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ABSTRACT

This report focused upon mathematical skills needed by the American consumer to function effectively in the marketplace. The nationwide assessment was conducted during the 1972-73 school year by the National Assessment of Educational Progress (NAEP). Respondents at four age levels were included: 9-year-olds, 13-year-olds, 17-year-olds, and young adults ages 26-35. The items on consumer mathematics skills were administered to individuals (probability samples) chosen in such a way that results could be generalized to an entire national population. The first chapter of the report describes results for problems involving money, using such skills as averaging and calculating percent and proportion. Chapter 2 discusses results of household problems involving estimating unit prices and converting units of measure. Chapter 3 examines the ability to read and interpret graphs. Chapter 4 deals with skill in computation of averages and percents. Chapter 5 summarizes the results. Data are reported for various groups within the national population. (JBW)

NATIONAL ASSESSMENT OF EDUCATIONAL PROGRESS
A Project of the Education Commission of the States

Arch A. Moore, Jr., Governor of West Virginia, Chairman, Education Commission of the States
Wendell H. Pierce, Executive Director, Education Commission of the States
J. Stanley Ahmann, Director, National Assessment

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CONSUMER MATH

Selected Results From the First National Assessment of Mathematics

Mathematics Report No. 04-MA-02

June 1975

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402

NATIONAL ASSESSMENT OF EDUCATIONAL PROGRESS

J. Stanley Ahmann
Director

George H. Johnson
Associate Director

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ACKNOWLEDGMENTS

Many people have made substantial contributions to the mathematics assessment, from the beginning of the National Assessment of Educational Progress (NAEP) in 1964 to this second report of findings in the area of mathematics. Unfortunately, it is not possible to acknowledge them all here, and an apology is due to those whose names have been omitted.

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J. Stanley Ahmann

J. Stanley Ahmann
Project Director

INTRODUCTION

The National Assessment of Educational Progress (NAEP) is an information-gathering project that surveys the educational attainments of 9-year-olds, 13-year-olds, 17-year-olds and adults (ages 26—35) in 10 learning areas: art, career and occupational development, citizenship, literature, mathematics, music, reading, science, social studies and writing. Different learning areas are assessed every year, and all areas are periodically reassessed in order to measure educational change.

Each assessment is the product of several years work by a great many educators, scholars and lay persons from all over the country. Initially, these people design objectives for each area, proposing specific goals that they feel Americans should be achieving in the course of their education. After careful reviews, these objectives are then given to exercise (item) writers, whose task it is to create measurement tools appropriate to the objectives.

When the exercises have passed extensive reviews by subject-matter specialists and measurement experts, they are administered to probability samples from various age levels. The people who comprise these samples are chosen in such a way that the results of their assessment can be generalized to an entire national population. That is, on the basis of the performance of about 2,500 9-year-olds on a given exercise, we can generalize about the probable performance of all 9-year-olds in the nation.

This report is focused upon mathematical skills needed by the American consumer to function effectively in the marketplace. Some of these skills, such as averaging and calculating percent and proportion, are often used in calculations with money. Other skills are needed to solve household problems — for example, estimating unit prices and converting units of measure. Magazine and newspaper articles often present information in graphs or tables that the consumer must be able to read and interpret. During the 1972—73 school year, National Assessment conducted a nationwide assessment of abilities in mathematics. Included in the assessment were a number of items measuring consumer-mathematics skills. The first chapter of this report describes results for problems involving money. Included in the second chapter are problems commonly encountered around the household — measuring things and making measurement conversions. Proficiency in reading and interpreting graphs is examined in the third chapter; the fourth chapter deals with skill in computation of averages and percents.

The assessment included respondents at four age levels — 9-year-olds, 13-year-olds, 17-year-olds and young adults ages 26—35. The consumer-math exercises were assessed primarily at ages 17 and adult since the necessary skills usually are not developed at the younger age levels. Some of the items were administered to 13-year-olds, and these results are included here.

The majority of National Assessment exercises are designed to be given to groups of 8 to 12 people, while others are to be administered on an individual basis. "Individual" exercises are used to elicit responses that would be difficult to observe in a group situation — for example, performing a science experiment or singing a song. In mathematics, these exercises were often used to observe the process by which a person solved a problem.

To prevent reading ability from affecting mathematics performance, the exercises in

group packages were played to the respondents on a tape recorder. Individually administered exercises were usually read aloud by the interviewer.

Many of the mathematics exercises were open-ended, meaning that the respondent had to supply an answer rather than select a response from a number of alternatives. The responses to the open-ended exercises were put into various categories. These categories reveal percentages of people who make particular errors, e.g., forget to carry or misplace a decimal. This provides some diagnostic information about common mathematical mistakes.

Responses that could not be placed in any of the error categories were placed in a category called "other unacceptable." Respondents were instructed to write the words "I don't know" on the answer line or to fill in the oval beside the "I don't know" choice if they felt they did not know the answer to a problem.

National Assessment releases approximately one-half of the exercises administered in a learning area for a given assessment year. The unreleased exercises will be reassessed in a future assessment to provide measures of change in ability levels. In this report, results for both released and unreleased exercises are discussed; however, actual exercise text appears only for released exercises. (Unreleased exercises are designated by a "U" at the beginning of the exercise number.)

This report concerns only consumer-math skills included in the mathematics assessment. Other reports are devoted to additional selected topics in mathematics. Complete data on the entire mathematics assessment are provided in the mathematics technical reports.

National Assessment also publishes a general information yearbook that describes all major aspects of the Assessment's operation. The reader who desires more detailed information about how NAEP defines its groups, prepares and scores its exercises, designs its samples and analyzes and reports its results should consult the *General Information Yearbook, Report 03/04-GIY.*

CHAPTER 1

DETERMINING COSTS: CONSUMER PROBLEMS INVOLVING MONEY

The exercises presented in this chapter are all concerned with determination of costs in a consumer setting. Several of the problems involve the use of percents in calculating costs, while others concern figuring taxes, comparing prices and determining costs for specific units of time or distance.

Cost Comparisons

Comparing costs on different items is a common application of consumer-mathematics skills. The ability to make cost comparisons is obviously needed at the supermarket where sizing and prices often confuse the consumer. Relative costs must also be considered in evaluating the advantages and disadvantages of cash and credit buying. The exercises discussed in this section present several typical consumer situations and ask the respondent to either give the difference in price or determine the most economical buy.

Two exercises required computation of comparative food costs. An exercise about finding the lowest price per ounce for rice is shown in Table 1. Percentages of correct responses show a successive increase from age 13 to adult, but at all three age levels a majority of the respondents evidently assumed that the largest size was the best buy. The actual prices per ounce were quite similar: 3.04¢ per ounce for the 1-pound, 12-ounce box and 3.09¢ for the 2-pound box. Respondents may have only calculated to two places and then assumed that since the prices were very close the larger size was the more economical. Thirteen percent of the 13-year-olds and 10% of the 17-year-olds evidently thought that lowest price per ounce meant lowest price.

TABLE 1. Exercise 1 and Results

A housewife will pay the lowest price per ounce for rice if she buys it at the store which offers

	Age 13	Age 17	Adult
○ 12 ounces for 40 cents.	13%	10%	4%
○ 14 ounces for 45 cents.	9	8	5
● 1 pound, 12 ounces for 85 cents.	25	34	39
○ 2 pounds for 99 cents.	46	46	47
○ I don't know.	6	3	4
No response	2*	+*†	+*†

**Figures may not add to 100% due to rounding error.*
†Plus equals rounded percents less than one.

A similar task was performed by 17-year-olds and adults on an unreleased, individually administered exercise (U1). In this case, respondents were to determine the best buy on various-sized cans of tuna fish. After estimating which can would be the best buy, respondents were asked to give a specific unit price for each can.

Forty percent of the 17-year-olds and 45% of the adults correctly determined which can sold for the lowest cost per ounce, 46% of the 17-year-olds and adults incorrectly guessed that the largest can sold for the lowest cost per ounce. The difference in price per ounce between the correct and the largest can was approximately 1¢.

TABLE 2. Male, Female Results for Exercises 1 and U1

	Age 17			Adult		
	National	Male	Female	National	Male	Female
Exercise 1—Rice, Lowest Unit Cost						
Percent answering correctly	34%	40%	29%	39%	45%	32%
Percent answering largest size	46	42	50	47	41	54
Exercise U1—Tuna Fish, Lowest Unit Price						
Percent answering correctly	40	42	39	45	55	37
Percent answering largest size	46	46	45	46	40	51

It is generally assumed that women do most of the grocery shopping in America. However, on these two exercises, adult males were more likely than adult females to give the correct answer; adult females were more likely to choose the largest size as the most economical. The gap between males and females is larger for adults than for 17-year-olds as Table 2 reveals.

A comparison between the cash and credit price for an automobile was requested in Exercise 2, shown in Table 3. Over one-half of the 17-year-olds and slightly over two-thirds of the adults correctly computed the difference in total price using cash and using credit.

Male and female results on this exercise were virtually identical at age 17, but at the adult level males held a 13-point advantage.

Another exercise (U2) asked for a comparison of costs per square foot for housing floor space. Total cost and total square footage of the houses were provided, and respondents were asked how much more one square foot would cost in one house than in the other. Twenty-one percent of the 17-year-olds and 32% of the adults successfully found the difference in unit costs. An additional 6% at age 17 and 10% at adult indicated they knew the correct process.

TABLE 3. Exercise 2 and Results

A new automobile can be bought for cash for $2,850 or on credit with a down payment of $400 and $80 a month for three years. How much MORE would a person pay by buying on credit rather than by buying the car for cash?

ANSWER	Age 17	Adult
$430, 430*	56%	68%
Correct process, wrong or no answer	8	9
30 or attempt at (36 x .80) - 2,850	6	4
3,280 or attempt at (36 x 80) + 400	2	1
Other unacceptable	20	12
"I don't know" or no response	9†	7†

**Asterisk indicates correct answer.*
†Figures may not add to 100% due to rounding error.

Taxes

Many adults must read tables — federal and state income tax tables, sales tax tables and postage-rate tables to name a few. Exercise 3 required adults to use a section of the Federal

Income Tax Tables to determine the tax for a married couple with three exemptions. Fifty-five percent, or slightly over half, of the adults responded with the correct amount of tax. About 10% of the adults used the table for two rather than three exemptions, indicating a need for careful reading of all relevant material. Another 13% responded with "I don't know." Although not all American adults pay federal income taxes, it may seem rather surprising that 45% of the adults ages 26—35 have difficulty in reading tax tables intended for their use.

The assessment also included two exercises using a simpler tax table. One multiple-part exercise (U3A—C) required finding the sales tax for different amounts of money. When asked to find the tax for amounts listed on the tax tables, one-half of the 13-year-olds, three-fourths of the 17-year-olds and four-fifths of the adults were able to do so. However, when asked to find the tax on an amount higher than the amount listed on the tax tables, 7% of the 13-year-olds, 30% of the 17-year-olds and 60% of the adults gave an acceptable answer.

On an individually administered exercise (U4), in which adults were asked to fill out an order form after hearing a simulated phone order, 62% of the adults calculated the cost of the items correctly and added to find the proper subtotal. However, only 53% then gave the proper sales tax. The amount was above those shown on the tax table so calculation was necessary. An additional 15% of the adults found the correct tax for their incorrect merchandise subtotal. Thus, about 70% of the adults were successful in reading the sales tax table compared to 55% for the Federal Income Tax Table.

The relationship of assessed value and property tax was considered in two exercises. On Exercise 4, shown in Table 4, over half of the adults gave the right answer; adults performed 16 percentage points above 17-year-olds.

A similar exercise (U5), presented in an open-ended format, was administered only to adults. Twenty-seven percent answered with the correct amount of tax. Twenty-six percent set up the problem correctly but made a mistake in the solution; an additional 18% also set up the problem correctly but rounded the numbers, most commonly the assessed value, before completing the computations.

TABLE 4. Exercise 4 and Results

If a city's property tax is $29.87 per $1,000 of assessed value, the tax on property assessed at $14,900 would be CLOSEST to which amount?

	Age 17	Adult
○ $400	8%	7%
○ $420	18	14
● $450	40	56
○ $470	18	14
○ I don't know.	16	8
No response	+*	+*†

*Plus equals rounded percents less than one.
†Figures may not add to 100% due to rounding error.

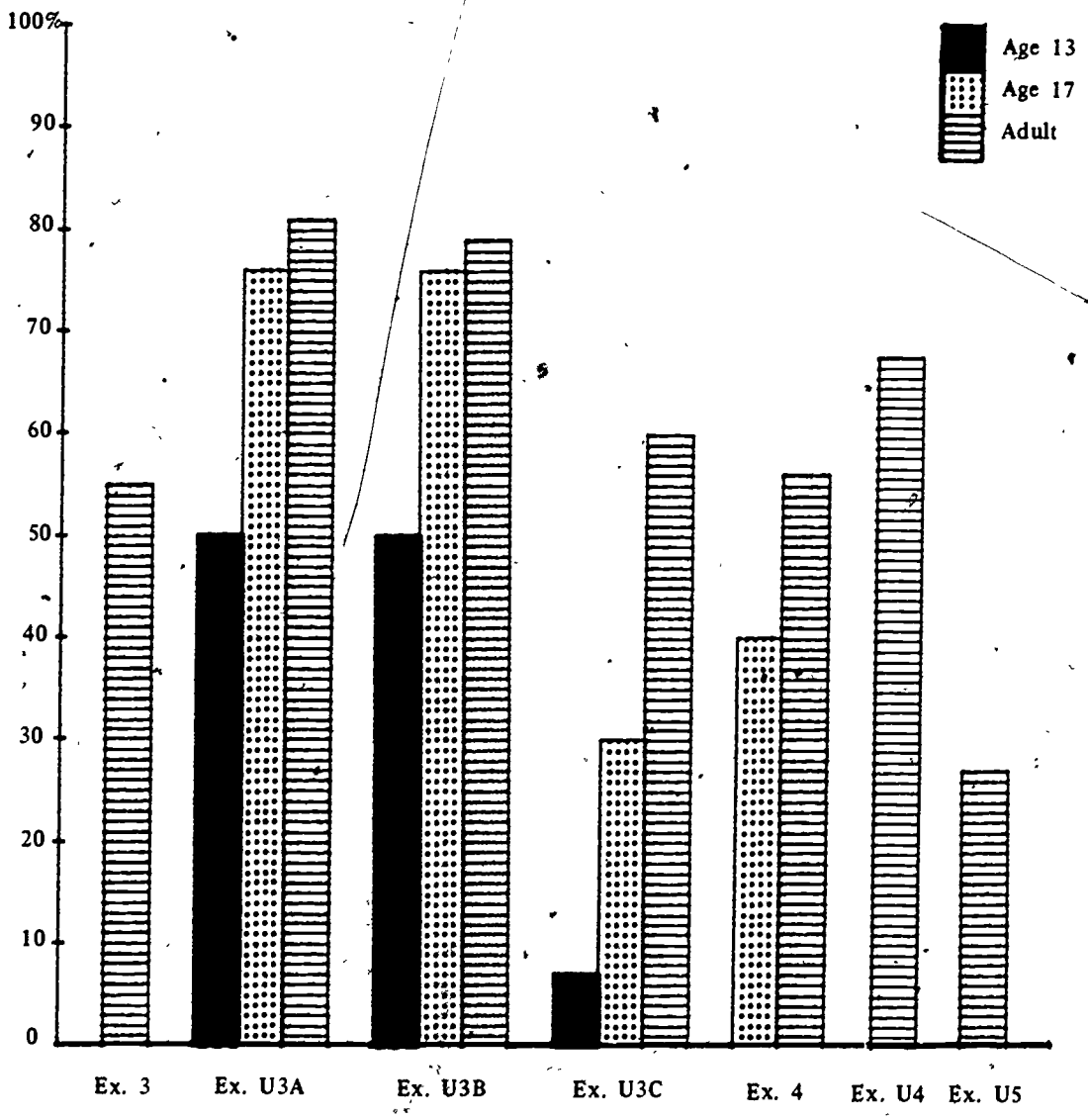
Summary of Tax Problems

The results from this section indicate that 75—80% of the 17-year-olds and adults could use a simple tax table, but percentages of success were lower for use of federal income tax tables and calculation of property taxes. Figure 1 shows national percentages of success on the tax exercises.

Costs Over Time and Distance

Several exercises dealt with figuring costs for a time period or for a distance traveled. In some cases, respondents had to cope with fractional units of time or distance and with differing rates for the first and subsequent units.

FIGURE 1. Results for Tax Problems



Exercise 5, shown in Table 5, involved charges for parking in a parking lot. Adults performed 10 percentage points above the 17-year-olds on this exercise.

In Exercise U6, respondents were asked to calculate a taxi fare. Percentages of success were not as high on this exercise; 10% of the 17-year-olds and 20% of the adults gave the correct fare. Large numbers responded with "I don't know" (21% at age 17 and 25% at adult) and with answers categorized as "other unacceptable" (41% at age 17 and 25% at adult). Given the results on these two problems, it appears that young Americans must accept whatever the parking lot attendant or the taxi cab meter tells them.

Seventeen-year-olds and adults were also asked to figure out a week's pay (Exercise U7) using a timecard showing in and out times and hourly pay rate. Thirty-one percent

TABLE 5. Exercise 5 and Results

A parking lot charges 35 cents for the first hour and 25 cents for each additional hour or fraction of an hour. For a car parked from 10:45 in the morning until 3:05 in the afternoon, how much money should be charged?

ANSWER

	Age 17	Adult
$1.35, 135¢, 135*	47%	57%
1.60 or attempt at (25 x 5) + 35†	9	11
$1.10 or attempt at (25 x 3) + 35†	4	4
Other unacceptable	33	22
"I don't know" or no response	7	5**

Asterisk indicates correct answer.
†Probable method of obtaining answer shown. Process used was not scored.
***Figures may not add to 100% due to rounding error.*

of the 17-year-olds and 48% of the adults correctly completed the timecard and computed the appropriate amount of pay. An additional 48% at age 17 and 42% at adult used a correct procedure but made a mistake in calculation. Although people may know how to use a timecard, they appear to be sloppy in using basic computational skills. Perhaps many are relying on their employer to pay them accurately.

Adults were asked to figure a weekly salary when a yearly salary was given (Exercise U8). Seventy-five percent of the adults successfully completed this exercise, and an additional 8% used the correct method but made a computational error.

Another exercise (U9) dealt with the unit cost for a common utility bill. Percentages of success were 14% for 17-year-olds and 35% for adults. An additional 9% at age 17 and 14% at adult used an appropriate method but failed to give the correct answer. Fourteen and 11%, respectively, of the 17-year-olds and adults divided the units by the total amount of money rather than vice versa. Large percentages at both ages (38% and 26%) responded with "I don't know."

Filling Out an Order Blank and Balancing a Checkbook

The National Assessment of Educational Progress uses exercises administered on a one-to-one basis to observe problem-solving methods and to provide a situation as similar to the "real thing" as possible. In one such individually administered exercise, U4 (discussed in the section on taxes), respondents heard an order for goods, as they would have heard it over the telephone, and were asked to fill out an order form including unit and total prices for each item, subtotal, sales tax (given on a tax table) and total cost of the order. This exercise was administered only to adults.

Forty-four percent of the adults correctly filled out the order form for all the items; 56% made some mistake in filling out the order form although not necessarily in the prices of the items. Approximately 45% of the adults determined the correct total cost for the order. An additional 46% correctly added the numbers they used, although they had made previous mistakes in entering amounts.

In another individually administered exercise, U10, 17-year-old and adult respondents were asked to balance a checkbook. Each respondent received a bank statement, a check register and cancelled checks. Respondents were also asked whether they had ever had a checking account and, if so, whether they had ever balanced a checkbook. Responses to these questions were then correlated to rates of success in balancing the checkbook. There were a number of factors to be considered in reconciling the statements, a subtraction error and a deposit error had to be corrected, and service charges and an outstanding check had to be included.

Sixteen percent of the 17-year-olds stated that they had a checking account at some time, but only 9% of the 17-year-olds had actually balanced their own account. Among

the adults, 87% had or had had a checking account, and 72% stated that they had balanced a checkbook.

The small number of 17-year-olds having actual experience with balancing a checkbook undoubtedly accounts for their low percentages of success on this exercise: 1% of all 17-year-olds gave the correct balance. Sixteen percent of the adults balanced the checkbook — a substantial increase over the 17-year-olds but still not a large percentage considering the number who had at some time balanced a checkbook.

About the same percentage of adult males and females stated that they had or had had checking accounts. Approximately 4% more females than males said that they had reconciled an account. Males and females showed about the same ability in actually balancing the account given in this problem.

Costs and Percentages

Two exercises involved finding the difference between two rates of percent on a fixed cost (see Table 6). A distinct improvement from age 13 to adult is evident in the results of the first exercise; the second exercise was administered only to adults, so no age-level comparisons are possible.

About one-third of the 13-year-olds, slightly over two-thirds of the 17-year-olds and almost three-fourths of the adults answered the first question with the correct money difference. A number of individuals at all three age levels either gave the difference in percent rather than the difference in price or neglected to include dollar signs ($) with their answers. For summary purposes, both answer categories were considered acceptable, meaning that 48% of the 13-year-olds, 76% of the 17-year-olds and 87% of the adults answered Exercise 6 correctly.

Adults did not do as well on Exercise 7, also shown in Table 6, perhaps because the numbers used may have contributed to the diffi-

TABLE 6. Exercises 6 and 7 and Results

Exercise 6

Television sets are on sale at two stores. One offers a 10 percent discount while the other offers 15 percent. What is the difference in the sale price of the two stores of a TV set that is regularly priced at $100?

ANSWER

	Age 13	Age 17	Adult
$5.00, $85 and $90*	32%	69%	74%
5%, 5, 85 and 90†	16	7	13
Adding two percentages together (25, $25, 25%)	2	1	1
Answering with numbers shown in the problem (10, 15)	4	4	2
Other unacceptable	22	10	6
"I don't know" or no response	24	9	5**

Exercise 7

A state changes its sales tax from 3 percent to 4 percent. How much ADDITIONAL sales tax would you now pay on a new car that costs $2,760.00?

ANSWER

	Adult
$27.60*	55%
1%, 33 1/3%, 1/3 more†	1
Correct process, wrong or no answer	10
$110.40 or attempt to multiply 2,760 x .04	6
Other unacceptable	14
"I don't know" or no response	13**

*Asterisk indicates correct answer.
†Also counted as correct.
**Figures may not add to 100% due to rounding error.

culty of the problem. They seemed less willing to attempt this problem than the previous one since 13% answered "I don't know" or gave no response.

Exercise U11 required finding a percentage of a given number and was answered correctly by 8% of the 13-year-olds, 36% of the 17-year-olds and 66% of the adults. Another exercise, U12, involved the same procedure, but, in addition, the percentage calculated had to be subtracted from the total number to obtain the answer asked for in the problem. Twenty-seven percent of the 17-year-olds and 54% of the adults solved this problem correctly.

The response categories for these two exercises and the percentage of responses in each are shown in Table 7. The text of the exercises is not shown because they will be used again in future assessments.

Thirteen-year-olds were unsure which computational operation to use; sizable percentages of them either divided or subtracted the two numbers given. The percentage attempting division decreased successively at ages 17 and adult. In both problems, adults had a higher percentage of success than 17-year-olds (a 30-percentage-point advantage on U11 and a 27-percentage-point advantage on U12), and more adults set up the problem correctly even if they did not give the right answer. Adults may simply be better at this operation, or they may have more experience with problems involving discounts and depreciation.

TABLE 7. Common Types of Errors, Percentage Problems U11 and U12

	Procedures for Solving Problem				
	Total x rate of percent = percentage, U11			Total - (total x rate of percent) = new total, U12	
	Age 13	Age 17	Adult	Age 17	Adult
Correct answer	8%	36%	66%	27%	54%
Correct process, wrong or no answer	3	5	7	8	12
Attempt to divide two numbers given	16	9	2	9	2
Attempt to subtract percentage from total	1	5	5		
Failure to subtract percentage from total				19	8
Rate of percent given as answer	3	3	1		
Attempt to subtract two numbers given	13	4	2		
Other unacceptable	25	23	13	21	14
"I don't know" or no response	32*	15	5*	17*	10

*Figures may not add to 100% due to rounding error.

Two other percent exercises could be solved by use of a proportion. Exercise 8 involved calculating total sales needed for a given commission and is shown in Table 8. The difference between 17-year-old and adult performance (20 percentage points) is not quite as great on this exercise as on the preceding two but is still substantial. Slightly more 17-year-olds than adults gave the correct method for solving the problem but did not successfully complete the calculations. Considerable numbers at both age levels simply attempted to multiply the two given figures.

TABLE 8. Exercise 8 and Results

A door-to-door salesman receives 20 percent of the retail value of his sales as commission. What must his total retail sales be if he is to earn a commission of $60?

ANSWER

	Age 17	Adult
$300, 300*	37%	57%
Correct process, wrong or no answer	5	3
20 x 60	25	15
20 + 60	1	1
Other unacceptable	18	12
"I don't know" or no response	14	13†

**Asterisk indicates correct answer.*
†Figures may not add to 100% due to rounding error.

Exercise U13 was considerably more difficult than any of the previous problems. It was solved correctly by 6% of the 17-year-olds and 21% of the adults. In this problem, the price of an appliance was reduced by a certain percent of the original price. Respondents were asked to find the original price using the reduced price and the percentage of reduction. This problem can be solved with the following equation:

$$\frac{100\% - \text{percent of reduction}}{\text{reduced price}} = \frac{100\%}{\text{original price}}$$

The most common error, made by 14% of the 17-year-olds and 25% of the adults, was to use the percentage of reduction given in the problem rather than subtracting that number from 100%. Other errors included adding, subtracting, multiplying or dividing the numbers given.

Figure 2 summarizes results for the six questions about costs and percentages. From 11% to 30% more adults than 17-year-olds answered these problems correctly. Performance on Exercises 8, U11 and U12 — all dealing with figuring costs using percent — ranged from 54—66% for adults and from 27—37% for 17-year-olds.

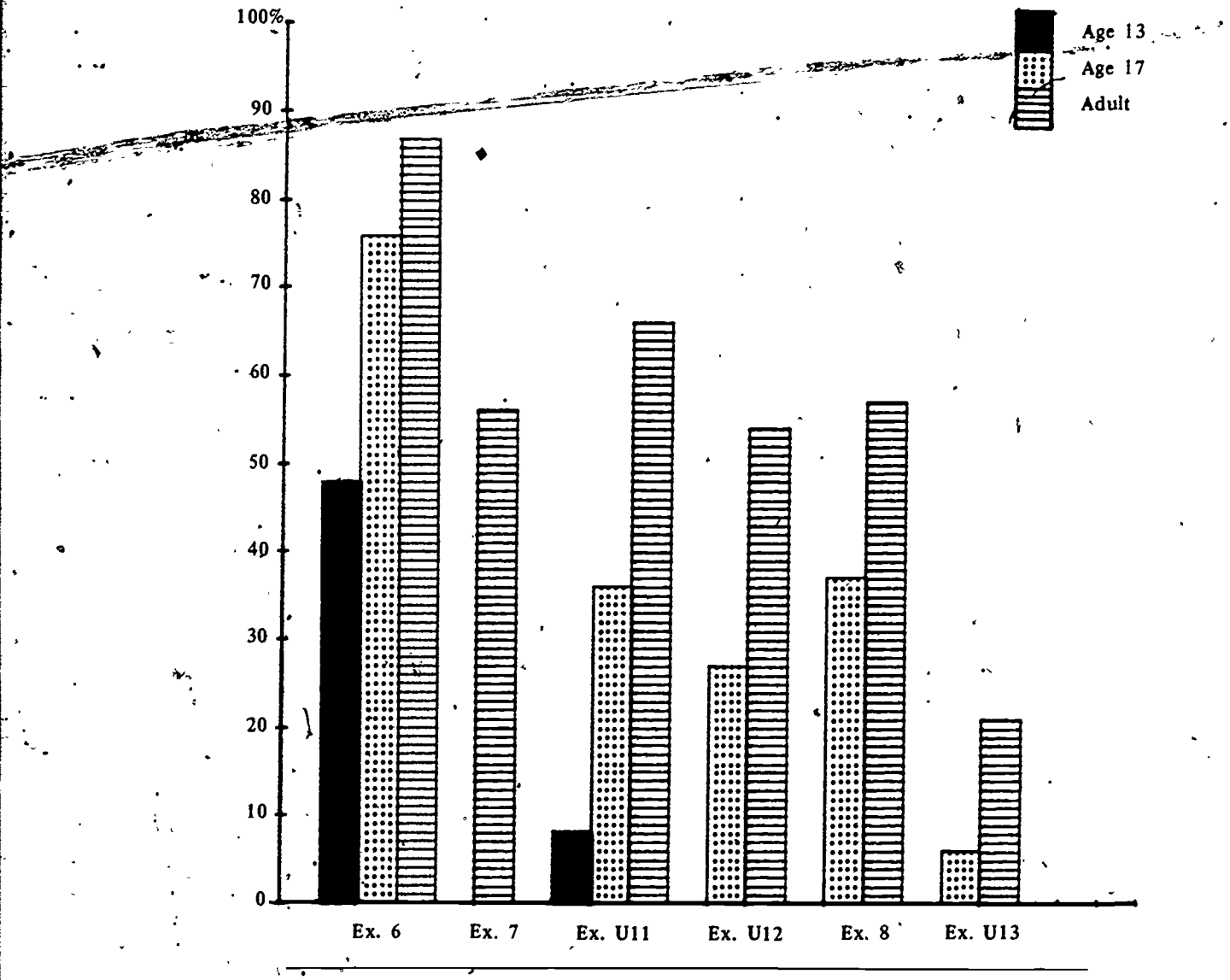
Chapter Summary: Consumer-Cost Problems

Adults showed an advantage over 17-year-olds on all consumer-cost exercises — in some cases a sizable advantage. This trend is somewhat surprising since adults have tended to perform less well than 17-year-olds in other learning areas assessed by National Assessment, especially in the more "academic" learning areas.[1] The greatest increases in performance between ages 17 and adult were on two percent problems (U11, finding percent of discount, and U12, finding amount of depreciation) and on Exercise U3C, finding an amount of tax not on the tax table.

Seventeen-year-olds had a distinct advantage over 13-year-olds on the exercises administered to both age levels. This advantage is to be expected since many of the skills required by the consumer-cost exercises are not introduced until the sixth through eighth grades.

[1] See *Update on Education A Digest of the National Assessment of Educational Progress* (Denver, Colo.: Education Commission of the States, 1975).

FIGURE 2. Results for Cost and Percentage Problems



Sex makes a considerable difference in performance, especially for adults. Figure 3 shows the difference from the nation in male and female performance on each exercise. The zero line represents the national performance level; each square shows the difference in percentage between the group's (male or female) percentage of success and the nation's. Arrows indicate the median difference from national performance, i.e., the point above and below which half the differences lie. Male-female results for 13-year-olds are not presented since the number of 13-year-old consumer-cost exercises was not sufficient for summary purposes.

At both the 17-year-old and adult levels, females performed more than 1% above the nation on only two exercises — U3A and B, reading sales tax from a table. Seventeen-year-old and adult males had the greatest advantage over females on Exercise 8, figuring a sales commission. Male-female performance on this exercise was separated by 14 percent-

FIGURE 3. Male-Female Differences. Consumer-Cost Problems

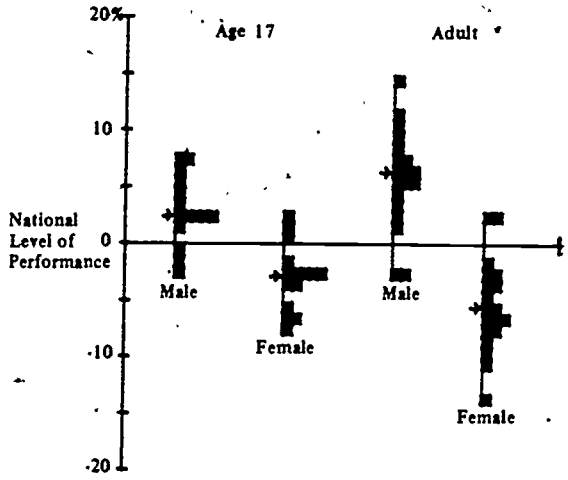
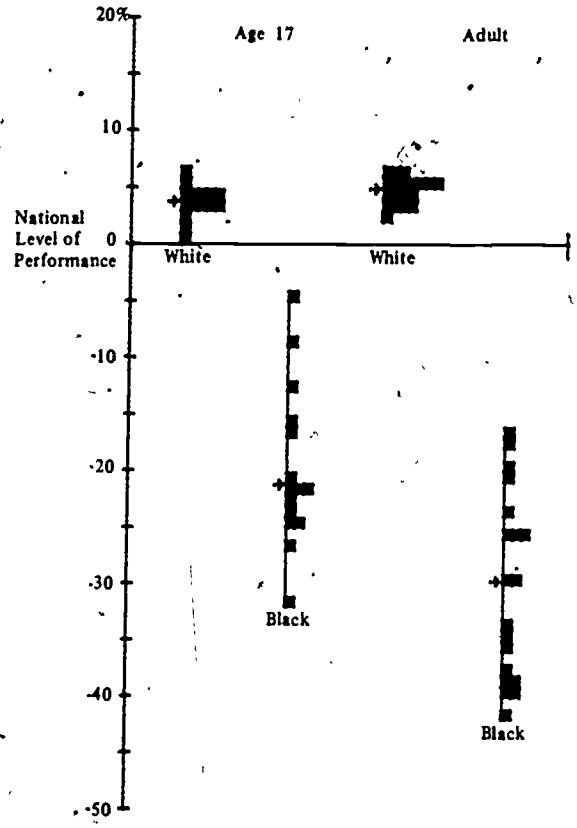


FIGURE 4. Black White Differences. Consumer-Cost Problems



age points at age 17 and 27 percentage points at adult.

On all exercises in this chapter, performance of blacks was below that of whites. Difference in achievement was more marked for adults than for 17-year-olds. At age 17, the median difference for whites was 4 percentage points above the nation; for blacks, 21 percentage points below the nation. For adults, the median difference was 5 percentage points above the nation for whites and 30 percentage points below for blacks. Figure 4 provides median and exercise-by-exercise differences from national performance for both blacks and whites.

Results for the sex and color groups give some indication of the disparities existing in consumer math skills. National Assessment also reports results for other population groups — region of the country, parental-education level and size and type of community. Complete group results for all consumer-mathematics exercises appear in Chapter 5.

CHAPTER 2

SOLVING HOUSEHOLD PROBLEMS

The consumer uses measurement concepts to solve many household problems. The family cook must know how many teaspoons there are in a tablespoon; the home handyman should be able to convert inches to feet. The exercises in this chapter concerned ability with various types of measures: weight, length, capacity, time and area. Some exercises required simple conversion of units; others demanded several computational steps in their solution.

Measures of Weight, Length and Capacity

Two exercises required ability to convert pounds to ounces. Percentages of success on Exercise 9 (see Table 9) were highest of any discussed in this chapter, with 81% of the 17-year-olds and 86% of the adults responding correctly.

TABLE 9. Exercise 9 and Results

A man bought two pounds of cheese in eight-ounce packages. How many packages did he buy?

ANSWER _____

	Age 17	Adult
4, 4 packages*	81%	86%
2, 2 packages	5	4
8, 8 packages	2	2
Other unacceptable	7	5
"I don't know" or no response	5	3

**Asterisk indicates correct answer.*

Performance levels were lower on an unreleased exercise (U14) that asked respondents to determine the number of ounces in a given number of pounds. Forty-three percent of the 13-year-olds, 64% of the 17-year-olds and 73% of the adults gave the correct number of ounces. These results represent a 17-percentage-point decrease for 17-year-olds and a 13-percentage-point decrease for adults from the previous exercise (Exercise 9).

Exercise 10, shown in Table 10, measured the ability to convert feet to inches. Two-thirds of the 17-year-olds and three-fourths of the adults answered this problem correctly. The most popular incorrect alternative was 72 inches. Respondents may have simply calculated the number of inches in 6 feet or they may have decided that 79 inches, the correct conversion of 6 feet, 7 inches, was closer to 72 inches than 84 inches.

TABLE 10. Exercise 10 and Results

Curtains six feet seven inches long are needed for a set of windows. Which one of the following standard curtain lengths is CLOSEST to the length required?

	Age 13	Age 17	Adult
○ 66 inches	14%	6%	5%
○ 72 inches	26	18	15
● 84 inches	46	66	75
○ 90 inches	9	4	3
○ I don't know.	5	4	1
No response	+†	1*	1+*†

**Figures may not add to 100% due to rounding error.*
†Plus equals rounded percents less than one.

Two capacity problems involved the relationship between pints and gallons. One exercise (U15) asked for the number of pints in a certain number of gallons. Percentages of success on this exercise were as follows: 45% for 13-year-olds, 61% for 17-year-olds and 68% for adults.

A more difficult capacity problem is presented in Table 11. At all three age levels, results were approximately 30 percentage points lower than on the previous exercise.

TABLE 11. Exercise 11 and Results

A recipe for punch calls for equal amounts of lemonade, limeade, orange juice, and ginger ale. How many PINTS of ginger ale would be needed in order to make two gallons of this punch?

ANSWER _____

	Age 13	Age 17	Adult
4, 4 pints*	17%	30%	38%
2, 2 gallons, 2 pints	16	16	15
8, 8 pints	15	10	10
16, 16 pints	9	6	7
3 1/2 pints	2	5	8
Other unacceptable	27	23	15
"I don't know" or no response	15†	11†	8†

**Asterisk indicates correct answer.*
†Figures may not add to 100% due to rounding error.

Approximately 3 out of 20 respondents answered with 2, the number given in the problem. People responding with 8 or 16 evidently knew the number of pints in a gallon but were confused by the problem.

Another capacity problem (U16) involved halving a punch recipe. The amount was given as a mixed number (a whole number and a fraction). Forty percent of the 17-year-olds and 49% of the adults answered successfully.

Summary of Results: Weight, Length and Capacity

Figure 5 summarizes results on the weight, length and capacity exercises. Results were highest for the exercise on buying cheese in eight-ounce packages; still, approximately 20% of the 17-year-olds and 15% of the adults did not know that two pounds of cheese equals four eight-ounce packages. Performance on the three conversion exercises (converting pounds to ounces, feet to inches and gallons to pints) was quite similar. Respondents had considerably more difficulty with the two capacity problems requiring calculations with units of measure.

Measures of Time and Area

Two units of measure, minutes and pounds, were included in Exercise 12 (see Table 12). Mistakes were spread over a number of error categories. Interestingly enough, males did better than females on this exercise, even though it is usually assumed that females do most of the cooking. Males were 10 percentage points above females at age 17 and 8 percentage points above at adult.

TABLE 12. Exercise 12 and Results

A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12 1/2 pounds is to be done by 5:00 p.m., what time should it be put in to cook?

ANSWER _____

	Age 17	Adult
12:50, 12:50 p.m., 10 to 1, 50 minutes after 12*	35%	42%

**Asterisk indicates correct answer.*

Two exercises required calculation of an area to find the solution. One exercise, 13, asked respondents to calculate how many gallons of paint would be needed to cover a given surface. This exercise is shown in Table 13.

FIGURE 5. Results for Weight, Length and Capacity Problems

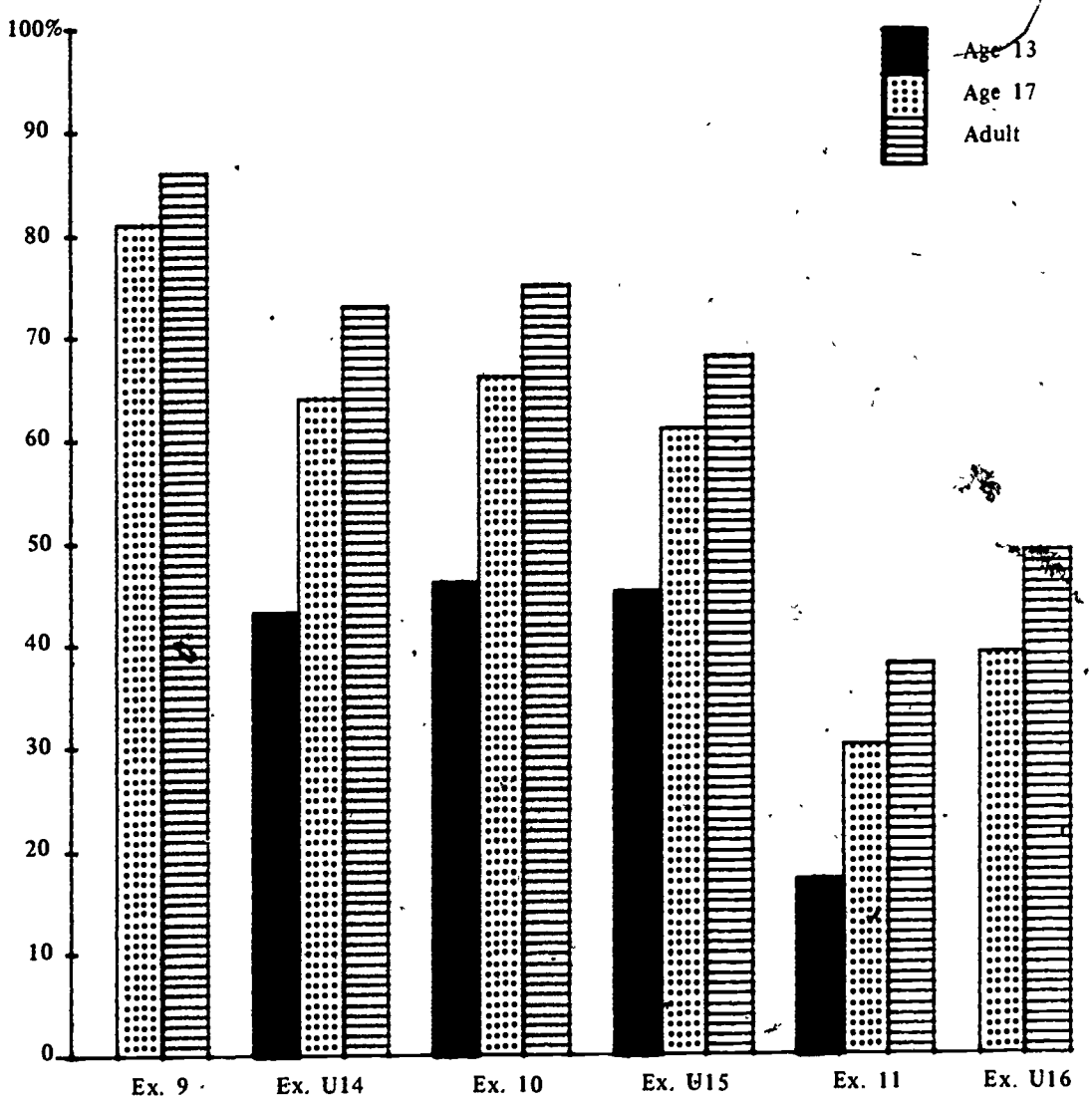


TABLE 13. Exercise 13 and Results

A gallon of asphalt paint will cover about 250 square feet of surface area. This paint is sold in gallon cans only. How many gallon cans are needed to paint a driveway 48 feet long and 10 feet wide?

ANSWER	Age 17	Adult
2, 2 cans, 2 gallons, about 2 gallons*	41%	61%
Correct process, wrong or no answer	5	2

**Asterisk indicates correct answer.*

Four out of ten 17-year-olds answered this problem correctly, while six out of ten adults gave the right answer. Discrepancies between male and female performance on this exercise were large, especially at the adult level. At age 17, males were 8 percentage points above and females 7 points below national performance levels, while at adult, males were 14 points above and females 13 points below the nation. In other words, 75% of the adult males and 48% of the adult females answered this problem correctly.

Another exercise involving area (U17) asked the price of a piece of carpet. Dimensions of the carpet (in feet) and price per square yard were given. This exercise was answered correctly by 10% at age 13, 26% at age 17 and 39% at adult. There was a steady increase in performance from age 13 to adult, but still only two out of five adults could correctly calculate the price. Males did better than females on this exercise at all three ages. At age 13, male-female performance was separated by 5 percentage points; at 17, by 12 percentage points; and at adult, by 25 percentage points.

Use of Proportion

Two exercises measured skill in applying principles of proportion to measurement questions. The first exercise, involving calories, is displayed in Table 14.

TABLE 14. Exercise 14 and Results

If there are 300 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of that food?

ANSWER	Age 17	Adult
100, 100 calories*	70%	80%
Correct process, wrong or no answer	3	2

**Asterisk indicates correct answer.*

This problem can be solved by setting up a proportion:

300 calories : 9 ounces = ? calories : 3 ounces.

The majority of 17-year-olds and adults answered this problem successfully; adult performance was 10 percentage points above that of the 17-year-olds.

On a similar unreleased exercise (U18), the percentages of success were lower — 29% for 13-year-olds, 61% for 17-year-olds and 58% for adults. In this problem, one of the units of measure was a metric unit, which may account for some of the adult difficulties with the exercise. The problem could be solved without knowledge of the exact size or nature of the metric unit; however, the appearance of a strange word in the problem may have discouraged some individuals.

Chapter Summary: Household Problems

On all exercises, performance improved from ages 13 to 17. The same was true of performance between ages 17 and adult on all but the exercise involving the metric system. Adults showed the greatest gain over 17-year-olds on Exercise 13, figuring gallons of paint needed to cover an area.

At age 17, males had an advantage on all the "household" consumer-mathematics exercises (see Figure 6). At the adult level, males again

FIGURE 6. Male-Female Differences. Household Problems

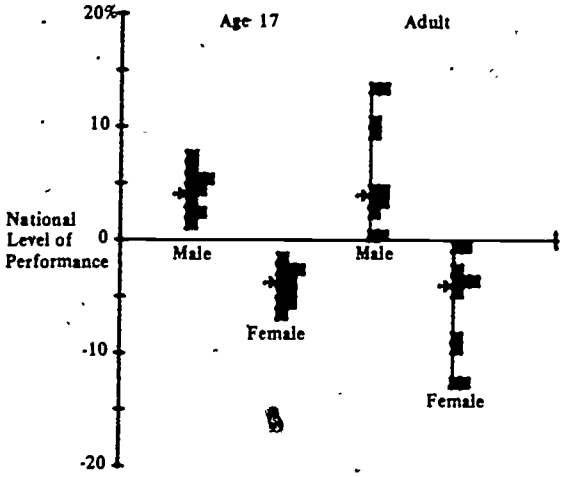
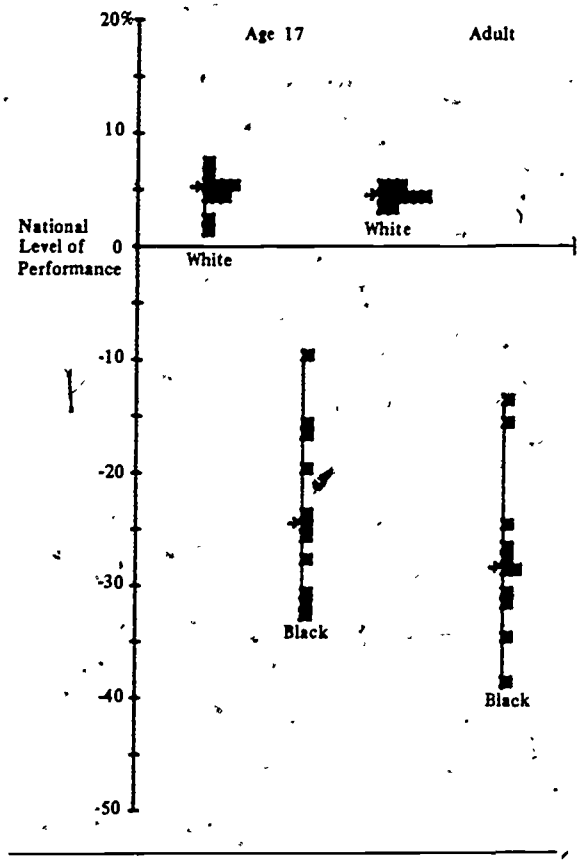


FIGURE 7. Black-White Differences. Household Problems



performed above females on all exercises, but differences were slight for two unit-conversion exercises: Exercise 9, number of eight-ounce packages in two pounds of cheese, and Exercise U15, converting gallons to pints. Males at both ages had the greatest advantage over females on the two problems involving calculation of area. Due to the small number of 13-year-old exercises, group results for 13-year-olds are not included in Figure 6.

Blacks experienced considerable difficulty with these exercises. The median group difference for black 17-year-olds was 24 percentage points below the nation and 29 percentage points below for black adults. Black 17-year-olds were furthest below the nation on Exercise 10, length of curtains, while black adults showed the largest deficit on Exercise 13, calculating the amount of asphalt paint needed. Figure 7 displays exercise-by-exercise differences from national performance for blacks and whites.

Additional group results appear in Chapter 5.

CHAPTER 3

READING AND INTERPRETING GRAPHS AND TABLES

Graphs and tables are widely used methods for organizing and presenting large amounts of information. The consumer encounters graphs and tables in magazines and newspaper articles on many different topics, from the Gross National Product to industrial profits, and government spending to sports statistics. Graphs give a pictorial representation of data, while tables use sets of numbers to present information in a compact form.

To use graphs and tables effectively, the individual must first find the desired information by reading the graph or table and then must make interpretations using the information that has been located. The exercises in the assessment measure abilities both in reading and in interpreting graphs and tables.

Reading Graphs

Two exercises on reading pictographs (graphs in which symbols represent a certain number of units) were included in the assessment. One exercise was given only to 13-year-olds; the other was administered at ages 17 and adult. Both exercises and their respective results are shown in Table 15.

Almost eight out of ten 13-year-olds correctly identified the two regions having the largest rural populations in 1970. An additional 13% properly identified the one region with the largest rural population. In comparison, 77% of the 17-year-olds and 78% of the adults answered Exercise 16 correctly. Performance on these two exercises does not show the usual increase between ages 13 and 17. These were not identical exercises, however, and the vocabulary in Exercise 16 ("decrease" and "prior") may have increased the difficulty of the problem.

Respondents read a line graph to answer two questions included in Exercise U19. Sixty-one percent of the 17-year-olds and 60% of the adults answered both questions correctly. Percentages of success were higher on the first question (79% for 17-year-olds and 76% for adults) than on the second question (70% for 17-year-olds and 68% for adults). For the second question, the lines crossed near the point at which the necessary information was found; this may, in part, account for the lower results.

Constructing a Graph

In Exercise 17, respondents were asked to complete a line graph that had been started for them. They were to plot the points using the data and the scales given and then connect the points using a ruler. Thirty-nine percent of the 13-year-olds, 64% of the 17-year-olds and 55% of the adults plotted all the points correctly and connected them with straight lines. An additional 17% at age 13, 18% at age 17 and 19% at adult plotted all the points correctly, except one, making a mistake on the point that fell between two horizontal lines on the graph. On this exercise, males performed better than females at every age level, with the difference increasing at the older ages. At age 13 there was an 8-percentage-point difference in performance; at age 17, a 10-percentage-point difference; and at adult, a 16-percentage-point difference.

TABLE 15. Exercises 15 and 16 and Results

U.S. Rural Population for Nine Regions in 1970

Region	Rural Population (O = 1 million persons)
1 New England	OOO
2. Middle Atlantic	OOOOOOO
3. East North Central	OOOOOOOOOO
4. West North Central	OOOOOO
5 South Atlantic	OOOOOOOOOOO
6 East South Central	OOOOOO
7 West South Central	OOOOO
8. Mountain	OO
9. Pacific	OOOO

Federal Grants for Education 1966-1970

Year	Expenditures (□ = $500 million)
1966	□□□□□□□□□□□
1967	□□□□□□□□□□□□□□□
1968	□□□□□□□□□□□□□
1969	□□□□□□□□□□□□□□□□
1970	□□□□□□□□□□□□□□□□□

Exercise 15

According to the chart, which TWO regions of the U.S. had the largest rural populations in 1970?

ANSWER. _____

_____

	Age 13
Percent answering regions number 3 and 5* (East North Central and South Atlantic)	79%
Answering region number 5 (South Atlantic)	13
Other unacceptable	6
"I don't know" or no response	3†

Exercise 16

According to the chart, for which year did federal grants for education decrease from the prior year?

	Age 17	Adult
○ 1966	16%	13%
○ 1967	1	1
● 1968	77	78
○ 1969	1	1
○ 1970	3	3
○ I don't know.	3	5
No response	†**	†**

**Asterisk indicates correct answer.*
†Plus equals rounded percents less than one.
***Figures may not add to 100% due to rounding error.*

Interpreting Graphs

To interpret information from graphs, respondents had to compare data obtained by reading the graphs. Exercise 18 concerned interpretation of data from a pictograph (see Table 16). Over one-half of the 17-year-olds and around three-fifths of the adults answered correctly. An answer of 12, given by 14% of the 17-year-olds and 10% of the adults, resulted from subtracting the number of telephones in Asia from the number in North America.

TABLE 16. Exercise 18 and Results

Number of Telephones in Operation in Various World Areas in 1968
(0 = 8 million telephones)

Area	No. of Telephones
North America	0000000000000000
Europe	000000000(
Asia	0000

According to the chart, in 1968 the number of telephones in operation in North America was how many times the number of telephones in operation in Asia?

ANSWER _____

	Age 17	Adult
4, 4 times as many, 4 x 1*	55%	62%
12, 12 times	14	10
3, 3 times	8	6
Other unacceptable	17	15
"I don't know" or no response	6	8†

**Asterisk indicates correct answer.*
†Figures may not add to 100% due to rounding error.

Respondents had to interpret information displayed by a line graph in order to answer Exercise 19. The exercise and results are presented in Table 17.

Seventeen-year-olds were more successful than adults on part A. Part B was quite difficult for respondents at all age levels. Several steps were needed to complete the problem. Respondents may have been confused by the words "maximum" and "minimum." As shown by the results, a number of individuals failed to convert the number of units shown on the graph into thousandths of units. Although these respondents read the graph accurately, they did not correctly interpret the information.

Exercise U20 included a line graph showing a company's income and expenses for a number of years. Respondents were asked to select, from several multiple-choice options, the year in which profits were largest. Fifty percent of the 17-year-olds and 58% of the adults chose the correct answer. A number of respondents (38% at age 17 and 24% at adult) picked the year when both expenses and income were highest, suggesting uncertainty about the word "profits."

Reading and Interpreting Tables

When asked to read a simple mileage chart (Exercise U21), 51% of the 13-year-olds, 63% of the 17-year-olds and 71% of the adults successfully located the requested distance. At all ages, males were more successful than females, and this gap in performance increased with age.

Exercise 20 (see Table 18) required interpretation of data read from a table. Results for part B are approximately 20 percentage

TABLE 17. Exercise 19 and Results

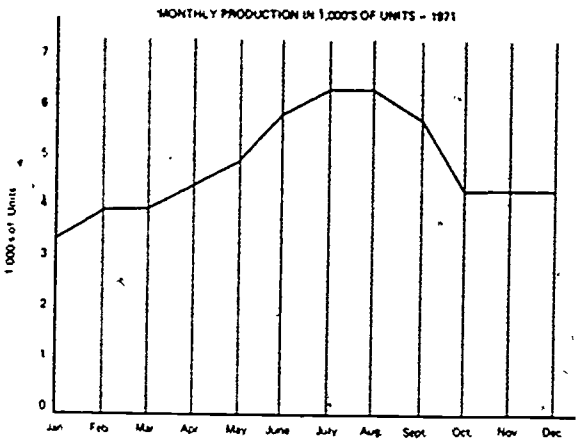
The graph on the opposite page shows the monthly production of Company X during 1971.

A. The greatest drop in production from one month to the next occurred between what two months?

ANSWER _____ to _____

B. The difference between maximum and minimum monthly production during 1971 was approximately how many units?

ANSWER _____



	Age 13	Age 17	Adult
Part A			
September to October, 9–10, 9 to 10*	45%	69%	63%
January to February	14	5	7
August to October	3	4	5
Other unacceptable	32	19	22
"I don't know" or no response	6	3	4†
Part B			
2,800 - 3,200*	6	18	20
2,500 - 3,500, excluding 2,800 - 3,200**	1	3	6
2.8 - 3.2	18	25	21
2.5 - 3.5, excluding 2.8 - 3.2	3	4	7
Other unacceptable	47	35	30
"I don't know" or no response	25	15	17†

**Asterisk indicates correct answer.*
†Figures may not add to 100% due to rounding error.
***Also counted as correct.*

TABLE 18. Exercise 20 and Results

The last five years' batting averages for six baseball players and the average of the team for which they play are shown below:

	1967	1968	1969	1970	1971
Team Average	220	212	231	224	226
Players					
1 Lehmann	280	256	295	265	261
2 Finley	210	224	216	221	210
3 Hlavaty	248	251	249	246	253
4 Heimer	252	256	258	264	270
5 Lee	275	280	280	279	283
6 Womer	266	315	295	304	320

A. Which player had the most CONSISTENT batting average between 1967 and 1971?

	Age 17	Adult
○ Lehmann	3%	4%
○ Finley	10	13
● Hlavaty	50	54
○ Heimer	13	8
○ Lee	4	3
○ Womer	17	13
○ I don't know.	3	6
No response	††	†*

B. Which player's batting average agrees most CLOSELY with the batting average of his team in all 5 years?

	Age 17	Adult
○ Lehmann	4%	3%
● Finley	70	70
○ Hlavaty	3	4
○ Heimer	3	4
○ Lee	7	5
○ Womer	4	3
○ I don't know.	9	11
No response	1*	††

**Figures may not add to 100% due to rounding error.*
†Plus equals rounded percents less than one.

points higher than those for part A. Part B could be answered correctly without doing computations for all five years; obviously incorrect answers are eliminated early in the process.

As might be expected from the content of this exercise, males show a distinct performance advantage over females on both questions. This advantage is greater for adults than for 17-year-olds.

Another exercise (U22) asked for interpretation of data from a table showing nutritive values of certain foods. Amounts of food given in the table were different than those specified in the problem. Thirty-three percent of the 13-year-olds, 54% of the 17-year-olds and 49% of the adults correctly interpreted the data shown. A common error was failure to convert the amounts of food given in the problem to the units shown on the table.

In Exercise U23, adult respondents used a table to find carrying charges on an installment plan. Before using the table, respondents had to subtract the down payment. The correct amount of carrying charges was given by 73% of the adults. An additional 5% apparently used the table correctly but forgot to first subtract the down payment.

Seventeen-year-olds and adults had to figure the ratio of pedestrian injuries to total injuries in order to interpret motor vehicle injury statistics (Exercise U24). This exercise was answered correctly by only 10% of the 17-year-olds and 16% of the adults. The most frequent mistake, made by 58% of the 17-year-olds and 40% of the adults, was to cite the group with the lowest number of pedestrian injuries rather than the group with the fewest pedestrian injuries per total injuries.

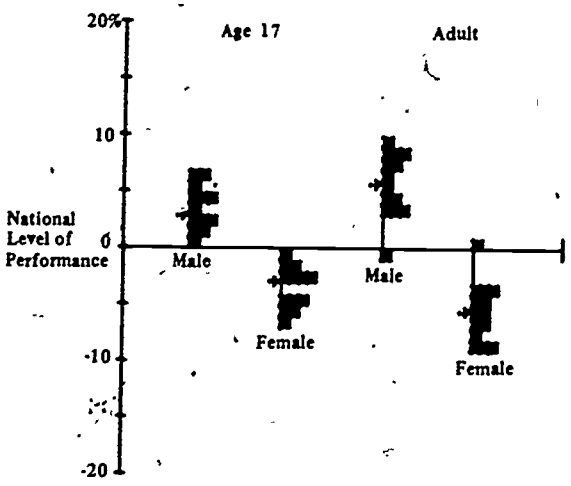
Chapter Summary: Reading and Interpreting Graphs and Tables

Exercises on reading graphs and tables evoked percentages of success ranging from 65% to 79% for 17-year-olds and adults, while exer-

cises requiring interpretation of data showed a greater variation in results. Results on the interpretation exercises appeared to be influenced by the extent of the calculations needed to solve the problems and the vocabulary used in the questions.

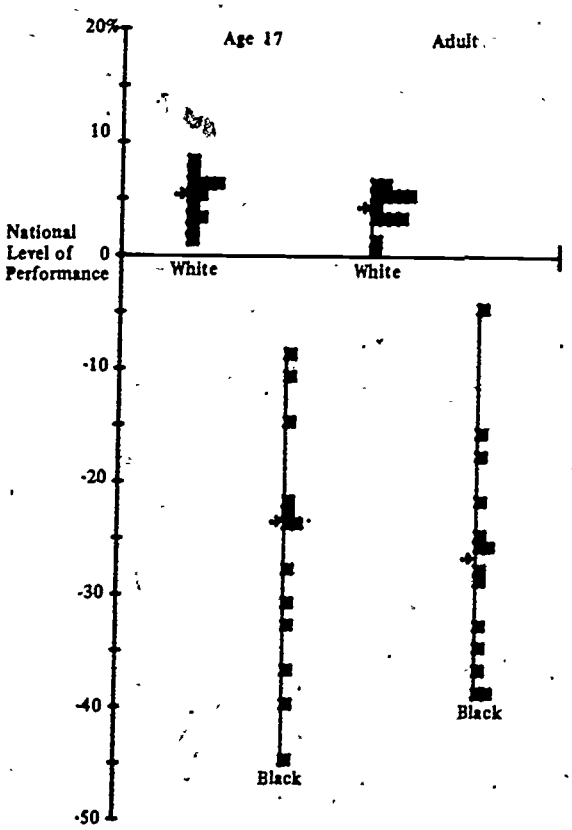
Contrary to the results for the consumer-cost and household exercises, adult performance dropped below that of 17-year-olds on several exercises in this chapter. Adult performance was furthest below that of 17-year-olds on Exercise 17 (constructing a graph) and was furthest above 17-year-olds on Exercise U20 (line graph — profits) and Exercise U21 (reading a mileage chart).

FIGURE 8. Male-Female Differences: Reading and Interpreting Graphs and Tables



Males held an advantage over females on almost all the exercises discussed in this chapter, an advantage that was most evident at the adult level. Figure 8 shows 17-year-old and adult male-female differences from national performance on each exercise. Adult females appear above the nation on one exercise, Exercise U23 (determining carrying charges from a table), but the differences in male and female performance are not large enough to be statistically reliable. Although

FIGURE 9. Black-White Differences: Reading and Interpreting Graphs and Tables



13-year-old results are not shown in Figure 8, it is noteworthy that 13-year-old females outperformed their male peers on one exercise, Exercise 15 (reading a pictograph on rural populations), by 12 percentage points.

Figure 9 compares black and white performance to that of the nation. The median difference between black and white performance remained relatively constant at ages 17 (29 percentage points) and adult (31 percentage points). Black 17-year-olds were furthest below the nation on Exercise 17 (constructing a line graph), while black adults showed the greatest deficits on the first part of Exercise 19 (graph of drop in production) and on Exercise U21 (reading a mileage chart).

CHAPTER 4

USING THE CONCEPTS OF AVERAGE AND PERCENT

An understanding of the concepts of average and percent is basic for dealing with many consumer situations. Averages are often used to estimate future costs and to allocate resources evenly. Many financial transactions are calculated with percent: taxes, interest, commissions, profit and loss statistics and so forth. Percent is also important to the household consumer. Contents of food and fabrics are expressed in percents; sales and discounts are commonly advertised by the percent of savings rather than the amount of money saved.

The exercises discussed in this chapter measured ability to use averages and percents. Several exercises concerned the concepts underlying percents. Others required respondents to calculate averages and percents in various word-problem contexts.

Average

Two exercises involved computing averages. Nearly 40% of the 13-year-olds and roughly two-thirds of the 17-year-olds and adults found the correct average in Exercise 21. This exercise and results for the three age levels are shown in Table 19.

A common mistake was adding or attempting to add the numbers given and then neglecting to divide. This error occurred considerably less often at the two upper age levels.

Results were lower on an unreleased exercise, U25, dealing with average; 19% of the 17-year-olds and 38% of the adults responded correctly. In this exercise, respondents were asked to determine an overall average weekly wage when given the number of employees in various wage categories. Wages had to be multiplied by the number of employees in the category, and the number of employees had to be totaled before the average could be computed. About 15% at both ages 17 and adult were able to set up the problem but did not complete the calculations correctly.

On the first averaging exercise, adults performed only slightly better than 17-year-olds, but on the second problem, adults outperformed the 17-year-olds by 19 percentage points. The content of the problem, average weekly wages, may have favorably influenced adult response rates.

TABLE 19. Exercise 21 and Results

Last summer Todd earned $205, Charlotte earned $562, and Dale earned $400. What is the average of their summer incomes?

	ANSWER		
	Age 13	Age 17	Adult
$389.00, 389*	38%	66%	69%
Correct process, wrong or no answer	9	8	8
Added or attempted to add numbers, no attempt to divide	38	16	11
Other unacceptable	9	6	5
"I don't know" or no response	6	5†	7

**Asterisk indicates correct answer.*
†Figures may not add to 100% due to rounding error.

Concepts of Percent

On two exercises requiring conversion of a fraction to a percent, approximately two-fifths of the 13-year-olds and around three-fifths of the 17-year-olds responded correctly. Exercise 22 asked for the percent equivalent to 1/5: 41% of the 13-year-olds and 65% of the 17-year-olds responded with 20%. Sixteen percent of the 13-year-olds and 11% of the 17-year-olds answered with 5, the denominator of the fraction. A similar unreleased exercise (U26) used 100 as the denominator of the fraction. Forty-one percent of the 13-year-olds and 58% of the 17-year-olds answered correctly. On this exercise, 17-year-olds were more likely to give the decimal equivalent of the fraction than 13-year-olds; 10% of the 17-year-olds gave the decimal equivalent compared to 5% of the 13-year-olds.

In response to Exercise U27, about 70% of both 17-year-olds and adults demonstrated that they knew a percent equals a number in relation to 100.

Figure 10 provides a quick comparison of results on these three exercises. Two-fifths of the 13-year-olds and an average of three-fifths of the 17-year-olds successfully converted fractions to percents. Approximately 70% at age 17 and adult successfully expressed a percent as a ratio of 100.

Computation With Percents

Respondents were also asked to compute using percents. Exercise 23, shown in Table 20, involved finding a percentage of a number when the rate of percent was given. Multiplication was the necessary operation — 4,200 votes x 70% = 2,940 votes.

Percentages of success increased dramatically across age levels on this exercise. Seventeen-year-olds performed 31 percentage points above the 13-year-olds, and adults performed 21 percentage points above the 17-year-olds.

TABLE 20. Exercise 23 and Results

Candidate A received 70 percent of the votes cast in an election. If 4,200 votes are cast in the election, how many votes did he receive?

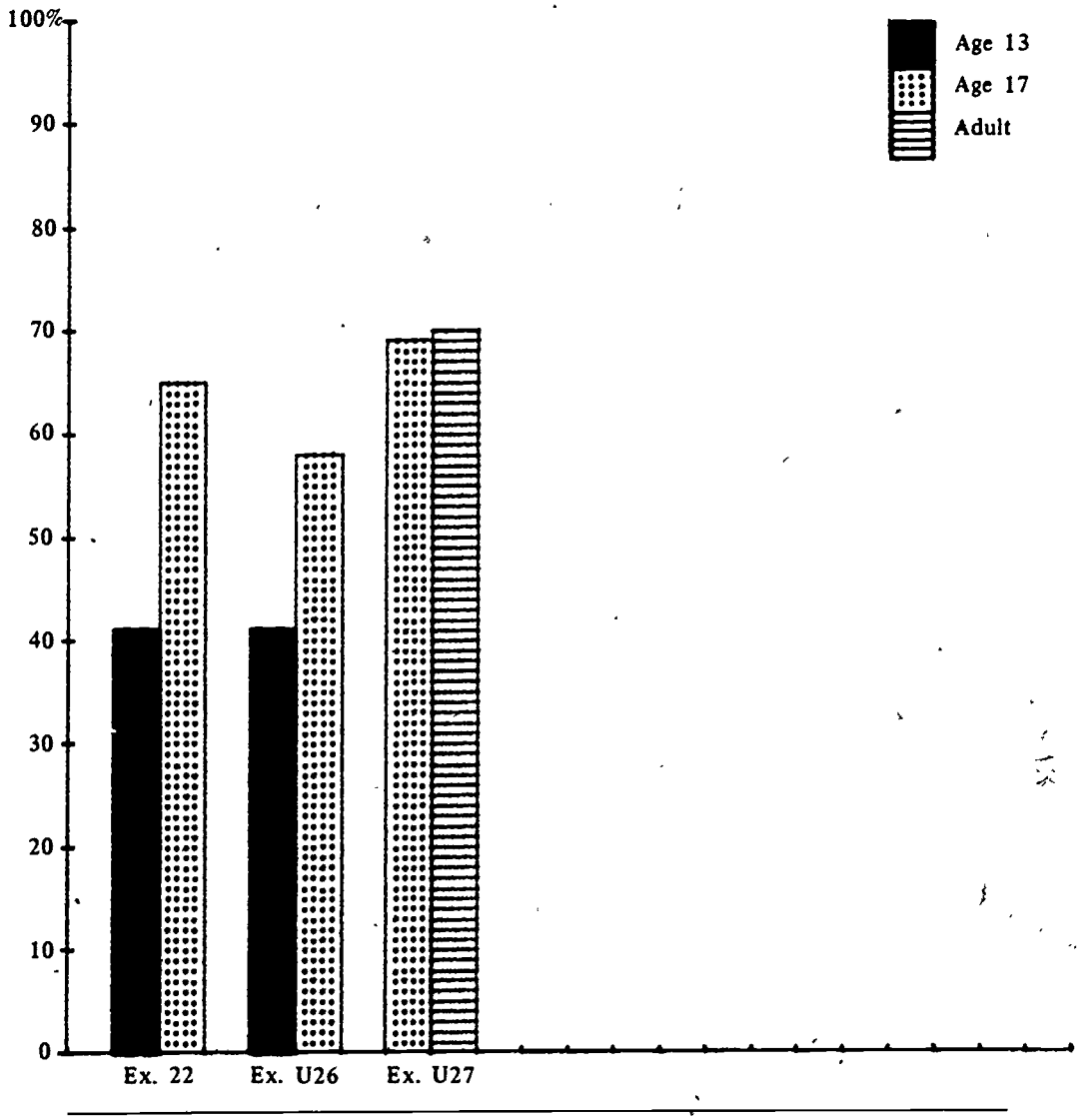
	ANSWER		
	Age 13	Age 17	Adult
2,940, 2,940 votes, 2,940 people*	10%	41%	62%
Correct process, wrong or no answer	2	3	5
Attempt to divide (4,200 ÷ 70)	29	17	6
Attempt to add (4,200 + 70) or subtract (4,200 - 70)	16	2	+†
Other unacceptable	20	19	15
"I don't know" or no response	24**	17**	13**

**Asterisk indicates correct answer.*
†Plus equals rounded percents less than one.
***Figures may not add to 100% due to rounding error.*

Large numbers of 13-year-olds were uncertain which operation to use; 16% attempted to add or subtract the two numbers, and 29% attempted to divide them. Seventeen-year-olds also favored division as a method of solution; this error was considerably less prevalent at the adult level.

In Exercise U28, the weight of a piece of meat and the percent of weight lost while cooking were given, and respondents had to find the amount of weight lost. Twenty-three percent of the 13-year-olds, 49% of the 17-year-olds and 55% of the adults calculated the correct weight loss. Adults were slightly more likely than the other age levels to give the weight remaining after the weight lost was subtracted — approximately 6% of the adults gave this answer compared to 2% of the 13- and 17-year-olds. Although giving the remaining weight showed knowledge of the proper process, it did not answer the question asked.

FIGURE 10. Results for Percent-Concept Problems



For Exercise 24 (see Table 21), respondents had to determine what percent one number was of a total. The problem was somewhat complicated in that three numbers had to be added to obtain the total before the percent could be calculated.

Less than half of the respondents at all age levels solved this problem correctly. There was a sizable increase in percentage of success from ages 13 to 17, 28 percentage points, but a small increase from age 17 to adult.

The results indicate that 13-year-olds were confused by this problem. Eight percent of them simply wrote down the number of votes Joe received (120) as his percent of the total vote. Various combinations of adding and dividing the three numbers given were tried at all age levels. One-fourth of the 17-year-old and adult responses were placed in the "other unacceptable" category, meaning that these answers followed no discernable error pattern and were not included in the scoring categories listed in Table 21.

TABLE 21. Exercise 24 and Results

In a school election with three candidates, Joe received 120 votes, Mary received 50 votes, and George received 30 votes. What percent of the total number of votes did Joe receive?

ANSWER	Age 13	Age 17	Adult
60, 60%*	17%	45%	47%
Equivalent fraction (120/200, 3/5, etc.)	2	1	3
40%, 40, 2/5	9	5	5
80%, 80	8	7	3
120%, 120	8	4	2
Attempt at 80/120, 200/3, 200/30	8	6	6
Other unacceptable	36	25	25
"I don't know" or no response	12	9†	9

**Asterisk indicates correct answer.*
†Figures may not add to 100% due to rounding error.

Percentages of success were higher at all age levels on Exercise U29, which also asked what percent one number was of another number, with 25% of the 13-year-olds, 58% of the 17-year-olds and 57% of the adults responding correctly. The difference in 13- and 17-year-old performance, 33 percentage points, was greater than on the previous exercise; the difference in 17-year-old and adult performance was negligible. Many respondents at all three age levels — 18% of the 13-year-olds, 5% of the 17-year-olds and 13% of the adults — responded with the decimal or fractional equivalent of the percent, indicating that they understood the idea of percent although they failed to give the answer in the form requested.

Results on the exercises requiring computation with percents are summarized in Figure 11. Adults showed a large advantage over 17-year-olds in Exercise 23. Seventeen-year-old and adult results are fairly similar on the other three exercises; 25% or less of the 13-year-olds successfully completed any of these problems.

Chapter Summary: Average and Percent Problems

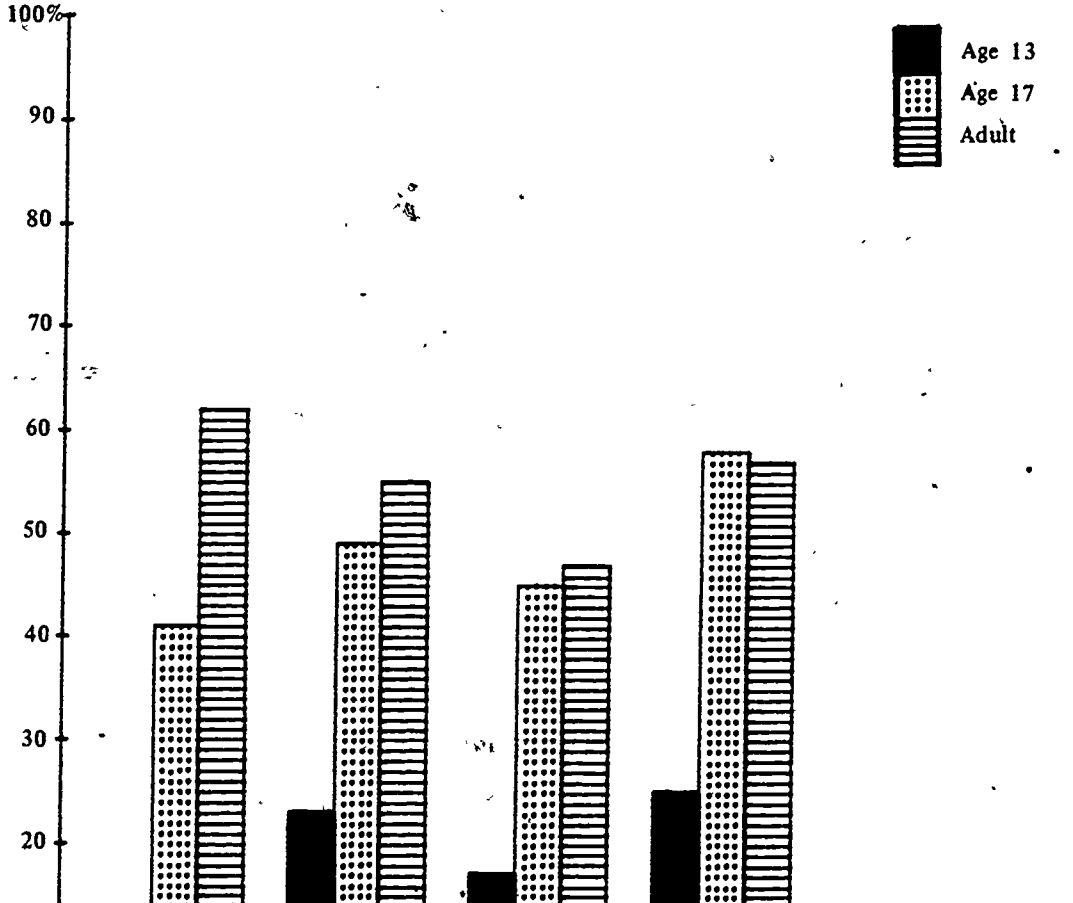
Changes in performance across age levels were remarkably similar for all the average and percent exercises. There was a consistent, large increase in percentages of success from ages 13 to 17 and a fairly consistent, although smaller, increase from age 17 to adult. The difference in 13- and 17-year-old performance ranged from 17 to 33 percentage points. The increase between age 13 and 17 was smaller for the problems on equivalent fractions and percents than on the exercises demanding computation with percents.

Adults showed a substantial advantage over 17-year-olds on two exercises: the problem about average weekly wages (19 percentage points) and the exercise about finding percent of total vote (21 percentage points). Differences between 17-year-olds and adults on other exercises were not as great, with adults being anywhere from 1 percentage point below to 6 percentage points above 17-year-old performance.

The highest percentage of success on any of these exercises was 70%, indicating that over one-fourth of the population at ages 17 and adult may have some difficulty in using averages and percents.

In some instances, over 70% of the respondents understood how to do the problem, but some respondents either set up the problem correctly and made a mistake in calculation or left the answer in the form of an equivalent

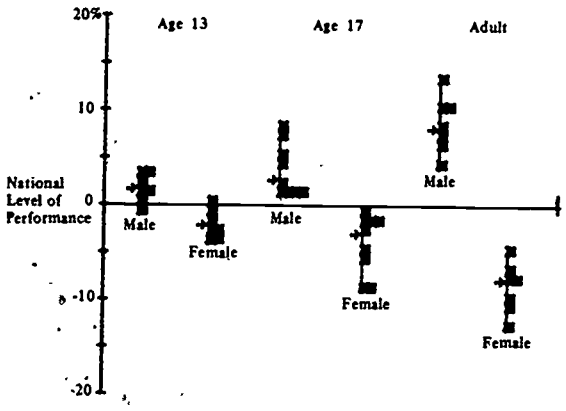
FIGURE 11. Results for Percent-Computation Problems



fraction or decimal. While these answers do not precisely answer the questions asked, they do indicate an understanding of the process to be used. For example, on Exercise 21 (averaging three summer wages), 66% of the 17-year-olds and 69% of the adults gave the correct answer. An additional 8% at these ages set up the problem correctly but failed to solve it. This implies that 74% of the 17-year-olds and 77% of the adults know how to set up a simple averaging problem of this type.

Striking differences in male and female performance are apparent on these exercises. Figure 12 shows the difference between male and female performance at each age level. On all but one exercise (Exercise 21, averaging three summer wages) at age 13, males did better than females, and the difference in male and female performance is greater at the upper age levels. The largest divergences in male-female performance were on exercises requiring computation with percents.

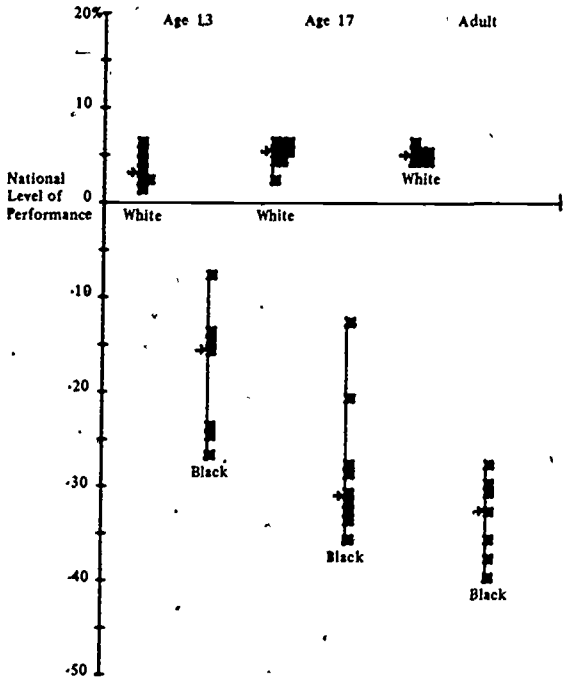
FIGURE 12 Male-Female Differences. Average and Percent Problems



Blacks had considerable difficulty with these exercises, their performance being below that of the nation in all cases. The differences in black and white performance ranged from 10 to 30 percentage points at age 13, from 15 to 42 percentage points at age 17 and from 32 to 46 percentage points for adults (see Figure 13).

Results for other population groups — region of the country, level of parental education and size and type of community — appear in Chapter 5.

FIGURE 13. Black-White Differences Average and Percent Problems



CHAPTER 5

SUMMARY OF GROUP RESULTS

In addition to reporting national performance levels, the National Assessment of Educational Progress (NAEP) provides results for various groups within the national population. Results are reported for sex, color, region of the country, size and type of community and level of parental education. The differences in achievement among these groups provide an indication of areas of strength and weakness in American education.

The results provided in this chapter summarize performance on all consumer-math exercises for each reporting group. Group results are discussed in terms of difference from national performance. The median difference for each group is the point above and below which half the differences lie.

National Assessment Reporting Groups

The National Assessment reporting groups are defined as follows:

Sex

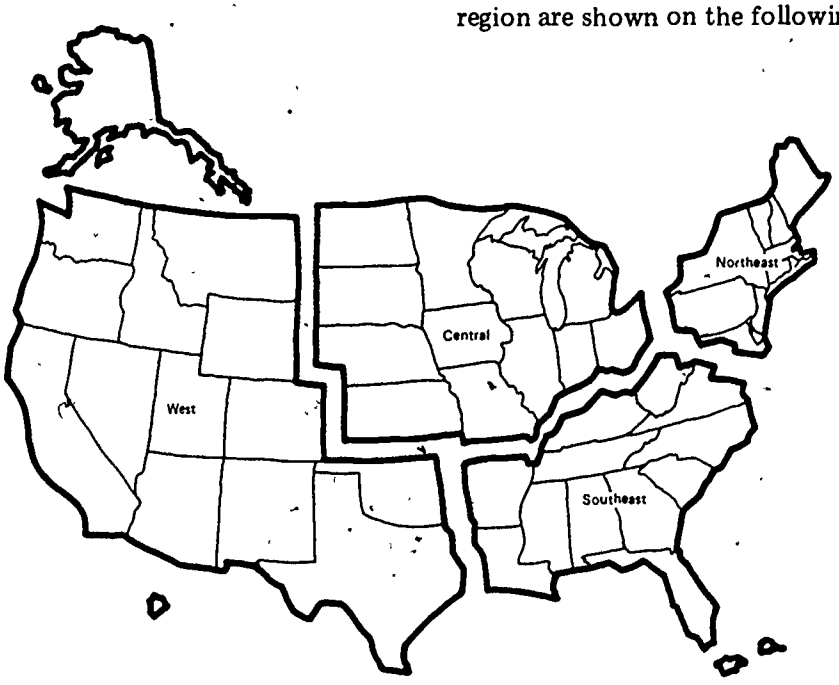
Results are presented for males and females.

Color

Currently, results are reported for blacks and whites.

Region

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



Parental Education

Four categories of parental education are defined by National Assessment. These categories include: (1) those whose parents have had no high school education, (2) those who have at least one parent with some high school education, (3) those who have at least one parent who graduated from high school and (4) those who have at least one parent who has had some post-high school education.

Size and Type of Community

Community types are identified both by the size of the community and by the type of employment of the majority of people in the community.

High metro. Areas in or around cities with a population greater than 200,000 where a high proportion of the residents are in professional or managerial positions.

Low metro. Areas in or around cities with a population greater than 200,000 where a high proportion of the residents are on welfare or are not regularly employed.

Extreme rural. Areas with a population under 10,000 where most of the residents are farmers or farm workers.

Urban fringe. Communities within the metropolitan area of a city with a population greater than 200,000, outside the city limits and not in the high- or low-metro groups.

Main big city. Communities within the city limits of a city with a population over 200,000 and not included in the high- or low-metro groups.

Medium city. Cities with populations between 25,000 and 200,000.

Small places. Communities with a population of less than 25,000 and not in the extreme-rural group.

Group Results

Sex

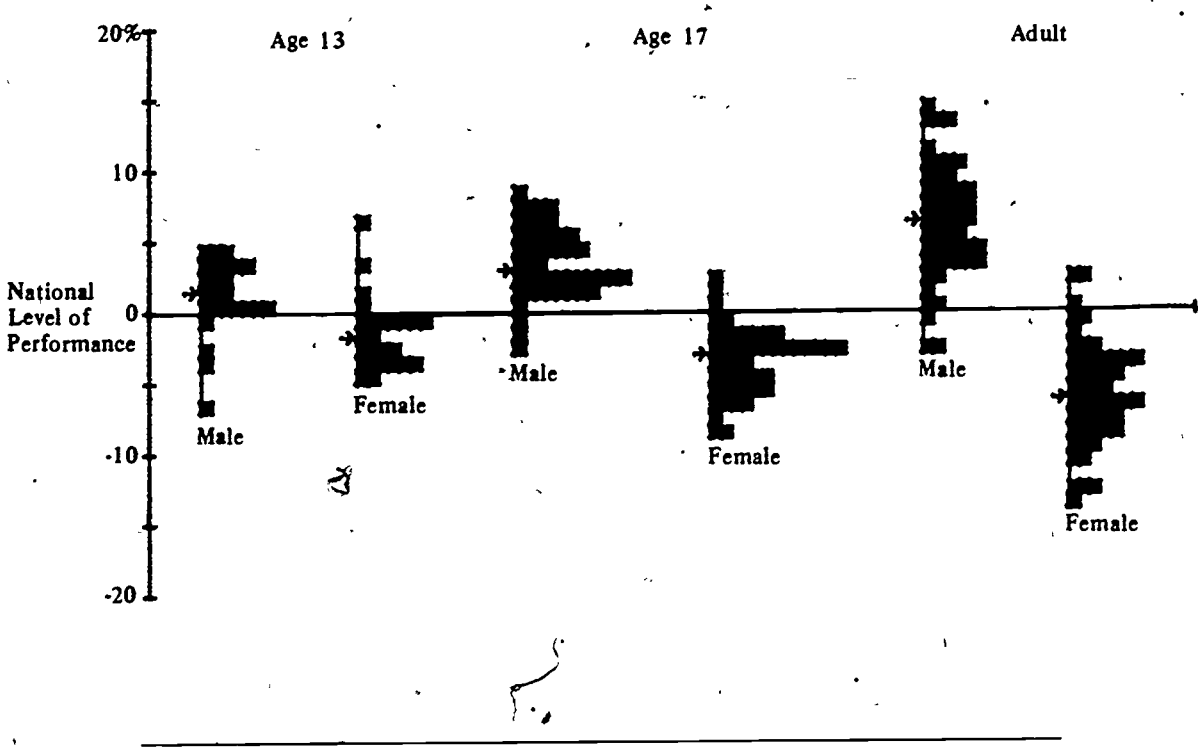
Males had a distinct advantage in answering consumer-math problems, an advantage that was greater at the upper age levels. Overall performance of males and females was separated by approximately 3 percentage points at age 13; at the adult level, this difference had increased to approximately 13 percentage points.

Figure 14 illustrates the difference in male and female performance at each age level for all consumer-math items. A square represents one exercise; distance above or below the zero line indicates the difference between group and national performance. Arrows mark the median difference in performance.

There were very few exercises on which females outperformed males. Results for females at ages 17 and adult showed a meaningful difference (over 1 percentage point) above the nation on only two exercises — the two exercises about reading sales tax from a tax table. In comparison, 17-year-old and adult males had the greatest advantage over females on exercises dealing with computation of percent and computation of area. Difference in male-female performance at age 17 on these exercises was around 14—17 percentage points; at the adult level, the difference on the same exercises increased to 25—27 percentage points.

The male advantage was not confined to any specific type of problem. Sixty percent of the adult males and 50% of the adult females correctly used an excerpt from a federal income tax form. When asked to determine the lowest price per ounce for a box of rice, 40% of the 17-year-old males and 45% of the adult males, but only 29% of the 17-year-old females and 32% of the adult females, selected the correct answer. Male performance on reading a simple mileage chart was 11 percentage points above that of females at age 17 and 18 percentage points above at adult.

FIGURE 14. Male-Female Differences: Consumer-Mathematics Exercises



These differences in male-female performance were substantially greater than those evidenced in the computational-mathematics exercises. For the computation exercises, females performed slightly above males at age 13; results for the two sexes were virtually identical at age 17, and adult males showed a small advantage. Data on the computation exercises, however, indicated that females tended to have more difficulty with word problems than with purely computational exercises.[1] The consumer-math exercises were all presented in word-problem format.

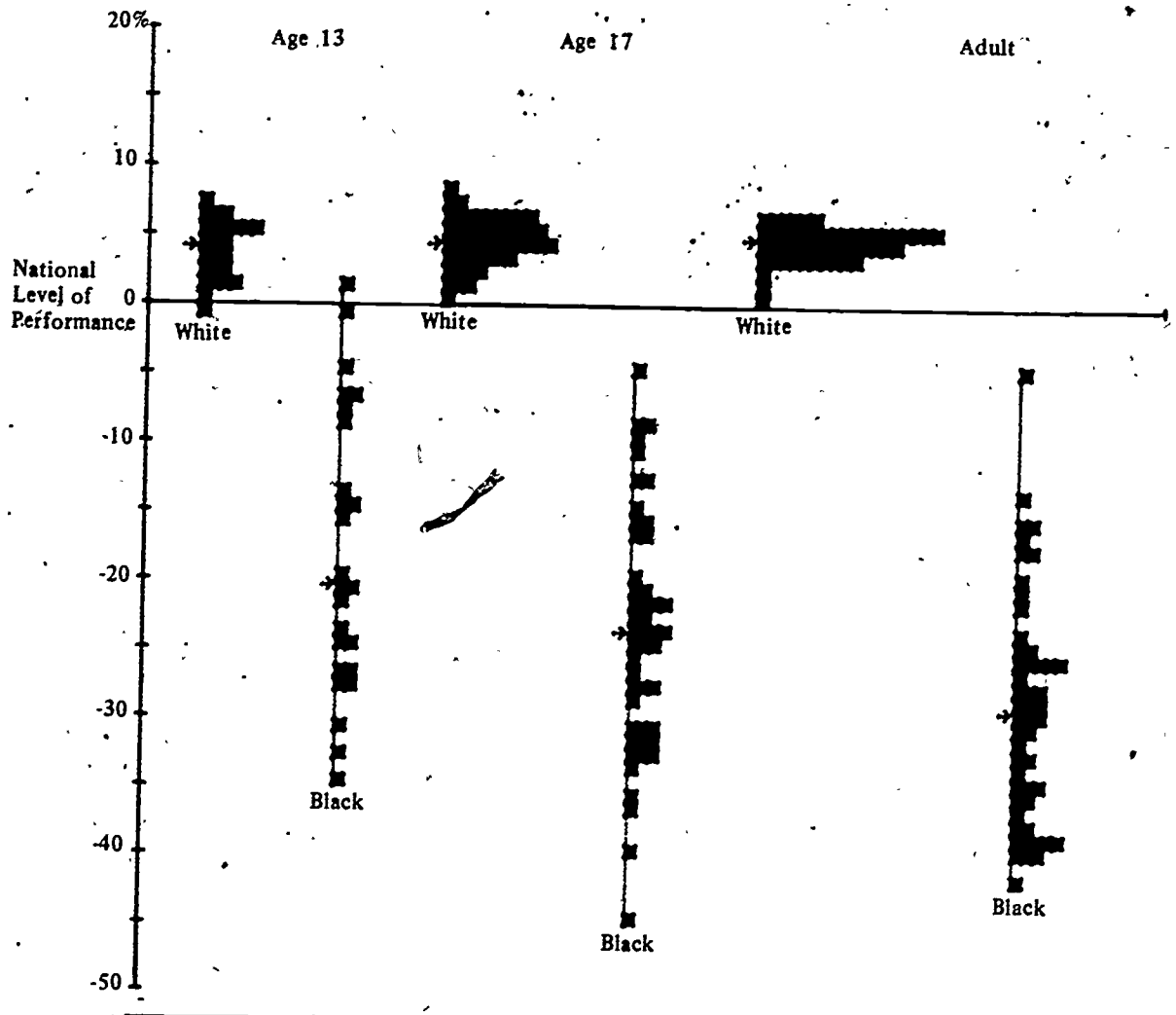
[1] See *Math Fundamentals. Selected Results From the First National Assessment of Mathematics, Mathematics Report 04-MA-01*, 1972—73 Assessment (Washington, D.C.: U.S. Government Printing Office, 1975).

Color

Blacks were also at a disadvantage on the consumer-math exercises, performing below the nation on virtually all exercises. As shown in Figure 15, white performance at all ages was 4—5 percentage points above the nation, increasing slightly at the upper ages, while blacks dropped further below the nation at ages 17 and adult. The median difference in performance for black 13-year-olds was 20 percentage points below the nation; for black 17-year-olds, 24 percentage points below; and for black adults, 29 percentage points below.

Black 13- and 17-year-olds showed the greatest deficit on two graphing exercises — 19A, finding a drop in production, and 17, constructing a graph. Black adults were furthest below the nation on Exercise 7, differences in 3 and 4% sales tax.

FIGURE 15. Black-White Differences: Consumer-Mathematics Exercises



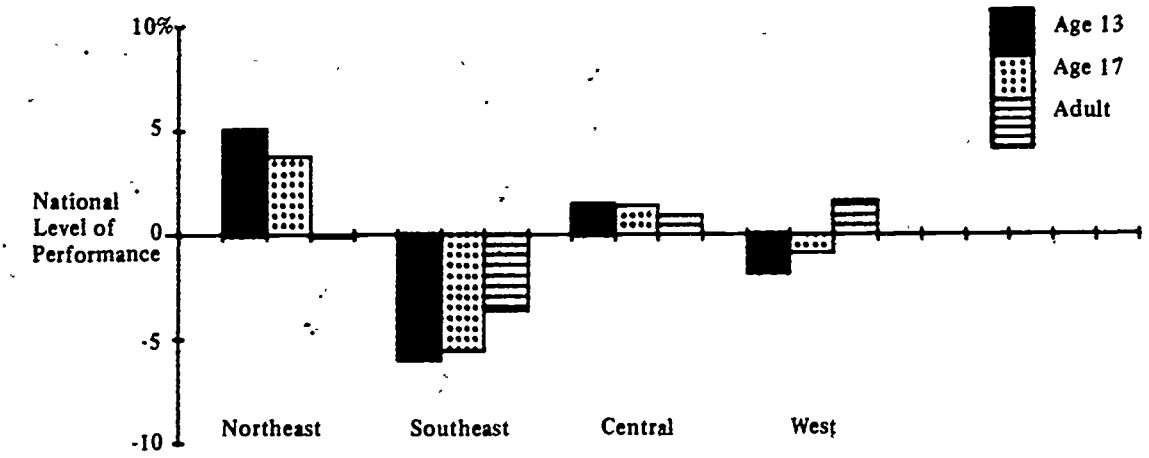
In considering group data, it must be remembered that membership in the group is not the only factor influencing performance. For example, data for the assessment conducted in 1971—72 indicated that 43% of the 17-year-old blacks lived in the Southeast. Thirty-eight percent of the 17-year-old black population lived in low-metropolitan areas, compared to 6% of the white population.[2] Thus, although National Assessment does report results by color, these results must be evaluated in light of other relevant data.

[2]Data on estimated population distributions of National Assessment reporting groups for 1971—72 are found in the *General Information Yearbook, Report 03/04-GIY* (Washington, D.C.: U.S. Government Printing Office, 1974). Similar data for Year 04 (1972—73) have not been published, however, variations over one year are not large.

Regions

Results are reported for four regions of the country: Northeast, Southeast, Central and West. Figure 16 displays regional performance relative to the nation. Performance in the Northeastern region was 5 percentage points above the nation at age 13 but was slightly below that of the nation for adults. Conversely, Southeastern 13-year-olds were 6 percentage points below the nation, but per-

FIGURE 16. Median Differences From National Performance by Region



formance improved steadily from age 13 to adult.

The median differences for the Central region were slightly above the nation and showed very little variation across age levels. In the West, adults performed slightly above the national level while 13- and 17-year-olds were slightly below.

Parental Education

The educational level of one's parents was related to assessment performance. Again, this effect cannot be separated from other factors that influence performance, such as color and community environment. However, the consistency of results for the different parental-education groups is noteworthy.

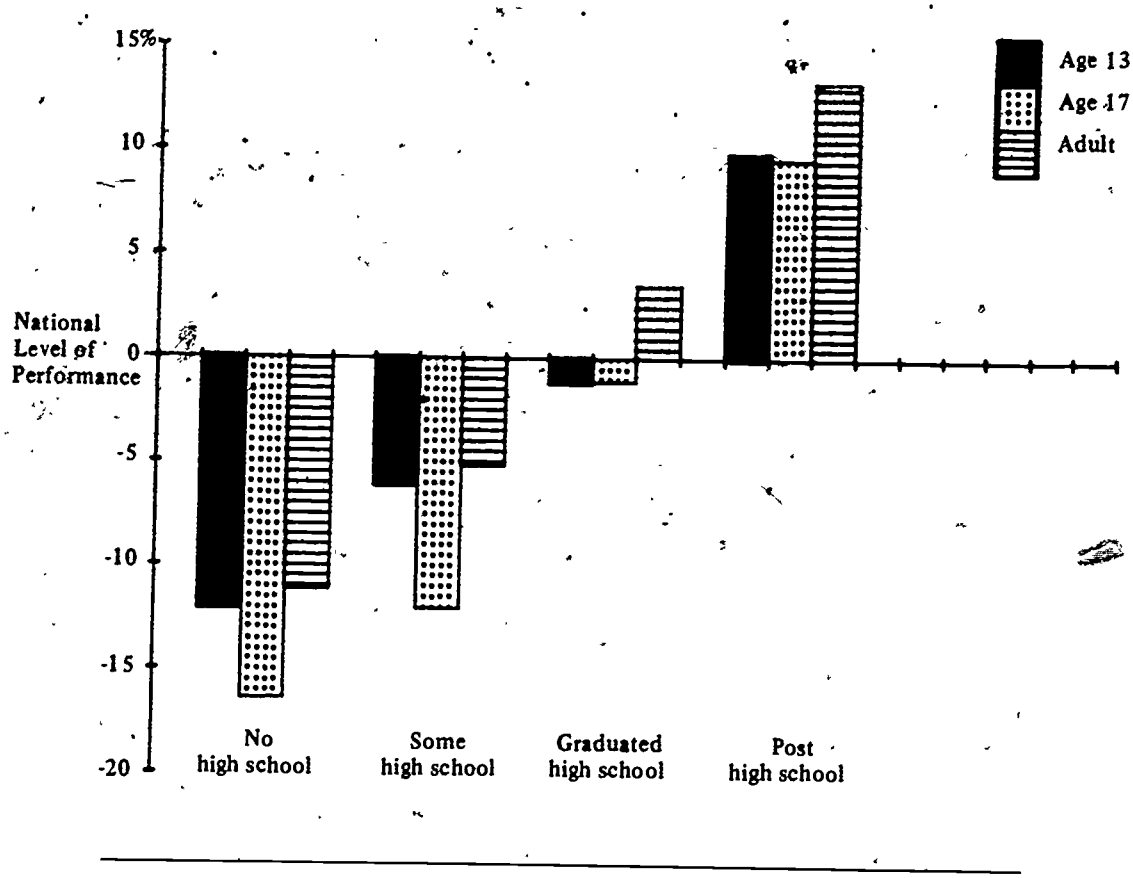
At each age level, percentages of success increased with the educational level of one's parents. Figure 17 indicates median differences from national performance. In cases with neither parent having any high school education, the median differences were from 11 to 16 percentage points below the nation. For those with at least one parent having some high school education, median differences were from 5 to 12 percentage points below national performance.

Twenty-six percentage points separated performance of the no-high-school and post-high-school groups at age 17; 24 percentage points separated these groups at the adult level. For all parental-education groups, adult performance relative to the nation was above that of 17-year-olds.

Size and Type of Community

Individuals living in different community environments showed varying levels of achievement. The variation was greatest for three groups that National Assessment defines as extremes — high metropolitan, low metropolitan and extreme rural (see page 30). These groups are defined both by the size of the community and the type of occupation of most of the adults in the community.

FIGURE 17. Median Differences From National Performance by Level of Parental Education



Median differences in performance are shown in Figure 18. The median differences for the high-metro group were from 11 to 13 percentage points above the nation; for the low-metro group, from 16 to 18 percentage points below the nation. The high-metro group held the greatest advantage at age 13, while performance of the low-metro group was furthest below that of the nation at the adult level.

The median difference for the extreme-rural group was slightly below the nation at ages 13 and adult (approximately 2 percentage points) and further below at age 17 (approximately 5 percentage points). A similar pattern was evident for the main-big-city group; 13-year-olds and adults were very close to national performance while 17-year-old results showed a greater deficit.

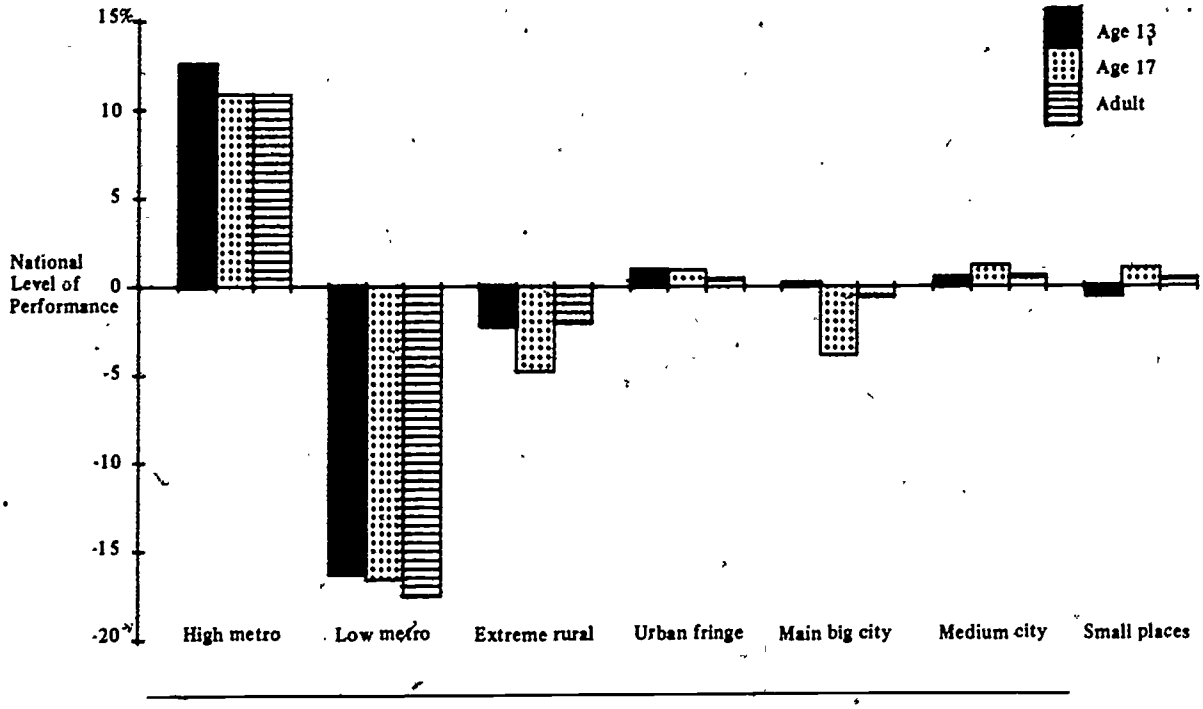
Results for the urban-fringe, medium-city and small-places groups were very close to that of the nation, with median differences generally less than 1%.

Summary

The importance of consumer mathematics in today's American society is indisputable. The consumer cannot afford to rely upon advertisements or computerized statements. Yet it appears that many Americans are doing just that.

National Assessment is a data-gathering organization and, as such, does not make interpretations of the data collected. However, the consumer-mathematics results should raise

FIGURE 18. Median Differences From National Performance by Size and Type of Community



some disturbing questions. For example, are we satisfied with American consumer-mathematics ability in light of the facts that 45% of the adults did not read a federal income tax form correctly, and under half of the population at ages 17 and adult successfully determined the most economical package size on two cost-comparison exercises?

Is the level of 17-year-old performance adequate? What implications does the increase in performance at the adult level have for consumer-mathematics education in the secondary schools? The dramatic increase in performance from ages 13 to 17 is understandable, since many consumer-mathematics skills are introduced at the sixth- through eighth-grade levels. However, does the increase in adult performance indicate that a number of adults master consumer-math skills only when they confront such problems in the marketplace?

How should we evaluate differences in group performance? The differences were similar to those observed in other learning areas assessed by National Assessment. Performance was generally below that of the nation for people living in the Southeast, blacks, people living in low-metropolitan areas and people whose parents had little or no high school education. These differences may seem particularly disheartening in consumer mathematics, since, in many cases, those who have less money to spend are also those lacking skills to manage it.

In most other NAEP learning areas, females tended to do better than males. However, the results for science and for consumer mathematics show females at a definite disadvantage. These data seem to reinforce the old stereotypes about female inability to cope with "technical" or "logical" subjects. What are the reasons for the apparent difference in ability?

The data on consumer mathematics do not point the direction we should take in teaching consumer-mathematics skills. Perhaps the levels of achievement are adequate; perhaps they are not. The data do indicate areas of strength and weakness, both in overall national performance and in performance by different population groups. Readers should consider these data carefully and evaluate them in light of their own particular background and concerns. National Assessment hopes that these results will stimulate further investigation of American skills in consumer mathematics.

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