X			X **	X **	X **		X	X **		X	
9	Literacy, CALIP	X **	X **		X	X	X **			X .	X **		X **		X	
10	CAQ Total		X **		**	X **	X	X	X			X **			X	
11	CAS Average		X									X				
12	Interest: Comput	X							**		X **		X **		X	
13	Words Typing				X **	X **	X	X **				X		X **		
14	Computer Class	X		X **	X	X	X **									X
15	Comput. Achievmt.		X **	X **										X **		X
16	Played Games					X **		X				X **	X **			**
17	Used Package	X **	X **		X **	X **	X **	X **	X **	X **				X **		X **
18	Wrote Programs							X **	X **	X **	X		X		X **	X **
19	Main frame comp						X				X **	X **	X			
20	-pair Computers										X		X		X	
21	Sold Computers	**					X								X **	X **
22	Design Hardware	X							X			X				
23	Manager, Comput		X **									X				
24	Statistics Prog.				X		X **		X **		X	X **	X **		X **	X
25	Word Processing			X **											X	
26	Graphics	.	X .					X						X **		X
27	Music						X								X **	
28	Accounting/Finan	X **		X **	X **			X **		X **				X **		
29	Engr/Architect.	X ** .			X		X **				X		X			
30	Medical				.						**				**	
31	Major: Math?	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
32	Undergrad GPA								X	X **					X	X **
33																
34																
35	Results of Regression Analyses, Using "= > .02 change" rule															
36	F-Ratio	2.95	3.58	2.22	7.17	3.04	3.67	7.65	3.67	8.96	1.44	4.98	1,69	12.21	2.1	7.45
37	Probability Level	0.01	0.005	0.07	.000	0.012	0.002	.000	0.003	.000	0.211	.000	0.128	.000	0.056	.000
38	R-Squared	0.4178	0.3911	0.2133	0.6016	0.3531	0.5355	0.6171	0.5243	0.6196	0.233	0.5806	0.2908	0.5982	0.4515	0.6578
39	Adjusted R-Squared	0.2762	0.2818	0.1173	0.5177	0.2369	0.3895	0.5365	0.3816	0.5504	0.0715	0.4641	0.1183	0.5492	0.236	0.5696