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ABSTRACT

As a baseline measurement of what is being learned about computers in California, the skills, knowledge, attitudes, and experiences of a representative sample of 17,861 high school seniors was assessed in December 1982. Developed by a committee of experts in computer technology drawn from the public school system, universities, and industry, the test permitted reporting of scores for 30 distinct computer science and computer literacy objectives. Nearly all groups studied showed a low level of understanding of the basic concepts of computer technology. Students who reported substantial programming experience were exceptions, and demonstrated a higher level of knowledge. Comparison of results with those from an earlier survey by the National Assessment of Educational Progress showed considerable gains in awareness of computer technology over the last 5 years. Boys appeared to have more access to and experience with computers than girls. Both of these factors were associated with higher test scores. Students from families with more education tended to score higher than those from families with less education. This report includes 23 tables, 3 figures, and a list of computer literacy objectives for students. (Author/LMM)

# Computer Literacy of California High School Seniors

Educational Data Center
Division of Planning Evaluation and Research
California Department of Education
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## ABSTRACT

Findings from a 1982 assessment of the skills, knowledge, attitudes and experiences of California high school seniors in the area of computer technology are reported. Nearly all groups studied showed a low level of understanding of the basic concepts of computer technology. Students who reported substantial programming experience were exceptions, and demonstrated a higher level of knowledge. Comparison of results with those from an earlier survey by the National Assessment of Educational Progress showed considerable gains in awareness of computer technology over the last five years. Boys appeared to have more access and experience with computers, which was associated with higher test scores, than girls. Students from families with more education tended to score higher than those from families with less education.

EXECUTIVE SUMMARY

More than two hundred years ago Leibnitz, the renowned German mathematician and philosopher, wrote that "it is unworthy of excellent men to lose hours like slaves in the labor of calculation." Virtually any person who has manually typed and edited a long manuscript or performed a long series of mathematical calculations by hand can identify with this sentiment. There is today a spirit of idealism which envisions computer technology as a useful response to Leibnitz' statement. Declining costs have at last permitted public schools access to this technology. Rational choices about the role of public schools in computer technology education will require depend in part on detailed information about students' knowledge and expectations of computers.

This study reports on the knowledge, attitudes and experiences of California high school seniors in the area of computer technology.[1] It is intended as a baseline measurement of what is being learned about computers in California, not as a measure of success.

Late in 1982 a committee of experts on computer technology was drawn from the public school system, universities and industry. The committee designed and constructed a test that assessed a wide variety of instructional objectives in the area of computer studies, as well as attitudes towards computer technology, and relevant experiences with

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[1] This study was carried out under the auspices of the California Assessment Program. Inquiries or requests for copies should be addressed to Dr. Mark Fetler, California Department of Education, 721 Capitol Mall, Sacramento, CA 95814.

computers. The test permitted reliable reporting of scores for thirty distinct objectives in the areas of computer literacy and computer science.[2] The tests were filled out and returned by a representative sample of 17,861 students in December of 1982.

More than half the sample reported having been exposed to computer programming. Instruction at school, particularly programming instruction, was associated with markedly higher scores in computer literacy and computer science. Playing games, whether instructional games or video-games, was not associated with higher test scores. A substantial majority exhibited awareness of routine uses and characteristics of computers. While this represents progress over the last five years, it was true that students' actual knowledge of computer technology and facility with programming was low. Test scores were not high for any of the objectives tested. This was not surprising given that most schools and districts are just beginning their computer studies programs. Test scores were low, near the so-called "chance level" (25 percent correct) of responding, for those objectives calling for knowledge of programming. This was true especially for those students with little actual programming experience. Most students demonstrated higher mastery of objectives relevant to: the operation of electronic devices; appropriate tasks for computers; logical analyses of

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[2] All references to test scores in this paper refer to performance on this test. A description of the student objectives corresponding to the reported scores can be found in Appendix A. The term "computer studies" is used to refer to the type of curriculum that would be used to teach the objectives listed in Appendix A. This general area is divided into "computer literacy" and "computer science," which are defined in terms of the listed objectives. This nomenclature is adopted as a matter of convenience and should not be intepreted as supporting any particular curriculum.

problems; and uses of computers in specific fields. Boys performed consistently better than girls. For most objectives the difference in mastery was between one and five percentage points. The better performance of boys was associated with greater exposure to computer technology. There was a clear relationship between test scores and parent educational level. Children of more highly educated parents consistently scored higher than children of less well educated parents. Differences in scores between students from advanced degree backgrounds and those whose parents did not complete high school were typically between five and fifteen points.

## INTRODUCTION

The computer can be a means of educating students and an object of study in itself. Historically, in the public schools, there has been more interest in the former application than in the latter. These two applications are not mutually exclusive. Using the computer as an instructional tool invariably requires learning something about the machine and how to operate it. It is also true that the study of computers and programming can be a natural and stimulating way to learn problem solving skills and various mathematical and scientific concepts.

There is strong evidence for the growth of a serious interest in computer studies. The California State Board of Education in 1983 made computer studies a part of its model graduation requirements, a measure which is being considered and duplicated in other states. The College Board in 1982 inaugurated an Advanced Placement test for high school students in the area of computer science. The National Center for Educational Statistics in 1983 initiated a nationwide study of computer literacy.

The primary goal of this paper is to report on the knowledge, attitudes and experiences of California high school seniors in the area of computer technology. The study was designed to encompass the diverse educational objectives of many different district and school programs. The result was a baseline measurement of what California high school seniors know about computer technology. It should not be interpreted as an evaluation of a particular course of instruction.

Educators have witnessed in recent years a lively debate about what students should learn about computers. Statements of educational objectives have been published by the Committee on Computer Education (1982), the National Council of Supervisors of Mathematics (1978), Johnson, Anderson, Hanson, and Klassen (1980), Anderson and Klassen (1980), Rogers (1982), and the Department of Defense Dependents Schools (1982), among others. Interest has risen to the point where textbooks have begun to appear (e.g. Horn and Poirot, 1981; Miller, Chaya and Santora, 1982; and Luerman and Peckham, 1983). Discussion of various key issues can be found in Papert (1980), Melmed (1982) and Shane (1982).

The National Assessment of Educational Progress included several questions on computers in its 1977-78 mathematics assessment, which have been reported by Carpenter, Corbitt, Kepner Lindquist and Reys (1980). They concluded that a large majority of the 13 and seventeen year old students tested had little or no experience in actual applications of computers. For example, only 8 percent of 13 year olds and 13 percent of seventeen year olds said they knew how to program a computer. By contrast, there was a somewhat higher level of awareness of the routine uses of computers. Understanding of more sophisticated uses of computers in complex decision making and mathematical modeling of problems was more limited.

## METHOD

Instrumentation. A committee of specialists in computer technology was assembled from the public school system, universities and industry. A test was designed to assess a wide variety of instructional objectives in the area of computer studies, as well as attitudes towards computer technology, and relevant experiences with computers. Cognitive test questions were written to conform to a set of objectives that had been developed and used with the Department of Defense Dependents Schools (DoDDS) curriculum shown in Appendix A.[3] Test questions were reviewed for relevance and accuracy of content, sex or ethnic bias and typographical correctness. All cognitive test questions were multiple choice with four options.

Attitude questions were obtained from a set that had been administered by the National Assessment of Educational Progress in a 1977-78 mathematics assessment. Each of the 13 attitude questions requested the student to indicate agreement (Strongly disagree, Disagree, Undecided, Agree, Strongly Agree) with a particular statement. The statements were:

- Computers dehumanize society by treating everyone as a number.
- The more computers are used, the less privacy a person will have.
- Computers will probably create as many jobs as they eliminate.
- Computers slow down and complicate simple business operations.
- Someday most things will be run by computers.
- A knowledge of computers will help a person get a better job.
- Computers can help make mathematics more interesting.

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[3] The terms, "computer literacy" and "computer science," as used in this paper should be understood in light of the described objectives. The number of questions relevant to each objective is written in parentheses after each statement. There were, in all, 430 questions, including 239 for the area of computer literacy and 191 for computer science. The Northwest Regional Educational Laboratory in Portland, Oregon, shared questions that had been written for a DoDDS evaluation and assisted in the question writing process.

- Computers are suited for repetitive monotonous tasks.
- Computers are programmed to follow precise, specific instructions.
- Computers require special languages for people to communicate with them.
- Computers have a mind of their own.
- Computers make mistakes much of the time.
- To work with a computer a person must be a mathematician.

The committee designed the background questions to assess relevant prior knowledge of computers and experiences with them. These questions were:

- Indicate which of the following languages you have actually used to write and run computer programs. (BASIC, PASCAL, LOGO, PILOT, FORTRAN, COBOL, FORTH, ASSEMBLY LANGUAGE, Other, None)
- Indicate which of the following video-games you have at home. (Atari, Odyssey, Intellivision, Colecovision, Other, None)
- Indicate which the the following types of microcomputers you have at home. (Atari 400 or 800, TRS-80, Apple, PET-Commodore, IBM, Texas Instruments, Osborne, Other, None)
- Indicate which of the following types of microcomputers you have used at school. (Atari 400 or 800, TRS-80, Apple, PET-Commodore, IBM, Texas Instruments, Osborne, Other, None)
- Approximately how many hours per week outside of school do you spend in each of the following activities? (Reading for pleasure, Doing homework, Playing video-games at home, Playing video-games away from home, Working with a computer, Athletics, Watching television, Other hobbies or recreation -- None, Less than 1 hour,

From 1 to 2 hours, From 2 to 3 hours, From 3 to 4 hours, From 4 to 5 hours, Between 5 and 10 hours, More than 10 hours)

- Indicate the types of in-school microcomputer learning experience you have had. (Write programs, Generally learn about computers, Drill and practice, Simulations (math or science demonstrations), Tutorial, Instructional games, I have had little experience with computer)
- Indicate where you have learned about computers. (At home, At friends' homes, Special summer programs, Museum of science hall, At school during the day, At school during the evening, Computer stores or salesmen, Playing with video-games, I know little about computers)

Students were asked to report demographic information, including sex, birthdate, and level of parent education. The five possible categories of parent education were:

- Not a high school graduate
- High school graduate
- Some college
- Four-year college graduate
- Advanced degree

That category corresponding to the highest educational level reached by a parent was to be selected.

The test was designed in a matrix format so that each student saw only a small part of the entire pool of questions. Eighty-six unique forms of the test were created, each containing five cognitive test questions, one attitude question and two background questions. The attitude and background questions were assigned to the 86 test forms so that each would appear roughly an equal number of times. A different set of cognitive test questions, selected to cover both computer literacy and computer science objectives, appeared on each form. These were arranged subjectively in an order from easy to difficult on each test. The test forms were spiraled for distribution so that each one would be given about the same number of times within each school.

Interpretation of scores from a test that is designed and administered according to a matrix format differs from that given to traditional, shorter, single-form tests. Matrix design permits economies of testing time while assessing broad areas of content. Even though several DoDDS objectives were represented on each form, each student saw only a small sample of the entire pool of questions. Of necessity, specific content and average difficulty of test forms differ. This and the brevity of each test form precluded the reporting of scores for individual students or even for small groups. Average test scores for groups were reliable and valid estimates of knowledge for the objectives assessed by the test.

Sample. Schools included in this study were sampled randomly. Using California Assessment Program[4] data collected the previous year, high schools were ranked and classified into five equal categories on the basis of number tested (a proxy for school size). Within each size category schools were ranked and classified into five equal groups on the basis of an average index of parent education (a proxy for social

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[4] The California Assessment Program is legally mandated to assess achievement in California public schools and examine factors related to achievement. Results are reported to various state and local education agencies.

class). This resulted in a five by five cross-classification of schools with equal numbers in each of the twenty-five cells. Schools were selected randomly with a probability of $p = .125$ from each cell. From the original population of 784 schools 98 were selected, containing an estimated 23,395 students. The sample did not differ significantly from the population in terms of achievement or parent education. The sample average number tested per school, $N = 239$, was smaller than the population average of $N = 281$, indicating a slight oversampling of small schools. Eighty-seven schools participated in the study, yielding a school response rate of 89 percent. Several schools declined to participate on the basis that their students were not prepared for such an assessment. Survey questionnaires were received from 17,861 students, yielding an estimated student response rate of 88 percent from participating schools.

Analyses. Responses to individual cognitive test questions were classified according to student objective and aggregated on the basis of parent education and sex. Students who did not attempt any of the five cognitive questions questions on a given test form were excluded from the analysis. Given the matrix format of the test, each of the 430 cognitive test questions was taken by about 200 students. Percents correct for all objectives are shown in table 1. Plots of computer literacy (CL) and computer science (CS) composite scores for different levels of parent education and sex are shown in figures 1-3. Percents of students selecting each option of the attitude questions were calculated, along with their average test scores, and these are shown in tables 2-14. Each of the 13 attitude questions appeared on six different forms of the test and was responded to by approximately 1200 students. For each option the percents of boys, girls and students in each parent education category are reported. Analyses of the background questions, shown in Tables 15-23, were similar. Background questions were placed on each test form in a pair, so that each one appeared on about 24 different test forms and was responded to by approximately 4800 students.

Interpretation of the results must be qualified in several ways. At the time of testing there was no recommended or uniform computer studies curriculum for California schools. The results should be seen as a set of baseline measurements, and not as a measure of success. More technical qualifications regard the calculation of standard errors and statistical significance. This is complicated both by nature of the sample, (sampling units are schools), and by the nature of the test, which was administered in a matrix format. These two factors make an accurate estimate of statistical significance of results difficult. However, given the large sample size even small differences are probably statistically significant. Determining the educational significance of these differences is a far more difficult problem which could only be addressed in the context of a continuing assessment over a period of years. The matrix design has the further effect of confounding the attitude and background questions with test forms. The practical effects of this were minimized by the systematic assignment of each question to many test forms and the effectively random assignment of test forms to students.

# RESULTS

Average scores for each student objective are shown in table 1. There were several trends evident here which were confirmed in subsequent analyses. Test scores were not high for any of the objectives tested. This is not surprising given that most schools and districts were just beginning their computer studies programs. Scores were low, near the so-called "chance level" (25 percent correct) of responding, for those objectives calling for knowledge of programming, especially for those students with little actual programming experience. Students demonstrated higher mastery of objectives relevant to: the operation of electronic devices; appropriate tasks for computers; logical analyses of problems; and uses of computers in specific fields. Boys performed consistently better than girls. In one skill only, "choosing a logical sequence of steps needed to perform a task," did girls outperform boys. For most objectives the difference in mastery was between one and five percentage points. There was a clear relationship between achievement and parent educational level. Children of more highly educated parents consistently scored higher than children of less well educated parents. Differences in scores between students from advanced degree backgrounds and those whose parents did not complete high school were typically between five and fifteen points.

These overall results are displayed graphically in figures 1, 2 and 3. Boys scored consistently higher than girls for all levels of parent education in both computer literacy and computer science, as shown in figures 1 and 2. Higher levels of parent education were associated with greater differences in test scores. These results may reflect either a tendency for boys to take more advantage of opportunities, or a tendency for parents to encourage boys more than girls, or a combination of both. Computer literacy and science test scores, broken down by parent education, are displayed in figure 3. There was an increasing separation of the curves associated with higher level of parent education. The reasons for this may be sex related, as discussed in connection with figures 1 and 2.

Concerns about privacy and being treated as a number are often associated with the introduction of computer technology. These issues are addressed in tables 2 and 3. Twenty-nine percent of students were undecided with regard to the statement that "computers dehumanize society by treating everyone as a number," as shown in table 2. There was a tendency for m[illegible] students to disagree than to agree. The high average score in computer literacy (CL) of 43.5 percent correct was obtained by those who disagreed, and the high average score of 34.0 in computer science (CS) by those who disagreed strongly. Of the 10.1 % who strongly disagreed more were male than female (boys = 62.3 %, girls = 35.6 %). Parent education is associated with attitudes here. A larger proportion of students from backgrounds without high school strongly agreed than strongly disagreed. Responses to the statement that "the more computers are used the less privacy a person will have," summarized in table 3, were similar to those in table 2. The modal response category, with 29.8 %, was "undecided." Those who disagreed tended to score higher than those who agreed. A higher percent of boys than girls strongly disagreed (boys = 58.9 %, girls = 38.4 %).

Tables 4, 5, 6, and 7 address attitudes towards the effects of computers in the workplace. To the statement that "computers will probably create as many jobs as they eliminate," there was a bimodal response pattern, shown in table 4, with large percents of students both disagreeing (24.2 %) and agreeing (34.9 %). Overall, more students tended to agree than disagree. The highest average scores were attained by the 9.6 % who strongly agreed (CL = 57.4, CS = 36.8). There were more boys than girls in this group (boys = 56.0 %, girls = 41.1 %).

A majority of 37.8 % of students strongly disagreed with the statement that "computers slow down and complicate simple business operations," as shown in table 5. Average scores of these students were higher than that of other groups (CL = 47.9, CS = 33.2). Relatively higher percents of students whose parents did not have a high school education tended to agree with the statement. The reverse was true for students from advanced degree backgrounds.

Seventy-nine percent of the sample either agreed (46.0 %) or strongly agreed (33.0 %) that "someday most things will be run by computers," shown in table 6. It was interesting, however, that the highest computer scores were obtained by the 3.0 % who disagreed (CL = 57.4, CS = 37.4). A higher relative proportion of students from advanced degree families fell into this group than into any of the other groups. This may reflect sophisticated awareness that while computers may control many processes, people are the ultimate controllers of computers.

A similar overall pattern of response, shown in table 7, was obtained for the statement that "a knowledge of computers will help a person get a better job." Nearly three-fourths of those responding either agreed

(46.2 %) or strongly agreed (28.5 %) with this statement. The highest average scores went to those who strongly agreed (CL = 44.6, CS = 32.2). There were more boys than girls in this group (boys = 52.0 %, girls = 47.1 %).

Computers studies are generally thought to be related to mathematics. Two aspects of this belief are reported on in tables 8 and 9. Some 48.2 % agreed and 23.9 % of the sample strongly agreed that "computers can help make mathematics more interesting." Those who strongly agreed had the highest test scores scores (CL = 51.4, CS = 30.5). Of this group 60.9 % were boys, compared to 35.4 % girls. A somewhat different attitude was expressed by the statement that "to work with a computer a person must be a mathematician." The pattern of responses here was bimodal with 39.0 % disagreeing and 21.9 % agreeing. The highest average scores were exhibited by the 14.3 % who disagreed strongly (CL = 46.8, CS = 31.4). Relatively larger percents of students from lower educational backgrounds either agreed or strongly agreed. Those from advanced degree backgrounds were more likely to disagree or strongly disagree.

Tables 10, 11, and 12 summarize responses to simple statements of fact about computers. The statements were: "Computers are suited for doing repetitive monotonous tasks;" "Computers are programmed to follow precise specific instructions;" and "Computers require special languages for people to communicate with them." Responses here were less reflections of value judgements than assessments of knowledge of very basic facts about computers. The general pattern of response was the same for all three statements. More students tended to agree than disagree with them. The modal response category was "agree" in each case. Although smaller percentages of students agreed strongly, their scores were consistently higher than that of the other groups. The group that agreed strongly tended to include about fifteen percent more boys than girls.

Responses to two possible misconceptions are summarized in tables 13 and 14. These are: "Computers have a mind of their own;" and "Computers make mistakes much of the time." Again, the task of the student was not so much to render a value judgement as to pass on the correctness of the statment. There were similar patterns of response to both statements. Larger percentages disagreed than agreed, and average test scores tended to be higher for those who disagreed. An exception to this were the high scores of the 1.8 % of students who strongly agreed that computers make mistakes much of the time. This may be a sophisticated minority who were responding on the basis that the quality of computer output is no better than what is input. Roughly fifteen percent more boys than girls strongly disagreed with these statements. Parent education was related to the response. Relatively larger percentages of students from advanced degree backgrounds either disagreed or disagreed strongly.

The ability to write and use computer programs is an important outcome of a course on programming. Students were asked to indicate the computer languages they had used to perform these tasks. Results are summarized in table 15. Percents in this and the following tables may not sum to 100 because students could select more than one option. BASIC, used by 37.0 % of students (boys = 54.4 %, girls = 44.2 %) was the most popular language. However, the highest average scores were attained by the 3.3 % minority who had used PASCAL (CL = 56.0, CS =40.1). Of the PASCAL users 70.7 % were boys and 28.1 % were girls. A plurality of 43.4 % indicated they had not used any languages, and their average scores were the lowest in this table (CL = 45.0, CS = 25.1). This group of non-users included 53.0 % girls and 45.3 % boys.

Video-games are considered by some to be a first introduction to computer technology. Responses are summarized in table 16 to the question, "Which of the following video-games do you have at home?" (Atari, Odyssey, Intellivision, Colecovision, Other, None) The most frequently chosen video-game was Atari, 27.9 %, followed by: Intellivision, 8.4 %; Odyssey, 3.0 %; and Colecovision, 2.3 %. The scores of the Atari group (CL = 48.6, CS = 32.0) were only marginally better than that of the 53.0 % of students who reported having no video-game at home (CL = 47.5, CS = 31.5). Access to the other video-games listed was associated with scores in the same range. Very few students from advanced degree backgrounds indicated having no video-game at home. This was not true for students in the other parent education groups.

Access to a microcomputer, whether at home or at school, ought to be positively associated with student mastery of computer technology. Schools provide a structured climate for learning, leading one to expect higher scores for students with school access to a microcomputer. This was not necessarily the case, as shown in tables 17, and 18. The microcomputers and percents reporting access were: Texas Instruments, 14 %; Atari, 9.9 %; Apple, 5.2 %; IBM, 4.0 %; TRS-80, 3.1 %; Commodore, 2.1 %; and Osborne, 0.8 %. The highest average scores were associated with IBM (CL = 53.8, CS = 27.8), and Apple (CL = 53.8, CS = 31.7). This apparent advantage of IBM and Apple may be related to parent education. Relatively high percentages of students from advanced degree backgrounds reported having access to these machines. Among the more popular machines, Atari and Texas Instruments, and for the group reporting no home access, the percentages of boys and girls are roughly equivalent.

Microcomputers found in the schools were: Apple, 20.0 %; IBM, 12.6 %; TRS-80, 10.2 %; Texas Instruments, 7.8 %; Atari, 7.0 %; Commodore, 7.0 %; and Osborne, 1.1 %. Machines that were popular in the home were not the most popular at school. One possibility is that schools may base their purchase decisions on the availability of educational software and inservice training. Price may be a more important criterion for home purchases. The highest average scores were associated with the TRS-80, (CL = 51.6, CS = 34.1) and the Apple, (CL = 50.5, CS = 31.6). These highs were somewhat lower than what was found for the top scoring students with home access. Relatively larger percentages of boys than girls enjoyed access to a microcomputer at school. This was noticeable for the Apple and TRS-80 machines at school. Of the 42.6 % of students who reported having no access to a microcomputer at school more were girls, (boys = 45.7 %, girls = 52.8 %).

It was reasonable to expect that the amount of time spent on activities outside of school, such as working with a computer or playing with a video-game, would be associated with test scores. Ideally, the amount of such activity would be observed directly by people trained for the task. This was not feasible, so students were asked to rate for themselves how many hours per week they typically spent in certain activities. The reliability and validity of such responses were limited by accuracy of memory and social desirability response biases. An indication that similar limitations may apply here was the non-response rate of about fifteen percent, compared to less than five percent for the other questions. Keeping this in mind, the results can still be used to indicate general trends. Percents of students in each activity category were shown in table 19, computer literacy scores in table 20 and computer science scores in table 21.

A majority of 59.2 % of the sample reported doing no computer programming at home. This was identical to the percent reporting no microcomputer at home. Comparable percents of students report not having a video-game at home (57.2 %). Relatively small percents of students reported programming computers at home more than 2 hours per week. More popular activities, involving more than ten hours per week were television (12.3 %), athletics (11.8 %), and homework (10.1 %). Increased involvement in four activities was associated with higher computer literacy scores, as shown in table 20. These were: computer programming; doing homework; pleasure reading; and watching television. The highest average scores were attained by the small group (1.9 %), which spent more then ten hours per week programming. All four of these activities, with varying degrees of efficiency, involve the transmission of information and have potential for learning. However, the one activity that involved actually working with computers, was associated with the highest test scores. Higher scores in the area of computer science were associated with only three activities. These were: computer programming; reading for pleasure; and homework. Again, the highest average scores were associated with programming activities.

One measure of the effectiveness of school programs is the extent to which they are associated with higher achievement. Data summarizing students' microcomputer learning in school are displayed in table 22. Fully 53.0 % reported having little such experience in school, and their average scores were the lowest in the table (CL = 49.4, CS = 33.7). Percents of students indicating each type of experience were: general learning, 16.9 %; programming, 15.6 %; games, 12.3 %; drill, 11.3 %; simulations, 8.4 %; and tutorial, 4.8 %. The highest average scores were associated with programming activities (CL = 56.9, CS = 46.8). Low average scores were associated with computer games (CL = 51.6, CS = 39.1). Boys were more likely to be involved in programming than girls (boys = 55.2 %, girls = 42.2 %), and girls were more likely to report having little experience with computers (boys = 45.6 %, girls = 53.2 %).

Learning about microcomputers in school appeared to have a powerful effect on test scores. This can be seen by comparing the scores of those who report having programming experience with scores of those reporting no experience. In computer literacy there was a gain from 49.4 to 56.9, or seven percent. The gain in computer science, from 33.7 to 46.8, or 13 percent, was about two times as large. Given that the test was not designed specifically to assess instructional outcomes in these classes, the estimated gains were probably conservative.

Microcomputers have so permeated our society that there are many different sources of information about them. Students responses to where they learned, displayed in Table 23, were: at school during the day, 28.0 %; video-games, 21.2 %; at home, 14.0 %; at friends' homes, 9.8 %; in computer stores, 6.4 %; summer programs, 3.4 %; at school in the evening, 2.4 %; and at museums, 2.0 %. Relatively higher scores were attained by those who reported learning in school, whether during the day, (CL = 47.2, CS = 35.1), or during the evening (CL = 47.0, CS = 38.8). This reinforces the earlier findings regarding the effects of instruction. The lowest average scores were exhibited by the 44.9 % of the sample who reported knowing little about microcomputers (CL = 38.6, CS = 27.3). This group contained more girls than boys (boys = 40.7 %, girls = 57.7 %). Although many students reported learning from video-games, their scores were, in fact, low (CL = 40.8, CS = 30.1).

## DISCUSSION

Affective goals are as much a part of the educational process as are cognitive goals. In addition to technical knowledge and skills students should develop a positive regard for the beneficial capabilities of computers. Ideally, the more one knows about computer technology, the more evident these attitudes should be. Related to this is the ability to recognize popular myths about computers and their implied value judgements. Concerns about privacy and being treated as a number, although valid when understood in the context of the actual capabilities and limits of technology, can be exaggerated in isolation from such knowledge. Students who exhibited higher test scores tended to reject these concerns. There was a similar tendency to reject other, more naive, myths about computers, i.e. that they have minds of their own or make mistakes much of the time. At the same time there was an awareness of basic facts about computers by a substantial majority of students. This general pattern of response supports the conjecture that a majority of twelfth graders have, at least, an accurate awareness of the general characteristics of computers. Responses to the background questions suggest that this awareness does not extend to widespread familiarity with machines or working knowledge of them for at least half the sample. When this was compared to the results of the NAEP mathematics assessment it was clear that there has been much progress in the last six or seven years, but that much remains to be done.

Perhaps the primary conclusion of the analysis of test scores was the generally low overall level of mastery, especially in the area of computer science. Results for the background questions provide some explanatory clues. Roughly half the sample had not ever used a programming language or had access to a microcomputer, whether at home or at school. Access to a video-game provided was not associated with higher test scores. It is a truism of computer programming that to learn one must actually write programs and run them. School appears to be a good place to learn programming, even though students with home access had high test scores. The BASIC programming language is probably more widely disseminated with microcomputers than any other, and over one-third of the sample reported having used it. However, FORTRAN, COBOL and PASCAL were each used by three to four percent of the sample, and they were associated with higher test scores than BASIC. This may be a reflection of the sophistication of the languages. It is thought to be more difficult to learn FORTRAN or COBOL, and having learned these languages one may know more about computer technology. Availability of software is probably one reason for the popularity of BASIC in the schools. The choice of programming language in schools needs further debate.

Boys had generally higher scores than girls. The reason for this appeared to be that boys had more experience with computers and programming than girls. This was true at school, and to a lesser extent at home. Sex equity has been an issue in public education and it is likely that related concerns will carry over into the area of computer studies. If students with a background in computer technology benefit professionally from their experience, there needs to be an assurance that specific subgroups of the population are not being discouraged from acquiring that experience. This study does not explain why girls appear to have less experience in computer studies than boys, but it supports the hypothesis that there is a difference.

It is unfortunate that social class, historically, has been correlated with achievement of all kinds. This relationship is clearly demonstrated in the area of computer studies, although possible reasons for it were not clear. The difference in computer literacy scores between the highest and lowest parent education groups was about three times as large as the difference between boys and girls. It was about one and a half times as large for computer science scores. There was no striking trend for students from lower educational backgrounds to be less involved in learning about computers in school. They were less likely to learn about them at home or from friends. It is striking that no students from the lowest parent education category reported learning about computers in museums. Opportunities for learning extend beyond the school into the community and the family. It would be desirable to assure equity of learning opportunities for students from all social classes, although this is no less difficult than important.

## CONCLUSIONS

The NAEP 1977-78 mathematics assessment concluded that a large majority of students had no experience programming a computer. The more optimistic conclusion of the current study is that a majority of students have had programming experience by the twelfth grade. Programming experience, particularly in school, but at home, as well, was associated with markedly higher test scores. This reflects substantial progress in implementing computer studies programs. A large majority of students exhibit awareness of routine characteristics and uses of computers. Performance on programming objectives is low, however, and mastery of general knowledge is not much higher. Boys appear to have an advantage over girls, which is probably the result of greater access to computers and experience with them, both at home and in school.

Students were aware that computer skills could lead to better jobs, yet the general level of mastery did not appear to be adequate for the practical needs of business. The issue, whether public schools should provide training sufficient for entry level jobs, is one that need to be squarely faced. A positive answer would affect the spending of large amounts of money on equipment, software and teacher training. If the commitment is made to computer studies the problem of equity of access by those who would potentially benefit, especially for girls, should be addressed. Efforts should be made to see that students from lower social classes benefit from such access as much as students from higher social classes.

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## Appendix A

## STUDENT OBJECTIVES

1. Demonstrate understanding of the capabilities, applications, and implications of computer technology. (239)
   1. Interact with a computer and/or other electronic devices. (42)
      1. Demonstrate ability to operate a variety of devices which are based on electronic logic. (8)
      2. Demonstrate ability to use a computer in the interactive mode. (13)
      3. Independently select a program from the computer resource library. (9)
      4. Recognize user errors associated with computer utilization. (12)
   2. Explain the functions and uses of a computer system. (91)
      1. Use an appropriate vocabulary for communicating about computers. (25)
      2. Distinguish between interactive mode and batch mode computer processing. (9)
      3. Identify a computer system's major components such as input, memory, processing, and output. (20)
      4. Recognize tasks for which computer utilization is appropriate. (14)

5. Describe the major historical developments in computing. (23)

3. Utilize systematic processes in problem solving. (58)

   1. Choose a logical sequence of steps needed to perform a task. (10)
   2. Diagram the steps in solving a program. (7)
   3. Select the appropriate tool and procedure to solve a problem. (11)
   4. Develop systematic procedures to perform useful tasks in areas such as social studies, business, science and mathematics. (12)
   5. Write simple programs to solve problems using a high level language such as PILOT, LOGO and BASIC. (18)

4. Appraise the impact of computer technology upon human life. (48)

   1. Identify specific uses of computers in fields such as medicine, law enforcement, industry, business, transportation, government, banking and space exploration. (12)
   2. Compare computer-related educations and careers. (13)
   3. Identify social and other non-technical factors which might restrict computer utilization. (10)
   4. Recognize the consequences of computer utilization. (11)
   5. Differentiate between responsible and irresponsible uses of computer technology. (2)

2. Demonstrate understandings of computer systems including software development, the design and operation of hardware, and the use of computer systems in solving problems. (191)

   1. Write structured and documented computer software. (95)

      1. Write well organized BASIC programs which include the use of color, sound and graphics statements. (41)
      2. Write programs which demonstrate advanced programming techniques used to solve problems in business, scientific or entertainment applications. (19)
      3. Write programs in an additional high level language such as PASCAL, COBOL or FORTRAN. (25)
      4. Write programs in a low level language such as machine language or assembler. (10)

   2. Demonstrate knowledge of the design and operation of computer hardware. (57)

      1. Demonstrate unassisted operation of at least two different configurations of computers and their peripherals. (16)
      2. Use a special purpose computer or computer interfaced devices to monitor or control events by sensing temperature, light, sound, or other physical phenomena. (10)
      3. Describe the computer's digital electronic circuitry in terms of of binary arithmetic and logical operators. (19)
      4. Perform vendor authorized minor maintenance on the computer system. (12)

3. Use computer systems in problem solving. (39)

   1. Use data processing utilities including word processing and data base management in problem solving. (12)
   2. Translate software from one language to another or to another version of the same language. (11)
   3. Analyze different solutions to the same problem. (16)

TABLE 1

Student Objectives for Computer Studies

| Objectives | Achievement: Total | Boys | Girls | Not High Schl | High Schl | Some Coll | Four Yrs Coll | Advd Degree |
|---|---|---|---|---|---|---|---|---|
| 1.Computer literacy | 46.0 | 47.7 | 44.3 | 41.3 | 43.6 | 45.5 | 49.3 | 49.5 |
| 1.Computer interactions | 50.3 | 51.3 | 49.3 | 47.3 | 48.3 | 50.0 | 53.0 | 52.5 |
| 1.Operations | 67.9 | 69.7 | 66.0 | 63.7 | 68.9 | 67.1 | 72.4 | 67.9 |
| 2.Interactive mode | 49.0 | 48.8 | 48.8 | 41.9 | 44.8 | 50.8 | 50.5 | 53.7 |
| 3.Program selection | 48.9 | 49.4 | 48.5 | 50.7 | 43.7 | 49.1 | 50.9 | 51.4 |
| 4.User errors | 40.7 | 43.4 | 38.5 | 37.5 | 40.7 | 39.6 | 44.6 | 41.3 |
| 2.Functions and uses | 41.5 | 44.2 | 38.9 | 35.7 | 38.5 | 40.5 | 45.4 | 46.8 |
| 1.Vocabulary | 38.5 | 40.6 | 36.6 | 32.2 | 35.5 | 37.0 | 42.6 | 44.0 |
| 2.Interactive vs batch | 25.9 | 27.1 | 24.8 | 24.1 | 25.9 | 23.0 | 31.1 | 27.2 |
| 3.System components | 44.2 | 47.4 | 40.9 | 36.4 | 40.6 | 44.3 | 47.9 | 49.6 |
| 4.Appropriate tasks | 69.8 | 71.7 | 67.8 | 62.7 | 63.6 | 71.0 | 73.7 | 77.4 |
| 5.History | 30.7 | 34.0 | 27.3 | 25.4 | 29.4 | 29.3 | 33.5 | 35.8 |
| 3.Problem solving | 44.2 | 45.3 | 43.2 | 40.0 | 43.2 | 43.6 | 46.8 | 46.3 |
| 1.Logical steps | 63.1 | 63.1 | 63.2 | 60.7 | 60.4 | 65.1 | 62.9 | 64.2 |
| 2.Diagrams | 49.5 | 49.7 | 49.1 | 41.7 | 50.3 | 46.6 | 55.4 | 50.6 |
| 3.Tools and procedures | 43.3 | 44.3 | 42.1 | 36.1 | 42.4 | 40.7 | 45.9 | 49.3 |
| 4.Useful tasks | 50.4 | 51.7 | 49.3 | 48.1 | 49.4 | 49.9 | 54.0 | 51.1 |
| 5.Simple programs | 28.3 | 30.0 | 26.6 | 26.5 | 27.4 | 27.7 | 30.6 | 28.6 |
| 4.Impact on life | 52.9 | 54.8 | 51.2 | 48.6 | 49.4 | 53.5 | 56.0 | 56.1 |
| 1.Specific uses | 58.3 | 62.6 | 54.2 | 56.3 | 53.6 | 58.1 | 62.9 | 61.3 |
| 2.Occupations | 49.3 | 49.7 | 48.9 | 44.3 | 46.3 | 50.3 | 51.1 | 54.2 |
| 3.Restrictions | 52.4 | 53.8 | 51.6 | 47.9 | 50.8 | 51.7 | 55.4 | 55.3 |
| 4.Consequences | 53.2 | 54.2 | 52.1 | 48.2 | 48.6 | 55.1 | 57.5 | 55.5 |
| 5.Responsible use | 43.8 | 44.8 | 42.8 | 35.0 | 44.1 | 46.1 | 40.6 | 45.7 |
| 2.Computer science | 29.2 | 30.7 | 27.8 | 27.1 | 27.4 | 29.2 | 30.1 | 31.9 |
| 1.Software | 26.1 | 27.1 | 25.2 | 24.7 | 24.9 | 25.8 | 26.3 | 29.1 |
| 1.BASIC programming | 28.7 | 30.1 | 27.7 | 25.0 | 26.0 | 29.1 | 29.4 | 33.5 |
| 2.Advanced techniques | 30.7 | 31.2 | 30.2 | 28.2 | 29.9 | 30.6 | 31.5 | 32.7 |
| 3.PASCAL, COBOL and FORTRAN | 20.0 | 20.8 | 19.4 | 20.8 | 19.5 | 20.5 | 19.5 | 20.5 |
| 4.Machine language | 21.7 | 23.1 | 19.9 | 26.7 | 24.0 | 17.0 | 20.1 | 25.1 |
| 2.Hardware | 34.8 | 36.7 | 32.9 | 31.6 | 32.5 | 35.5 | 35.6 | 37.1 |
| 1.Configurations | 37.4 | 39.7 | 35.3 | 33.9 | 33.4 | 38.5 | 35.8 | 43.6 |
| 2.Interface devices | 50.2 | 51.0 | 49.5 | 45.1 | 46.8 | 49.3 | 56.4 | 53.7 |
| 3.Circuitry | 21.7 | 23.8 | 19.5 | 19.8 | 21.9 | 22.2 | 21.1 | 22.2 |
| 4.Maintenance | 39.0 | 40.8 | 37.3 | 35.2 | 38.1 | 40.4 | 39.9 | 38.7 |
| 3.Problem solving | 28.6 | 30.3 | 26.9 | 26.5 | 25.9 | 28.0 | 31.4 | 31.2 |
| 1.System utilities | 33.7 | 36.1 | 31.5 | 32.0 | 30.5 | 33.7 | 38.0 | 34.6 |
| 2.Software translation | 18.3 | 20.4 | 16.5 | 15.3 | 16.4 | 17.7 | 20.2 | 21.5 |
| 3.Analysis | 31.6 | 33.1 | 30.4 | 29.8 | 29.0 | 31.1 | 33.3 | 35.0 |

TABLE 2

Computers treat everyone as a number

| Response | Total Percent | Test Scores: Lit-eracy | Test Scores: Sci-ence | Subgroup Percents: Boys | Girls | Not High Schl | High Schl | Some Coll | Four Yrs Coll | Advd Deg-ree |
|---|---|---|---|---|---|---|---|---|---|---|
| Strongly Disagree | 10.1 | 42.4 | 34.0 | 62.3 | 35.6 | 8.2 | 12.3 | 30.8 | 22.6 | 23.3 |
| Disagree | 25.8 | 43.5 | 32.5 | 51.5 | 47.7 | 8.9 | 17.0 | 29.7 | 20.2 | 22.6 |
| Undecided | 29.0 | 38.5 | 28.3 | 44.4 | 54.0 | 10.1 | 24.2 | 27.6 | 22.3 | 13.7 |
| Agree | 22.4 | 41.6 | 28.1 | 49.2 | 49.5 | 12.4 | 24.5 | 26.3 | 19.2 | 16.1 |
| Strongly Agree | 7.3 | 38.3 | 27.9 | 60.0 | 39.1 | 15.2 | 16.2 | 24.8 | 14.3 | 24.8 |

TABLE 3

The more computers are used, the less privacy there is

| Response | Total Percent | Test Scores: Lit-eracy | Test Scores: Sci-ence | Subgroup Percents: Boys | Girls | Not High Schl | High Schl | Some Coll | Four Yrs Coll | Advd Deg-ree |
|---|---|---|---|---|---|---|---|---|---|---|
| Strongly Disagree | 8.4 | 42.1 | 35.8 | 61.5 | 32.8 | 8.2 | 16.4 | 25.4 | 24.6 | 18.9 |
| Disagree | 27.1 | 43.2 | 30.6 | 42.4 | 56.1 | 14.5 | 16.3 | 25.5 | 21.7 | 20.4 |
| Undecided | 29.8 | 38.3 | 26.8 | 44.2 | 52.8 | 11.1 | 24.1 | 27.6 | 20.4 | 14.8 |
| Agree | 23.1 | 40.0 | 30.3 | 46.1 | 51.5 | 12.3 | 23.4 | 25.5 | 21.6 | 16.5 |
| Strongly Agree | 7.7 | 43.0 | 29.7 | 58.9 | 38.4 | 11.6 | 18.8 | 25.0 | 17.9 | 20.5 |

TABLE 4

Computers create as many jobs as they eliminate

| Response | Total Percent | Test Scores: Literacy | Test Scores: Science | Subgroup Percents: Boys | Girls | Not High Schl | High Schl | Some Coll | Four Yrs Coll | Advd Degree |
|---|---|---|---|---|---|---|---|---|---|---|
| Strongly Disagree | 8.8 | 54.7 | 35.6 | 69.0 | 28.7 | 17.1 | 20.9 | 31.8 | 16.3 | 12.4 |
| Disagree | 24.2 | 53.8 | 33.7 | 51.1 | 47.5 | 8.5 | 20.1 | 29.1 | 20.3 | 20.6 |
| Undecided | 18.9 | 52.2 | 34.3 | 48.6 | 49.6 | 14.1 | 19.9 | 26.8 | 20.7 | 16.3 |
| Agree | 34.9 | 56.5 | 33.0 | 48.0 | 49.9 | 9.2 | 22.9 | 28.4 | 20.2 | 18.4 |
| Strongly Agree | 9.6 | 57.4 | 36.8 | 56.0 | 41.1 | 9.2 | 26.2 | 28.4 | 18.4 | 16.3 |

TABLE 5

Computers complicate simple business operations

| Response | Total Percent | Test Scores: Literacy | Test Scores: Science | Subgroup Percents: Boys | Girls | Not High Schl | High Schl | Some Coll | Four Yrs Coll | Advd Degree |
|---|---|---|---|---|---|---|---|---|---|---|
| Strongly Disagree | 37.8 | 47.9 | 33.2 | 58.9 | 39.6 | 10.1 | 15.1 | 30.1 | 20.6 | 21.5 |
| Disagree | 34.9 | 48.1 | 29.7 | 43.7 | 55.1 | 10.3 | 20.9 | 31.2 | 19.1 | 16.5 |
| Undecided | 13.0 | 44.3 | 23.1 | 37.2 | 61.7 | 12.2 | 24.5 | 35.1 | 10.6 | 17.0 |
| Agree | 6.4 | 37.6 | 29.2 | 40.2 | 59.8 | 13.0 | 34.7 | 21.7 | 17.4 | 10.9 |
| Strongly Agree | 2.3 | 32.6 | 13.2 | 54.6 | 39.4 | 24.2 | 15.2 | 21.2 | 24.2 | 12.1 |

TABLE 6

Someday most things will be run by computers

| Response | Total Percent | Test Scores: Literacy | Test Scores: Science | Subgroup Percents: Boys | Girls | Not High Schl | High Schl | Some Coll | Four Yrs Coll | Advd Degree |
|---|---|---|---|---|---|---|---|---|---|---|
| Strongly Disagree | 4.2 | 50.0 | 30.3 | 59.0 | 39.3 | 9.8 | 23.0 | 16.4 | 24.6 | 23.0 |
| Disagree | 3.0 | 57.4 | 37.4 | 51.2 | 46.5 | 11.6 | 16.3 | 14.0 | 27.9 | 30.2 |
| Undecided | 10.0 | 45.6 | 27.8 | 50.7 | 48.6 | 13.9 | 25.7 | 30.6 | 13.9 | 15.3 |
| Agree | 46.0 | 52.1 | 30.7 | 48.4 | 49.8 | 8.9 | 21.7 | 28.2 | 19.5 | 20.1 |
| Strongly Agree | 33.0 | 52.9 | 33.6 | 51.5 | 46.9 | 8.8 | 20.6 | 29.8 | 20.0 | 19.5 |

TABLE 7

Knowledge of computers helps to get a better job

| Response | Total Percent | Test Scores: Literacy | Test Scores: Science | Subgroup Percents: Boys | Girls | Not High Schl | High Schl | Some Coll | Four Yrs Coll | Advd Degree |
|---|---|---|---|---|---|---|---|---|---|---|
| Strongly Disagree | 3.4 | 42.0 | 29.9 | 59.2 | 38.8 | 16.3 | 28.6 | 16.3 | 16.3 | 18.4 |
| Disagree | 5.4 | 34.8 | 29.2 | 41.6 | 57.1 | 6.5 | 20.8 | 26.2 | 18.2 | 28.6 |
| Undecided | 13.1 | 41.4 | 26.7 | 40.4 | 58.0 | 11.2 | 25.5 | 30.3 | 17.6 | 13.8 |
| Agree | 46.2 | 43.2 | 28.8 | 50.9 | 48.5 | 10.4 | 23.0 | 28.0 | 20.0 | 17.5 |
| Strongly Agree | 28.5 | 44.6 | 32.2 | 52.0 | 47.1 | 11.7 | 22.2 | 26.8 | 19.5 | 17.3 |

TABLE 8

Computers make mathematics more interesting

| Response | Total Percent | Test Scores: Literacy | Test Scores: Science | Subgroup Percents: Boys | Girls | Not High Schl | High Schl | Some Coll | Four Yrs Coll | Advd Degree |
|---|---|---|---|---|---|---|---|---|---|---|
| Strongly Disagree | 4.3 | 40.0 | 26.8 | 51.6 | 46.9 | 10.9 | 9.4 | 32.8 | 21.9 | 21.9 |
| Disagree | 4.4 | 40.7 | 29.1 | 43.1 | 53.9 | 18.5 | 24.6 | 15.4 | 16.9 | 23.1 |
| Undecided | 15.9 | 41.5 | 25.9 | 45.5 | 52.8 | 12.3 | 26.0 | 23.8 | 16.6 | 20.9 |
| Agree | 48.2 | 44.9 | 27.0 | 43.6 | 54.3 | 12.8 | 21.1 | 25.9 | 21.4 | 17.4 |
| Strongly Agree | 23.9 | 51.4 | 30.5 | 60.9 | 35.4 | 13.0 | 19.8 | 28.1 | 19.8 | 18.7 |

TABLE 9

To work with a computer a person must be a mathematician

| Response | Total Percent | Test Scores: Literacy | Test Scores: Science | Subgroup Percents: Boys | Girls | Not High Schl | High Schl | Some Coll | Four Yrs Coll | Advd Degree |
|---|---|---|---|---|---|---|---|---|---|---|
| Strongly Disagree | 14.3 | 46.8 | 31.4 | 53.2 | 45.1 | 6.4 | 19.1 | 27.8 | 26.0 | 20.8 |
| Disagree | 39.0 | 44.1 | 29.6 | 51.3 | 47.3 | 9.9 | 21.1 | 25.7 | 20.0 | 21.9 |
| Undecided | 11.6 | 38.3 | 22.8 | 44.7 | 51.8 | 12.8 | 31.2 | 27.0 | 13.5 | 14.2 |
| Agree | 21.9 | 42.1 | 25.8 | 48.1 | 49.3 | 14.7 | 22.6 | 30.5 | 16.2 | 15.4 |
| Strongly Agree | 9.1 | 37.8 | 30.4 | 48.7 | 48.7 | 21.6 | 25.2 | 28.8 | 9.9 | 11.7 |

TABLE 10

Computers are suited for repetitive monotonous tasks

| Response | Total Percent | Test Scores | | Subgroup Percents | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Lit-eracy | Sci-ence | Boys | Girls | Not High Schl | High Schl | Some Coll | Four Yrs Coll | Advd Deg-ree |
| Strongly Disagree | 6.8 | 53.8 | 29.1 | 49.0 | 45.5 | 12.2 | 14.3 | 20.4 | 23.5 | 25.5 |
| Disagree | 10.1 | 49.3 | 31.0 | 41.5 | 55.8 | 12.2 | 15.7 | 28.6 | 21.8 | 18.4 |
| Undecided | 21.3 | 48.7 | 29.8 | 44.2 | 53.9 | 12.0 | 26.6 | 27.9 | 17.2 | 13.3 |
| Agree | 37.3 | 53.0 | 34.6 | 45.6 | 52.4 | 9.8 | 21.1 | 25.9 | 22.4 | 18.5 |
| Strongly Agree | 17.5 | 55.8 | 41.4 | 62.5 | 36.4 | 10.3 | 16.2 | 29.6 | 18.6 | 23.3 |

TABLE 11

Computers are programmed to follow instructions

| Response | Total Percent | Test Scores | | Subgroup Percents | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Lit-eracy | Sci-ence | Boys | Girls | Not High Schl | High Schl | Some Coll | Four Yrs Coll | Advd Deg-ree |
| Strongly Disagree | 4.0 | 38.7 | 38.0 | 36.0 | 62.0 | 14.0 | 26.0 | 28.0 | 22.[illegible] | 8.0 |
| Disagree | 2.6 | 30.2 | 23.4 | 53.1 | 43.8 | 15.6 | 31.3 | 12.5 | 15.6 | 18.8 |
| Undecided | 9.7 | 40.7 | 24.6 | 44.3 | 53.3 | 10.7 | 28.7 | 26.3 | 13.9 | 19.7 |
| Agree | 40.7 | 40.1 | 30.0 | 40.9 | 57.0 | 11.4 | 19.7 | 28.3 | 23.0 | 16.1 |
| Strongly Agree | 37.2 | 45.4 | 35.4 | 56.0 | 42.5 | 9.0 | 16.3 | 26.0 | 25.5 | 22.5 |

TABLE 12

Computers require special languages

| Response | Total Percent | Test Scores: Literacy | Test Scores: Science | Boys | Girls | Not High Schl | High Schl | Some Coll | Four Yrs Coll | Advd Degree |
|---|---|---|---|---|---|---|---|---|---|---|
| Strongly Disagree | 7.2 | 39.2 | 24.2 | 59.3 | 40.7 | 15.4 | 22.0 | 19.8 | 21.9 | 18.7 |
| Disagree | 13.8 | 40.4 | 25.4 | 53.1 | 45.7 | 10.9 | 26.9 | 35.4 | 15.4 | 11.4 |
| Undecided | 18.1 | 39.9 | 24.0 | 43.2 | 53.7 | 10.9 | 22.3 | 27.1 | 19.7 | 19.2 |
| Agree | 37.5 | 41.9 | 28.4 | 46.9 | 52.3 | 11.3 | 21.9 | 24.4 | 19.3 | 20.4 |
| Strongly Agree | 19.0 | 43.3 | 33.4 | 56.4 | 41.9 | 12.0 | 17.8 | 23.2 | 23.7 | 21.2 |

TABLE 13

Computers have a mind of their own

| Response | Total Percent | Test Scores: Literacy | Test Scores: Science | Boys | Girls | Not High Schl | High Schl | Some Coll | Four Yrs Coll | Advd Degree |
|---|---|---|---|---|---|---|---|---|---|---|
| Strongly Disagree | 31.5 | 60.7 | 31.5 | 62.3 | 35.7 | 9.7 | 17.9 | 23.4 | 23.4 | 22.9 |
| Disagree | 31.4 | 53.1 | 28.3 | 47.5 | 50.3 | 8.7 | 21.0 | 28.8 | 19.5 | 19.8 |
| Undecided | 14.3 | 46.8 | 22.8 | 32.4 | 64.8 | 12.6 | 23.6 | 28.6 | 14.3 | 17.6 |
| Agree | 14.0 | 47.6 | 24.1 | 45.5 | 50.6 | 15.2 | 30.9 | 24.1 | 16.9 | 11.2 |
| Strongly Agree | 5.3 | 41.5 | 27.2 | 52.9 | 45.6 | 23.5 | 22.1 | 25.0 | 8.8 | 16.2 |

TABLE 14.

Computers make mistakes much of the time

| Response | Total Percent | Test Scores | | Subgroup Percents | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Literacy | Science | Boys | Girls | Not High Schl | High Schl | Some Coll | Four Yrs Coll | Advd Degree |
| Strongly Disagree | 22.2 | 56.8 | 34.4 | 61.9 | 35.6 | 9.4 | 22.3 | 21.2 | 16.9 | 28.4 |
| Disagree | 40.3 | 48.4 | 28.6 | 50.5 | 48.3 | 9.9 | 19.4 | 27.9 | 19.2 | 22.0 |
| Undecided | 20.5 | 43.4 | 24.2 | 43.2 | 54.9 | 12.5 | 24.9 | 30.0 | 14.8 | 16.0 |
| Agree | 11.4 | 43.2 | 25.2 | 44.4 | 53.5 | 12.5 | 22.9 | 29.2 | 13.9 | 16.7 |
| Strongly Agree | 1.8 | 50.0 | 39.6 | 54.6 | 40.9 | 4.6 | 40.9 | 31.8 | 9.1 | 9.1 |

TABLE 15

Programming Languages Actually Used

| Response | Total Percent | Test Scores | | Subgroup Percents | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Lit-eracy | Sci-ence | Boys | Girls | Not High Schl | High Schl | Some Coll | Four Yrs Coll | Advd Deg-ree |
| BASIC | 37.0 | 49.7 | 30.9 | 54.4 | 44.2 | 11.3 | 19.6 | 27.0 | 20.5 | 20.8 |
| PASCAL | 3.3 | 56.0 | 40.1 | 70.7 | 28.1 | 7.9 | 15.9 | 30.5 | 17.7 | 26.2 |
| LOGO | 3.4 | 47.1 | 27.1 | 55.8 | 40.7 | 9.3 | 16.3 | 31.4 | 18.6 | 20.4 |
| PILOT | 2.2 | 42.4 | 32.0 | 75.2 | 22.0 | 13.8 | 18.4 | 33.0 | 11.9 | 20.2 |
| FORTRAN | 4.2 | 52.6 | 34.5 | 59.1 | 36.1 | 6.3 | 18.8 | 25.0 | 24.5 | 24.0 |
| COBOL | 4.4 | 51.1 | 35.1 | 58.3 | 38.5 | 6.9 | 21.6 | 28.4 | 19.3 | 21.6 |
| FORTH | 1.0 | 45.2 | 38.1 | 79.2 | 16.7 | 8.3 | 12.5 | 39.6 | 20.8 | 16.7 |
| ASSEMBLY | 4.7 | 48.9 | 32.3 | 62.9 | 34.6 | 15.6 | 19.4 | 25.7 | 19.0 | 16.9 |
| Other | 4.5 | 49.7 | 36.8 | 59.5 | 39.2 | 11.9 | 16.3 | 30.0 | 17.2 | 23.4 |
| None | 43.4 | 45.0 | 25.1 | 45.3 | 53.0 | 10.3 | 21.5 | 27.3 | 21.0 | 18.3 |

TABLE 16

Video-Games at Home

| Response | Total Percent | Test Scores | | Subgroup Percents | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Literacy | Science | Boys | Girls | Not High Schl | High Schl | Some Coll | Four Yrs Coll | Advd Degree |
| Atari | 27.9 | 48.6 | 32.0 | 52.3 | 45.8 | 9.7 | 21.1 | 30.4 | 18.9 | 18.2 |
| Odyssey | 3.0 | 50.0 | 32.5 | 59.0 | 38.2 | 6.9 | 17.4 | 33.3 | 18.8 | 20.4 |
| Intellivision | 8.4 | 47.9 | 28.4 | 58.7 | 40.3 | 7.1 | 19.1 | 30.7 | 20.9 | 19.1 |
| Colecovision | 2.3 | 44.6 | 29.4 | 67.6 | 28.7 | 12.0 | 19.4 | 31.5 | 15.7 | 17.6 |
| Other | 8.2 | 50.8 | 34.5 | 58.3 | 40.2 | 8.2 | 20.5 | 27.1 | 16.1 | 25.8 |
| None | 53.0 | 47.5 | 31.5 | 49.9 | 51.8 | 13.0 | 20.2 | 26.9 | 19.1 | 1.6 |

TABLE 17

Microcomputers at Home

| Response | Total Percent | Test Scores | | Subgroup Percents | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Lit-eracy | Sci-ence | Boys | Girls | Not High Schl | High Schl | Some Coll | Four Yrs Coll | Advd Deg-ree |
| Atari | 9.9 | 49.9 | 29.9 | 48.9 | 48.3 | 8.6 | 21.9 | 30.2 | 19.7 | 17.8 |
| TRS-80 | 3.1 | 51.9 | 29.9 | 65.0 | 30.9 | 11.3 | 12.4 | 33.0 | 18.6 | 23.7 |
| Apple | 5.2 | 53.8 | 31.7 | 61.4 | 34.4 | 6.8 | 11.7 | 30.1 | 19.6 | 27.6 |
| PET-Commodore | 2.1 | 47.7 | 31.0 | 71.2 | 25.8 | 9.1 | 10.6 | 25.8 | 22.7 | 28.8 |
| IBM | 4.0 | 54.5 | 27.8 | 56.8 | 40.0 | 8.8 | 16.0 | 23.2 | 17.6 | 28.8 |
| Texas Instruments | 14.0 | 48.4 | 31.7 | 48.1 | 49.7 | 10.8 | 19.2 | 27.5 | 18.7 | 21.7 |
| Osborne | 0.8 | 48.4 | 23.8 | 72.0 | 20.0 | 16.0 | 12.0 | 20.0 | 20.0 | 12.0 |
| Other | 6.0 | 51.8 | 31.5 | 52.4 | 43.9 | 9.5 | 13.2 | 27.5 | 20.1 | 25.9 |
| None | 59.2 | 50.3 | 29.8 | 49.2 | 49.7 | 12.0 | 21.8 | 28.6 | 18.6 | 17.8 |

TABLE 18

Microcomputers at School

| Response | Total Percent | Test Scores: Literacy | Test Scores: Science | Subgroup Percents: Boys | Girls | Not High Schl | High Schl | Some Coll | Four Yrs Coll | Advd Degree |
|---|---|---|---|---|---|---|---|---|---|---|
| Atari | 7.0 | 42.0 | 24.7 | 59.5 | 37.0 | 12.7 | 23.1 | 27.5 | 19.2 | 15.4 |
| TRS-80 | 10.2 | 51.6 | 34.1 | 64.9 | 33.1 | 7.1 | 22.8 | 27.7 | 21.3 | 19.8 |
| Apple | 20.2 | 50.5 | 31.6 | 56.3 | 41.7 | 10.1 | 19.7 | 26.5 | 21.0 | 21.2 |
| PET-Commodore | 7.0 | 49.6 | 32.9 | 63.5 | 33.3 | 10.5 | 21.9 | 28.6 | 17.4 | 19.1 |
| IBM | 12.6 | 42.9 | 26.2 | 20.8 | 57.1 | 15.1 | 24.5 | 25.9 | 19.7 | 12.4 |
| Texas Instruments | 7.8 | 47.1 | 26.2 | 53.4 | 43.6 | 10.0 | 20.5 | 27.1 | 20.5 | 18.8 |
| Osborne | 1.1 | 45.5 | 31.8 | 70.0 | 23.8 | 10.0 | 20.0 | 27.5 | 17.5 | 22.5 |
| Other | 11.0 | 49.8 | 32.1 | 55.2 | 42.8 | 10.3 | 18.4 | 29.0 | 19.6 | 21.1 |
| None | 42.6 | 43.9 | 26.2 | 45.7 | 52.8 | 10.8 | 21.3 | 25.8 | 21.4 | 18.9 |

TABLE 19

Percents of Students in Selected Activities

| Activity | Hours Per Week Outside of School | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | None | Less Than 1 | 1-2 | 2-3 | 3-4 | 4-5 | 5-10 | More Than 10 |
| Reading | 15.4 | 20.4 | 19.7 | 8.9 | 6.3 | 5.4 | 4.8 | 3.6 |
| Homework | 6.9 | 12.0 | 18.1 | 10.6 | 8.0 | 8.8 | 12.9 | 10.1 |
| Video-games at home | 57.2 | 12.7 | 5.4 | 2.5 | 1.6 | 0.8 | 0.9 | 0.7 |
| Video-games away | 45.5 | 22.2 | 7.4 | 3.1 | 2.0 | 0.9 | 0.8 | 0.7 |
| Computer | 59.2 | 9.2 | 4.0 | 2.1 | 1.6 | 1.6 | 1.6 | 1.9 |
| Athletics | 15.9 | 11.0 | 13.3 | 10.7 | 7.4 | 6.6 | 8.4 | 11.8 |
| Television | 6.7 | 9.5 | 12.5 | 11.9 | 9.6 | 10.7 | 13.0 | 12.3 |
| Other | 6.7 | 5.4 | 10.0 | 10.8 | 9.6 | 9.9 | 12.4 | 21.0 |

TABLE 20

Computer Literacy Achievement for Selected Activities

| Activity | Hours Per Week Outside of School | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | None | Less Than 1 | 1-2 | 2-3 | 3-4 | 4-5 | 5-10 | More Than 10 |
| Reading | 41.7 | 46.8 | 48.7 | 49.1 | 49.1 | 49.0 | 51.0 | 47.7 |
| Homework | 38.6 | 45.0 | 45.3 | 44.6 | 47.6 | 47.0 | 52.1 | 51.9 |
| Video-games at home | 47.2 | 46.4 | 47.8 | 43.3 | 49.0 | 59.2 | 49.1 | 45.4 |
| Video-games away | 46.6 | 48.2 | 46.0 | 47.4 | 44.1 | 48.8 | 37.4 | 47.2 |
| Computer | 45.4 | 49.6 | 55.7 | 54.8 | 55.4 | 49.5 | 51.8 | 55.4 |
| Athletics | 44.1 | 47.8 | 46.7 | 46.8 | 43.8 | 49.1 | 48.3 | 48.9 |
| Television | 42.2 | 46.5 | 46.5 | 44.2 | 47.5 | 47.3 | 49.5 | 47.7 |
| Other | 40.1 | 49.2 | 44.4 | 48.2 | 47.3 | 47.7 | 48.3 | 47.7 |

TABLE 21

Computer Science Achievement for Selected Activities

| Activity | Hours Per Week Outside of School | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | None | Less Than 1 | 1-2 | 2-3 | 3-4 | 4-5 | 5-10 | More Than 10 |
| Reading | 29.9 | 28.9 | 31.2 | 32.2 | 33.8 | 35.3 | 35.7 | 34.6 |
| Homework | 28.3 | 30.3 | 28.8 | 30.7 | 31.0 | 32.6 | 34.8 | 32.8 |
| Video-games at home | 31.1 | 32.0 | 34.2 | 31.2 | 34.3 | 29.9 | 27.6 | 21.7 |
| Video-games away | 31.1 | 31.4 | 33.9 | 33.2 | 33.2 | 27.1 | 26.4 | 30.4 |
| Computer | 29.3 | 33.0 | 39.5 | 39.3 | 34.1 | 40.3 | 41.9 | 46.2 |
| Athletics | 31.2 | 32.4 | 29.6 | 32.0 | 28.5 | 33.3 | 31.8 | 30.4 |
| Television | 32.2 | 33.9 | 28.9 | 29.5 | 30.1 | 31.4 | 31.6 | 32.4 |
| Other | 28.2 | 33.2 | 30.7 | 30.1 | 31.1 | 28.8 | 34.5 | 31.6 |

TABLE 22

Microcomputer Learning in School

| Response | Total Percent | Test Scores | | Subgroup Percents | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Lit-eracy | Sci-ence | Boys | Girls | Not High Schl | High Schl | Some Coll | Four Yrs Coll | Advd Deg-ree |
| Program | 15.6 | 56.9 | 46.8 | 55.2 | 42.2 | 9.3 | 19.8 | 24.0 | 21.7 | 19.8 |
| General | 16.9 | 56.8 | 44.7 | 48.5 | 48.9 | 10.1 | 20.6 | 27.0 | 18.7 | 21.2 |
| Drill | 11.3 | 53.5 | 42.5 | 49.8 | 48.9 | 10.9 | 18.3 | 24.4 | 21.9 | 21.5 |
| Simula-tions | 8.4 | 56.2 | 42.8 | 51.5 | 45.9 | 12.6 | 18.6 | 29.0 | 18.2 | 19.9 |
| Tutorial | 4.8 | 55.0 | 47.1 | 52.6 | 45.9 | 9.8 | 21.1 | 25.6 | 20.3 | 21.1 |
| Games | 12.3 | 51.6 | 39.1 | 54.1 | 44.1 | 10.4 | 19.8 | 31.7 | 19.2 | 17.5 |
| Little E perience | 53.0 | 49.4 | 33.7 | 45.6 | 53.2 | 9.5 | 21.2 | 28.1 | 21.4 | 18.6 |

TABLE 23

Where Learned about Computers

| Response | Total Percent | Test Scores: Lit-eracy | Test Scores: Sci-ence | Subgroup Percents: Boys | Girls | Not High Schl | High Schl | Some Coll | Four Yrs Coll | Advd Deg-ree |
|---|---|---|---|---|---|---|---|---|---|---|
| Home | 14.0 | 46.1 | 33.6 | 57.4 | 40.4 | 4.0 | 14.2 | 24.7 | 26.4 | 28.7 |
| Friends | 9.8 | 45.0 | 33.0 | 64.4 | 33.8 | 5.7 | 18.9 | 23.8 | 23.1 | 27.1 |
| Summer Programs | 3.4 | 45.6 | 36.4 | 49.0 | 51.0 | 9.2 | 25.5 | 23.5 | 13.3 | 24.5 |
| Museums | 2.0 | 44.9 | 35.8 | 56.9 | 37.9 | 0.0 | 13.8 | 32.8 | 22.4 | 27.6 |
| School (day) | 28.0 | 47.2 | 35.1 | 48.1 | 50.0 | 12.0 | 23.2 | 27.2 | 16.7 | 19.0 |
| School (evening) | 2.4 | 47.0 | 38.8 | 62.3 | 36.2 | 8.7 | 24.6 | 23.2 | 20.3 | 18.8 |
| Stores | 6.4 | 47.5 | 31.3 | 67.2 | 32.8 | 8.7 | 15.9 | 27.9 | 21.3 | 23.5 |
| Video-games | 21.2 | 40.8 | 30.1 | 56.9 | 40.8 | 11.7 | 23.8 | 27.7 | 16.0 | 19.0 |
| Know Little | 44.9 | 38.6 | 27.3 | 40.7 | 57.7 | 10.4 | 22.5 | 27.2 | 19.0 | 19.3 |

FIGURE 1
PERCENT CORRECT FOR MALES AND FEMALES BROKEN DOWN BY
PARENT EDUCATIONAL LEVEL
AREA=COMPUTER LITERACY

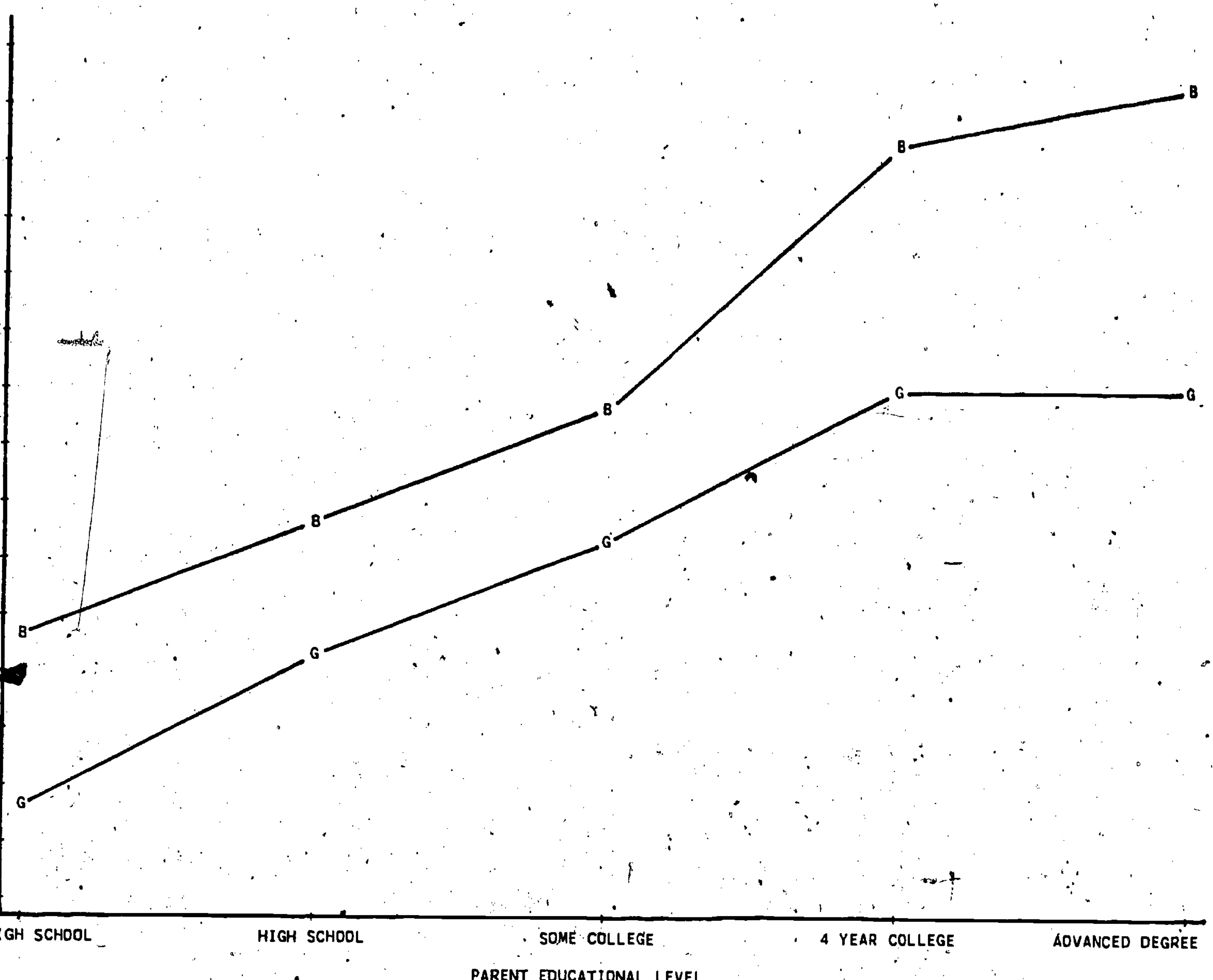

FIGURE 2
PERCENT CORRECT FOR MALES AND FEMALES BROKEN DOWN BY
PARENT EDUCATIONAL LEVEL
AREA=COMPUTER SCIENCE

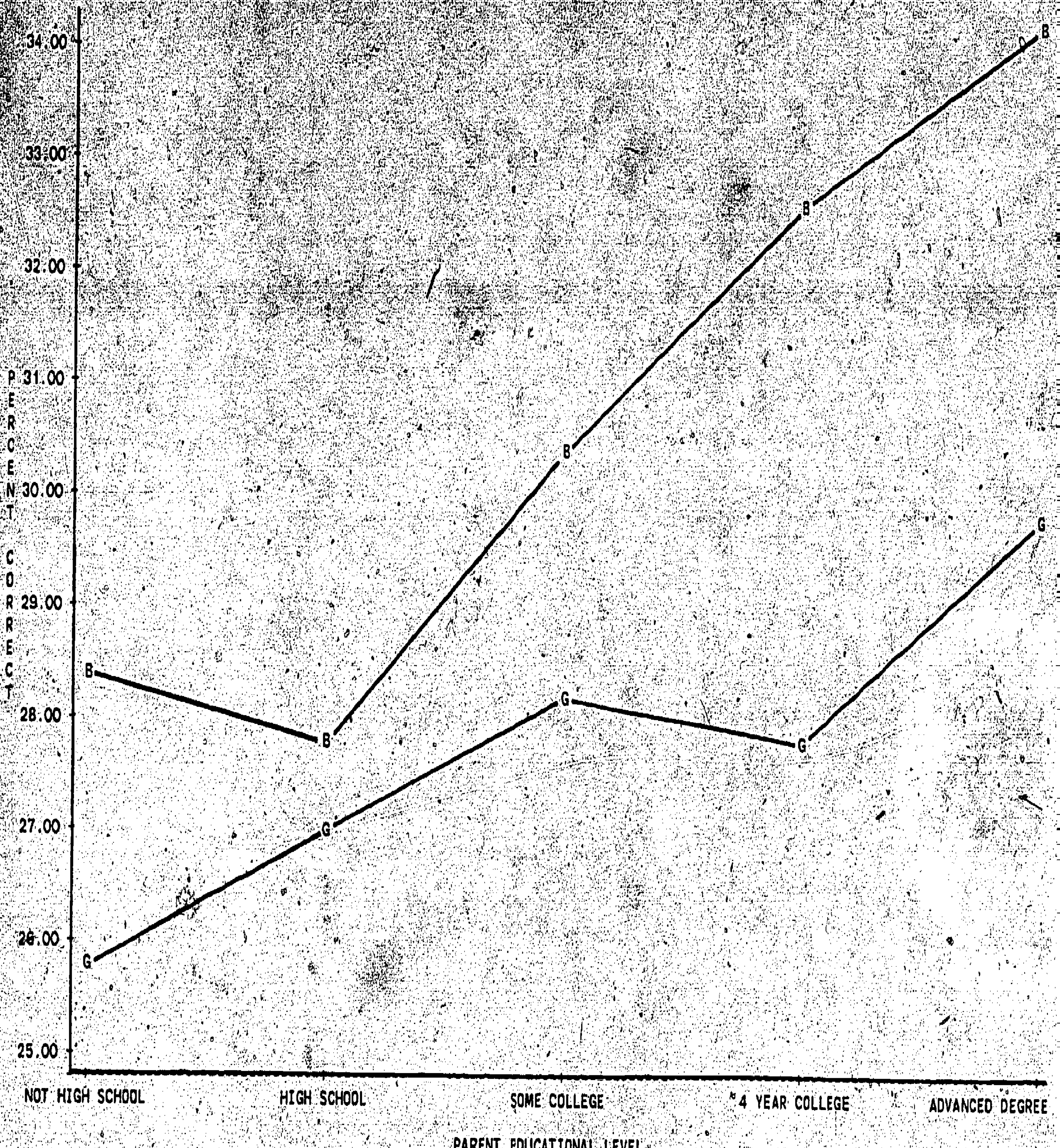

FIGURE 3

PERCENT CORRECT FOR GENERAL AREAS (COMPUTER LITERACY = L
COMPUTER SCIENCE = S) BY PARENT EDUCATIONAL LEVEL