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ABSTRACT

This report contains the results of a national survey conducted by the National Assessment of Educational Progress (NAEP) during the 1985-86 school year. The report, which attempts to capture the interacting forces influencing computer competence among students, is presented in six chapters: (1) Overview (major findings, significance of this assessment, and importance of computer competence); (2) Assessing Computer Competence (i.e., knowledge of computer technology, computer applications, and computer programming); (3) Attitudes, Instruction, and Access (student attitudes toward computers, experience with computers, computer use in the school, and computer use outside the school); (4) Computer Competence among Subgroups (e.g., gender, race/ethnicity, parental education, public/non-public education, and community and religion); (5) Computer Coordinators (their characteristics, teaching activities, professional experience and training, and professional confidence); and (6) Implications. The major findings of this survey indicate that access to a computer at home is positively related to computer competence; students like using computers; computers are seldom used in subject areas such as reading, math, or science; males demonstrate more competence than females; racial differences exist, favoring white students over black students; computer competence is increased for students whose parents went to college, who attend non-public schools, and who live in the northeast; and many computer coordinators have minimal training in computer studies. Sample survey questions are provided in each area and the results are reported in tables and graphs as well as in narrative form. A description of the methodology of the study is appended. Numerous charts and graphs are included, and a procedural appendix concludes the document. (DB)

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Computer Competence

The First National Assessment

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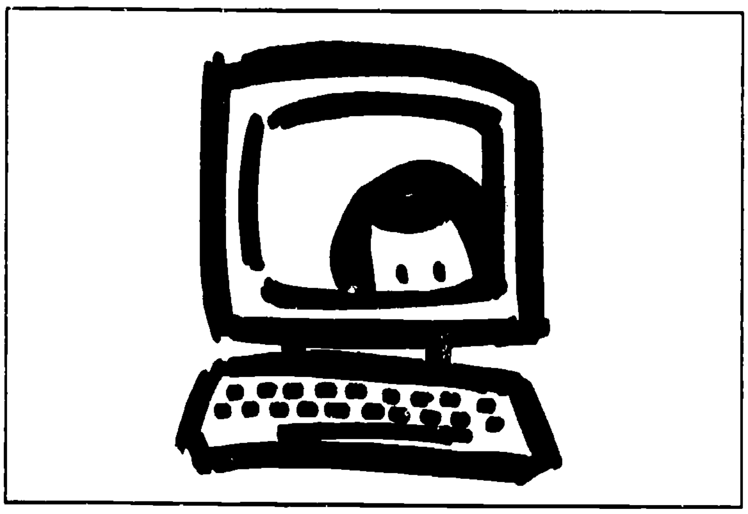
Computer Competence

The First National Assessment



Michael E. Martinez □ Nancy A. Mead

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ABOUT THIS REPORT

IN 1983, *A Nation at Risk* identified computer competence as a fourth basic skill. Three years later, the Nation's Report Card, the National Assessment of Educational Progress (NAEP), conducted the first nationwide survey of computer competence.

The assessment showed that:

- Computers are seldom used in subject areas such as reading, mathematics, or science. Computers are used almost exclusively to teach about computers.
- There are clear racial/ethnic differences in computer competence favoring White students over Black and Hispanic youngsters. A large part of these differences concerns access to computers in school and the availability of machines at home.
- Many school coordinators have minimal training in computer studies and rate themselves as mediocre in their ability to use computers.

The first national assessment of American students' computer competence emerges as the nation's homes and schools adapt to a dynamic computer age. Not only is there no consensus as to how computer studies should be handled by schools, but the situation is complicated by constant changes in technology.

NAEP assessed proficiency in three areas: knowledge of computer technology, understanding of computer applications, and understanding of computer programming. Basic to all of these skills is access to equipment. Worrisome inequities exist, however, between disadvantaged youth and their more affluent counterparts.

It seems clear that our society wants *all* of its young people to know about computers and what they can do, *most* of its young people to be able to perform simple functions with a computer at home and in the workplace, and *some* of its young people to be able to program these machines in effective and creative ways.

We hope the availability of these baseline data will enlighten the debate essential to refining these objectives in ways that will permit American schools to carry out their mission.

Archie E. Lapointe
Executive Director

Access to the Future

CHAPTER 1
Overview

... a first attempt at characterizing the computer competence of the nation's young people ...

IN THE 1985-86 school year, the National Assessment of Educational Progress (NAEP) surveyed the nation's third-, seventh-, and eleventh-grade students for their knowledge and skill in using a computer. The result of the assessment is this report, which attempts to capture the interacting forces influencing computer competence among students. It deals with the tremendous differences of opinion about what students should learn about computers and what skills they should be taught. Given these circumstances, this assessment provides a baseline for judging students' performance; it is a first attempt at characterizing the computer competence of the nation's young people by means of a national survey.

Major Findings

Several key findings emerge from this first national assessment of computer competence:

- Students generally had difficulty answering questions on the assessment, especially questions about computer applications and programming.
- The experiences of having used a computer, of studying computers in school, and of having access to a computer at home are positively related to computer competence.

- Most students like using computers and want greater access to them.

- Much learning about computers takes place outside of school and independent of formal instruction. Across demographic subgroups, the increased competence associated with having a computer at home is comparable to the advantage linked to studying and using computers at school. Students who study computers at school and have access to a computer at home are the most competent.

- Computers are seldom used in subject areas such as reading, math, or science. Rather, the use of computers in schools is largely confined to computing classes.

- Males, in general, demonstrate a slightly higher level of computer competence than females.

- There are clear racial/ethnic differences in computer competence, favoring White students over Black and Hispanic students. These differences are present even between students who have comparable levels of experience. But the differences are accentuated by greater experience with computers among White students.

There are clear racial/ethnic differences in computer competence . . .

- Other subgroup comparisons show an advantage for:

  - students whose parents are college graduates
  - students who attend nonpublic schools
  - students who live in high socioeconomic metropolitan areas
  - students who live in the northeastern United States

  These subgroups are most likely to have used a computer, to be studying computers in school, and to have a computer at home.

- Many computer coordinators have minimal training in computer studies and rate themselves as mediocre in their ability to use computers.

In the chapters that follow, data are presented to support these findings. In the final chapter, implications are drawn.

The Significance of This Assessment

The significance of this report is two-fold: First, it reveals national baseline information about computer competence; second, it relates competence to instructional and access variables. But the report also describes other important information, such as who uses computers, where and how often they are used, and the purposes for which they are used. In addition, the report describes students' attitudes toward computers—whether they like them and perceive them as useful.

The report relates key background variables, such as sex, race/ethnicity, and parental education, to computer access, instruction, and computer competence. This knowledge can alert decisionmakers to possible inequities in the allocation of instructional resources and might be used to inform policy decisions. Finally, this report describes the characteristics of computer coordinators: their training and the confidence they have in their own ability to use a computer. The assessment shows where today's young people stand with respect to computer competence and suggests how education in this field can be improved.

The Importance of Computer Competence

America's prominence in the world economy rests to a large extent upon its technological competitiveness. We are no longer so much a nation rich in industry as a nation rich in information. Our future industrial strength depends on how effectively we can use computer-based technologies, such as robotics and computer-aided design.

In the office, microcomputers are now standard equipment, largely displacing typewriters for the tasks of writing letters, memos, and reports. Computers can help manage large amounts of information, such as inventories and distribution lists. Increasingly, computers are used to create high-quality graphics, publish newspapers and magazines, and communicate electronically. Experienced workers find that they must learn computer skills to be competitive in their fields: Secretaries must have word processing skills; commercial artists must be able to use computer-generated graphics; auto-parts clerks must be able to search large databases. Across the professional landscape, computers enhance both creativity and efficiency.

In the home, computers are being used more frequently for such purposes as managing personal finances and keeping up with correspondence. Using educational software, children can design experiments, compose music, and graph equations. People of all ages can enjoy the recreational uses of a computer, which vary from computerized chess to flight simulation.

American education has also been deeply affected by the computer revolution.

American education has also been deeply affected by the computer revolution. No longer is it sufficient to be competent in the three R's. In *A Nation at Risk*, the National Commission on Excellence in Education recognized a fourth basic skill: computer competence. Schools have reacted quickly to the need for computer-literate Americans. In 1980, 15 percent of elementary schools and 50 percent of secondary schools offered instruction in the use of computers.* By 1985, 82 percent of elementary schools and 93 percent of secondary schools offered such instruction.

*"Trends in Educational Computing: Decreasing Interest and the Changing Focus of Instruction," *Educational Researcher*, May 1986.

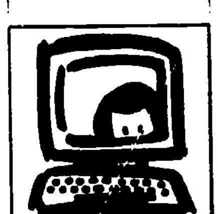
The meteoric rise in the popularity of computers in education has been accompanied by considerable optimism. But it has not been without problems. Teachers with little or no training in computers found themselves teaching introductory courses. Confusion reigned about *what* to teach. Initially, most instruction in secondary schools was in computer programming, particularly in the programming language BASIC, because it often accompanied computers and required no additional expense.

Teachers with little or no training in computers found themselves teaching introductory courses.

Compounding these problems were rapid changes in hardware and software capabilities. At one time, 16K RAM was considered to be a lot of memory; soon the standard became 64K. Prices of hardware plummeted while microcomputer capabilities soared. A specialized vocabulary (e.g. ROM, monitor, floppy disk, format) developed and became teachers' lounge jargon; some terms became household words. Although the nature, capabilities, and costs of microcomputers were volatile, the educational establishment was chided for poor planning. While the controversies churned, little was known about the capabilities of American youth in using computers, how computer knowledge and skill might be improved, and what students thought about computers.

By 1986, the time was ripe for the first nationwide assessment of computer competence. The assessment was a large-scale project, involving 24,000 students in three grades. To advise NAEP in planning the assessment, a Learning Area Committee on Computer Competence was formed. The committee, composed of experts in computer education, was charged with recommending which skills should be assessed and how they should be measured. Although most of the major recommendations were followed, an important one was not. The committee felt that an assessment of computer competence would be most effective if a hands-on or performance component were included. Unfortunately, the high costs of performance testing prohibited using this method. The assessment was therefore limited to the pencil-and paper format but went beyond multiple-choice items by including some open-ended questions.*

NAEP. the Nation's Report Card, hopes that this will be the first in a series of assessments of computer competence. These will enable NAEP to track the progress of American youth in the decades ahead. This first assessment will provide a baseline for understanding computer education in America, how far we have come, and how far we have yet to go.



**A Framework for Assessing Computer Competence: Defining Objectives.* National Assessment of Educational Progress (1986).

CHAPTER 2
Assessing Computer Competence

FOR THIS assessment, computer competence is defined as the knowledge and skill gained from experience with computers, both within and outside school settings. The scope and method of measuring computer competence were deliberated and prescribed by the Learning Area Committee for Computer Competence and later reviewed by more than 100 educators from across the country. The result was a set of assessment objectives that guided the construction of the questions and tasks.

When the Learning Area Committee members specified objectives that guided construction of assessment questions, they were, of course, influenced by their own beliefs about what a computer-competent student should know and be able to do. Therefore, judgments about good or poor performance contain a good bit of subjectivity.

The objectives framework reflects the variety of valued outcomes for computer studies.* Ultimately, the committee specified three major categories of computer objectives:

- **knowledge of computer technology**
- **understanding of computer applications**
- **understanding of computer programming.**

In this chapter, these categories are defined and examples of questions are provided. Assessment results are reported for each of these competence categories. Following this, an overall performance index is reported for each grade level.

Knowledge of Computer Technology

Knowledge objectives deal with the recognition or recall of specific ideas, facts, and procedures related to the use of computers. Items in this category were intended to assess whether students had an understanding of computer operations, terminology, use of documentation, use of software, and the functions of a computer's principal components.

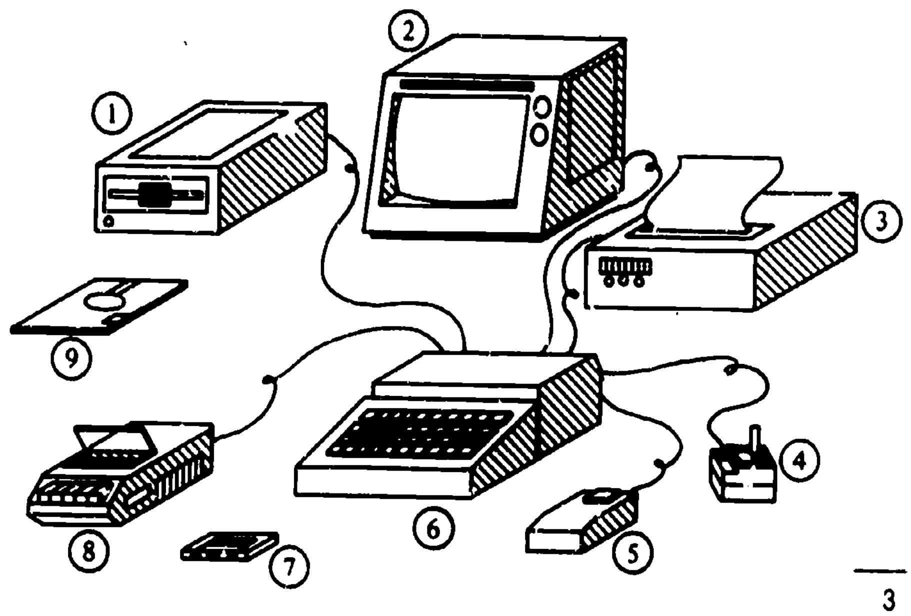
Most third graders had no difficulty identifying the major components, and by the seventh grade nearly all students could identify them.

Examples of knowledge questions and the corresponding response data are shown in FIGURES 2.1., 2.2., and 2.3. For each of these sample questions, the correct choice is identified. The questions in FIGURE 2.1 ask students to identify components of a computer system. Most third graders had no difficulty identifying the major components, and by the seventh grade nearly all students could identify them. Questions in FIGURE 2.2 require familiarity with the function of a cursor, software/hardware distinctions, the role of a computer program, and the purpose of a modem. FIGURE 2.3 shows additional examples of knowledge questions. Question 1 asks "What is an algorithm?," a question that few seventh graders could answer correctly and that most eleventh graders found difficult. Question 2, which deals with the importance of software development to the increased use of microcomputers, was also challenging for many students.

*These objectives are specified in the NAEP publication, *A Framework for Assessing Computer Competence: Defining Objectives.*

Sample Knowledge Questions

FIGURE 2.1



					Percent Correct by Grade Level		
					3	7	11
1. Which picture shows a keyboard?	Picture 1 ○	Picture 2 ○	Picture 3 ○	Picture 6 ●	85.6	98.2	98.7
2. Which picture shows a disk drive?	Picture 1 ●	Picture 3 ○	Picture 8 ○	Picture 9 ○	69.3	93.4	94.8
3. Which picture shows a joystick?	Picture 4 ●	Picture 5 ○	Picture 7 ○	Picture 9 ○	89.2	98.2	98.9
4. Which picture shows a display screen or video monitor?	Picture 1 ○	Picture 2 ●	Picture 3 ○	Picture 6 ○	81.8	97.0	98.4
5. Which picture shows a floppy disk?	Picture 4 ○	Picture 5 ○	Picture 7 ○	Picture 9 ●	67.7	92.4	95.1
6. Which picture shows a printer?	Picture 1 ○	Picture 2 ○	Picture 3 ●	Picture 6 ○	80.6	96.1	97.9

Additional Knowledge Questions

FIGURE 2.2

1. What does a cursor do?

- ● It shows the place on the display screen where you are typing.
- ○ It holds diskettes for storage.
- ○ It changes the brightness of the display screen.
- ○ It changes the volume of the computer's speaker.

Percent Correct by Grade Level

3	7	11
38.5	66.0	71.6

Mark the category to which each example belongs.

	Hardware	Software	Percent Correct by Grade Level 7	11
2. Electronic spreadsheet	○	●	62.8	61.5
3. Printer	●	○	74.0	78.4
4. Keyboard	●	○	76.1	79.0
5. Word processing program	○	●	69.3	78.9
6. Video display	●	○	50.8	60.5

7. What is the main role of a computer program?

- ○ To put data into the computer
- ○ To give the computer a memory
- ● To tell the computer what to do
- ○ To let the computer know if it is doing a good job

Percent Correct by Grade Level

3	7	11
32.3	34.3	46.0

8. What does a modem do?

- ○ It stores information in a computer's memory.
- ○ It copies data from disk to disk.
- ○ It lets you connect a joystick to a computer.
- ● It lets you connect a computer to a telephone line.

Percent Correct by Grade Level

3	7	11
13.0	29.1	40.4

Additional Knowledge Questions

FIGURE 2.3

1. What is an algorithm?

- ● A step-by-stepprocess for solving a given type of problem
- ○ A word processing program for the computer language ALGOL
- ○ A special procedure for interpreting computer output
- ○ A special program for algebra

Percent Correct by Grade Level	
7	11
15.6	30.9

2. Which of the following contributed most to the increased use of microcomputers?

- ○ Cathode-ray tubes
- ● Useful software applications
- ○ Letter-quality printers
- ○ Hard disks

Percent Correct by Grade Level	
7	11
43.7	55.5

TABLE 2.1 shows the average performance of third-, seventh- and eleventh-grade students on items measuring knowledge of computer technology. The first three lines show the average performance in different grades; questions answered by students in different grades, however, were not identical. The last three rows of data show performance across grades on common questions. Overall, students were able to answer most of these questions correctly—most had a substantial knowledge of computer func-

Knowledge of Computer Technology*

TABLE 2.1

All items given to:	Number of items	Grade 3	Grade 7	Grade 11
Grade 3	16	50.8 (0.5)	—	—
Grade 7	42	—	57.2 (0.3)	—
Grade 11	33	—	—	65.3 (0.4)
Grades 3 & 7	16	50.8 (0.5)	66.0 (0.4)	--
Grades 7 & 11	30	—	58.1 (0.3)	64.9 (0.4)
Grades 3, 7, & 11	26	38.7 (0.3)	55.2 (0.4)	64.8 (0.5)

*Mean percent correct; standard errors are printed in parentheses.

tions and components. Comparisons across grades show, as expected, that students in higher grades tended to answer a higher percentage of questions correctly.

Computer Applications

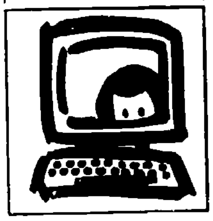
Items in this category tested students' skill in using applications software, such as word processing, graphics programs, database management systems, and spreadsheets. Items were generic in that they were not intended to measure familiarity with features or terminology of particular products. Word processing items, for example, asked about functions common to most word processing systems, such as insertion, deletion, and replacement.

Examples of *word processing* questions are found in FIGURE 2.4. All three questions presented the students with an error-ridden recipe for baking a cherry pie. The questions call on knowledge of the word processing functions of search and replace, insertion, and movement of text. While between 60 and 70 percent of eleventh graders correctly identified these functions, the performance of third and seventh graders varied more from question to question.

All three questions presented the students with an error-ridden recipe for baking a cherry pie.

Sample *graphics* questions appear in FIGURE 2.5. In these examples, a hypothetical student, Jamie, is drawing a seascape with a graphics package. Students were asked what Jamie should do to add birds to the picture and to color the sky. Responses to these questions suggest that students at the three grade levels did not have a clear understanding of graphics functions.

Sample *database* items are shown in FIGURE 2.6. Questions 1 and 2, given only to third graders, involve a database that stores information about state birds and flowers. Because these questions could be answered only yes or no, one would expect 50 percent of the students to get the item right by chance alone. In fact, only 42.1 percent were able to answer the first question correctly; 58.2 were able to answer the second question correctly. The same pattern was found for answers to the third question, asked of seventh and eleventh graders. The implication is that, in general, students did not have a good understanding of the structures or functions of databases.



Sample Word Processing Questions

FIGURE 2.4

Put dough in a pi~~y~~e dish. Grese pi~~y~~e dish.
Open a can of cherry pi~~y~~e filling and pour it
in pi~~y~~e dish. Bake at 350 degrees for 45
minutes and lett cool.

1. "Pie" is spelled wrong four times. What is the best way to fix this problem?

- ● Search and Replace
- ○ Move (or Cut and Paste)
- ○ Insert
- ○ Delete

Percent Correct by Grade Level

3	7	11
57.1	67.0	70.7

Put dough in a pie dish. Grease pie dish.
Open can of cherry pie filling and pour it
in pie dish. Bake at 350 degrees for 45
minutes and lett cool.

2. The word "grease" is spelled wrong. What command is the best way to fix this one error?

- ○ Search and Replace
- ○ Move (or Cut and Paste)
- ● Insert
- ○ Delete

Percent Correct by Grade Level

3	7	11
17.4	29.5	60.3

Put dough in a pie dish. Grease pie dish.
Open can of cherry pie filling and pour it
in pie dish. Bake at 350 degrees for 45
minutes and lett cool.

3. The words "Grease pie dish" should go before "Put dough in a pie dish." What is the best way to fix this problem?

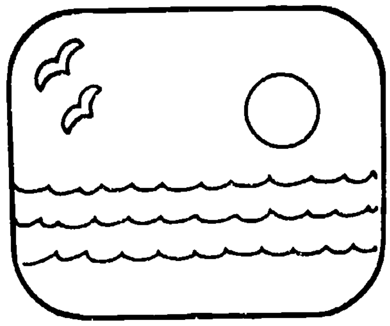
- ○ Search and Replace
- ● Move (or Cut and Paste)
- ○ Insert
- ○ Delete

Percent Correct by Grade Level

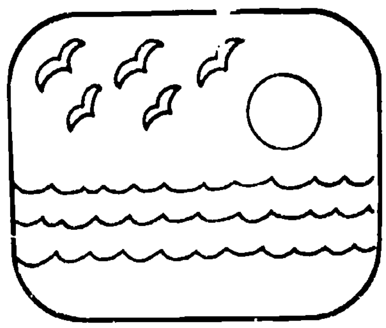
3	7	11
27.6	48.4	67.1

Sample Graphics Questions

FIGURE 2.5



1. Jamie wants to add more birds to the picture, as shown below.



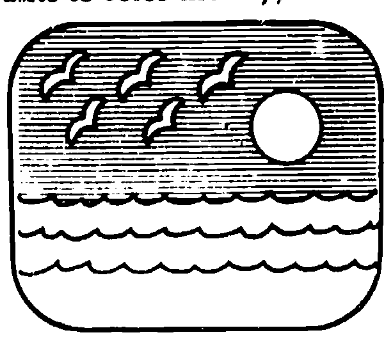
What should Jamie use to add the birds?

- ○ SAVE
- ○ FILL
- ○ MOVE
- ● COPY

Percent Correct by Grade Level

3	7	11
38.3	35.6	35.0

2. Now Jamie wants to color the sky, as shown below.



What should Jamie use?

- ○ GRAPH
- ● FILL
- ○ MOVE
- ○ COPY

Percent Correct by Grade Level

3	7	11
36.7	41.6	45.3

A class used a computer to store information about all 50 states in a database like the one below.

NAME OF STATE:
STATE BIRD:
STATE FLOWER:
DATE STATE BECAME PART OF THE UNITED STATES:

1. Can the class use the database to list all states that have red flowers?

○ Yes

● No

Percent Correct
Grade 3
42.1

2. Can the class use the database to list all states that have the daisy as their state flower?

● Yes

○ No

Percent Correct
Grade 3
58.2

3. A library has a computerized file of its books. A reader of science fiction wants to search the file and print a report like the one below. What would be the best procedure to follow?

SCIENCE FICTION BOOKS PUBLISHED AFTER 1960

AUTHOR	TITLE	DATE
ASIMOV, ISAAC	TRIANGLE	1961
ASIMOV, ISAAC	FANTASTIC VOYAGE	1966
ASIMOV, ISAAC	THE FOUNDATON TRILOGY	1972
ASIMOV, ISAAC	THE GODS THEMSELVES	1974
CLARKE, ARTHUR C.	2001: A SPACE ODYSSEY	1968
CLARKE, ARTHUR C.	REPORT ON PLANET THREE	1972
CLARKE, ARTHUR C.	THE LOST WORLDS OF 2001	1972
CLARKE, ARTHUR C.	IMPERIAL EARTH	1976

○ Sort by title and author, select year greater than 1960, print

○ Sort by author and title, select year less than 1960, print

● Sort by author and date, select year greater than 1960, print

○ Sort by author, select year less than 1960, sort by title, print

Percent Correct by Grade Level	
7	11
23.5	28.8

FIGURE 2.7 gives examples of *spreadsheet* questions. Question 1, asked only of seventh-grade students, required an understanding of the grid structure of spreadsheets. Almost two-thirds of seventh graders were able to recognize the correct cell location for entering a new piece of data. The second question, asked only of eleventh graders, required knowledge of how to obtain a total cost figure by summing a row of cells. Forty-one percent of eleventh graders were able to answer this question correctly.

Sample Spreadsheet Questions

FIGURE 2.7

1. Mrs. Johnson created the spreadsheet below to maintain financial records for her home flower shop. She wishes to keep sales totals for each of 10 different flowers and total sales throughout the year.

	A	B	C	D	E	F	G
1			JOHNSON'S FLOWER SHOP				
2			Months				
3		Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec		
4	FLOWER					TOTAL SALES	
5						TO DATE	
6	Carnations	1400	1320			2720	
7	Mums	1150	1240			2390	
8	Roses	1240	1070			2310	
9	Lilies	200	350			550	
10	Daisies	560	730			1290	
11	Tulips	430	610			1040	
12	Daffodils	590	740			1330	
13	Iris	120	190			310	
14	Lilacs	110	170			280	
15							
16							
17	Quarterly Totals	5800	6410			Total To Date 12430	

Mrs. Johnson has sold 680 daisies during the period July through September. In which cell of the spreadsheet should she enter this information?

D17	B10	D10	B7
○	○	●	○

Percent Correct
Grade 7
63.0

Sample Spreadsheet Questions (continued)

FIGURE 2.7

2. Pat has constructed the following spreadsheet to calculate the cost of supplies for a lemonade stand open from May through August.

	A	B	C	D	E	F	G
1							
2		COST OF LEMONADE INGREDIENTS					
3							
4			May	June	July	Aug	
5							
6	Sugar		\$ 9.00				
7	Lemons		\$12.00				
8	Bottled Water		\$ 8.00				
9							
10	TOTAL BY MONTH		\$29.00				

What should Pat do to calculate the total cost of lemons for all four months?

○ Calculate the average of cells C6 through F6.

○ Calculate the average of cells C7 through F7.

○ Calculate the sum of cells C6 through F6.

● Calculate the sum of cells C7 through F7.

Percent Correct
Grade 11
41.1

Scores for the most common applications are given in TABLE 2.2. Apart from word processing, students appear to have had difficulty in most categories. The performance of seventh graders was mediocre across all categories, while for eleventh graders, performance was much more linked to the particular application. For example, eleventh-grade students were able to answer a high proportion of word processing questions correctly but had much more difficulty with the spreadsheet questions. When performance is compared across grades on common items, it appears that the greatest gains in competence are in word processing.

Low frequencies of using common applications may explain why many students had difficulty answering the questions. TABLE 2.3 lists the fre-

Understanding of Computer Applications*

TABLE 2.2

All items given to:	Number of items	Grade 3	Grade 7	Grade 11
		Word Processing		
Grade 3	8	31.0 (0.6)	—	—
Grade 7	10	—	52.8 (0.5)	—
Grade 11	8	—	—	72.2 (0.7)
Grades 3 & 7	8	31.0 (0.6)	54.7 (0.6)	—
Grades 7 & 11	8	—	54.7 (0.6)	72.2 (0.7)
Grades 3, 7, & 11	8	31.0 (0.6)	54.7 (0.6)	72.2 (0.7)
		Graphics		
Grade 3	3	34.7 (0.6)	—	—
Grade 7	3	—	50.4 (0.6)	—
Grade 11	8	—	—	60.7 (0.6)
Grades 3 & 7	2	37.5 (0.9)	38.6 (0.8)	—
Grades 7 & 11	3	—	50.4 (0.6)	55.3 (0.9)
Grades 3, 7, & 11	2	37.5 (0.9)	38.6 (0.8)	40.2 (1.1)
		Databases		
Grade 3	4	40.0 (0.5)	—	—
Grade 7	12	—	43.8 (0.4)	—
Grade 11	13	—	—	53.4 (0.6)
Grades 3 & 7	0	—	—	—
Grades 7 & 11	12	—	43.8 (0.4)	53.6 (0.6)
Grades 3, 7, & 11	0	—	—	—
		Spreadsheets		
Grade 7	5	—	44.4 (0.8)	—
Grade 11	4	—	—	31.0 (0.5)
Grades 7 & 11	0	—	—	—

*Mean percent correct; standard errors are printed in parentheses.

Sample BASIC Questions

FIGURE 2.9

1. You type these lines:

```
10 PRINT 5 * 7
20 PRINT 5 + 7
RUN
```

What does the computer print after you type RUN?

○ Nothing

● 35
12

○ 5 * 7
5 + 7

○ 35 12

Percent Correct by Grade Level

3	7	11
9.1	24.0	34.4

2. You type these lines:

```
10 PRINT "MONDAY"
LIST
```

What does the computer print after you type LIST?

○ Nothing

● 10 PRINT "MONDAY"

○ MONDAY

○ PRINT "MONDAY"

Percent Correct by Grade Level

3	7	11
35.9	41.1	44.7

3. Write a program in BASIC to print this:

```
COMPUTER
COMPUTER
COMPUTER
COMPUTER
COMPUTER
```

```
10 FOR X = 1 TO 5
20 PRINT "COMPUTER"
30 NEXT X
```

[Note: This is one possible solution frequently offered by students.]

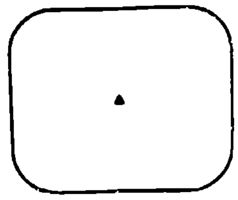
Percent Correct by Grade Level

	3	7
Incorrect	23.0	32.4
Partial	0.2	3.5
Correct	1.0	15.2
Omit	75.7	48.9

Sample Logo Questions

FIGURE 2.8

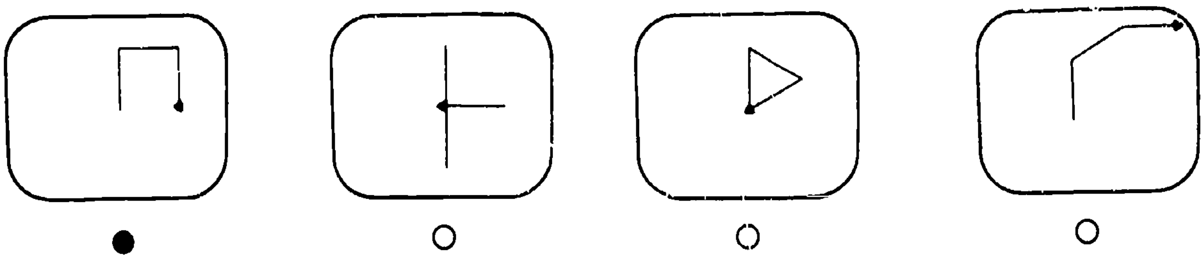
1. Here is a picture of the Logo turtle.



Which picture is made when you type this line?

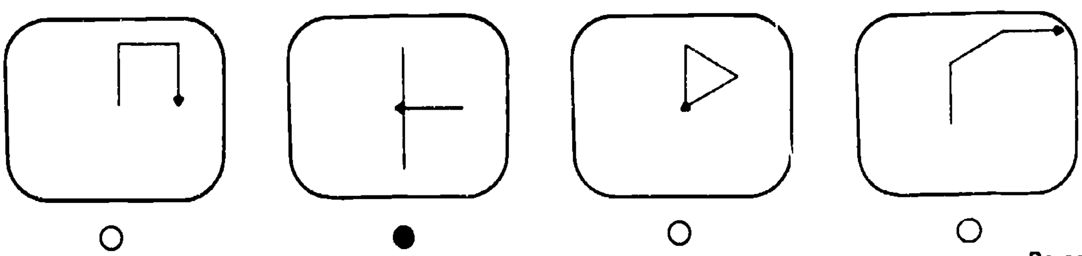
REPEAT 3 [FORWARD 50 RIGHT 90]

Percent Correct by Grade Level	
3	7
18.1	28.0



2. Which picture is made when you type this line?

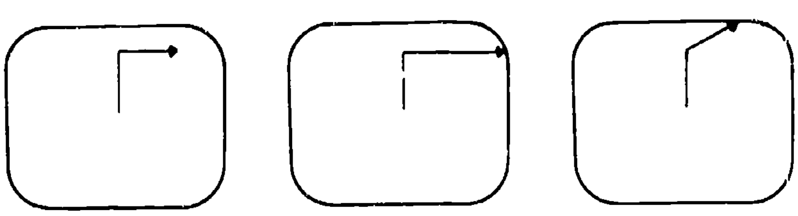
REPEAT 3 [FORWARD 50 BACK 50 RIGHT 90]



Percent Correct by Grade Level	
3	7
36.8	48.2

3. Draw the three pictures that the turtle draws when you type each of the following lines:

FD 50 RT 90 FD 50	FD 50 RT 90 FD 180	FD 50 RT 60 FD 50



	Percent Correct by Grade Level	
POINTS	3	7
0 (incorrect)	73.7	77.5
1 (partial)	2.7	3.4
2 (partial)	4 8	7.7
3 (correct)	6.4	9.0
Omit	12.5	2.4

Frequency of Computer Application Use — TABLE 2.3

How often do you use a computer to:	Frequency: Almost Every Day	Several Times a Week	About Once a Week	Less than Once a Week	Never
Grade 7					
Write Letters, Stories, Reports	3.4%	6.9%	12.5%	27.0%	50.2%
Make Graphs	2.2	3.5	6.5	14.8	73.0
Make a Database	1.5	2.4	4.1	7.5	84.6
Grade 11					
Write Letters, Stories, Reports	4.4%	6.1%	8.5%	27.4%	53.5%
Make Graphs	1.4	2.0	4.3	13.3	78.9
Make a Database	2.2	3.4	3.3	8.5	82.7

... students seemed to be getting infrequent, if any, practice using word processing, graphics, or database applications.

quency of application use for seventh and eleventh graders. Answers to the first question, "How often do you use a computer to write letters, stories, and reports?" provide a rough estimate of how often word processing programs are used. In addition, the table provides an estimate of how often students use graphics and database packages. The striking pattern of this table is that students seemed to be getting infrequent, if any, practice using word processing, graphics, or database applications. Even among those who used the common applications, the frequency of use is low. Only about 10 percent of seventh and eleventh graders practiced as much as once a week. Graphics and database packages were used less frequently.

Computer Programming

Students were asked questions about three programming languages: Logo, BASIC, and Pascal. Third and seventh graders were asked questions about Logo and BASIC, the languages with which they are most likely to be familiar. Eleventh graders were asked questions about BASIC and Pascal, the most common programming languages for high school students.

Examples of Logo questions are shown in FIGURE 2.8. The first two questions required students to recognize the screen display that would result from typing the given instructions.

The third question is open-ended: students were required to construct a response rather than choose one. Most open-ended responses were given partial credit when they had elements of a correct response. In the Logo example, one point was awarded for each correctly drawn picture and three points were needed for the answer to be judged "correct."

Sample questions in BASIC are shown in FIGURE 2.9. These include two multiple-choice questions and one open-ended question. The open-ended question asked students to write a program that would print COMPUTER five times on five lines. One percent of third graders were able to write a correct program; in the seventh grade 15 percent were able to write the program correctly.

Questions on the Pascal language were divided into two categories: general and specific. FIGURE 2.10 shows an example of a general Pascal question. Items in this category might be answered by students who have knowledge of some programming language, though not necessarily Pascal. To answer the specific Pascal items, however, required familiarity with Pascal syntax. An example of a specific Pascal item is shown in FIGURE 2.11.

Sample General Pascal Question

FIGURE 2.10

```
PROCEDURE Draw (N: integer; S: char);
VAR C: integer;

BEGIN
  FOR C : = 1 TO N DO
    write(S);
  writeln
END;
```

What is produced by the following code segment?

```
Draw(5, 'x');
Draw(5,'o')
```

● xxxxx
ooooo

○ xoxoxoxox

○ xo

○ xxxxx
xxxxx
xxxxx
xxxxx
xxxxx
ooooo
ooooo
ooooo
ooooo
ooooo

○ x
o
x
o
x
o
x
o
x
o

○ xo
xo
xo
xo
xo

Percent Correct
Grade 11
55.2
55.2

In general, students had greater difficulty correctly answering questions about programming than questions about computer knowledge or applications. TABLE 2.4 shows the mean percent correct scores for the programming items. Some caution in interpreting these findings is called for, because different versions of Logo, BASIC, and Pascal exist, and terms used in the assessment may not correspond precisely to the terms students used in their classrooms.

There is evidence that programming competence increases through the grades.

TABLE 2.4 indicates that students at all three grade levels answered between 20 percent and 30 percent of all the programming items correctly. There is evidence that programming competence increases through the grades. Even so, eleventh graders averaged only 38.8 percent on BASIC questions also given to third- and seventh-graders. As a whole, students knew little about programming in the languages most commonly taught in schools: Logo, BASIC, and Pascal.

It can be argued that only small numbers of students have experience with programming languages. But the picture is changed only moderately when observations are confined to students who said they knew the lan-

Sample Specific Pascal Question

FIGURE 2.11

```
FUNCTION Get Value (VAR A, B: integer): integer;
  BEGIN
    A : = A + 1;
    B : = B + 1;
    Get Value : = A + B
  END;

PROCEDURE Work(First, Second: integer);
  CONST Stop = 10;
  BEGIN
    writeln(First);
      REPEAT
        writeln(Second)
      UNTIL Get Value(First, Second) > Stop
  END;
```

What would happen if the value of Stop were changed to 0 and the procedure call Work(5,7) were made?

- ○ Get Value would never be called.
- ● Get Value would only be called once.
- ○ Get Value would be called 12 times.
- ○ The loop would never stop.

Percent Correct
Grade 11
28.3

Knowledge of Computer Programming*

TABLE 2.4

All Items given to:	Number of Items	Grade 3	Grade 7	Grade 11
		Logo		
Grade 3	13	26.8 (0.5)	—	—
Grade 7	27	—	27.7 (0.5)	—
Grades 3 & 7	8	21.4 (0.6)	30.0 (0.9)	—
		BASIC		
Grade 3	15	20.9 (0.2)	—	—
Grade 7	30	—	25.6 (0.4)	—
Grade 11	32	—	—	27.2 (0.5)
Grades 3 & 7	10	18.5 (0.3)	31.6 (0.7)	—
Grades 7 & 11	10	—	25.5 (0.6)	32.4 (0.6)
Grades 3, 7, & 11	5	14.6 (0.4)	28.5 (1.0)	38.8 (1.2)
		Pascal		
		All Items		
Grade 11	25	—	—	29.9 (0.5)
		General Pascal		
Grade 11	13	—	—	35.2 (0.5)
		Specific Pascal		
Grade 11	12	—	—	24.0 (0.6)

*Mean percent correct; standard errors are printed in parentheses.

guages. TABLE 2.5 shows the average performance in Logo, BASIC, and Pascal for three categories of students: those who reported no knowledge of the programming language (and non-respondents), those who said they knew the language, and those who said they knew that language best of all programming languages. Scores of students who reported knowing a language best were between about 2 and 11 points higher than those who reported not knowing the language. On the whole, however, percentages of correct responses were low regardless of the category of student responding.

Programming Performance*, by Self-Reported Knowledge of Programming Language

TABLE 2.5

Knowledge of Programming Language (Self-Reported)	Grade 3	Grade 7	Grade 11
Logo			
Do not know Logo/No Response	25.6 (0.5)	24.7 (0.3)	—
Know Logo	31.1 (1.2)	32.5 (0.9)	—
Know Logo best	31.6 (1.1)	33.6 (1.4)	—
BASIC			
Do not know BASIC/No Response	19.8 (0.3)	21.5 (0.6)	19.5 (0.5)
Know BASIC	21.8 (0.5)	26.6 (0.4)	29.8 (0.6)
Know BASIC best	21.3 (0.4)	26.9 (0.4)	29.8 (0.6)
Pascal			
Do not know Pascal/No Response	—	—	29.2 (0.2)
Know Pascal	—	--	35.7 (2.8)
Know Pascal best	—	—	39.8 (4.1)

*Mean percent correct: standard errors are printed in parentheses.
Scores are not comparable across grade levels

Why do students' programming abilities appear to be low?

Why do students' programming abilities appear to be low? TABLE 2.6 points to the low frequency of programming practice. About two-thirds of students assessed had never written computer programs; only about 10 percent of students had written computer programs more than once per week. It appears that only a small proportion of students had sufficient experience to demonstrate proficiency on the programming questions.

Low frequencies of programming practice probably reflect different emphases in computer courses. Some courses are dedicated to teaching programming whereas others do not teach it at all. Despite low levels of programming competence overall, some students showed that they did know how to interpret and write computer programs, and on open-ended items, some students were able to write exemplary programs.

Programming Frequency: Percentage of Students

TABLE 2.6

How often do you write computer programs?	Grade 7	Grade 11
Almost every day	3.4	4.9
Several times a week	6.0	6.1
About once a week	10.2	5.5
Less than once a week	19.6	15.6
Never	60.8	67.6

Overall Results

TABLE 2.7 displays, by grade level, the mean percent correct for all assessment questions. The table shows the results from all questions given to grades 3, 7, and 11 separately, as well as the results of questions given to more than one grade. Comparisons between grade levels should be confined to performance on the common questions.

Most students appear to have had difficulty answering the assessment questions.

Most students appear to have had difficulty answering the assessment questions. No grade averaged even 50 percent correct, and third graders were able to answer only a third of the items correctly. While overall performance appears to be disappointing, there is an important caveat for interpretation: American educators disagree over what should be taught about computers in

Overall Computer Competence*

TABLE 2.7

All items given to:	Number of items	Grade 3	Grade 7	Grade 11
Grade 3	59	33.7 (0.3)	—	—
Grade 7	131	—	41.2 (0.3)	—
Grade 11	125	—	—	46.2 (0.4)
Grades 3 & 7	44	33.9 (0.3)	48.3 (0.4)	—
Grades 7 & 11	65	—	48.9 (0.3)	57.9 (0.4)
Grades 3, 7, & 11	26	38.7 (0.3)	55.2 (0.4)	64.8 (0.5)

*Mean percent correct; standard errors are printed in parentheses.

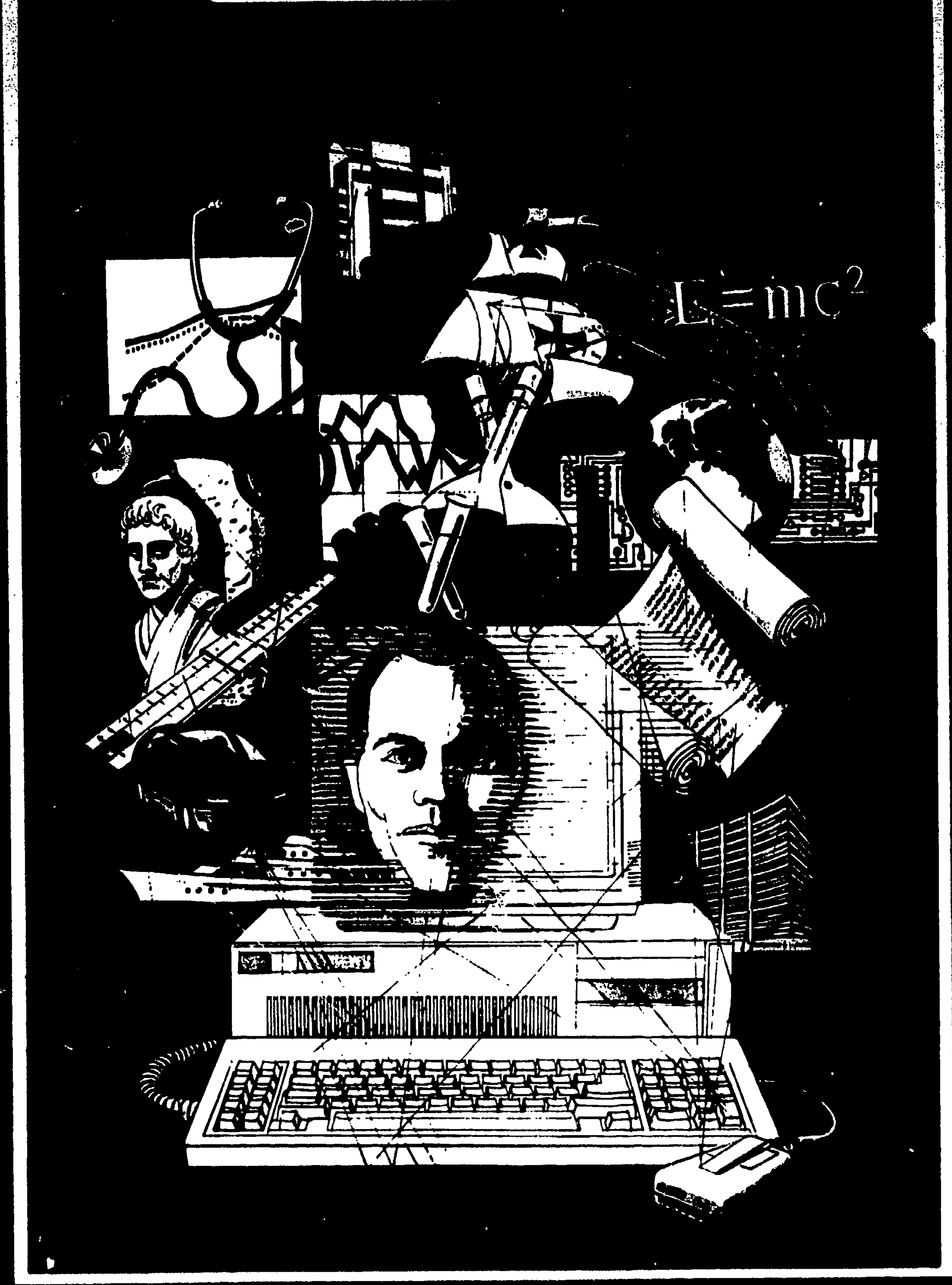
schools. Although most students had difficulty answering questions, the seriousness of the problem remains open to debate.

Summary

Most American youngsters have some familiarity with computers. Most, for example, can identify a keyboard, disk drive, and printer. Most have some practical knowledge of computers. A majority of seventh and eleventh graders, for example, can distinguish between hardware and software. But, with the exception of word processing, only a small fraction were able to answer questions about the most important computer applications or about programming.

Although some schools offer excellent computer curricula, many other schools apparently do not provide effective instruction, at least in computer applications and programming, to a large proportion of pupils. Poor performance in using applications and in programming seems to be related to the low frequencies of computer use in these areas. In the chapters that follow, frequencies and patterns of computer use are described in more detail, as are instruction in the use of computers and access to computers outside of school. In addition, the relationships of these experience factors to computer competence is further explored.

Mind, Machine, and Knowledge



CHAPTER 3
Attitudes, Instruction, and Access

THE ASSESSMENT data show that there are important differences in computer competence between students when they are grouped according to sex, race/ethnicity, parental education, public/nonpublic education, and community and region of residence. In this chapter, these differences are examined in light of students' attitudes toward computers and, especially, their experience with computers. Three aspects of experience are examined: computer use, instruction in computers, and access to computers outside of school. All three experience factors are shown to have strong positive relationships with computer competence.

What do the youth of this country think about computers?

Attitudes Toward Computers

What do the youth of this country think about computers? Overall, their appraisal is positive. When third- and seventh-grade students were asked if they like using computers, more than 86 percent in both grades responded affirmatively (FIGURE 3.1). Among third graders, the percentage of students who indicated that they like computers actually exceeded the percentage of students who said they have used computers. Among seventh graders, the percentage who liked computers was almost equal to the percentage who had used them.

Students were asked how often they *wish* they could use computers in class. One response choice, "I never use a computer in class," was used to separate students who had used a computer from those who had not. Most students who had used computers wished they could use them more often in class (FIGURE 3.2). About 15 percent of seventh and eleventh graders were satisfied with their frequency of computer use. Very few students wished that they could use a computer less often.

Experience with Computers

In understanding students' experience with computers, the most basic question is whether students have used one at all. In TABLE 3.1, we find that roughly 75 percent of third graders had used a computer at one time or another. By eleventh grade, about 87 percent of students had used a computer. These percentages seem high, but the fact that 13 percent of eleventh graders have never used a computer is unsatisfactory if we believe that familiarity with computers is a reasonable goal for all.

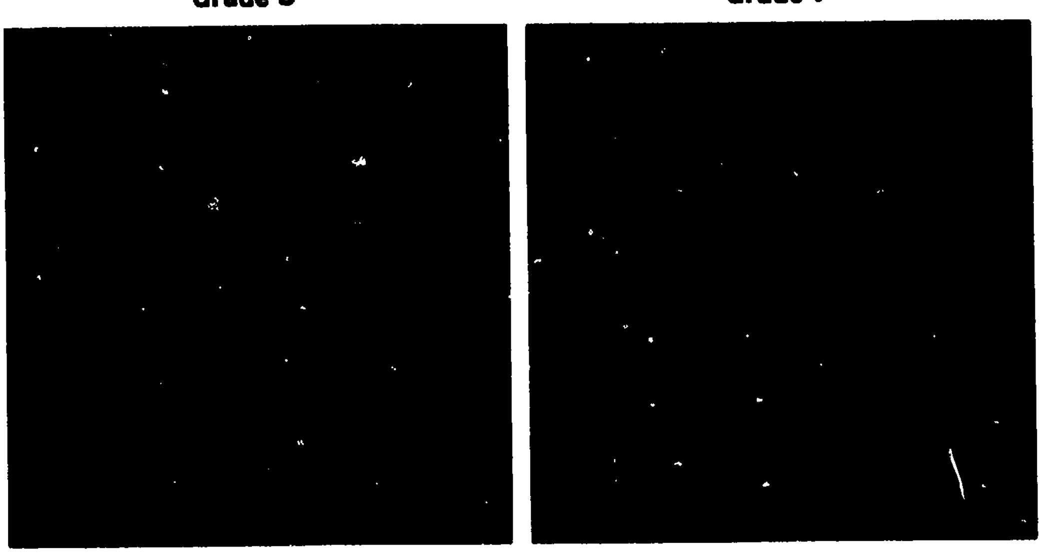
. . . roughly 75 percent of third graders had used a computer at one time or another.

Liking for Computers

FIGURE 3.1

Do you like using computers?

Grade 3 **Grade 7**



Attitudes Toward Frequency of Computer Use

FIGURE 3.2

How often do you wish you could use computers in class?

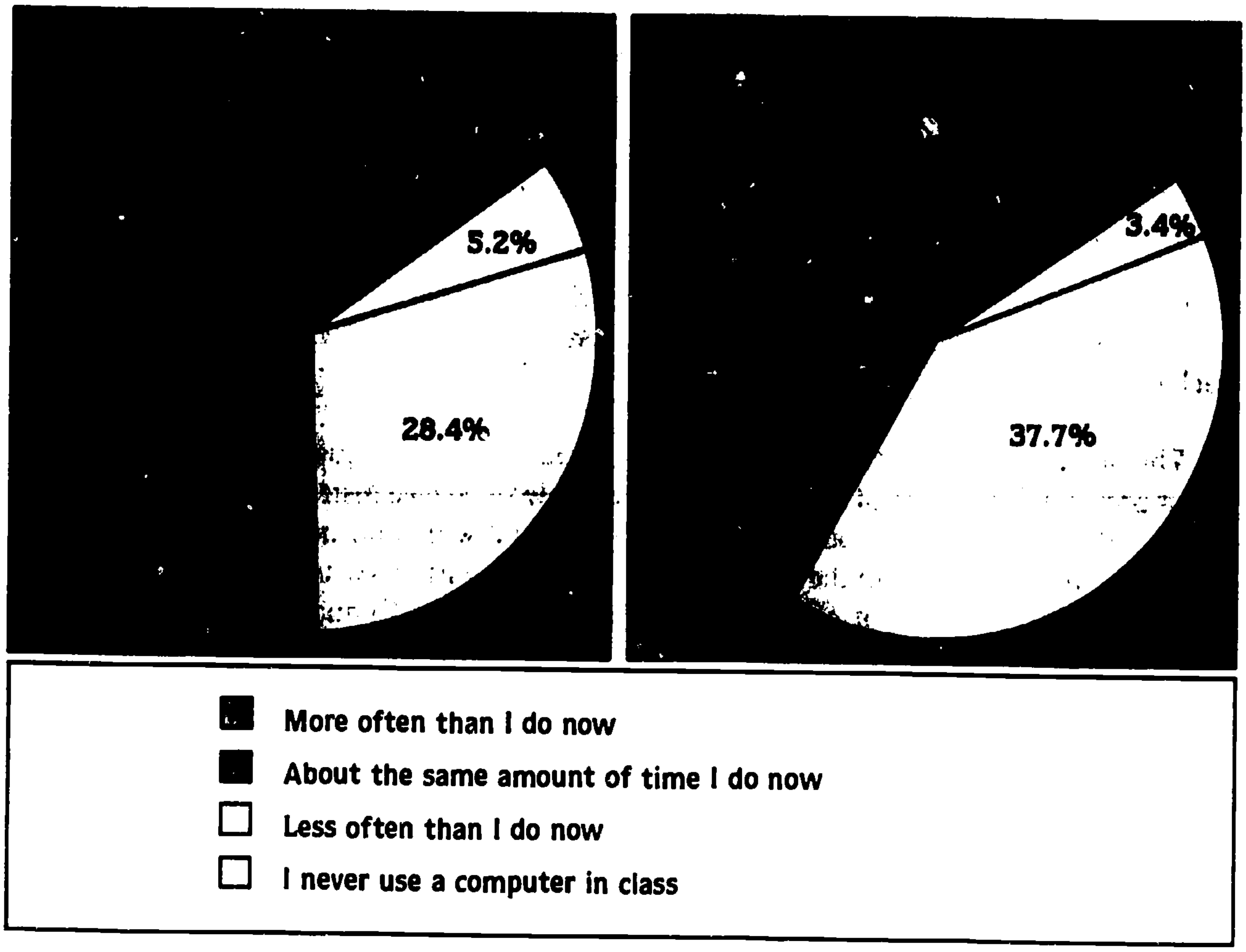


TABLE 3.2 shows that experience using a computer is positively related to overall computer competence. The pattern confirms intuition: An inexperienced person might know some facts about computers, but probably would not be able to answer questions about computer applications or program-

Computer Use by Grade Level TABLE 3.1

Have you used a computer?	Grade 3	Grade 7	Grade 11
Yes	74.9% (1.1)	89.0% (0.6)	86.8% (0.7)
No	25.1 (1.1)	11.0 (0.6)	13.2 (0.7)

Computer Competence*, by Computer Use — TABLE 3.2

Have you used a computer?	Grade 3	Grade 7	Grade 11
Yes	34.6 (0.3)	42.2 (0.3)	47.6 (0.4)
No	30.8 (0.4)	34.0 (0.3)	37.4 (0.4)

*Mean percent correct: standard errors are printed in parentheses.
Caution: Scores do not have equivalent meanings across grade levels.

ming. It also makes sense that hands-on experience is more critical for advanced students, because learning advanced uses seems unlikely without such experience.

The importance of experience to computer competence raises questions about access. Which types of students are more likely to receive instruction in computer uses? Which students own computers and which do not? Do subgroups differ in access? In the next sections we analyze patterns of use and the relationship of those patterns to competence. We begin with questions about the nature of instruction in computers. What is taught? How often? With what result?

Computer Use in the School

An essential step in understanding the use of computers in schools is to find out how many students are currently studying computers. TABLE 3.3 shows that 48 percent of third graders and 40 percent of seventh graders reported studying computers at the time of the assessment.* By the eleventh grade, that proportion dropped to around 20 percent. Although the meaning of "studying computers" is not equivalent across the grades, it does appear that fewer students in the higher grades regularly use computers in school. Why is there a dropoff in computer instruction, especially between the seventh and eleventh grades? One possible explanation is that most high school computer courses are taken before the eleventh grade, perhaps because eleventh graders have more difficulty fitting computer studies into their study programs.

Why is there a dropoff in computer instruction, especially between the seventh and eleventh grades?

*Based on a 1983 survey of schools that had computers, Becker estimated that 16 percent of elementary school students and 13 percent of secondary school students used computers each week. See Becker, H. J. (1983). *School uses of microcomputers* (Issue No. 2). Baltimore, MD: Johns Hopkins University: Center for Social Organization of Schools.

Computer Studies by Grade Level

TABLE 3.3

Are you currently studying computers?	Grade 3	Grade 7	Grade 11
Yes	48.0%	39.8%	20.5%

The relationship between the current study of computers and overall computer competence is positive (TABLE 3.4). This relationship is both expected and reassuring: Students who take courses in computers are likely to be more computer competent than those who do not. Instruction is more clearly related to competence in the higher grades, where courses are more rigorous and fewer students enroll in them.

Computer Competence*, by Current Study of Computers

TABLE 3.4

Are you currently studying computers?	Grade 3	Grade 7	Grade 11
Yes	34.8 (0.5)	44.1 (0.6)	52.8 (1.1)
No	32.6 (0.3)	39.5 (0.2)	45.1 (0.3)

*Mean percent correct: standard errors are printed in parentheses.
Caution: Scores do not have equivalent meanings across grade levels.

In general, computers have not been integrated into the standard curricula.

Computer studies has been called a basic subject. One characteristic of a basic subject is that its skills are useful across curriculum domains. To what extent do students use computers in other subject areas? Not enough to fully tap the computer's potential for enhancing learning in traditional subjects. In general, computers have not been integrated into the standard curricula. When students were asked if they had ever used a computer in various subjects, many indicated that computers are used in math courses but are rarely used in others (TABLE 3.5). Only between 10 percent and 15 percent of students had used a computer in science classes—a surprising finding considering the strong ties between computers and science in modern society. Integration of computers into other subjects is least likely to take place in the higher grades.

When seventh- and eleventh-grade students were asked *how often* they used computers in the various subject areas, it became clearer that computers have not yet been utilized to an adequate extent outside the computer

Computer Use in Subject Areas*

TABLE 3.5

Have you used a computer in any of the following classes?	Grade 3	Grade 7	Grade 11
Math	53.0%	39.4%	29.1%
Reading/English	25.0	23.9	16.9
Science	12.8	11.6	15.4
Social Studies	11.7	10.2	4.6
Art	21.6	7.3	3.2
Music	16.9	7.0	3.9

*Column percentages may add up to more than 100% because multiple responses were possible.

studies curriculum. High percentages of students never use a computer to practice math, reading, and other skills from traditional subjects (TABLE 3.6). For those who use a computer to practice subject-matter skills or to compose music, only about 5-10 percent do so more than once per week. As with applications and programming practice, less than 10 percent of students

Frequency of Computer Use in Subject Areas

TABLE 3.6

How often do you use a computer to:	Almost Every Day	Several Times a Week	About Once a Week	Less than Once a Week	Never
Frequency—Grade 7					
Practice Math	5.7%	4.7%	9.8%	17.5%	62.3%
Practice Reading	3.1	3.8	5.9	8.8	78.4
Practice Spelling	2.8	3.3	7.8	10.0	76.1
Do Science Problems	1.9	2.9	3.1	6.8	85.3
Learn and Make Music	2.4	3.0	6.2	10.3	78.1
Play Games	19.4	15.4	16.3	24.6	24.3
Frequency—Grade 11					
Practice Math	3.4%	3.0%	3.6%	12.1%	77.9%
Practice Reading	1.8	2.1	2.0	6.9	87.2
Practice Spelling	1.4	1.6	2.8	6.7	87.5
Do Science Problems	0.8	1.5	1.9	8.6	87.2
Learn and Make Music	1.4	1.7	2.2	9.0	85.6
Play Games	8.5	9.8	14.0	33.9	33.8

Coordinators' Estimates of Computer Use in Subject Areas	TABLE 3.7

How much time does a *typical* student during a *typical* week use a computer to aid his or her instruction in the subject areas?	**Grade 7**	**Grade 11**
More than one hour	12.4%	6.3%
30 minutes to one hour	22.3	16.4
Less than 30 minutes	38.2	43.9
None	17.9	17.3
I don't know	8.2	14.8

practice with enough regularity to become skilled in the most important uses of computers.

In contrast, between 70 and 80 percent of students indicated they had used computers to play games, whether in or outside of school (TABLE 3.6). In fact, the responses "almost every day" and "several times a week," were marked for *play games* about as frequently as for all other listed uses combined. The nature of the games, however, is unknown. It may well be true that some of the activities students interpret to be games serve important instruction or drill-and-practice functions.

. . . it is clear that computer use in traditional subject areas is quite limited.

The infrequency of computer use in the subject areas was confirmed by estimates made by school computer coordinators (TABLE 3.7). Coordinators were asked, "How much time does a *typical* student during a *typical* week use a computer to aid his or her instruction in the subject areas?" From information provided by coordinators, we again find that few students regularly used computers in reading, math, science, and the other subjects, and that computers were used least frequently in subject areas in the higher grades. Whether we depend on data provided by coordinators or data from students, it is clear that computer use in traditional subject areas is quite limited.

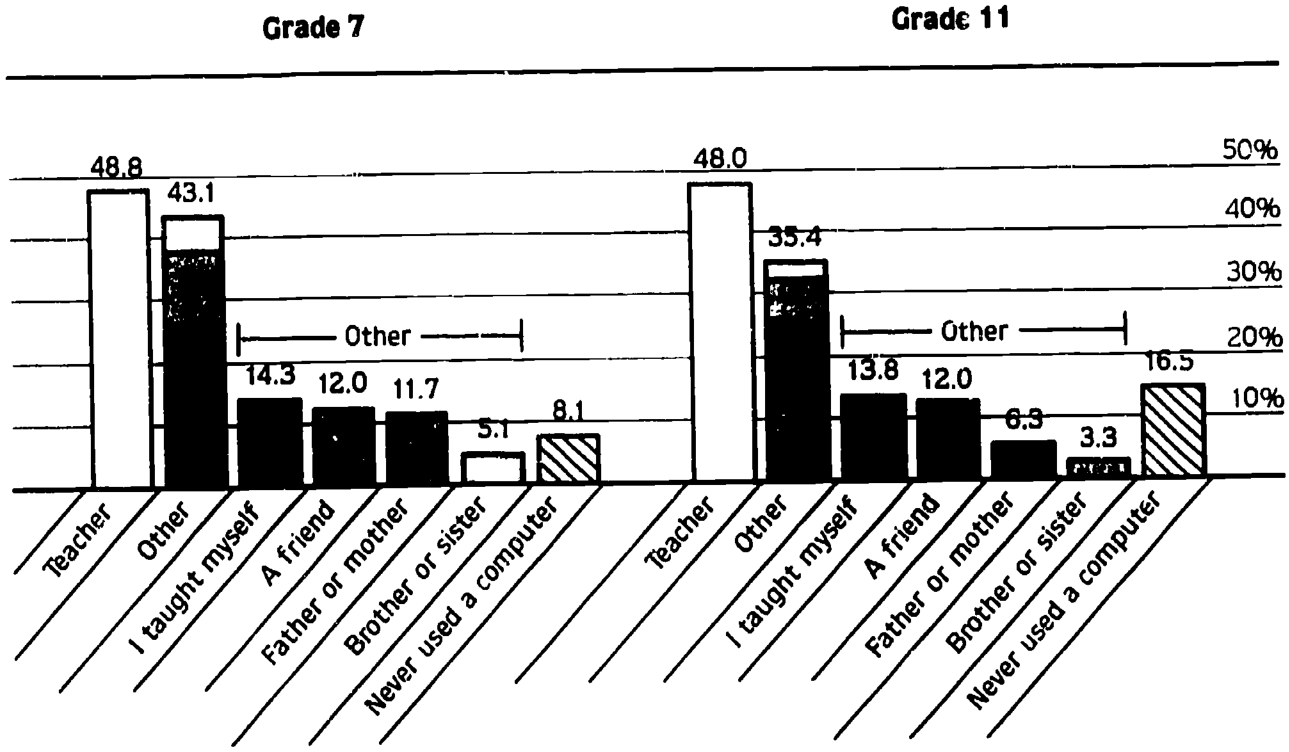
Computer Use Outside the School

The assessment data make it clear that computer use in schools is related to computer competence. Patterns of computer use outside the school are equally intriguing and potentially as useful for understanding why students vary in computer competence. Extracurricular use of computers is important

Sources of Learning About Computers (Percentage of Students)

FIGURE 3.3

Who has helped you the most to learn how to use a computer?



because of the special nature of computer studies. Although curriculum subjects such as math, science, and history have been learned independently and zealously by a few young students over the years, most treat these topics as uniquely school related. Computers fall into a different category because, for many young people, they are the subject of intense personal interest and enjoyment.

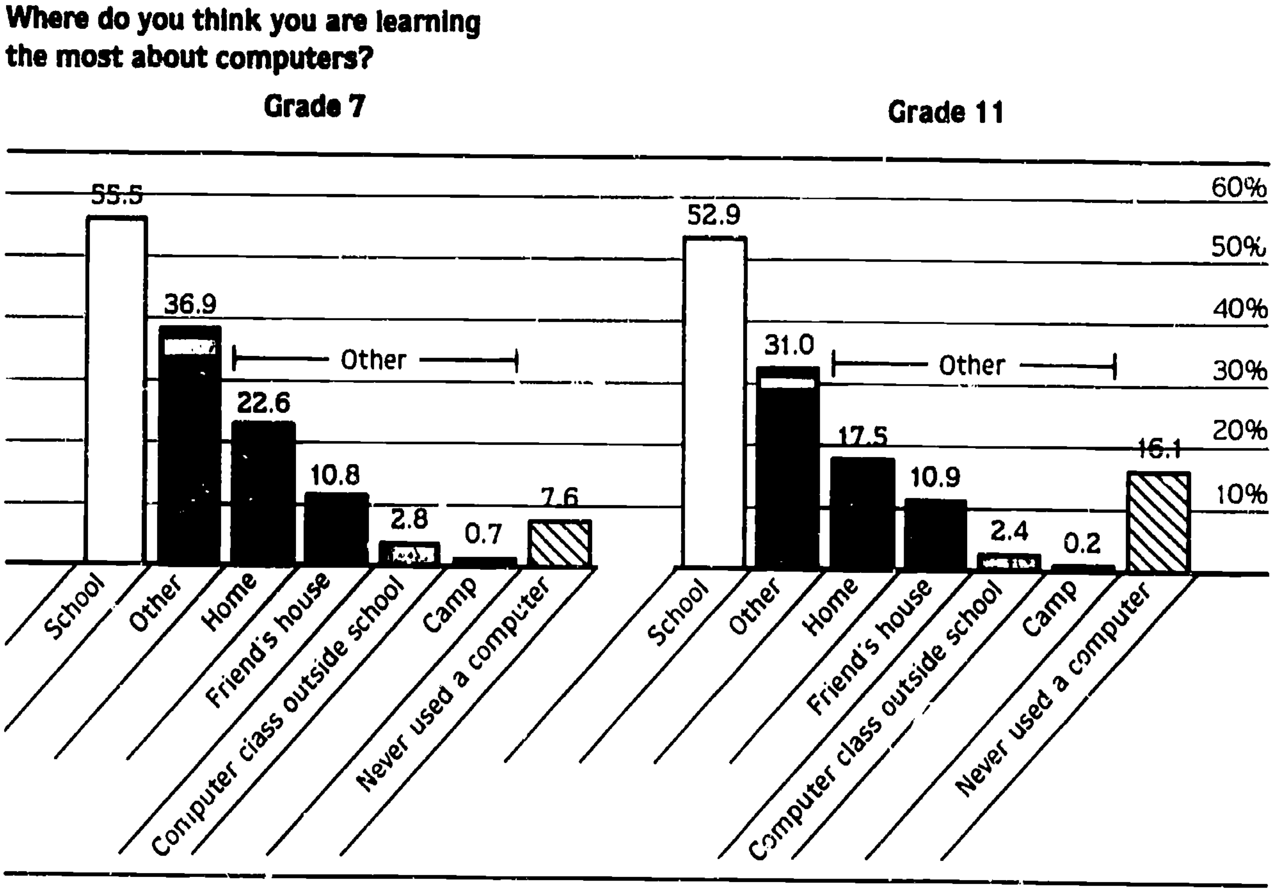
How much learning about computers takes place independently of the teacher?

How much learning about computers takes place independently of the teacher? Almost half of the students at grades seven and eleven reported that a teacher had helped them most in learning to use a computer (FIGURE 3.3). For many students, however, the classroom teacher had *not* been the most important person helping to develop these skills. Many young people consider themselves to be largely self-taught. Others have benefited most from the help of a friend, a parent, or a sibling.

Just as many students learn most about computers from someone other than a classroom teacher, many learn more about computers outside of school than inside (FIGURE 3.4). And it is the informal home setting, not camps or extracurricular classes, that accounts for most of the learning that takes place away from school.

Site of Learning About Computers (Percentage of Students)

FIGURE 3.4



Fairly high proportions of students have access to a computer at home. TABLE 3.8 shows the proportions of students whose families own a computer, separated by grade level. Throughout the span of three grades, roughly 30 percent of students have a computer at home. The importance of home computers is highlighted by the fact that *more than half* of seventh- and eleventh-grade students whose families own a computer reported that they learn most about computers at *home* (TABLE 3.9). This is unusual among school subjects: It is unlikely that such high proportions of students would learn more at home than at school in, for example, biology or history.

Computer Ownership Rates

TABLE 3.8

Family owns computer?	Grade 3	Grade 7	Grade 11
Yes	28.7%	32.8%	30.1%

Percentage of Students Who Learn Most About Computers at Home by Computer Ownership

TABLE 3.9

Where do you think you are learning the most about computers?	Grade 7	Grade 11
	Family Owns Computer	
Home	58.3	53.0
Other	41.6	47.0
	Family Does Not Own Computer	
Home	5.8	2.7
Other	94.3	97.3

Computer Competence*, by Computer Ownership

TABLE 3.10

Family owns computer?	Grade 3	Grade 7	Grade 11
Yes	36.4 (0.7)	46.1 (0.4)	52.7 (0.7)
No	32.5 (0.3)	38.9 (0.3)	43.5 (0.3)

*Mean percent correct: standard errors are printed in parentheses.
Caution: Scores do not have equivalent meanings across grade levels.

Programming Competence*, by Computer Ownership

TABLE 3.11

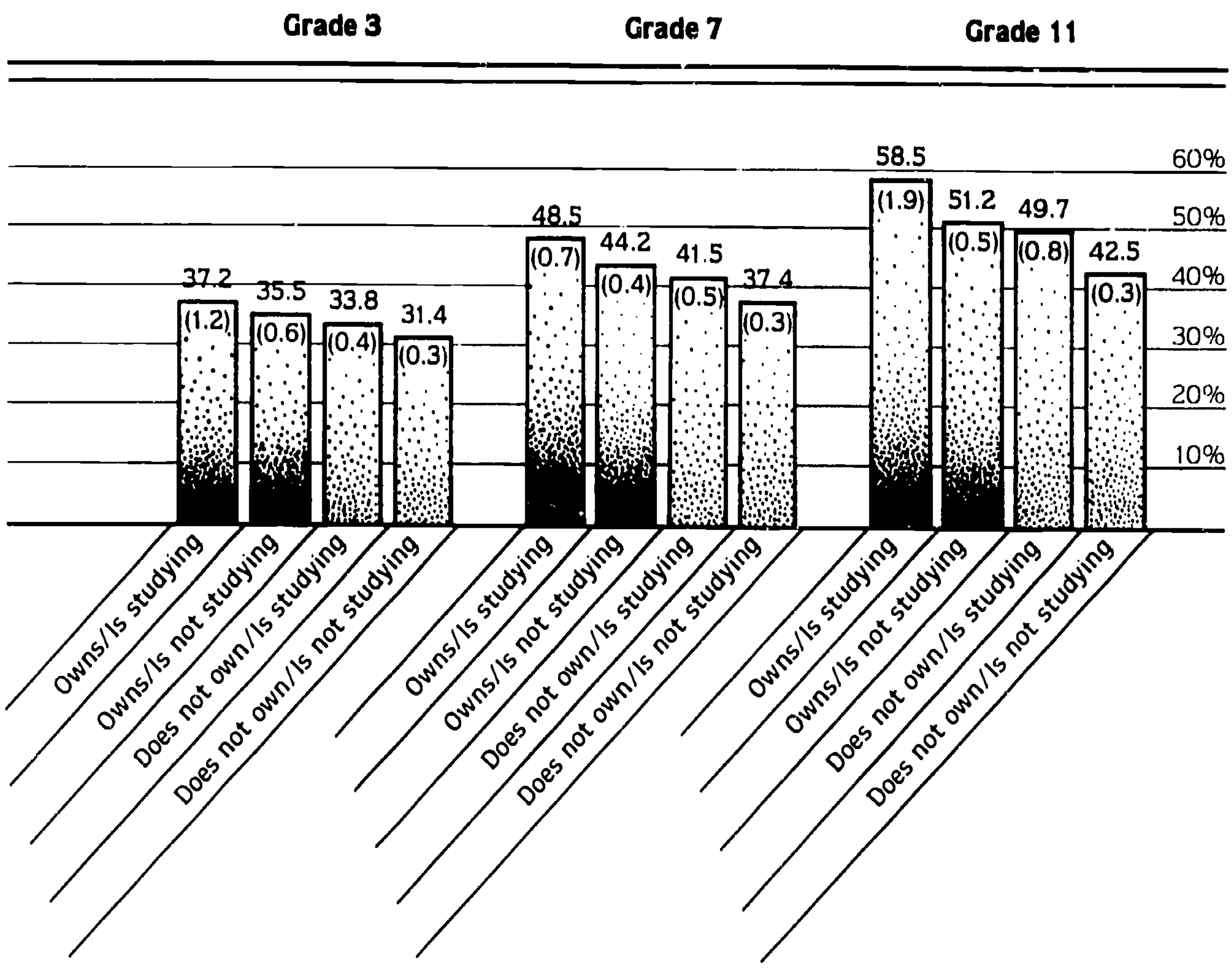
Family owns computer?		Grade 3	Grade 7	Grade 11
Logo ▶	Yes	28.8 (1.1)	29.5 (0.5)	—
	No	26.0 (0.5)	26.1 (0.4)	—
BASIC ▶	Yes	23.0 (0.5)	30.8 (0.7)	36.5 (0.9)
	No	19.9 (0.3)	22.9 (0.3)	23.9 (0.5)
Pascal ▶	Yes	—	—	32.3 (1.0)
	No	—	—	28.8 (0.4)

*Mean percent correct: standard errors are printed in parentheses.
Caution: Scores do not have equivalent meanings across grade levels.

Computer Competence*, by Home/School Experience

FIGURE 3.5

Family owns computer/Is studying computers



*Mean percent correct: standard errors are printed in parentheses.
Caution: Scores do not have equivalent meanings across grade levels.

The importance of home access to computers is also suggested by its relationship to overall computer competence. TABLE 3.10 shows that, on the average, students whose families own a computer are more computer competent than those who do not. The same pattern holds for programming competence. TABLE 3.11 shows that students who have a computer at home answered more programming items correctly. This trend is pronounced with the BASIC items, perhaps because home computers were likely to have BASIC included.

Summary

Data presented in this chapter have pointed out the positive relationship between computer studies and computer competence, as well as between computer ownership and competence. But how do computer studies and computer ownership interact? FIGURE 3.5 indicates that their effects build upon each other. Students who both own a computer and study computers in school demonstrate the highest competence. Those who neither own a computer nor study computers have the lowest overall competence. And, for students in the middle—those who either study computers or own one—it is those who *own* a computer who have the higher competence.

Clearly, a great deal of learning about computers occurs outside of the classroom as well as in. The importance of experience in learning to use computers raises questions about the equality of access to that experience for different groups. This is the subject of the next chapter.

CHAPTER 4
Computer Competence Among Subgroups

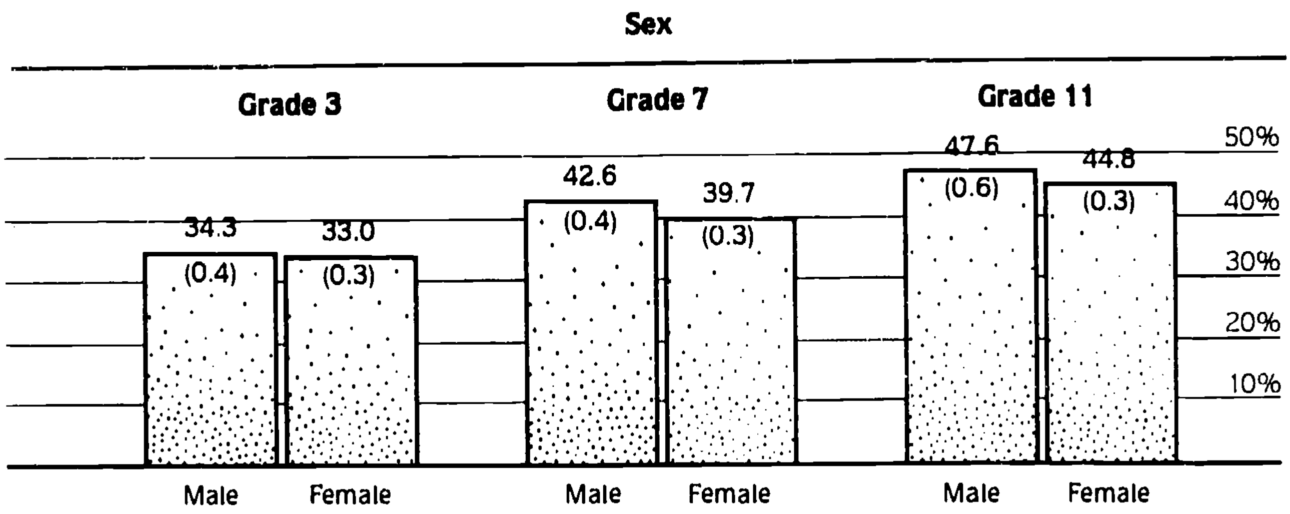
THIS CHAPTER explores differences in computer competence among various subgroups along six demographic dimensions: sex, race/ethnicity, parental education, public/nonpublic education, type of community, and region of the country. The purpose of the chapter is to point out differences in competence levels between subgroups and to identify possible contributors to those differences. A major theme is that differences in competence between subgroups are highly related to access to computers, both in and outside the school setting.

Sex

Competence differences. Comparisons between the performance of male and female students show that at the third, seventh, and eleventh grades, males demonstrate slightly higher computer competence than females (FIGURE 4.1). Though these small differences are statistically significant, their practical importance is unknown.

Sex Differences in Computer Competence*

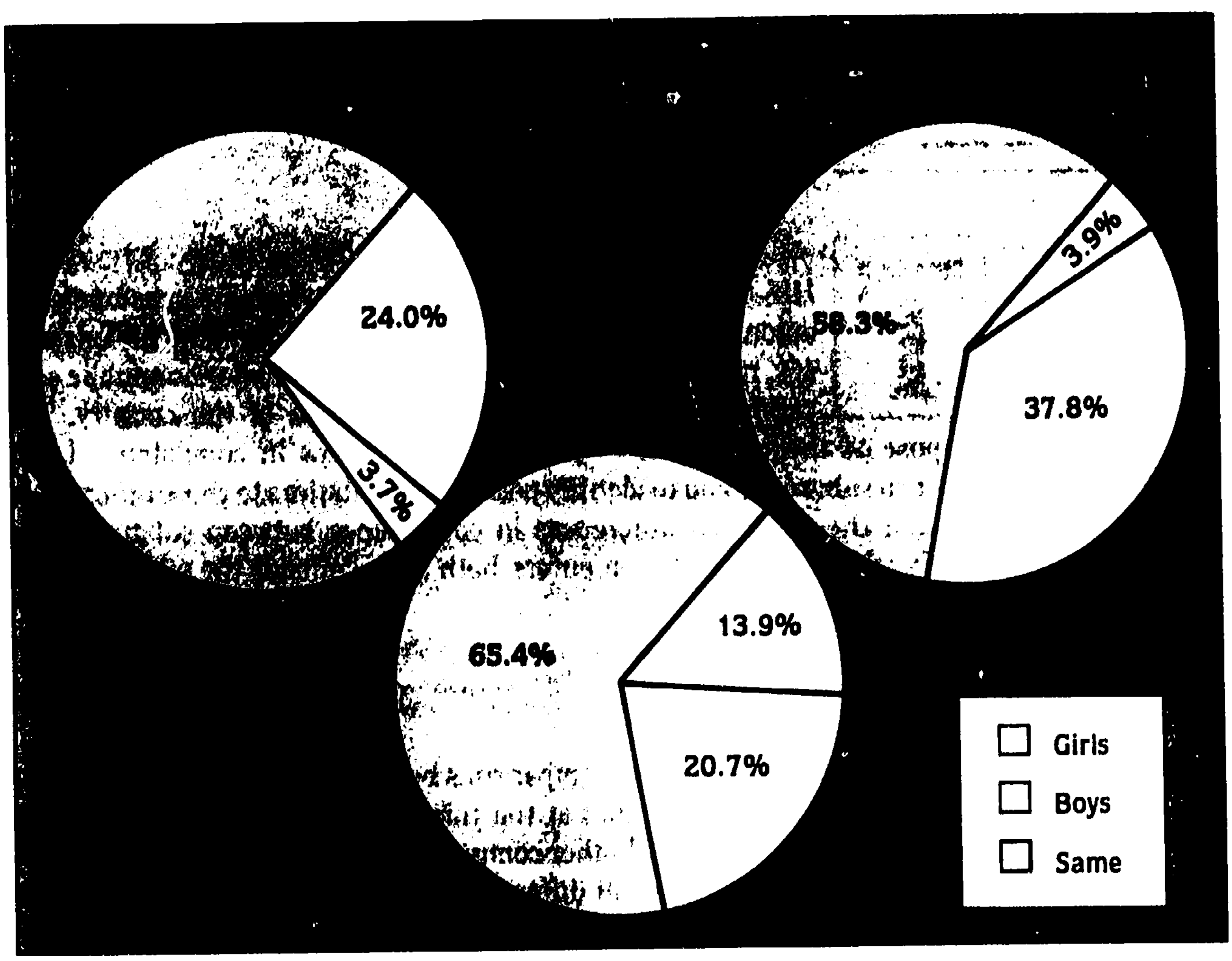
FIGURE 4.1



*Mean percent correct: standard errors are printed in parentheses.
Caution: Scores do not have equivalent meanings across grade levels.

Beliefs about Sex Differences in Computer Competence Grade 3 Responses

FIGURE 4.2



Given these sex differences in performance, to what extent might they be attributable to students' *beliefs* about sex-appropriate roles in using computers? Third graders were posed the question, "Who do you think are better at using computers, girls or boys?" Two-thirds of the students responded that girls and boys are the same in their abilities (FIGURE 4.2). For those who identified one sex as more proficient than the other, girls tended to believe that girls are better at using computers, and boys believed boys are better. About four percent of boys and girls thought that the other sex was better at using computers.

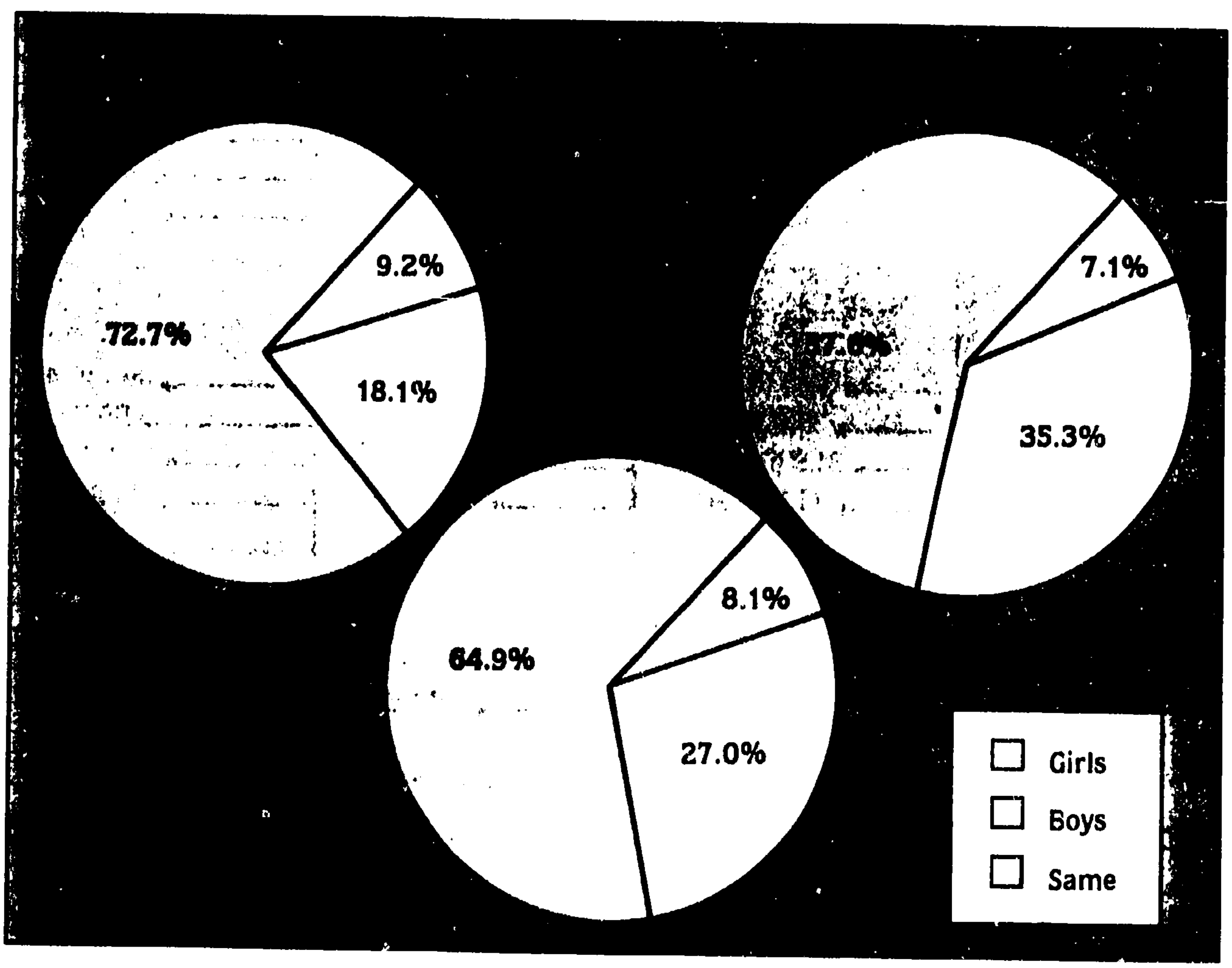
... boys were cited three times more often than girls as liking computers more.

Seventh graders were asked a different question: "Who do you think like using computers more, girls or boys?" Roughly two-thirds said that boys and girls were the same in their liking (FIGURE 4.3). But three out of four of the other respondents said boys liked computers more. Boys and girls were both more likely to say that boys liked computers more, but a higher percentage of boys expressed this belief.

Experience and competence. The experiences of having used a computer, of studying computers, and of owning a computer are all related to

Beliefs about Sex Differences in Liking for Computers
Grade 7 Responses

FIGURE 4.3



increased competence among girls and boys (FIGURE 4.4). Eleventh-grade boys who were not studying computers scored 46.1 percent correct, but those who were studying computers scored 55.7 percent correct. The pattern was similar among eleventh-grade girls: Those not studying computers averaged 44.1 percent correct, and those studying computers averaged 49.5 percent correct. For girls as well as boys, experience with computers both within and outside the classroom was associated with computer competence.

Differences in experience. If experience leads to competence, differences in experience might explain differences in achievement between subgroups. FIGURE 4.5 shows that, across grades 3, 7, and 11, boys were slightly more likely than girls to have used a computer. At the third grade, about 7 percent more boys than girls responded that they had used a computer. The difference decreases with age, however, so that by the eleventh grade there were virtually no differences in having used computers—almost 90 percent had used a computer by that age.

Sex Differences in Computer Competence*, by Experience Variables

FIGURE 4.4

	Grade 3	Grade 7	Grade 11
Have you used a computer?			
Male NO	31.4 (0.5)	33.9 (0.6)	37.2 (0.6)
Male YES	35.2 (0.4)	43.7 (0.4)	49.1 (0.6)
Female NO	30.3 (0.5)	34.1 (0.4)	37.6 (0.5)
Female YES	34.0 (0.3)	40.5 (0.3)	46.0 (0.3)
Studying computers?			
Male NO	33.3 (0.4)	40.8 (0.4)	46.1 (0.4)
Male YES	35.4 (0.7)	45.7 (0.7)	55.7 (1.5)
Female NO	31.8 (0.3)	38.2 (0.3)	44.1 (0.3)
Female YES	34.3 (0.5)	42.3 (0.6)	49.5 (0.8)
Family owns a computer?			
Male NO	32.8 (0.3)	39.6 (0.3)	43.5 (0.5)
Male YES	37.5 (0.9)	48.1 (0.6)	55.1 (1.0)
Female NO	32.2 (0.3)	38.2 (0.4)	43.5 (0.3)
Female YES	35.0 (0.6)	43.4 (0.4)	49.0 (0.6)

Scale in each grade column: 25% 50% 75%

*Mean percent correct: standard errors are printed in parentheses.
Caution: Scores do not have equivalent meanings across grade levels.

A similar pattern is found when boys and girls are contrasted according to whether they were studying computers at the time of the assessment. At all three grades, a greater proportion of boys reported studying computers. But in the third grade, where the advantage for boys is greatest, the difference is only 2.1 percent; and in the eleventh grade, it is only about 1 percent.

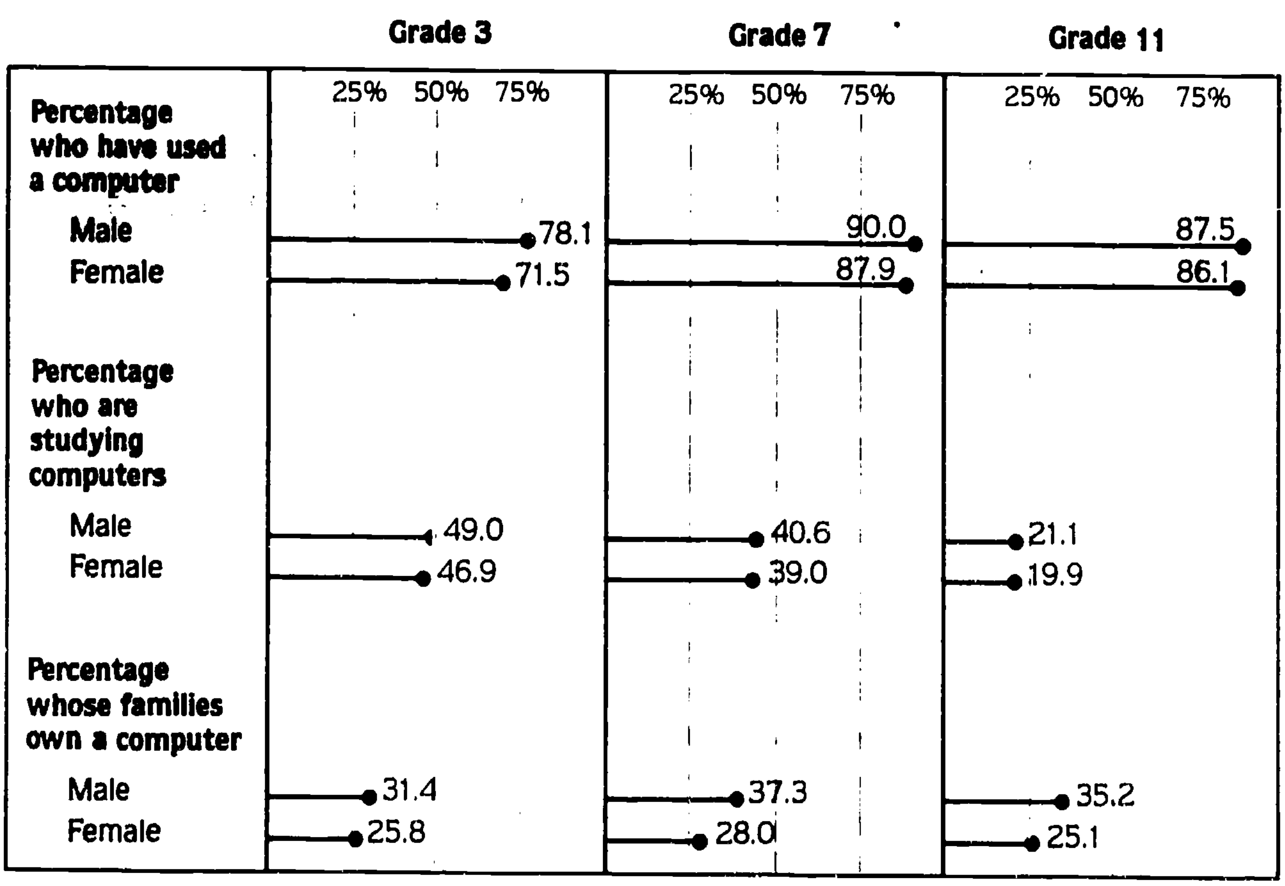
Boys and girls differ most in whether or not their families own a computer. Across the three grade levels, families of boys were more likely to own a computer. The difference is notable even among third graders, where 31.4 percent of boys had computers at home, compared with 25.8 percent of girls. In the eleventh grade, boys were 40 percent more likely to have access to a computer at home.

Race/Ethnicity

Competence differences. When racial/ethnic groups were compared in terms of overall computer competence, White students were shown to have a clear advantage over Black and Hispanic students across the grades.* The

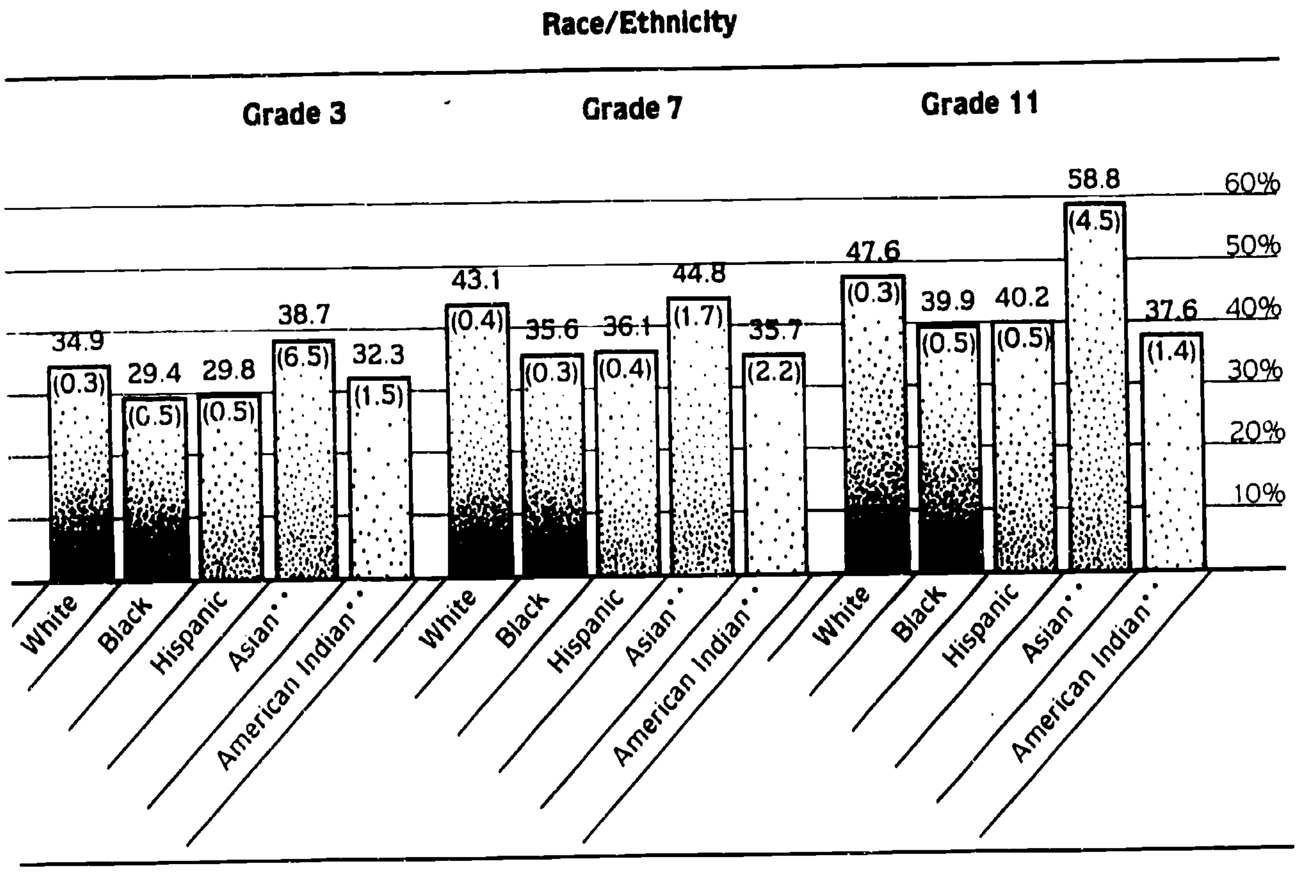
*Although data were collected from Asian and American Indian students, the sample sizes for these groups were too small to make reliable statements about national patterns of computer experience or competence. In order to avoid the risk of making unwarranted claims, these data are omitted from analysis in this chapter, with the exception of the report on overall computer competence (FIGURE 4.6 and discussion).

Experience with Computers, by Sex FIGURE 4.5



Racial/Ethnic Differences in Computer Competence*

FIGURE 4.6



*Mean percent correct; standard errors are printed in parentheses.
Caution: Scores do not have equivalent meanings across grade levels.
**Caution: Competence scores reported for this group are highly uncertain. Statements of comparison with other groups should be regarded as extremely tentative.

greatest performance differences appeared in the higher grades (FIGURE 4.6). While Black and Hispanic students differed little in overall computer competence, mean scores for White students averaged between 5 and 8 percent higher.

In this figure, mean scores for Asian and American Indian students are included, but the scores reported are uncertain because of the relatively small numbers of these students who participated in the assessment. Comparisons between these and other groups should be regarded as highly tentative. Because mean scores for Asian and American Indian students are not dependable, further racial/ethnic comparisons in this chapter are confined to White, Black, and Hispanic students.

Role models. While differences in access to computers probably contribute to disparities in achievement between racial/ethnic groups, it is also possible that the performance of minority students suffers because of a lack of role models. Computer coordinators were asked, among many other questions, their racial/ethnic identity. In both the seventh and eleventh grades, more than 90 percent of computer coordinators were White (TABLE

Race/Ethnicity of Computer Coordinators

TABLE 4.1

Race/Ethnicity	Grade 7	Grade 11
White	90.7%	92.9%
Black	4.0	4.4
Hispanic	2.8	1.1

4.1). Black and Hispanic coordinators were underrepresented compared to the percentage of Black and Hispanic individuals in the general population. The problem of underrepresentation was especially serious for Hispanic coordinators, who composed only 1 percent of high school computer coordinators.

Experience and competence. When the effects of experience are examined within racial/ethnic groups, it is clear that experience is dependably associated with computer competence (FIGURE 4.7). Within each racial/ethnic group and across grade levels, experience, instruction, and home access to computers were associated with higher levels of skill and knowledge. When, for example, Hispanic eleventh graders were divided into those taking a computer course and those who were not, students currently enrolled had about a six-point advantage in mean percent correct. A similar advantage is found among Hispanic students who had a computer at home, compared to those who did not.

The advantage associated with family ownership of a computer is comparable to or even slightly larger than the advantage linked with current instruction. For example, Black eleventh graders who were currently enrolled in a computer course averaged 43.7 percent correct, 4.5 points higher than those not enrolled in a course. But Black eleventh graders who had a computer at home averaged 44.8 percent correct, 6.2 percent higher than those whose families do not own a computer.

...experience in the form of instruction and home access is associated with computer competence...

There are other potential contributors to computer competence associated with ownership of a computer—especially socioeconomic status. The underlying causes of high computer competence may therefore go far deeper than whether families own a computer. The most important point, however, is that experience in the form of instruction and home access is associated with computer competence for all racial/ethnic groups.

Differences in experience. In computer experience, coursework, and access, White students have a definite advantage over Black and Hispanic students. FIGURE 4.8 indicates that, across three grade levels, White children are more likely to have used a computer than are Black or Hispanic children.

Racial/Ethnic Differences in Computer Competence*, by Experience Variables

FIGURE 4.7

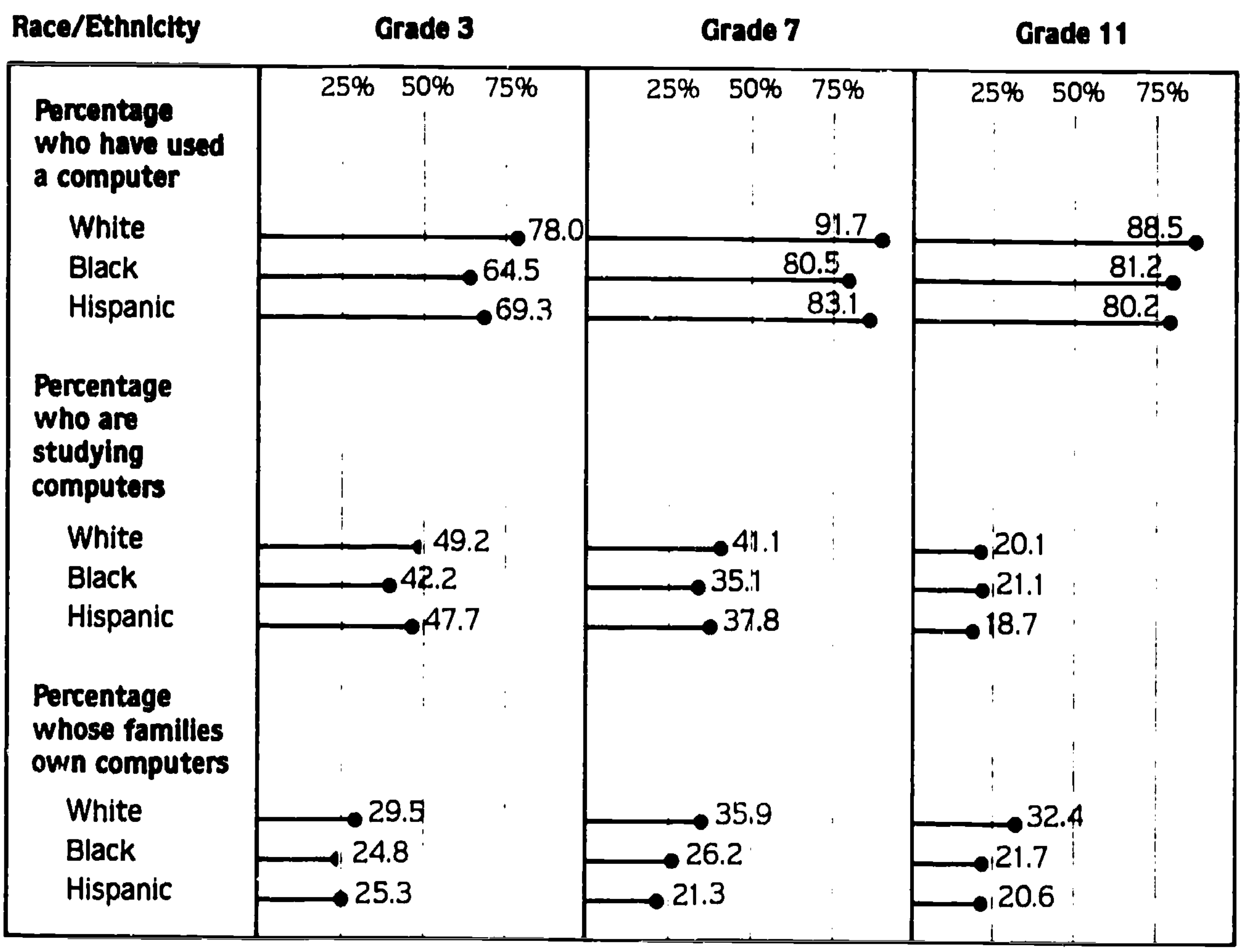
	Grade 3	Grade 7	Grade 11
Have you used a computer?			
White NO	32.3 (0.6)	35.3 (0.5)	38.5 (0.6)
White YES	35.6 (0.4)	43.9 (0.4)	48.8 (0.3)
Black NO	28.0 (0.5)	32.2 (0.5)	35.2 (0.8)
Black YES	30.1 (0.7)	36.5 (0.3)	41.0 (0.6)
Hispanic NO	27.9 (1.0)	31.8 (0.6)	35.1 (0.8)
Hispanic YES	30.8 (0.6)	37.1 (0.5)	41.5 (0.7)
Studying computers?			
White NO	33.8 (0.3)	41.2 (0.3)	46.5 (0.4)
White YES	36.1 (0.4)	46.1 (0.6)	53.8 (0.8)
Black NO	29.3 (0.6)	34.8 (0.3)	39.2 (0.5)
Black YES	29.5 (0.6)	37.4 (0.6)	43.7 (1.3)
Hispanic NO	29.1 (0.6)	35.1 (0.4)	39.6 (0.5)
Hispanic YES	30.5 (0.8)	37.9 (0.8)	45.9 (1.2)
Family owns a computer?			
White NO	33.7 (0.3)	40.6 (0.4)	44.9 (0.4)
White YES	37.7 (0.5)	47.7 (0.5)	53.3 (0.5)
Black NO	29.0 (0.5)	34.6 (0.3)	38.6 (0.5)
Black YES	30.5 (1.0)	38.8 (0.6)	44.8 (1.3)
Hispanic NO	29.4 (0.5)	35.5 (0.4)	39.1 (0.5)
Hispanic YES	31.0 (1.4)	39.4 (1.2)	45.0 (1.5)

*Mean percent correct; standard errors are printed in parentheses.
Caution: Scores do not have equivalent meanings across grade levels.

Differences in exposure are least in the higher grades, presumably because by the eleventh grade most students have had the opportunity to use a computer. Yet, among eleventh graders, there are clear differences in exposure between racial/ethnic groups: About 20 percent of Black and Hispanic students had never used a computer, while 13 percent of White students had not used one.

There is less discrepancy between racial/ethnic groups in the amount of instruction in computers, particularly in the eleventh grade. In the third and seventh grades, nearly equal proportions of White and Hispanic students reported studying computers, while proportions were slightly lower for Black

Racial/Ethnic Differences in Experience with Computers FIGURE 4.8



students. By the eleventh grade, these differences between racial/ethnic groups were practically negligible.

Differences among groups can be found in the proportions of students whose families own a computer. Across the grades, families of White students are more likely to have a computer at home than families of Black or Hispanic students.

All of the three experience variables examined here—use, instruction, and home access—have been shown to have a clear positive relationship to computer competence. In all three, White students have an advantage over Black and Hispanic students.

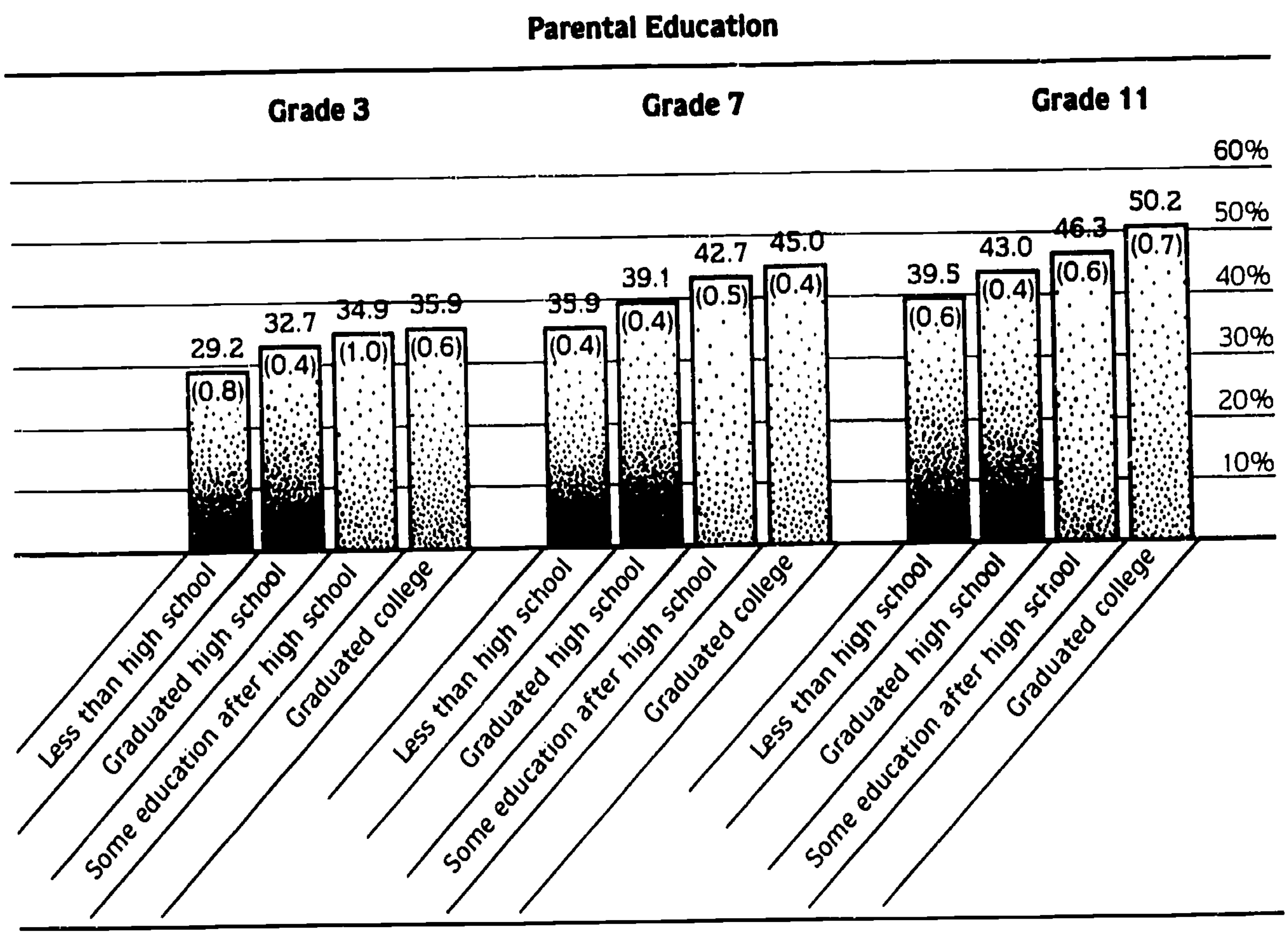
Parental Education

Students whose parents did not finish high school had the lowest levels of computer competence.

Competence differences. A third dimension along which we can compare students is the educational attainment of their parents. FIGURE 4.9 depicts differences in computer competence across four levels of parental education for third-, seventh-, and eleventh-grade students. This figure shows consistent differences in competence between children whose parents differ in

Parental Education and Computer Competence*

FIGURE 4.9



*Mean percent correct: standard errors are printed in parentheses.
Caution: Scores do not have equivalent meanings across grade levels.

educational attainment. Students whose parents have graduated from college demonstrated the greatest competence, especially in the higher grades. Students whose parents did not finish high school had the lowest levels of computer competence.

Experience and competence. For the development of computer-related knowledge and skill, experience with computers is important for children, whatever the level of their parents' education (TABLE 4.2). Instruction and home access are consistently related to advantages in computer competence. Furthermore, the advantages conferred by instruction and home access tend to be greater for children whose parents have more education. Among eleventh graders whose parents did not finish high school, home access to a computer was associated with a 3.8 percent advantage, while for children of college graduates, home access was linked to an 8.9 percent advantage. Thus, if experience promotes computer competence, children of more educated parents seem to benefit more from that experience.

Differences in experience. When children were grouped according to the education of their parents, it was clear that they differed in their average

Parental Education and Differences in Computer Competence*, by Experience Variables

TABLE 4.2

	Grade 3		Grade 7		Grade 11	
Have you used a computer?	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**
Less than H.S.	27.9 (1.0)	30.2 (1.0)	32.1 (0.9)	36.8 (0.4)	33.8 (0.8)	41.3 (0.7)
Graduated H.S.	31.3 (1.1)	33.1 (0.5)	34.5 (0.5)	39.8 (0.4)	37.3 (0.7)	44.1 (0.4)
Some education after H.S.	29.7 (1.8)	36.5 (0.8)	36.2 (0.9)	43.2 (0.5)	39.2 (0.8)	47.4 (0.6)
Graduated College	32.8 (0.8)	36.5 (0.6)	35.5 (0.9)	45.6 (0.4)	38.2 (0.6)	51.4 (0.7)
Studying computers?	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**
Less than H S.	29.0 (0.9)	29.9 (1.6)	35.8 (0.5)	36.7 (0.8)	39.1 (0.7)	44.1 (1.2)
Graduated H.S.	31.7 (0.5)	33.8 (0.7)	37.8 (0.3)	41.4 (0.6)	41.9 (0.5)	49.5 (1.0)
Some education after H.S.	34.3 (0.7)	35.5 (1.5)	40.9 (0.5)	45.8 (0.9)	45.1 (0.5)	52.2 (1.2)
Graduated College	34.2 (0.5)	37.3 (1.0)	42.8 (0.4)	47.9 (0.7)	48.8 (0.5)	56.9 (1.9)
Family owns a computer?	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**
Less than H.S.	29.2 (0.8)	29.1 (2.3)	35.7 (0.4)	37.5 (1.2)	39.0 (0.6)	42.8 (1.9)
Graduated H.S.	32.5 (0.4)	33.0 (0.9)	38.2 (0.4)	42.0 (0.5)	41.6 (0.4)	48.5 (0.9)
Some education after H.S.	34.3 (1.0)	36.0 (0.4)	40.6 (0.5)	47.1 (1.1)	44.3 (0.6)	51.3 (0.7)
Graduated College	34.4 (0.5)	38.2 (1.0)	41.6 (0.3)	48.7 (0.5)	46.6 (0.5)	55.5 (1.1)

*Mean percent correct: standard errors are printed in parentheses.
Caution: Scores do not have equivalent meanings across grade levels.

experience with computers. The consistent pattern was that the higher the parents' education, the more likely the children were to have used a computer, to be currently studying computers in school, and to have a computer at home. The greatest differences appeared in family ownership of a computer (TABLE 4.3). These differences were most striking among families of seventh

Experience with Computers, by Parental Education

TABLE 4.3

Level of Education	Grade 3	Grade 7	Grade 11
Percentage who have used a computer			
Less than high school	62.7	81.7	77.3
Graduated high school	74.0	86.6	83.8
Some study after H.S.	77.8	92.6	87.6
Graduated college	82.4	93.8	91.0
Percentage who are currently studying computers			
Less than high school	40.9	32.8	17.5
Graduated high school	46.7	37.5	18.6
Some study after H.S.	50.9	40.2	22.0
Graduated college	52.6	44.1	21.8
Percentage whose families own a computer			
Less than high school	15.1	14.5	12.6
Graduated high school	21.6	24.8	20.5
Some study after H.S.	38.7	32.4	28.7
Graduated college	38.7	47.9	41.8

Public/Non-public Education and Computer Competence*

TABLE 4.4

Type of School	Grade 3	Grade 7	Grade 11
Public	33.7 (0.3)	40.8 (0.3)	45.9 (0.4)
Non-public	33.1 (0.8)	44.4 (1.1)	49.3 (1.1)

*Mean percent correct; standard errors are printed in parentheses.
Caution: Scores do not have equivalent meanings across grade levels.

and eleventh graders: Parents who graduated from college were about twice as likely to own a computer as high school graduates, and three times as likely to own a computer as those who did not finish high school.

Public/Nonpublic Education

...students who attended nonpublic schools demonstrated superior computer competence...

Competence differences. For some time, there has been considerable interest in comparing the performance of students in nonpublic and public schools. In this assessment, students who attended nonpublic schools demonstrated superior computer competence (TABLE 4.4). These differences did not appear in the third grade, but by the seventh and eleventh grades they clearly existed.

Experience and Competence. In both public and nonpublic schools, instruction and family ownership of a computer both appeared to lead to higher levels of competence (TABLE 4.5). Computer competence was more strongly associated with home ownership of a computer than with current instruction in computers, especially among nonpublic school students. Among eleventh-grade nonpublic school pupils, those who had a computer at home averaged 10.5 percent higher than those without computers. This compares to a 1.5 percent advantage for those taking a computer course over those who were not.

Public/Non-public School Differences in Computer Competence*, by Experience Variables

TABLE 4.5

	Grade 3		Grade 7		Grade 11	
Have you used a computer?	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**
Public	30.7 (0.4)	34.7 (0.4)	33.6 (0.3)	41.8 (0.3)	37.4 (0.3)	47.3 (0.4)
Non-public	30.8 (1.2)	33.7 (0.8)	37.8 (1.4)	45.0 (1.1)	36.0 (2.3)	50.8 (1.1)
Studying computers?	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**
Public	32.5 (0.3)	35.1 (0.5)	39.2 (0.3)	43.6 (0.6)	44.6 (0.3)	52.9 (1.1)
Non-public	33.1 (1.3)	33.0 (1.1)	42.1 (0.8)	46.6 (1.5)	49.6 (1.4)	51.1 (2.2)
Family owns a computer?	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**
Public	32.5 (0.3)	36.7 (0.7)	38.7 (0.3)	45.7 (0.4)	43.4 (0.3)	52.3 (0.8)
Non-public	32.6 (0.7)	34.2 (1.8)	41.1 (1.0)	48.5 (1.3)	44.6 (1.0)	55.1 (1.4)

*Mean percent correct; standard errors are printed in parentheses.
Caution: Scores do not have equivalent meanings across grade levels.

Experience with Computers, by Type of School			TABLE 4.6
School	**Grade 3**	**Grade 7**	**Grade 11**
Percentage who have used a computer			
Public	74.5	88.7	86.7
Non-public	78.4	91.4	88.3
Percentage who are studying computers			
Public	47.2	38.3	20.4
Non-public	54.8	51.8	21.9
Percentage whose families own computers			
Public	28.1	31.2	28.8
Non-public	33.4	45.5	43.6

Differences in experience. Nonpublic school children, on average, were more experienced with computers than were public school children (TABLE 4.6). Students' reports of whether they had ever "used" a computer showed, however, little difference between the two groups. Larger differences appeared in the proportions who were currently studying computers. These differences were greatest in seventh grade, where 51.8 percent of nonpublic school children reported that they are studying computers. Only 38.3 percent of public school children made the same claim. In eleventh grade there was little difference between the groups in whether they were taking a computer course.

Across three grade levels, there were substantial differences in computer ownership between public and nonpublic school students: Families whose children went to nonpublic schools were more likely to have a computer. In both the seventh and eleventh grades, about 14 percent more nonpublic school pupils had computers than did public school pupils.

Families whose children went to nonpublic schools were more likely to have a computer.

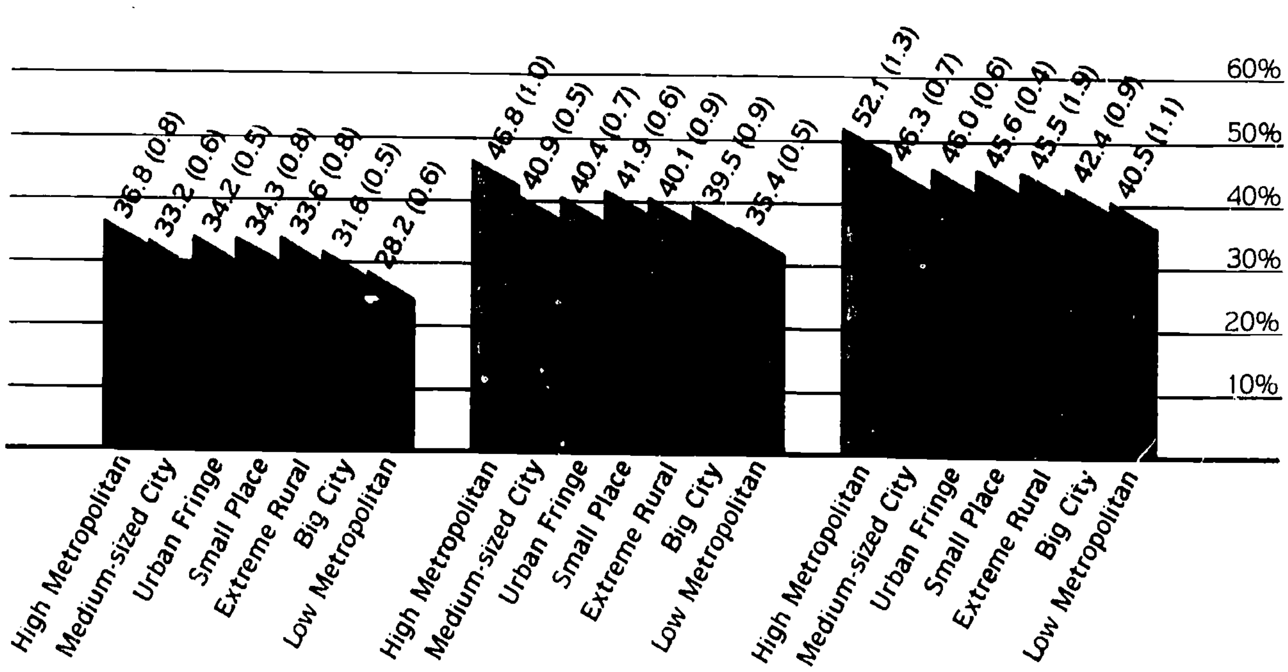
Community and Region

Competence differences. FIGURES 4.10 and 4.11 show strong differences in computer competence between students who live in different types of communities and in different regions of the country*. Figure 4.10 shows that

*Definitions of the community types and regions of the country are provided in the procedural appendix.

Type of Community and Computer Competence*

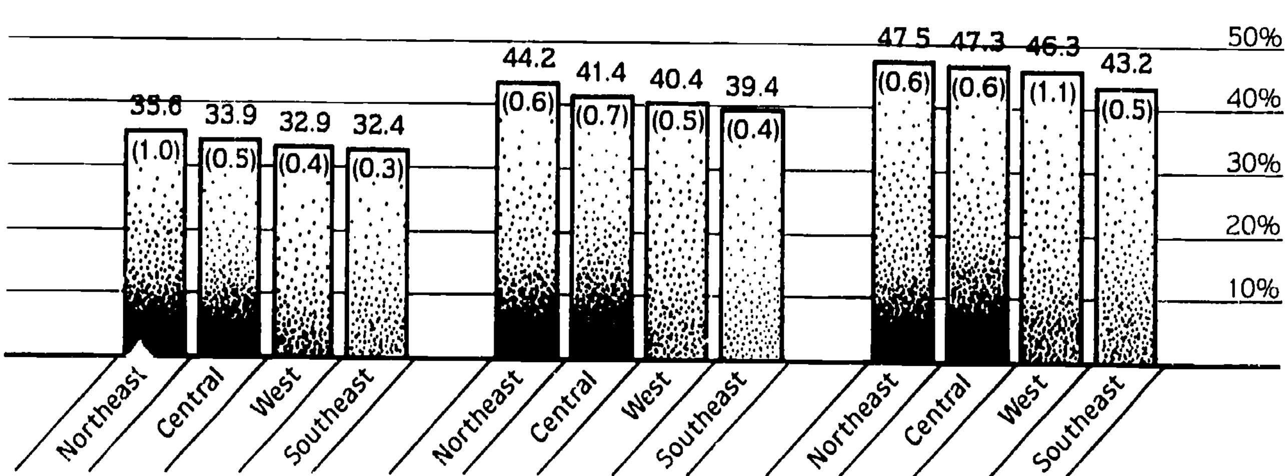
FIGURE 4.10



*Mean percent correct; standard errors are printed in parentheses.
Caution: Scores do not have equivalent meanings across grade levels.

Region and Computer Competence*

FIGURE 4.11



*Mean percent correct; standard errors are printed in parentheses.
Caution: Scores do not have equivalent meanings across grade levels.

Community Differences in Computer Competence*, by Experience Variables

TABLE 4.7

	Grade 3		Grade 7		Grade 11	
Have you used a computer?	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**
High Metropolitan	33.2 (1.1)	37.5 (0.9)	36.2 (1.8)	47.3 (0.9)	39.0 (1.3)	53.2 (1.3)
Medium-sized City	30.1 (0.6)	34.2 (0.7)	33.5 (0.6)	42.0 (0.5)	36.7 (0.9)	47.8 (0.7)
Urban Fringe	33.2 (1.2)	34.6 (0.6)	34.8 (1.2)	41.2 (0.8)	39.8 (1.1)	47.0 (0.6)
Small Place	30.8 (1.0)	35.5 (0.9)	34.7 (0.7)	42.7 (0.5)	37.5 (0.8)	47.0 (0.4)
Extreme Rural	32.1 (1.2)	33.9 (0.9)	33.7 (2.5)	40.8 (0.9)	34.8 (1.3)	46.6 (1.8)
Big City	30.5 (0.9)	32.0 (0.6)	34.1 (1.0)	40.4 (1.0)	34.9 (1.0)	43.8 (0.8)
Low Metropolitan	26.6 (0.7)	29.1 (0.7)	31.7 (0.6)	36.5 (0.6)	34.5 (0.8)	41.9 (1.2)
Studying computers?	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**
High Metropolitan	36.8 (1.1)	36.8 (0.9)	43.4 (0.9)	49.4 (1.1)	50.5 (0.9)	60.9 (4.0)
Medium-sized City	32.6 (0.6)	34.1 (1.2)	39.3 (0.5)	44.1 (0.9)	45.4 (0.8)	51.7 (1.3)
Urban Fringe	32.5 (0.5)	36.0 (0.8)	39.2 (0.9)	42.0 (0.9)	45.1 (0.8)	51.1 (2.1)
Small Place	32.9 (0.6)	35.9 (1.5)	40.2 (0.6)	44.8 (0.8)	44.4 (0.5)	52.1 (0.9)
Extreme Rural	32.3 (0.5)	34.9 (1.4)	40.7 (0.9)	39.4 (1.4)	42.3 (1.1)	54.8 (4.3)
Big City	30.7 (0.5)	32.4 (0.8)	37.2 (0.6)	43.0 (1.6)	42.3 (0.8)	45.5 (1.3)
Low Metropolitan	28.0 (0.7)	28.2 (0.9)	35.0 (0.6)	36.7 (0.8)	30.3 (0.9)	47.1 (2.8)
Family owns a computer?	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**
High Metropolitan	35.3 (0.6)	38.9 (1.4)	43.2 (1.4)	50.5 (1.0)	47.3 (0.8)	59.2 (2.0)
Medium-sized City	32.1 (0.6)	35.8 (0.6)	38.6 (0.5)	45.5 (0.9)	44.0 (0.6)	52.3 (1.4)
Urban Fringe	33.1 (0.5)	36.8 (1.1)	38.3 (0.7)	44.6 (0.8)	43.4 (0.7)	50.7 (0.9)
Small Place	33.1 (0.5)	37.5 (2.1)	39.6 (0.7)	46.8 (0.8)	43.4 (0.5)	51.8 (0.7)
Extreme Rural	32.8 (0.8)	36.2 (1.4)	38.8 (0.9)	45.7 (1.2)	43.4 (1.8)	53.9 (2.8)
Big City	31.0 (0.6)	33.2 (1.1)	38.8 (0.9)	43.5 (1.2)	40.6 (0.7)	47.3 (1.0)
Low Metropolitan	28.1 (0.9)	28.3 (0.9)	34.4 (0.4)	38.7 (0.9)	38.8 (0.8)	47.0 (2.8)

*Mean percent correct; standard errors are printed in parentheses.
Caution: Scores do not have equivalent meanings across grade levels.

students from advantageu (higher SES) metropolitan areas were the most computer competent across all three grade levels, and students from disadvantaged (lower SES) metropolitan areas were the least competent. When comparing regions of the country, we find that students from the Northeast

Regional Differences in Computer Competence*, by Experience Variables

TABLE 4.8

	Grade 3		Grade 7		Grade 11	
Have you used a computer?	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**
Northeast	31.9 (1.1)	36.8 (1.1)	36.0 (1.2)	44.9 (0.7)	37.5 (0.9)	48.7 (0.7)
Central	31.5 (0.8)	34.6 (0.5)	33.0 (0.8)	42.4 (0.7)	37.8 (0.7)	48.5 (0.6)
West	29.7 (0.7)	34.0 (0.6)	33.9 (0.4)	41.3 (0.5)	37.3 (0.7)	47.6 (1.1)
Southeast	30.2 (0.4)	33.3 (0.3)	33.8 (0.4)	40.5 (0.5)	36.6 (0.9)	44.7 (0.4)
Studying computers?	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**
Northeast	33.7 (0.8)	37.7 (1.6)	42.2 (0.6)	46.3 (0.9)	46.8 (0.8)	51.6 (1.6)
Central	32.9 (0.8)	35.1 (0.6)	39.3 (0.6)	44.6 (0.8)	45.9 (0.5)	54.1 (1.1)
West	32.0 (0.6)	33.8 (0.7)	39.0 (0.4)	43.1 (0.9)	44.8 (0.7)	55.1 (3.0)
Southeast	31.8 (0.4)	33.0 (0.6)	38.5 (0.4)	41.6 (1.3)	42.3 (0.5)	48.9 (0.8)
Family owns a computer?	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**
Northeast	33.4 (0.7)	39.7 (1.7)	41.1 (0.6)	48.6 (0.9)	44.2 (0.6)	53.4 (0.9)
Central	33.0 (0.6)	36.5 (0.8)	39.2 (0.7)	46.5 (0.8)	45.1 (0.7)	52.7 (1.2)
West	32.1 (0.5)	34.9 (1.0)	38.5 (0.6)	44.7 (0.4)	43.2 (0.5)	53.4 (1.9)
Southeast	31.7 (0.2)	34.2 (0.7)	37.4 (0.2)	44.5 (0.9)	41.2 (0.5)	49.9 (1.2)

*Mean percent correct; st[illegible] errors are printed in parentheses.
Caution: Scores do not have [illegible]valent meanings across grade levels.

consistently outperformed students from the Central region, the West, and the Southeast (Figure 4.11).

Experience and competence. In all types of communities, experience with computers was related to increased computer competence (TABLE 4.7). The benefits of instruction in computers and home access to computers were greatest for students who live in high socioeconomic metropolitan areas. Another consistent pattern was that the advantage associated with family ownership of a computer is comparable to or slightly exceeded the advantage of being enrolled in a computer course. Similar patterns were found when experience and competence were compared within regions (TABLE 4.8).

Differences in experience. In communities and regions associated with higher computer competence, there were corresponding higher frequencies of computer studies and computer ownership (TABLES 4.9 and 4.10). Larger

Experience with Computers, by Community TABLE 4.9

Type of Community	Grade 3	Grade 7	Grade 11
Percentage who have used a computer			
High Metropolitan	83.3 (2.7)	95.3 (1.0)	92.5 (1.2)
Medium-sized City	76.8 (1.6)	87.2 (1.6)	86.7 (1.3)
Urban Fringe	77.2 (2.3)	88.5 (1.4)	86.1 (1.2)
Small Place	73.8 (2.5)	90.4 (1.4)	86.1 (1.6)
Extreme Rural	76.7 (2.5)	90.7 (1.6)	90.0 (1.8)
Big City	72.4 (3.1)	87.4 (2.0)	84.5 (2.7)
Low Metropolitan	59.8 (3.4)	79.6 (3.3)	79.9 (2.9)
Percentage who are studying computers			
High Metropolitan	59.7 (7.1)	55.8 (7.7)	21.3 (3.7)
Medium-sized City	44.1 (3.7)	31.4 (5.4)	19.2 (1.8)
Urban Fringe	51.1 (6.3)	45.6 (6.8)	20.9 (2.3)
Small Place	47.5 (5.0)	39.2 (5.8)	20.0 (1.4)
Extreme Rural	40.6 (12.0)	29.6 (6.2)	28.5 (3.5)
Big City	46.9 (7.1)	41.7 (6.4)	17.3 (2.5)
Low Metropolitan	44.9 (6.8)	34.1 (6.7)	22.1 (2.1)
Percentage whose families own a computer			
High Metropolitan	42.3 (2.5)	49.5 (1.9)	40.9 (2.2)
Medium-sized City	31.3 (1.9)	34.0 (1.9)	28.1 (1.5)
Urban Fringe	32.9 (2.2)	33.5 (2.2)	34.1 (1.4)
Small Place	25.3 (1.8)	31.3 (1.3)	27.9 (1.5)
Extreme Rural	18.1 (2.2)	21.8 (1.8)	19.2 (2.6)
Big City	28.3 (2.3)	29.4 (1.5)	29.0 (2.6)
Low Metropolitan	21.0 (1.4)	25.7 (3.3)	22.4 (2.6)

differences appear when communities and regions are compared according to whether students were studying computers. For example, seventh-grade students in high metropolitan areas were much more likely to be studying computers (55.8 percent) than students from low metropolitan areas (34.1 percent). Similarly, 50.8 percent of northeastern seventh graders reported studying computers, but only 36.5 percent of western seventh graders reported the same.

Experience with Computers, by Region			TABLE 4.10
Region	**Grade 3**	**Grade 7**	**Grade 11**
Percentage who have used a computer			
Northeast	76.1	92.0	89.1
Central	78.4	90.5	87.9
West	74.5	88.4	86.8
Southeast	70.0	85.3	82.6
Percentage who are currently studying computers			
Northeast	48.2	50.8	22.2
Central	47.0	40.4	21.6
West	51.7	36.5	18.7
Southeast	44.1	40.4	19.3
Percentage whose families own a computer			
Northeast	33.6	41.4	36.0
Central	26.3	29.8	29.3
West	30.1	32.4	30.8
Southeast	25.3	29.4	23.4

The most impressive difference across communities and regions is in family ownership of a computer. At the high end of the ownership scale, we find that families of about half of seventh-grade students in high metropolitan areas own computers. At the low end, only about one in five of their rural peers have home access to computers. When regions are compared, we find students from the northeast considerably more likely to have a computer at home than students from the southeast.

Summary

The central message of this chapter is that demographic subgroups vary significantly in computer competence, and that these differences are strongly associated with differences in experience with computers. The differences in competence between groups follow familiar achievement patterns. White students, for example, showed higher levels of computer competence than

Black and Hispanic students. Differences were also found across other demographic dimensions: sex, parental education, public and nonpublic schooling, community of residence, and region of the country.

The question of experience was further differentiated into experience at school and access at home. The dominant themes of the last chapter were that students vary in both school experience and home access, and that these differences are related to differences in demonstrated competence. Data presented in this chapter show that school instruction and home access are as important within demographic subgroups as they are between them. Thus, instruction is important for boys and for girls, and for Black, Hispanic, and White students. Similarly, having a computer at home appears to offer an advantage to all demographic subgroups, and the increased competence associated with home access usually equals or exceeds the advantage associated with current instruction. When subgroups are compared on experience, we find the groups who are most competent with computers are more likely to have used computers, to have studied computers, and to have a computer at home.

. . . groups who are most competent with computers are more likely to have used computers, to have studied computers, and to have a computer at home.

CHAPTER 5
Computer Coordinators

WITH THE advent of computer instruction in schools, there has been concern over whether computer teachers are adequately prepared. In this chapter, we explore this and related issues by examining data from questionnaires given to computer coordinators—persons responsible for computer studies at the assessment sites. Not all schools had computer coordinators, nor did all computer coordinators complete and return a questionnaire to NAEP. But in this chapter data are reported for the large number of computer coordinators who responded. The characteristics of computer coordinators are described, including their professional preparation and self-evaluations of their ability to teach computer studies.

Characteristics

TABLE 5.1 displays some background characteristics of computer coordinators. The top section of the table shows the breakdown, by sex, of coordinators at the third, seventh, and eleventh grade. At the elementary level, 70 percent of computer coordinators are female. At the high school level, the proportions reverse: 65 percent of the coordinators are male.

Characteristics of Computer Coordinators TABLE 5.1

	Grade 3	Grade 7	Grade 11
Sex			
Male	29.1%	37.7%	64.5%
Female	70.0	60.3	35.5
Race/Ethnicity			
White	87.9%	90.7%	92.9%
Black	7.7	4.0	4.4
Hispanic	3.1	2.8	1.1
Mean Age (years)	39.0	40.3	38.6
Mean Number of Years Teaching (years)	11.2	13.0	12.8
Do you own your own computer or have access to one outside of school?			
Yes	67.8%	67.3%	73.5%
No	32.2	32.5	26.5
Number of coordinators who returned questionnaires	233	275	329
Number of assessment sites	632	568	433

Across the grade levels, computer coordinators are predominantly White. In comparison to their proportions in the general population, Hispanic and Black coordinators are underrepresented. This underrepresentation may be attributable to a lack of Black and Hispanic teachers, or to an underrepresentation of Black and Hispanic teachers in the position of computer coordinators, or both. Whatever the causes, inadequate numbers of such teachers and coordinators might contribute to lower levels of computer competence among youth of the same race or ethnicity (See Chapter 4).

The mean age of computer coordinators was fairly uniform across the grade levels. The average age of coordinators of third-grade programs was 39 years. Average ages of coordinators at the seventh and eleventh grades were, respectively, 40.3 years and 38.6 years. The mean number of years teaching was also fairly constant at about 12 years.

A high proportion of coordinators reported owning their own computers or having access to a computer outside of school. An important finding from earlier chapters is that many students depend upon access to computers outside of school to learn most of what they know about computers. It may also be important for teachers of computer studies to have access to a computer at their own home or at another location outside of school.

Teaching Activities

To what extent can statements about computer coordinators be applied to teachers of computer studies? TABLE 5.2 indicates that not all computer coordinators were teaching computer science at the time of the assessment, but a good percentage were. The proportions ranged from 65 percent at the third grade to 85 percent at the eleventh grade.

Much smaller percentages of coordinators, however, taught computer studies a majority of the time. Coordinators of third-grade programs were

Teaching Activities of Computer Coordinators — TABLE 5.2

Are you currently teaching computer science?	Grade 3	Grade 7	Grade 11
Yes	65.2%	69.9%	85.5%
No	28.4	25.7	12.2
What subject do you teach the majority of the time?			
Computers	17.4%	28.3%	28.6%
Mathematics	10.9	18.1	32.0
Science	1.8	5.0	7.7
English	0.5	0.1	2.7
Reading/Language Arts	8.0	3.1	0.6
Social Studies	0.7	0.9	0.3
History	0.0	0.4	0.4
Other	14.9	19.1	17.8
I don't teach any one subject a majority of the time	45.3%	23.3%	9.8%

most likely to answer that they did not teach any one subject a majority of the time, presumably because many were also multiple-subject classroom teachers. Coordinators at the level of seventh grade were most likely to say that they taught about computers more than any other subject. At the eleventh grade, however, coordinators were most likely to spend most of their instructional time teaching math. Much smaller percentages reported teaching science a majority of the time and, with the exception of third-grade reading teachers, few teachers of other subjects were also computer coordinators.

In the next section, the training of computer coordinators is considered. As statements are made concerning the adequacy of preparation, it is important to remember that not all computer coordinators taught computer studies at the time of the assessment. Inexperience with a programming language, Pascal for example, should not necessarily be taken as evidence that a computer coordinator is inadequately trained or unable to carry out the responsibilities of his or her job.

Professional Experience and Training

How many teachers have either an undergraduate major or minor in computer science? According to TABLE 5.3, only a small proportion of coordinators had either a major or minor in computer studies. Relevant

Relevant Education of Computer Coordinators — TABLE 5.3

Do you have an undergraduate major or minor in computer science?	Grade 3	Grade 7	Grade 11
Yes	5.5%	8.1%	14.9%
No	86.4	84.4	75.8
Have you had post-bachelor's study in computer science?			
Yes	52.7%	62.5%	64.3%
No	38.3	31.5	29.6
Where did you receive *most* of your training in computers?			
Self-taught	26.9%	26.4%	31.3%
College course(s)	25.5	36.6	45.0
School in-service	13.9	14.6	2.1
Technical school	1.5	1.3	1.8
Previous work experience	0.8	0.5	3.5
Other	1.8	0.9	1.7

...only a small proportion of coordinators had either a major or minor in computer studies.

undergraduate preparation is least common among coordinators at the seventh-grade level. It should be born in mind, however, that until recentl, few universities offered undergraduate degrees in computer science and that more than 80 percent of computer coordinators were over the age of thirty. Thus, while undergraduate preparation in computer studies might be desirable for computer teachers and coordinators, the opportunity was simply unavailable for many.

Although undergraduate study of computers was rare, TABLE 5.3 indicates that a majority of coordinators have had some kind of computer-related training. Many coordinators consider themselves to be largely self-taught, but one-quarter to one-third reported having taken some relevant college coursework. The likelihood of having taken coursework in computers increases in the higher grades. Forty-five percent of coordinators of eleventh-grade programs received most of their training through college courses.

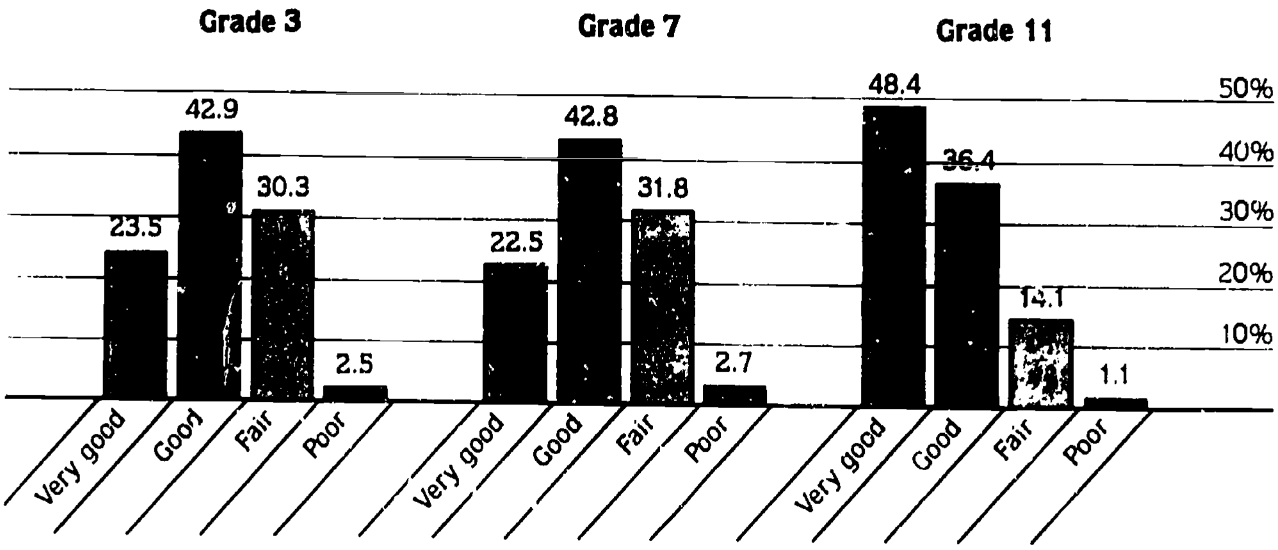
Coordinators of third- and seventh-grade computer programs were more likely to cite district-provided in-service training as most significant to their understanding of computers. Few coordinators received most of their training in technical schools. Aside from a small percentage of high school coordinators, previous work experience was not often cited as the primary source of training in computers.

Professional Confidence

Computer coordinators were asked to evaluate their own abilities in using computers. One question asked simply, "How good are you at using a computer?" Responses, presented in FIGURE 5.1, indicate that there were

Confidence of Computer Coordinators FIGURE 5.1

How good are you at using a computer?



notable differences among coordinators at different grade levels. Roughly 50 percent of high school coordinators believed that they were "very good" at using a computer, but only about 23 percent of third- and seventh-grade coordinators had the same impression of their skills.

At the low end of the scale, a relatively high proportion of coordinators indicated that they were either "fair" or "poor" at using a computer. Approximately one-third of coordinators from grades 3 and 7 chose one of these responses. The overall picture is that quite a few coordinators had relatively low levels of confidence about their ability to use a computer, and these feelings were more prevalent among coordinators in the elementary and middle grades.

A more direct question was, "Do you feel adequately prepared to teach computer science?" Thirty-two percent of third grade coordinators and 23 percent of seventh grade-coordinators responded "No" (TABLE 5.4). However, it is possible that some coordinators were not responsible for teaching about computers. Also, approaches to computer studies are varied, and many approaches would not be properly called computer science.

BASIC is clearly the best-known language among coordinators.

Data about coordinators' knowledge of programming languages is presented in TABLE 5.5. BASIC is clearly the best-known language among coordinators. This is not surprising considering the importance of BASIC to initial attempts at teaching programming in schools. Knowledge of Logo and Pascal is much less common. Recall that seventh graders were assessed for their ability to program in BASIC and Logo, while eleventh graders were assessed for their ability to use BASIC and Pascal. Students seemed to have difficulty answering questions about programming, especially in Logo and Pascal. These results seem to fit coordinators' reports of their ability to use these programming languages. Less than half of third- and seventh-grade coordinators knew Logo, and only about a third of eleventh-grade coordinators knew Pascal.

Knowledge of Logo and Pascal is much less common.

Preparedness of Computer Coordinators*

TABLE 5.4

Do you feel adequately prepared to teach computer science?	Grade 3	Grade 7	Grade 11
Yes	60.0%	71.4%	86.4%
No	32.2	23.1	10.1

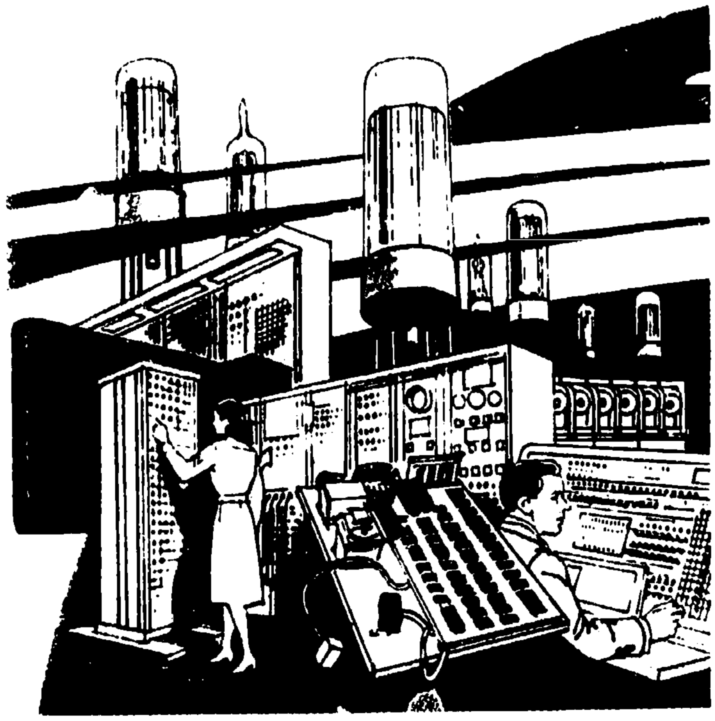
*Because of non-responses, columns do not add up to 100%.

Computer Coordinator's Ability to Teach Programming			TABLE 5.5
Language			
	Grade 3	Grade 7	Grade 11
BASIC	62.3%	80.8%	91.9%
Logo	46.4	45.7	35.4
Pascal	4.9	13.2	35.8

*Because of non-responses, columns do not add up to 100%.

Summary

The computer age has, in a sense, taken the American educational system by storm. Many teachers, caught in that storm, found themselves inadequately prepared for the teaching about computers. Most graduated from college when few computer courses were offered and before degrees in computer studies were awarded. While this lack of formal training in computers does not necessarily disqualify them from performing well, too many teachers make low evaluations of their knowledge and skill. As computer education matures and finds its niche in the education system, the teaching force, no doubt, will continue to increase in effectiveness. Meanwhile, educational planners and administrators will do well to find ways to continually advance the knowledge and skill of computer coordinators and teachers.

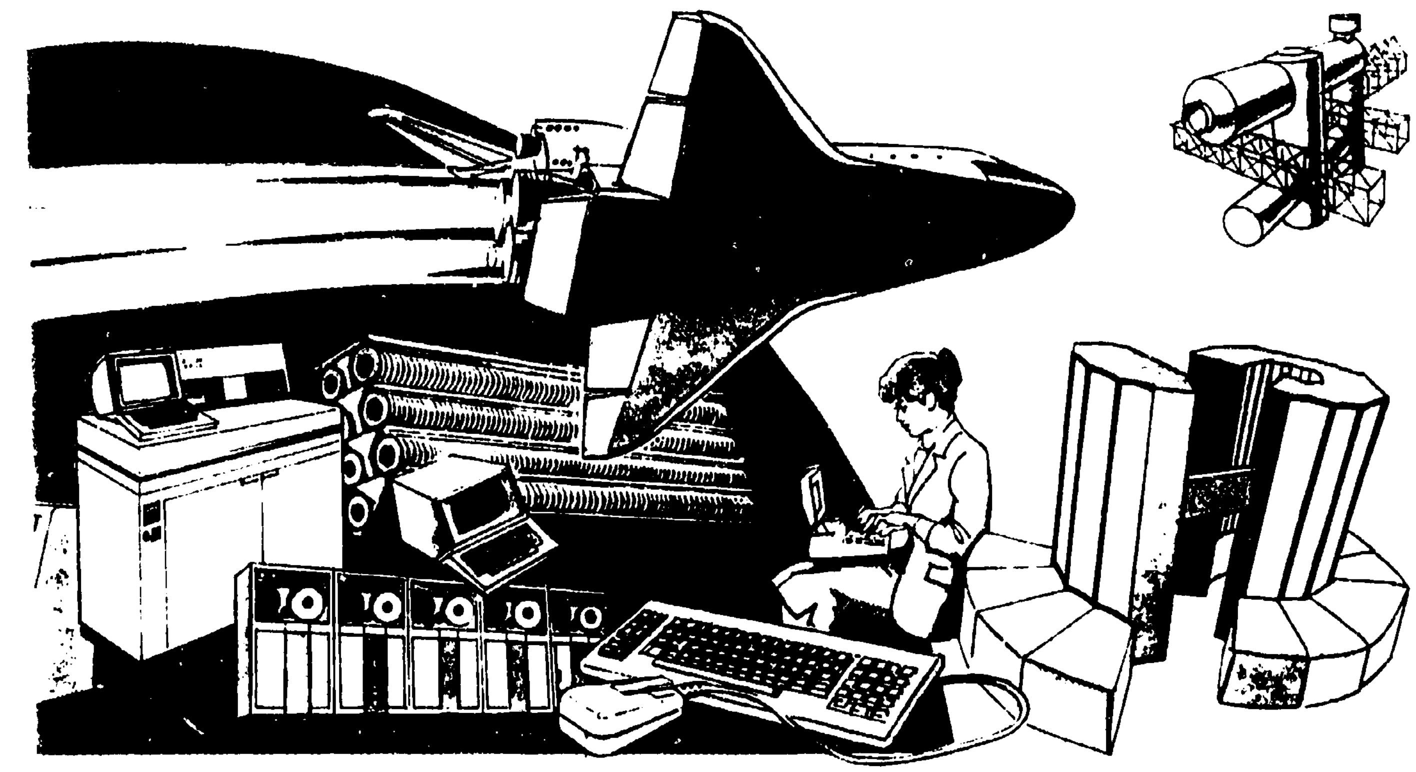


CHAPTER 6
Implications

IN 1983, The National Commission on Excellence in Education declared that computer science is one of the "New Basics." If this is so, we must be concerned about what appear to be low levels of computer competence described in this report. Students should know more about computers. But what aspects of computer knowledge and use are essential for students to learn? Some argue that, above all, students should know how to use flexible applications software, such as word processing and spreadsheet programs. If these are important, then clearly the data are disappointing. Most students do not have such skills, nor do they have the instruction necessary to develop the skills. Others argue that an elementary knowledge of a programming language is essential. But programming, also, is learned by few students.

In middle and high schools, the use of computers is largely confined to computer studies courses. This compartmentalization restricts students from using the computer as a general-purpose learning tool that is useful across curriculum domains. The restricted use may reflect both the limited availability or obsolescence of equipment and software, or the uncertainty among teachers about how computers can be integrated into the study of their subject areas.

In addition to increasing the use of computers in traditional curricula, students should probably be encouraged or required to enroll in computer studies courses—but this may not be so easy. Few would argue that reading, writing, and mathematics are essential; science education, as well, has gained



increasing attention as America has been slipping from its place of pre-eminence in science and technology. What will become dispensable in order to make room for an enriched computer studies program?

Finally, what about discrepancies in computer competence among subgroups? Black and Hispanic students have less exposure to computers than their White peers. The greatest differences in exposure are outside of school, where families of White students, males especially, are more likely to own computers. The assessment data show that many students depend on extracurricular access to learn about computers. Indeed, the advantages associated with home access to a computer were frequently greater than the advantages associated with the current study of computers at school.

Experience with computers, both within and outside the school, is critical to the development of knowledge and skill.

The issue of *experience* is central to this report. Experience with computers, both within and outside the school, is critical to the development of knowledge and skill. Differences in experience appear to account for much of the disparity in achievement between subgroups. Further, experience, especially formal training, seems to be what is sorely needed by a great proportion of computer studies teachers. Many questions remain. What should be taught? How can we promote equitable opportunities of instruction and access? How can we help teachers to be more effective in this domain? In entering the computer age, American education has truly come a long way in a short time, but the path ahead looms with challenges and possibilities that can only be imagined.

PROCEDURAL APPENDIX

The Design of the NAEP Computer Competence Assessment Spring 1986

Background

THE NATION'S Report Card, the National Assessment of Educational Progress (NAEP), is an ongoing, congressionally mandated project established to conduct national surveys of the educational attainments of young Americans. Its primary goal is to determine and report the status and trends over time in educational achievement. NAEP was created in 1969 to obtain comprehensive and dependable national educational achievement data in a uniform, scientific manner. Today, NAEP remains the only regularly conducted national survey of educational achievement at the elementary-, middle-, and high-school levels.

NAEP was created in 1969 to obtain comprehensive and dependable national educational achievement data in a uniform, scientific manner.

Since 1969, NAEP has assessed 9-year-olds, 13-year-olds, and 17-year-olds attending public and private school. In 1983, NAEP began sampling students by grade as well as by age. The results presented in this report are for students in grades 3, 7, and 11. In addition, NAEP periodically samples young adults. The subject areas assessed have included reading, writing, mathematics, science and social studies, as well as citizenship, computer competence, literature, art, music, and career development. Assessments were conducted annually through 1980 and have been conducted biennially since then. All subject areas, with the exception of career development and computer competence, have been reassessed to determine trends in achievement over time. To date, NAEP has assessed approximately 1,300,000 young Americans.

From its inception, NAEP has developed assessments through a consensus process. Educators, scholars, and citizens representative of many diverse constituencies and points of view design objectives for each subject area assessment, proposing general goals they feel students should achieve in the course of their education. After careful reviews, the objectives are given to item writers who develop assessment questions appropriate to the objectives.

The young people sampled are selected so that their assessment results may be generalized to the entire national population.

All exercises undergo extensive reviews by subject-matter and measurement specialists, as well as careful scrutiny to eliminate any potential bias or lack of sensitivity to particular groups. They are then field tested, revised, and administered to a stratified, multi-stage probability sample. The young people sampled are selected so that their assessment results may be generalized to the entire national population. Once the data have been collected, scored, and analyzed, NAEP publishes and disseminates the results. Its purpose is to provide information that will aid educators, legislators, and others to improve education.

To improve the utility of NAEP achievement results and provide an opportunity to examine policy issues, NAEP, in recent assessments, has collected information about numerous background issues; students, teachers, and school officials answer a variety of questions about demographics, educationally related activities and experiences, attitudes, curriculum, and resources.

NAEP is supported by the U.S. Department of Education, Office of Educational Research and Improvement, Center for Education Statistics. In 1983, Educational Testing Service assumed the responsibility for the administration of the project, which had previously been administered by the Education Commission of the States. NAEP is governed by an independent, legislatively defined board, the Assessment Policy Committee.

General Information

The NAEP Computer Competence assessment was administered in the Spring of 1986 as one of four principal subject areas in the 1986 NAEP Assessment—the others being Mathematics, Science, and Reading. The assessment was given to students in third, seventh, and eleventh grade, and also to students who are 9, 13, and 17 years of age. For this assessment, birth-date ranges for eligible 9-, 13-, and 17-year-olds were defined as October 1 through September 30 for each age level.

The final design of the computer competence assessment contained fifteen primary blocks of computer-related test items. Three of the blocks were administered to the age 9/grade 3 group of students, and the remaining twelve were equally divided among the other two student groups (age 13/grade 7 and age 17/grade 11). In addition to the primary blocks in each of the four principal subject areas, each student was also given a block of common core items. Some of the common core items were computer-related, but a majority gathered general educational information. TABLE 1 shows the primary block allocation for the Computer Competence Assessment, the other three principal subject area assessments, and the add-on assessments.

1986 NAEP Assessment: Primary Block Allocation				TABLE A-1
Assessment Area	**Age 9/ Grade 3**	**Age 13/ Grade 7**	**Age 17/ Grade 11**	**Total**
Computer Competence	3	6	6	15
Mathematics	7	9	11	27
Science	7	9	11	27
Reading	6	6	6	18
*History	0	0	6	6
*Literature	0	0	6	6
Language Minority	3	3	3	9
TOTAL	**26**	**33**	**49**	**108**

*NOTE: The History and Literature assessment areas together comprise the *Foundations of Literacy* add-on assessment.

Test Booklet Composition

Each of the students participating in the 1986 NAEP Assessment received a single test booklet containing three primary item blocks and one common-core item block. The three primary item blocks in each booklet were selected from among the four principal subject areas using a statistical technique called Balanced Incomplete Block (BIB) spiralling. Under this method, the primary blocks in a test booklet may be from three different subject areas, two from one subject area and a third from another, or all three from the same subject area. Using BIB spiralling, 50 booklets were generated at the age 9/grade 3 level, 66 at the age 13/grade 7 level, and 90 at the age 17/grade 11 level, for a total of 206 different assessment booklets. Of these 206 booklets, 70 contain at least one block of Computer Competence items (16, 25, and 29 booklets at each of the three respective age/grade levels). TABLE A-2 shows the composition of assessment booklets with a least one primary block of Computer Competence items. The first four columns in the table display how many blocks from each of the four principal subject areas contribute to the composition of each booklet. The last four columns in the table display the number of booklets at each age/grade level and overall for the ten different booklet composition combinations.

The BIB spiralling method cycles the booklets for administration so that typically only a few students in any assessment session receive the same booklet. At each age/grade level, each block of exercises is administered to approximately 2,600 students, providing about 2,000 student responses to each item for the grade-level analyses reported herein.

At each age / grade level, each block of exercises is administered to approximately 2,600 students . . .

Composition of Booklets With at Least One Computer Competence Block

TABLE A-2

Composition C	R	M	S	Age 9/ Grade 3	Age 13/ Grade 7	Age 17/ Grade 11	Total
3	0	0	0	1	4	2	7
2	1	0	0	0	3	9	12
2	0	1	0	0	0	0	0
2	0	0	1	0	0	0	0
1	2	0	0	3	3	3	9
1	1	1	0	3	4	2	9
1	1	0	1	3	4	2	9
1	0	2	0	0	0	5	5
1	0	1	1	6	7	2	15
1	0	0	2	0	0	4	4
TOTAL				16	25	29	70

Computer Competence Item Categories

Each Computer Competence primary item block is composed of items from four different categories:

1. **Computer Background and Attitude**

   a) General Background... items which determine the degree of the student's computer exposure, the sources of computer resources, the courses taken by the student which use computers, the programming languages the student knows, and other general computer-related information.

   b) Attitude... items which test the student's attitudes toward computer-related issues such as copyright restrictions, software piracy, and computer ethics.

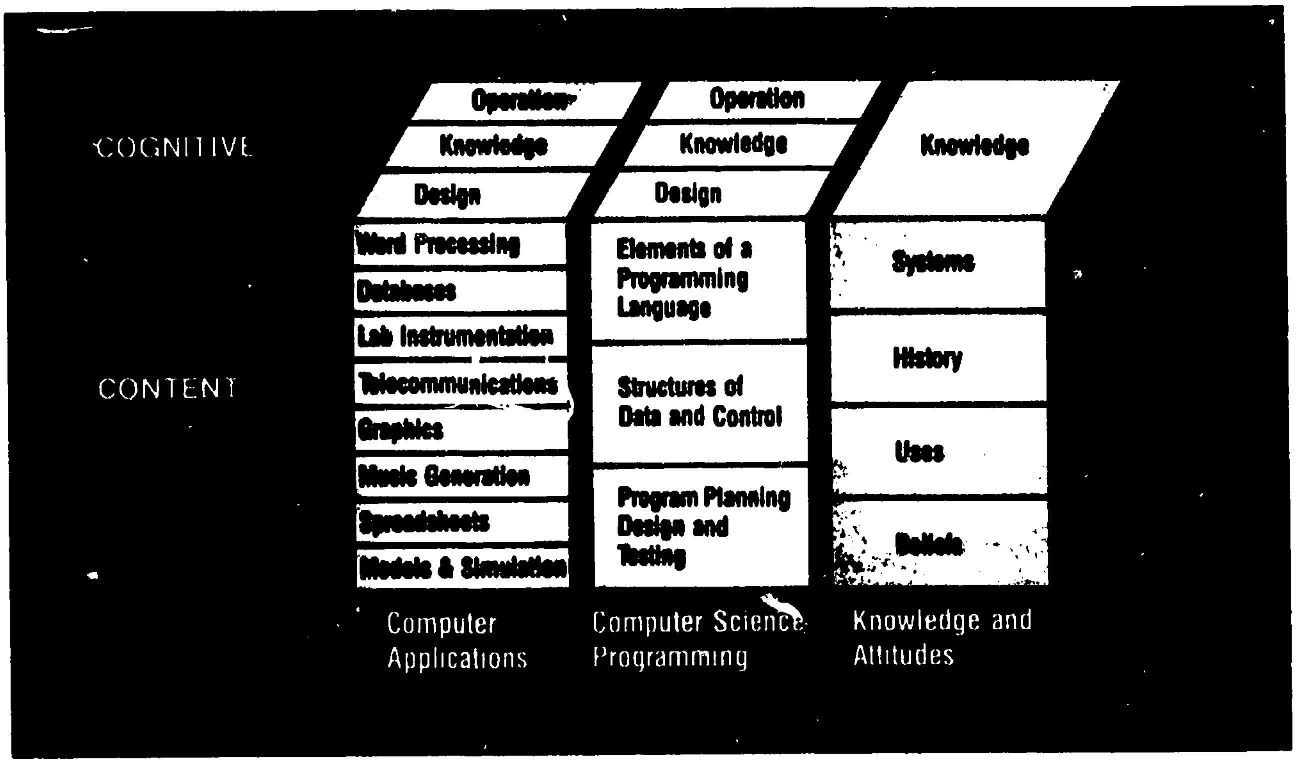
2. **Computer Knowledge**. . . items which determine the student's knowledge of computer systems, the history of computing, and the uses for computer technology.

3. **Computer Applications**... items which test the student's familiarity with various computer applications areas, including their operation and design.

4. **Computer Science/Programming**. . . items which test the student's knowledge of programming language elements and structures, and his/her ability to plan and design programs.

Computer Competence Categories: Cognitive and Content Areas

FIGURE A-1



Items falling into the Knowledge, Applications, and Programming categories are referred to as cognitive items because they assess certain cognitive skills, including Operation, Knowledge, and Design. Items in the Background and Attitude category are called non-cognitive items because they do not assess any cognitive skills but simply collect information about each student. Each of the Computer Competence categories is further subdivided into classification areas. FIGURE A-1 displays the cognitive item categories and the classifications they contain.

In the 15 primary Computer Competence blocks, items falling into the same category are generally grouped together. This is not a set rule for all blocks, however, due to page and printing restrictions and other considerations. Groups of Background items appear at the start of most blocks, followed by groups of Knowledge and Applications items, and then by items in Computer Science/Programming.

Each primary block contains two sections of Computer Science/Programming items, one in each of two different programming languages. The blocks administered at the age 9/grade 3 level and at the age 13/grade 7 level contain programming items using the BASIC and Logo programming languages. The age 17/grade 11 blocks contain programming items using the BASIC and Pascal programming languages.

In general, each of the primary blocks contain 4 or more items per category. The number of Background/Attitude items per block ranges from

Item Distribution Information: Items per Block by Category	TABLE A-3

Block	Background & Attitude	Knowledge	Applica-tions	Programming BASIC	Logo	Pascal	Total*
9CA	28	6	5	5	4	0	48 (40)
13CA	29	6	5	5	5	0	50 (42)
17CA	29	6	5	5	0	7	52 (44)
9CB	23	5	5	5	4	0	42 (34)
13CB	23	6	5	5	4	0	43 (35)
17CB	23	6	5	6	0	4	44 (36)
9CC	18	5	5	5	5	0	38 (33)
13CC	9	7	8	5	4	0	33 (28)
17CC	9	7	8	5	0	4	33 (28)
13CD	12	14	4	5	6	0	41 (37)
17CD	28	5	6	7	0	1	45 (40)
13CE	15	5	6	5	6	0	35 (30)
17CE	25	11	5	4	0	6	49 (44)
1:3CF	17	6	5	6	5	0	38 (33)
1 /CF	24	5	8	5	0	4	41 (36)
TOTAL	**312**	**100**	**85**	**78**	**43**	**26**	**632 (540)**
UNIQUE	**112**	**53**	**50**	**58**	**35**	**26**	**324**

*NOTE: The counts for total items per block are presented in two ways. The totals outside the parentheses include counts for items allowing multiple responses as several items. The totals inside the parentheses treat multiple response items as single items.

4 to 23, the number of Knowledge items from 5 to 13, and the number of Applications items from 5 to 8. Under the Programming category, each block has 8 or more items in two different programming languages. TABLE A-3 contains information about the number of items in each block by category. Note that some items are cross-categorized a both Knowledge and Applications items and, therefore, appear in the counts for both these categories but are counted once in the total for all items.

Item Types

The items in the Computer Competence portion of the assessment were of two basic types: multiple-choice items, and open-ended items. The vast majority of the items were of the multiple-choice type. Multiple-choice items in the Background and Attitude category had no correct answer associated with them, and some even required or allowed multiple responses. Those in the cognitive categories, however, had a correct answer or key associated with them and did not allow multiple responses.

There were only a handful of open-ended items on the Computer Competence assessment. Most appeared in the Computer Science/Programming section of each item block. Open-ended items were hand scored according to a scoring rubric prepared for each item. Most open-ended items were scored on a standard scale:

0 = No response or not reached
1 = An attempt was made, but incorrect
2 = The students had some idea of what they were doing
3 = Correct answer
4 = Best possible answer
9 = An "I don't know," off-task, or irrelevant response

Some, however (especially those in the non-cognitive categories), were scored in a quantitative fashion, grouping students into categories based on their responses.

Assessment Session Timing

Between 54 and 57 minutes were allotted for each assessment session.

Between 54 and 57 minutes were allotted for each assessment session. At the age 9/grade 3 level, each student was given 14 minutes to complete items in each of the primary blocks and an additional 13-15 minutes to complete the common core block of items, which were read aloud. Students at the other two age/grade levels had 16 minutes per block to complete their primary block items and 6 minutes to answer their common-core items. The time allotted for completion of each of the primary blocks was based, in part, on timing estimates gathered during the field test of Computer Competence items.

Sampling

All NAEP assessments are based on a deeply stratified, three-stage sampling design. The first stage entails defining primary sampling units (PSUs)—typically counties, but sometimes aggregates of small counties; classifying the PSUs into strata defined by region and community type; and randomly selecting PSUs. For each age level, the second stage entails enumerating, stratifying, and randomly selecting schools both public and private within each PSU selected at the first stage. The third stage involves randomly selecting students within a school for participation in NAEP. Some students sampled (less than 5 percent) are excluded because of limited English proficiency or severe handicap. In 1984, NAEP began collecting information about excluded students to be able to report more accurately on the nature of assessment results.

In 1984, NAEP began collecting information about excluded students to be able to report more accurately on the nature of assessment results.

Item/Block Overlap and Item Appearance

Under the final design for the 1986 Computer Competence assessment, several of the blocks contain duplicate items. Eight of the fifteen blocks consist largely of overlap items from three overlap item groups. It is important to note that these eight blocks DO NOT produce three identical blocks. Instead, each of the eight blocks gathers a majority of its items from one of the three overlap item groups but fills the balance of its item pool with unique items. The item overlap under the present assessment design gathers data for large groups of items across age/grade levels, allowing comparisons of performance over age/grade level to be made.

Item Distribution Information

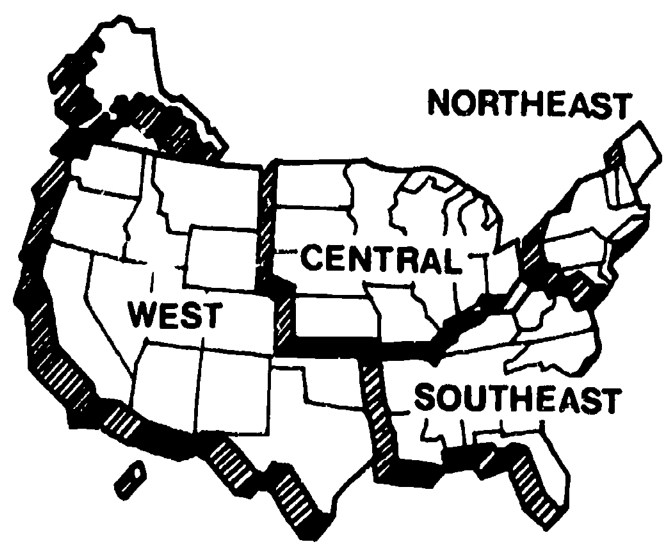
The 1986 NAEP Computer Competence assessment administered 632 items in the 15 primary blocks. Of these 632 total items, 324 were unique items, each appearing in one or more blocks. One hundred-twelve of the unique items were non-cognitive, falling in the Background/Attitude category, and 212 were cognitive, falling in the Knowledge, Applications, and Computer Science/Programming categories. There were 53 unique Knowledge items, 40 unique Applications items, and 119 Computer Science/Programming items. Of the unique Programming items, 58 were in BASIC, 35 in Logo, and 26 in Pascal.

NAEP Reporting Groups

NAEP does not report results for individual students. It only reports for groups of students. In addition to national results, this report contains information about subgroups defined by region of the country, sex, race/ethnicity, and size and type of community. Definitions of these groups follow.

Region

The country has been divided into four regions: Northeast, Southeast, Central and West. States included in each region are shown on the following map.



Gender

Results are reported for males and females.

Race/Ethnicity

Results are presented for Black, White, and Hispanic students. Classification is based on student self-reports of their racial/ethnic identity according to the following categories: White, Black, Hispanic, Asian or Pacific Islander, American Indian or Alaskan Native, and Other. The sample sizes were insufficient to permit separate reliable estimates for the additional subgroups defined by race/ethnicity. In many tables and graphs, data are reported only for Black, White, and Hispanic students, because of small sample sizes and high standard errors associated with other groups.

Size/Type of Community

Community types are defined by an occupational profile of the area served by the school as well as by the size of the community in which the school is located. The definitions of community types are as follows:

High metropolitan: City areas where a high proportion of adults was employed in professional or managerial positions and a low proportion employed as factory or farm workers, not regularly employed, or on welfare. Schools in such communities were in cities, or the urbanized areas of cities, with populations greater than 200,000.

Medium-sized city: Cities with populations of between 25,000 and 200,000 which did not classify as urban fringe or big cities.

Urban fringe: Urbanized areas, but outside the limits of cities with populations over 200,000, but not classified as high or low metropolitan.

Small place: Communities with populations of less than 25,000. These communities were not located in urbanized areas of big cities and could not be classified as extreme rural.

Extreme rural: Areas where a high proportion of adults were farmers or farm workers and a low proportion were professional, managerial, or factory workers. At least some of the students in these communities were from open country areas or places with a population of less than 10,000.

Big city: Cities with population greater than 200,000, but not classified a high or low metropolitan.

Low metropolitan: Areas where a high proportion of the adult population was either not regularly employed or on welfare and a low proportion was employed in professional or managerial positions. The schools in these communities were located in cities, or the urbanized areas of cities, with a population of greater than 200,000.

Additional Background Factors

Students at grades 3 and 7 were asked about 30 questions and those at grade 11 approximately 50 questions about their school experiences and their home environment . . .

In addition to the standard NAEP reporting variables of region, gender, race/ethnicity, and size and type of community, NAEP also makes use of background information collected from students. In the common core block, NAEP asked all students a number of general background questions. Students at grades 3 and 7 were asked about 30 questions and those at grade 11 approximately 50 questions about their school experiences and their home environment, including reading materials in the home, level of parents' education, and the time spent on homework. NAEP also asked computer-related background questions in each primary computer block administered in the assessment. These questions asked students about their exposure to computers, their source of computer resources, their knowledge of programming languages, and their source of formal computer instruction. Information in this report appears broken down by some of these background variables used as factors, as well as by composites of various background variables.

THE NATION'S REPORT CARD naep

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The success of the National Assessment depends on the talents and dedication of many NAEP staff members and outside consultants. This report is the result of the hard work, persistence, and creativity of these professionals. A number who have made outstanding contributions are acknowledged below.

The Learning Area Committee for the Computer Competence assessment, which was responsible for the generation of assessment objectives, was chaired by Marc Tucker, now president of the National Center of Education and the Economy in Rochester, New York. Members of the committee were Harold Abelson, Sharon Burrowes, Eugene Galanter, Vinetta Jones, Arthur Luehrmann, Michelle Rohr, and Joyce Tobias. Another panel, consisting of Mr. Leuhrmann and Ms. Rohr of the Learning Area Committee, as well as Robert Vivens and Nicolas Petreley, was given responsibility for developing an analysis and interpretation plan. In addition to these panels, more than 60 teachers, researchers, and computer curriculum specialists from around the country served as reviewers for the project.

The design of the 1986 NAEP assessment was the result of the technical creativity and precision of Albert Beaton, Sam Messick, and Robert Mislevy. Eleanor Driscoll, Jeff Wadkins, and Jim Braswell worked on item development. Data analyses were performed by Dave Freund, Laurie Barnett, and Norma Norris. Andy Mychajlowycz coordinated the scoring of the open-ended questions and also wrote the procedural appendix. The operational aspects of the assessment, such as the production of test booklets, data collection at the school sites, and data entry, were supervised by Nancy Mead. Much of the sampling and data collection were carried out by WESTAT, Inc.

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