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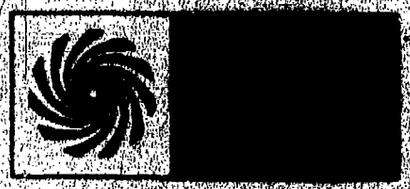
ABSTRACT

The effects of cursory preliminary directions on the use of numerical tables, bar graphs, and line graphs by 288 fourth and sixth graders were investigated. Participants received no directions, written directions only, or written directions with assistance where necessary. The undirected table and bar graph users performed moderately well. Their directed counterparts did not perform reliably better. The undirected line graph users performed near a chance accuracy level. Their counterparts receiving written directions with assistance where necessary performed reliably better. Appendices contain: (1) participant characteristics; (2) numerical tables materials; (3) bar graphs materials; (4) line graphs materials; and (4) the means and standard deviations and analysis of variance (ANOVA) results for the three investigations. (Author/BS)



SWRL EDUCATIONAL RESEARCH AND DEVELOPMENT

Effects of Preliminary Directions on Table- and Graph-Using Proficiencies of Upper Elementary Schoolers

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TECHNICAL REPORT 66

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EFFECTS OF PRELIMINARY DIRECTIONS ON TABLE- AND GRAPH-USING PROFICIENCIES OF UPPER ELEMENTARY SCHOOLERS

Joseph F. Follettie

ABSTRACT

The effects of cursory preliminary directions on the use of numerical tables, bar graphs, and line graphs by 4th and 6th graders were investigated. Participants received no directions, written directions only, or written directions with assistance where necessary. The undirected table and bar graph users performed moderately well. Their directed counterparts did not perform reliably better. The undirected line graph users performed near a chance accuracy level. Their counterparts receiving written directions with assistance where necessary performed reliably better. Make no curative efforts unless there is an illness. An illness present, a little medicine can work minor miracles.

Contents

EFFECTS OF PRELIMINARY DIRECTIONS ON TABLE- AND GRAPH-USING PROFICIENCIES OF UPPER ELEMENTARY SCHOOLERS[1]

Joseph F. Follettie

1. INTRODUCTION

Research at SWRL concerning how well upper elementary schoolers--4th-6th graders--use analytic information displays to obtain specified information stems from an apparent underutilization of such display forms in pertinent published educational materials (cf. Follettie, 1978a). The tendency to avoid using numerical tables, bar graphs, and other analytic information display forms where technically legitimate could be based on a variety of entertainable premises. For example, authors and publishers might believe that upper elementary schoolers are insufficiently proficient in the use of these forms. They might feel that all descriptive statistics should be learned rather than used as one uses a reference work. Conceivably, they might think that it is easier to wade through an algorithm or operating procedure dotted with conditionalities when the description is in glorious written discourse form than when it is flowcharted or put in decision table form. Whatever their views, analytic information display forms exist because there are conditions under which they represent superior means for presenting information. To the extent that biases against their use to present informaton to upper elementary schoolers are unevaluated--which they apparently are--it is pertinent to assess the tenability of these biases--the purpose of the research effort of which the present work is a part.

From Fall 1977 through Spring 1979 a small staff at SWRL studied how proficiently 4th and 6th graders use certain types of numerical tables, bar and line graphs, road and street maps, decision tables, and flowcharts. Some of these display forms--e.g., numerical tables--were familiar to most participants. Some--e.g., decision tables--were outside the experience of most participants. Some displays conveyed essentially uncomplicated information--e.g., output based on single-factor input, such as corn production in each of several states during a given year. Some conveyed information that was organizationally more complex--e.g., corn production in each of several western and eastern states, corn and wheat production in each of several states. Participants typically used a display to obtain information specified in a query appearing below

[1] Data collection was managed by Gail Pratt. The data were collected by Pratt and LoAnn Easlon.

the display. In most investigations, featured query forms were designed to minimize student effort required to use the display proficiently. Featured display-using tasks typically varied from minimally complex (involving one or few cognitive operations and minimal storage of "interim solutions") to somewhat more complex (involving more operations and/or interim storage). Findings are summarized in a series of technical reports (Follettie, 1978b, 1979a, 1979b, 1979c).

Most of the earlier work featured cursory written preliminary directions clarifying pertinent display-formatting conventions and the nature of one or a few display-using tasks to be performed immediately following presentation of the directions, which constituted "how-to" microinstruction.

Students typically were asked to respond to a handful of queries embedded in the written directions. Incorrect responses to these queries were taken as evidence that the directions were misunderstood (whether due to defects in the directions themselves or to a self-administration procedure that permitted the student to read them as carefully or casually as he/she wished). Incorrect responses were the occasion for short explanations by attending research personnel. These explanations were provided a few seconds after an incorrect response was made. The time taken to read the directions, respond to associated queries, and receive explanations where pertinent typically was on the order of 3-5 minutes.

When 4th and 6th grders were so oriented to the work, simpler display/task combinations typically yielded high mean accuracy and speed for display-using at one or both grade levels. Really poor performance typically occurred only when display/task combinations reflected complexity levels one would not expect to encounter often in semantic contents addressed in the upper elementary grades.

Whether the means obtained in the earlier work would have been as high had the preliminary directions and/or associated researcher assistance been withheld could not usually be determined in light of the study design used. Hence, the present investigations were undertaken to explore the effects of preliminary cursory directions, with or without clarifying assistance where needed, on consequent display-using performance.

There are any number of hunches one might entertain concerning the conditions under which preliminary cursory directions might or might not prove useful. Some of these are presented in the Method section.

This report presents findings for three classes of display--numerical tables, bar graphs, and line graphs--negotiated following one of three conditions for display-task clarification--no directions, written directions only, and written directions with

clarifying assistance where needed--by 4th and 6th graders. The displays and tasks featured in the investigations were at two levels of complexity--low and moderate.[2]

A companion report (Follettie, 1980b) covers the same ground for street maps, decision tables, and tree diagrams except that the condition of written directions with clarifying assistance was not investigated.

[2]An earlier preliminary report (Follettie, 1980a) describing some of the findings incorporated in this report has since been found to contain some scoring and posting errors that are corrected herein.

2. METHOD

In most work involving several classes of analytic information display, even when given semantic content can be presented using each of the different forms, it usually will not do justice to each if semantic content is held constant. Numerical tables can be used to convey a good deal of digital information--precise numerical values. Such information can be conveyed using a bar graph. But the bar graph will highlight relative magnitudes--analog information--with approximations of tabled numerical values available only in consequence of scale interpolation. Line graphs typically reflect either functional relationships or time series data. The time series data can be presented using a bar graph, but bar graphs are not conventionally used to convey functional relationships. If one attempts to use a bar graph to express the information contained in a table having 7 columns x 10 rows, the result will be 10 clusters of 7 bars--a large number of bars whose 7 intracluster positions will need be visually differentiated. The table will be rather compact and uncluttered. The bar graph at best will have a complicated appearance.

All things considered, semantic content cannot usefully be held constant in investigations that involve several different display classes. Herein, content varies with display class studied. Hence, display class cannot be considered a systematic independent variable in a larger factorial design. Rather, the present work is conceived as three parallel investigations--one for numerical tables, one for bar graphs, and one for line graphs.

PERSPECTIVE AND DESIGN

No theory that an engineer could exploit exists in the area of inquiry. In consequence, I present below a Poor Richard's perspective concerning what to expect in investigations such as these. Both the credit and the blame for this construction should go to Ben Franklin.

At the outset, Ben surely would note that the potental effectiveness of cursory preliminary directions is inversely proportional to the need for them. He would say that undirected students who score high for accuracy (e.g., in the .80-.95 range) are unlikely to manifest reliably more accurate display-using performance simply on the basis of cursory directions. Conversely, undirected students scoring much lower (e.g., in the .40-.60 range) indeed might profit from cursory directions if these are pertinent, understandable, and not overly dull. One can well imagine him saying that undirected tykes might be able to handle simpler

numerical tables and bar graphs, whereas even some of the founding fathers would have difficulty with line graphs unless imaginatively coached.

Nor would Ben fail to note that where 4th graders profit from cursory directions but 6th graders do not, then it is likely that the added pertinent experience of most 6th graders renders the need for cursory directions low or nil. Nor the converse corollary that where 4th graders do not profit from cursory directions but 6th graders do, then the directions must be ineffective for 4th graders. But he would have gone beyond this bare tautology to remark that the problem for 4th graders then might take one of three forms. First, the directions as written exceed 4th grader language proficiencies. Second, the 4th graders require more extensive instruction as the basis for high accuracy. Finally, the 4th graders are insufficiently maturationally (or at any rate conceptually) advanced to perform the levied tasks with high accuracy.

Whatever the grade level, Ben would point out, undirected students might be able to perform simpler display-processing tasks involving simpler displays but not more complex tasks involving more complex displays. Cursory directions then might lead to reliably more accurate performance involving more complex display-task combinations. Extrapolating from this line of thought, he would note that undirected students who perform poorly even when dealing with the simplest combinations might perform reliably better for these after receiving cursory directions.

Ben's perspective surely would convey that empirical work on the effects of cursory directions should to the extent possible be predicated on obtaining significant main effects for display complexity and/or task complexity factors. He would encourage investigators to specify displays and tasks at a moderate level of comlexity that are reliably more difficult for 4th graders than those at a low level of complexity. But not impossibly more difficult. Inherent in this point is a perspective for educational research that exceeds the needs of this paper--a Not-So-Poor Richard's perspective.

Each of three investigations featured six groups of 16 students--two grade levels (A; 4th, 6th) times three conditions for directions (B; none, written only, assisted where necessary). The display-using portion of each investigation featured two levels of display complexity (C; low, moderate) and two of task complexity (D; low, moderate). All students in a group negotiated materials reflecting each of the four combinations for display/task complexity, with counterbalancing of presentation sequence for the combinations.

It follows from Franklin's perspective that each investigation should be centrally concerned with the main effects of the

directions factor (B) and with the first-order interactions between grade level and directions (AxB), directions and display complexity (BxC), and directions and task complexity (BxD).

PROCEDURE

The investigations were conducted during January-May 1980. Participants were drawn from nine 4th and nine 6th grade classes spread over five K-6 schools in Los Angeles and Orange Counties. They were previously screened using a 28-item screen featuring reading-decoding tasks. Those making more than eight incorrect responses were excused. Of the 394 students accepted for participation (84% of those screened), 288 participated--in 18 groups of 16.

Administrative conditions rendered it desirable that a given group of 16 students be drawn from a single classroom insofar as possible. Only two groups included some students from a second classroom. Within a classroom, selection from the pool of accepted students was random except that it was biased against higher scoring 6th graders. (Mean scores on the screen rise slightly with grade level.) Screening results and group screening score means are presented in Appendix A.

Materials are presented in Appendix B for the numerical tables investigation, Appendix C for the bar graphs investigation, and in Appendix D for the line graphs investigation. Materials consist of written directions (3 pages), display-using work (4 pages), and format comprehension work (1 page). The preliminary directions presented in the appendices are for the condition of assistance where needed. Those for the condition of written directions only differed in just one respect: answers to queries were provided in a paragraph immediately following the query or set of queries. Directions of course were deleted under the no directions condition.

Each display-using page consisted of an information display and four queries involving use of the display. A given page featured one of four combinations for display/task complexity--low/low, low/mod, mod/low, mod/mod.

Display-using chance accuracy varied across investigations, being 1/64 for numerical table queries, 1/12 on the average for bar graph queries, and 1/6 for line graph queries. Chance accuracy for format comprehension queries was 1/5 across investigations.

Students were seen during morning hours at the school in groups of two in available space outside the classroom. Participation was completed during a single session usually lasting 30 minutes or less. The students in a group proceeded at their own pace, with each page of study materials timed. Each participant first

negotiated the pertinent condition for directions, then the display-using pages, and finally the format comprehension page. Noted earlier, the display-using pages were counterbalanced for presentation sequence.

For each page of materials, the student received an accuracy (ACC) and a speed (RATE) score. From these scores an accuracy/time (ACC/TIME) score was derived. The speed score was transformed to reflect number of queries responded to per minute. The accuracy/time score reflects the number of queries correctly responded to per minute.

Accuracy of course is primary in investigations of information processing proficiency (or display effectiveness). Speed is secondarily pertinent in most instances. A speed score becomes pointless only when a student does not understand what is required, senses this, and so opts to respond as quickly as possible by guessing. The accuracy/time score, which combines accuracy and speed facets of performance, reflects those instances where speed is not indicative of information processing proficiency (or display effectiveness). The data were analyzed in terms of all three measures.

The work of which these investigations are a part is in a sense antistatistical power research. Cell n (size of the experimental group) almost invariantly is set at 16. Participants more nearly perform in a goldfish bowl than under carefully controlled laboratory conditions. We do not remove the inevitable nongermane intragroup variance that results when different levels of within-subjects factors are counterbalanced for presentation sequence. The philosophy is that positive findings that survive this gauntlet merit consideration.

3. RESULTS

The tasks central to these investigations fall under a display-using heading. In such tasks, one uses an information display to obtain information solicited in a query placed beneath the display. After students had completed the display-using portion of their participation, they were queried concerning understanding of formatting conventions characterizing the assigned display. The directions addressed both kinds of tasks.

Herein, the no directions condition is denoted ND, the written directions only condition PD, and the written directions with assistance where needed condition PD+. Our impression is that many participants did not require the assistance that transforms PD into PD+ directions. However, we failed to make the tallies that would quantify this impression. Suffice to say that not all PD+ students actually received PD+.

The data for a given participant reflects three measures (ACC, RATE, A/T) times two classes of task (display-using, format comprehension), with the display-using data further alternatively differentiated into low and moderate display and task complexity components. The pertinent group cell means and standard deviations are presented in Appendix E, together with summaries of ANOVA results.

A summary of the appended summaries of ANOVA results is presented in Table 1. The reliability of differences between grade level means is a customary finding and not of central concern here, although the rate superiority of 4th graders when processing line graphs should be noted. This outcome is to be expected when an appreciable number of students at the lower grade level adopt a strategy to minimize duration of the agony. In many instances, the RATE data are interesting in their own right. Here they are not. All in all, the accuracy/time (A/T) data afford the less equivocal basis for gauging the pertinent effects of RATE.

The general reliability of differences between display-using means based on low and moderate values for display and task complexity is noteworthy only in that these findings reflect that the materials were successfully engineered in most instances.

Noted in the presentation of Franklin's perspective, the critical F-ratios and associated p-values for the display-using portions of these investigations are those for the directions factor and first-order interactions involving this factor. The directions factor had significant effects on accuracy only for line graphs. There were a number of significant or near-significant interactions

Table 1
Summary of ANOVA Results[a]

Source	Num Tables			Bar Graphs			Line Graphs		
	ACC	RATE	A/T	ACC	RATE	A/T	ACC	RATE	A/T
Display-Using									
Grade Level (A)	<.10	<.001	<.001	<.001	<.01	<.001	<.01	<.05[b]	<.05
Display Complexity (C)	<.01	<.001	<.001	<.001	<.001	<.001	<.05		
Task Complexity (D)	<.001	<.001	<.001	<.001	<.001		<.05	<.05	<.001
Directions (B)		<.001[c]	<.001[c]	[d]	[e]		<.001[f]		<.001
AxB Interaction		<.05[c]	<.10[c]	<.05[d]	<.05[e]		<.05[f]		
BxC Interaction		<.10							
BxD Interaction									
Format Comprehension									
Grade Level (A)		<.001	<.001	<.001		<.001	<.001		<.001
Directions (B)					[g]	[g]	<.001	[h]	<.001[h]
AxB Interaction		<.10			<.05[g]	=.10[g]		<.01[h]	<.05[h]

[a]For blank entries, $p > .10$.

[b]In favor of 4th graders.

[c]Directions are effective for 6th graders. PD is sufficient.

[d]Directions are effective for 4th graders. PD+ works best.

[e]Directions are effective for 6th graders. PD+ works best.

[f]Directions are effective at both grade levels. PD+ works best.

[g]4th graders perform reliably more poorly under the PD+ condition.

[h]Directions are effective for 6th graders. PD+ works best.

between grade level and directions (AxB). The import of these interactions is indicated in the footnotes of Table 1. The interactions involving display (BxC) and task (BxD) complexity proved in general nonsignificant.

Directions had no reliable effect on numerical tables format comprehension, only negative effects on bar graphs format comprehension, and reliable positive effects only on line graphs format comprehension.

Table 2 relates the reliability of key differences between means to the values of these means in a grade level times level of directions x class of task presentation. The implications of findings are straightforwardly drawn in Table 3. When the rate data are set aside, then directions simply are not needed when 4th and 6th graders use the simpler numerical tables and bar graphs featured here or when their understanding of pertinent formatting conventions are at issue. Conversely, directions with assistance where necessary are helpful when the display is a simpler line graph.

Table 2
Means and Reliability of Differences between Means
for Directions by Grade Level

Grade	Directions Condition	Num Tables ACC	Num Tables RATE	Num Tables A/T	Bar Graphs ACC	Bar Graphs RATE	Bar Graphs A/T	Line Graphs ACC	Line Graphs RATE	Line Graphs A/T
Display-Using										
4th	ND	.69	2.3	1.5	.70	2.7	1.9	.21	3.6	.7
	PD	.79	2.6	2.1	.71	2.6	1.9	.32	3.9	1.2
	PD+	.79	2.3	1.9	.83	2.5	2.1	.84	3.2	2.7
	p<.05?	NO	NO	NO	YES	NO	NO	YES	NO	YES
6th	ND	.78	2.8	2.2	.87	2.9	2.5	.47	2.9	1.4
	PD	.82	3.6	3.0	.91	2.7	2.5	.58	3.0	1.9
	PD+	.90	3.8	3.4	.84	3.3	2.9	.81	3.1	2.6
	p<.05?	NO	YES	YES	NO	YES	NO	YES	NO	YES
Format Cphn										
4th	ND	.71	2.3	1.6	.55	2.4	1.4	.44	2.8	1.1
	PD	.70	2.4	1.7	.40	2.2	.9	.30	2.9	.8
	PD+	.65	1.8	1.2	.55	1.6	.9	.71	2.2	1.4
	p<.05?	NO	NO	NO	NO	NO[a]	NO[a]	YES	NO	NO[b]
6th	ND	.74	3.1	2.4	.69	2.0	1.4	.62	2.5	1.5
	PD	.78	3.6	2.9	.72	2.0	1.5	.51	2.5	1.3
	PD+	.77	3.7	3.0	.71	2.2	1.6	.81	3.1	2.6
	p<.05?	NO	NO	NO	NO	NO	NO	YES	YES	YES

[a]4th graders perform reliably more poorly when receiving PD+.

[b]The effect of directions approaches significance (p<.10).

Table 3
Implications of Findings

Class of Display	Class of Task	Grade	Measure	Mean ND Score	Are directions reliably helpful?	Sufficient Condition
Numerical Tables	Display-Using	4th	ACC	.69	No	ND
			A/T	1.5	No	ND
		6th	ACC	.78	No	ND
			A/T	2.2	Yes	PD
	Format Cphn	4th	ACC	.71	No	ND
			A/T	1.6	No	ND
		6th	ACC	.74	No	ND
			A/T	2.4	No	ND
Bar Graphs	Display-Using	4th	ACC	.70	No	ND
			A/T	1.9	No	ND
		6th	ACC	.87	No	ND
			A/T	2.5	No	ND
	Format Cphn	4th	ACC	.55	No	ND
			A/T	1.4	No	ND
		6th	ACC	.69	No	ND
			A/T	1.4	No	ND
Line Graphs	Display-Using	4th	ACC	.21	Yes	PD+
			A/T	.7	Yes	PD+
		6th	ACC	.47	Yes	PD+
			A/T	1.4	Yes	PD+
	Format Cphn	4th	ACC	.44	Yes	PD+
			A/T	1.1	No[a]	ND[a]
		6th	ACC	.62	Yes	PD+
			A/T	1.5	Yes	PD+

[a] $p < .10$.

4. DISCUSSION

Perhaps owing to limited pertinent experience, undirected upper elementary schoolers on the average perform line graph-using tasks not remarkably more accurately than chance level. Such students apparently find cursory preliminary directions helpful.

Conversely, undirected upper elementary schoolers perform numerical table- and bar graph-using tasks moderately well. Raising such students reliably above this "entry" level for accuracy and speed entails more extensive instruction than inheres in cursory preliminary directions.

The aggregate data of course hide the fact that some students under all conditions perform quite accurately and that at least a few students under the best of conditions perform around chance.

I doubt that most 4th graders who performed the line graph-using tasks well in consequence of receiving preliminary directions with assistance where required had more than a rudimentary understanding of the nature of featured functional relationships. Nonetheless, it is illuminating how much performance involving such esoterica can be improved in consequence of some straightforward coaching over the course of a minute. Concepts might take a bit longer, but not inordinately complex procedures can be learned quickly.

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APPENDIX A: PARTICIPANT CHARACTERISTICS

The investigations were conducted at two K-6 schools in the ABC Unified School District, two K-6 schools in the Westminster Elementary School District, and one K-6 school in the Hacienda-La Puente School District. Screening results, by school and grade level, are presented in Table A-1.

Table A-1
Screening Results for Nine 4th and Nine 6th Grade Classes Spread Over Five Schools

Grade	School	Screened	Accepted	Proportion Accepted
4	A	51	45	.88
	B	57	35	.61
	C	40	31	.77
	G	24	20	.83
	H	58	46	.79
	All 4th	230	177	.77
6	A	63	61	.97
	B	52	48	.92
	C	49	40	.82
	G	25	24	.96
	H	50	44	.88
	All 6th	239	217	.91
Both	All	469	394	.84

Participants were assigned to one of 18 16-student groups. The nature of these groups and their means and standard deviations are indicated in Table A-2.

Table A-2
Screening Score Means and Standard Deviations
for Participating Groups of 16

Grade	Condition	Numerical Tables $\bar{X}$	SD	Bar Graphs $\bar{X}$	SD	Line Graphs $\bar{X}$	SD
4	No Directions	25.2	2.0	24.6	3.0*	24.6	1.9
	Directions Only	25.2	1.7	24.7	3.0*	25.1	2.3
	Assisted Directions	25.5	1.9	25.7	1.9	26.4	1.7
6	No Directions	25.3	1.8	25.7	2.4	25.8	1.2
	Directions Only	26.3	1.4	25.5	1.7	25.8	1.3
	Assisted Directions	26.2	1.8	26.7	1.3	27.2	1.3

*There was a dearth of accepted students in School B 4th grades. Absences necessitated using a student scoring 18 on the screen in the No Directions/Bar Graph 4th grade group and one scoring 19 in the Directions Only/Bar Graph 4th grade group. These two students account for the appreciably higher standard deviations for their groups.

APPENDIX B: NUMERICAL TABLES MATERIALS

The materials consist of a cover page, three pages of preliminary directions (the assistance where needed version), four pages of display-using work, and one page of format-comprehension work.

Each page of the display-using work features a table containing eight rows and columns (64 entries). The first and third pages reflect low complexity displays, with one factor in the row margin and one in the column margin. The second and fourth pages reflect moderate complexity displays, with one factor in the row margin and two, in factorial organization, in the column margin. Note that the queries to these tables are top-down organized, mentioning the pertinent year first and then the pertinent category of the second factor.

The first and second pages reflect a low complexity task--obtaining absolute information. The third and fourth pages reflect a moderate complexity factor--obtaining relative information. To perform the second task entails first finding the largest or smallest entry in a specified column and then identifying its associated producer.

The first-to-fourth page combinations for display/task complexity are 1/1 (low/low), 2/1 (mod/low), 1/2 (low/mod), and 2/2 (mod/mod).

WU 204: SERIES 80-1 NUMERICAL TABLES GR: 4th 6th PD: Yes No SN: _____

FIRST, FILL IN THE BLANKS. THEN READ THE DIRECTIONS.

Name: _____ Room: _____
First Name First Letter of Last Name

Teacher: _____

Today you will be answering some questions using a numerical table. The work you are to do will not be the same for everyone. Most of you should be finished in 30 minutes.

Some of you will receive preliminary directions on how to use tables. Some of you will not. We know the work will be harder for those not receiving preliminary directions. But please try hard to figure out how to use the table to answer the questions.

All of your work will be timed. But it is more important to understand what you read and to get answers right than to work fast. If someone finishes ahead of you, don't be bothered. There is no prize for finishing first.

On the pages with questions, there is some coded material at the top—above a line that crosses the page, as on this page. Don't bother with these codes. They just help us keep everything straight.

Read and look at **everything** below the line that crosses the page at the top. In particular, look closely at the table. Look at its title and the names of its rows and columns. You are sure to miss the questions if you don't do this.

RAISE YOUR HAND WHEN YOU'VE FINISHED READING THESE DIRECTIONS.

PRELIMINARY DIRECTIONS

You might already know something about numerical tables. The facts are reviewed here. Even the simplest tables have four parts. These are the title, names of rows, names of columns, and numbers called entries. These parts are labelled in the table.

TITLE = Scores of Four Students on Five Tests

Student	Test					
	Art	Math	Music	Reading	Spelling	= COLUMN NAMES
Alice	64	74	84	70	68	
Carl	80	90	60	86	76	
Frank	92	66	72	94	96	
Joan	98	82	88	78	62	

ROW NAMES = (Alice, Carl, Frank, Joan) = ENTRIES

The title tells us what goes in the rows (here, scores of four students) and in the columns (scores on five tests). Notice that only the title tells us what the numbers stand for. They are **scores**. Some are art scores, some math scores. Some scores belong to Alice, some to Carl. But all are scores. In some tables, you can only tell what the numbers stand for by reading the title. The underlined words in these titles tell us what the numbers would stand for.

- Dozens of Roses Sold in Two Stores
- Tons of Manure Used on Five Farms
- Hundreds of Tons of Grapes Grown in Four States

A number in the table for roses stands for dozens of roses sold in one of the stores. A number in the table for grapes stands for hundreds of tons of grapes grown in one of the states.

TITLE = Scores of Four Students on Five Tests

Student	Test					
	Art	Math	Music	Reading	Spelling	= COLUMN NAMES
Alice	64	74	84	70	68	
Carl	80	90	60	86	76	
Frank	92	66	72	94	96	= ENTRIES
Joan	98	82	88	78	62	

ROW NAMES =

All of the scores in the **first row** belong to Alice. There are five of them. All of the scores in the **last column** are spelling scores. There are four of them. One spelling score belongs to Alice, one to Carl, and so on.

If you want to know Alice's spelling score, you go across in the row for Alice until you come to the column for Spelling. The number where the row and column cross is Alice's spelling score—68. Answer the following questions:

- What is Carl's reading score? _____
- What is Frank's math score? _____

Now have me look at your answer.

Let's try a different kind of question.

- On what test did Alice get her highest score? _____

Now have me look at your answer.

We can ask this kind of question another way. For example:

- Who got the highest score on the reading test? _____
- Who got the lowest score on the art test? _____

Now have me look at your answers.

Not all tables are as simple as the one we have been discussing. Let's look at what happens if we want to show scores on several tests taken before a lesson (say on Monday) and after a lesson (say on Friday).

Scores of Four Students on Three Tests Taken on Monday and Friday

Student	Monday			Friday		
	Art	Math	Music	Art	Math	Music
Alice	64	74	84	77	89	93
Carl	80	90	60	85	93	67
Frank	92	66	72	95	65	81
Joan	98	82	88	99	97	91

Answer these questions:

- What was Carl's score on the Friday test in math? _____
- What was Joan's score on the Monday test in music? _____
- On which day did Frank score highest in math? _____

Your answers should be 93, 88, and Monday. This ends the review.

Now let me look at your answers.

This completes the review.

WHEN FINISHED, RAISE YOUR HAND.

WU 204: Series 80-1

NUM 1 / TASK 1 GR: 4th 6th Acc: _____ Min/Sec: _____

SN: _____ PD: Yes No 60A/Sec: _____ Sec: _____

E: 1 2 240/Sec: _____

STUDY THE TABLE CAREFULLY. USE IT TO ANSWER THE QUESTIONS:

Quarts of Apple Juice Made by Eight Families in Some Months of 1978

Family	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
Barlow	14	31	57	73	32	92	65	22
Cantor	11	38	49	80	41	89	58	42
Elwood	23	29	71	69	24	79	45	25
Grimes	16	44	46	55	26	64	51	33
LaRose	10	27	63	81	30	84	62	35
Montez	19	36	59	78	43	97	50	28
Sapper	20	48	54	91	37	88	56	40
Villon	21	34	60	67	47	94	72	39

CIRCLE THE ANSWER IN THE TABLE.

1. In August, who made 26 quarts of juice? Circle the family.
2. When did the LaRose family make 63 quarts of juice? Circle the month.
3. How much juice did the Villon family make in July? Circle the number.
4. How much juice did the Montez family make in October? Circle the number.

RAISE YOUR HAND WHEN FINISHED.

WU 204: Series 80-1

NUM 2 / TASK 1 GR: 4th 6th Acc: _____ Min/Sec: _____

SN: _____ PD: Yes No 60A/Sec: _____ Sec: _____

E: 1 2 240/Sec: _____

STUDY THE TABLE CAREFULLY. USE IT TO ANSWER THE QUESTIONS:

Tons of Barley and Wheat Grown by Eight Farmers In Some Recent Years

Farmer	1970		1973		1976		1979	
	Barley	Wheat	Barley	Wheat	Barley	Wheat	Barley	Wheat
Adams	18	27	24	44	33	48	36	42
Denni	25	40	31	47	14	61	41	81
Hicks	21	53	17	58	26	74	56	90
Lopes	10	19	11	39	15	82	38	77
Miles	28	76	22	80	37	75	49	99
Perry	16	92	20	88	29	66	45	94
Reese	12	83	13	96	34	91	52	78
Tully	23	35	32	50	30	43	46	86

CIRCLE THE ANSWER IN THE TABLE.

1. In 1973, who grew 80 tons of wheat? Circle the farmer.
2. When did Tully grow 46 tons of barley? Circle the year.
3. In 1976, how many tons of wheat did Perry grow? Circle the number.
4. In 1973, how many tons of barley did Lopes grow? Circle the number.

RAISE YOUR HAND WHEN FINISHED

WU 204: Series 80-1

NUM 1 / TASK 2 GR: 4th 6th Acc: _____ Min/Sec: _____

SN: _____ PD: Yes No 60A/Sec: _____ Sec: _____

E: 1 2 240/Sec: _____

STUDY THE TABLE CAREFULLY. USE IT TO ANSWER THE QUESTIONS:

Houses Built by Eight Companies in Some Recent Years

Company	1972	1973	1974	1975	1976	1977	1978	1979
Anchor	39	40	28	35	33	25	42	22
Dibble	92	89	75	64	84	97	88	94
Fallco	67	91	78	81	55	69	80	73
Hammer	31	38	29	44	27	36	48	34
Jensen	14	11	23	16	10	19	21	20
Oxford	60	54	59	63	66	71	49	57
Nallum	32	41	24	26	30	43	37	47
Trublu	72	56	50	62	51	45	58	65

CIRCLE THE ANSWER IN THE TABLE.

1. Who built the largest number of houses in 1977? Circle the company.

2. Who built the smallest number of houses in 1974? Circle the company.

3. What was the Hammer Company's best year? That is, when did it build its largest number of houses? Circle the year.

4. What was the Oxford Company's worst year? That is, when did it build its smallest number of houses? Circle the year.

RAISE YOUR HAND WHEN FINISHED.

WU 204: Series 80-1

NUM 2 / TASK 2 GR: 4th 6th Acc: _____ Min/Sec: _____

SN: _____ PD: Yes No 60A/Sec: _____ Sec: _____

E: 1 2 240/Sec: _____

STUDY THE TABLE CAREFULLY. USE IT TO ANSWER THE QUESTIONS:

Boys and Girls Born in Eight Towns in the 1960s and 1970s

Town	1960		1965		1970		1975	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
Biiko	78	43	16	28	38	56	41	16
Flick	30	52	92	76	77	90	81	27
Gabby	35	29	96	37	26	11	33	14
Ingot	23	13	66	75	39	74	61	48
Jenks	86	83	20	22	15	17	31	24
Quint	46	12	89	80	82	58	47	44
Solow	50	91	45	10	49	21	25	36
Voron	32	34	94	99	19	40	53	42

CIRCLE THE ANSWER IN THE TABLE.

1. In 1965, where were the largest number of girls born? Circle the town.
2. In 1975, where were the smallest number of boys born? Circle the town.
3. For the town of Gabby, when were the largest number of girls born? Circle the year.
4. For the town of Jenks, when were the smallest number of boys born? Circle the year.

RAISE YOUR HAND WHEN FINISHED.

WU 204: Series 80-1

NUM / CPHN GR: 4th 6th Acc: _____ Min/Sec: _____

SN: _____ PD: Yes No 60A/Sec: _____ Sec: _____

E: 1 2 480/Sec: _____

STUDY THE TABLE CAREFULLY. USE IT TO ANSWER THE QUESTIONS:

Thousands of Bales of Cotton Grown by the Farmers of Pearl County in the Depression Years = A

Farmer	Year 1930	1933	1936	1939
Benson	14	23	16	25
Cooper	21	30	27	32
Garcia	11	24	18	29
Minsky	22	19	15	34
Porter	26	17	20	28

C = Farmer

= B

= D

1. What kind of crop did the farmers grow? _____

2. Locate the number 14 in the table. This number stands for one of the following. Circle the answer.

   Benson farmers 1930 thousands of bales years

3. What does Cooper do for a living? He is a _____.

4. How many numbers are there in any one row of the table? _____

Notice = A, = B, = C, = D. A, B, C, and D are codes. These codes stand for parts of the table. You use these codes to answer questions 5 to 8.

5. The different farmers are named in the part of the table whose code is _____.

6. How much each farmer grew in each year is shown in the part whose code is _____.

7. The title of the table is the part whose code is _____.

8. The different years are shown in the part whose code is _____.

RAISE YOUR HAND WHEN FINISHED.

APPENDIX C: BAR GRAPHS MATERIALS

The bar graph materials mirror those for numerical tables (Appendix B), with the following exceptions. First the low complexity displays contain just 8 bars (members of a single set), whereas the moderate complexity displays contain 24 bars in 8 clusters of 3, reflecting two factors in factorial arrangement. Second, the low complexity task when using bar graphs--obtaining relative information--is the moderate complexity task when using numerical tables, whereas the moderate complexity task when using bar graphs--obtaining absolute information--is the low complexity task when using numerical tables. This reversal makes sense intuitively and is empirically substantiated in earlier work (Follettie, 1979a).

WU 204: SERIES 80-1 BAR GRAPHS GR: 4th 6th PD: Yes No SN: _____

FIRST, FILL IN THE BLANKS. THEN READ THE DIRECTIONS.

Name: _____ Room: _____
First Name First Letter of Last Name

Teacher: _____

Today you will be answering some questions using a bar graph. The work you are to do will not be the same for everyone. Most of you should be finished in 30 minutes.

Some of you will receive preliminary directions on how to use bar graphs. Some of you will not. We know the work will be harder for those not receiving preliminary directions. But please try hard to figure out how to use the graph to answer the questions.

All of your work will be timed. But it is more important to understand what you read and to get answers right than to work fast. If someone finishes ahead of you, don't be bothered. There is no prize for finishing first.

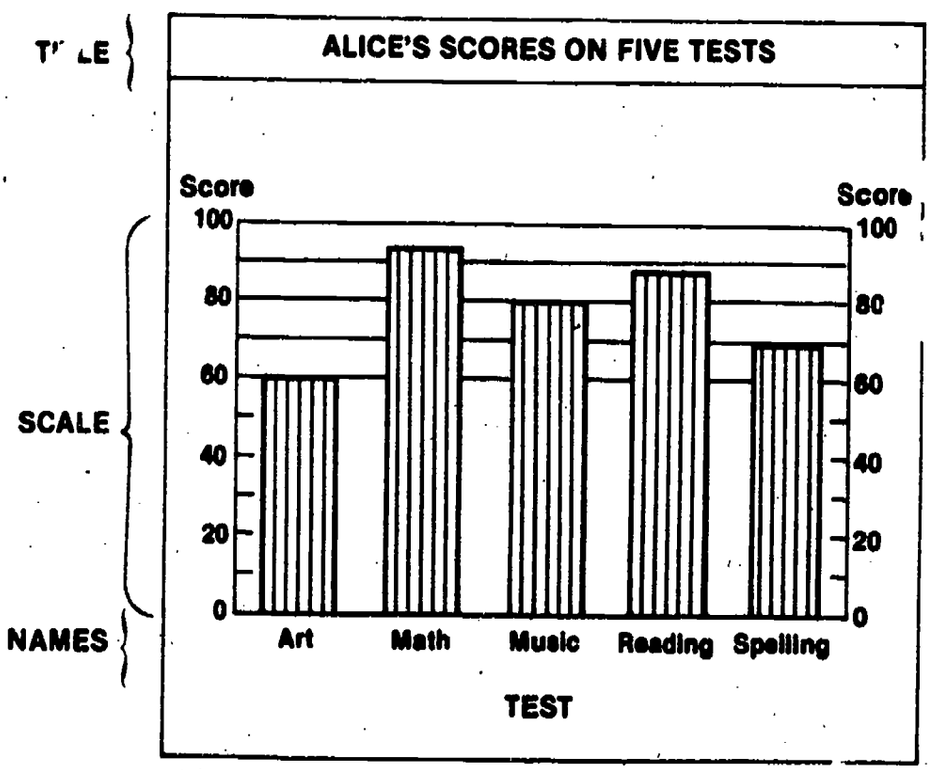
On the pages with questions, there is some coded material at the top—above a line that crosses the page, as on this page. Don't bother with these codes. They just help us keep everything straight.

Read and look at everything below the line that crosses the page at the top. In particular, look closely at the bar graph. Look at its title and the number scales at the sides and bar labels at the bottom. You are sure to miss the questions if you don't do this.

RAISE YOUR HAND WHEN YOU'VE FINISHED READING THESE DIRECTIONS.

PRELIMINARY DIRECTIONS

You might already know something about bar graphs. The facts are reviewed here. Even the simplest bar graphs have four parts. These are the title, the scale, the bar names, and the bars. The first three of these parts are labeled in the bar graph. You can see where the bars are.



The title tells us that each bar stands for one test score. The first bar stands for Alice's score on the art test, the second for her score on the math test, and so on. The higher the bar, the higher the score. In this bar graph, it doesn't matter how wide the bars are. They could be half as wide or twice as wide and still mean the same thing.

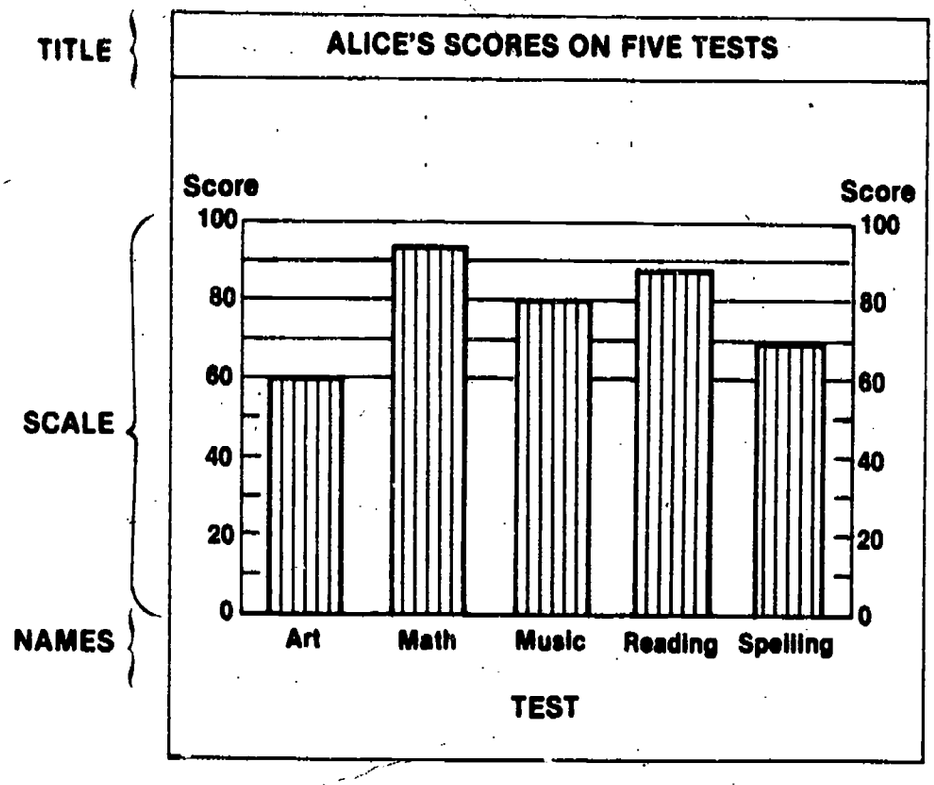
Notice the faint lines that go across from the left scale to the right one. These are called gridlines. They make it easier to use the scale to tell how high the bar is—or what score the bar stands for. Also notice that what the scale stands for—score in this bar graph—is indicated at the top of the scale.

For some questions, you don't need to use the scale to get the answer. Answer these questions.

- On what test did Alice score lowest? _____
- On what test did Alice score highest? _____

The answer to the first question is art; the second, math.

Now have me look at your answers.



Let's look at the scale more closely. It indicates that the lowest score one can make on a test is 0 and the highest is 100. There is a tickmark at 0, 10, 20, etc.—that is, every ten points from 0 to 100. But only the even tickmarks are labeled—0, 20, 40, etc. Answer the following questions.

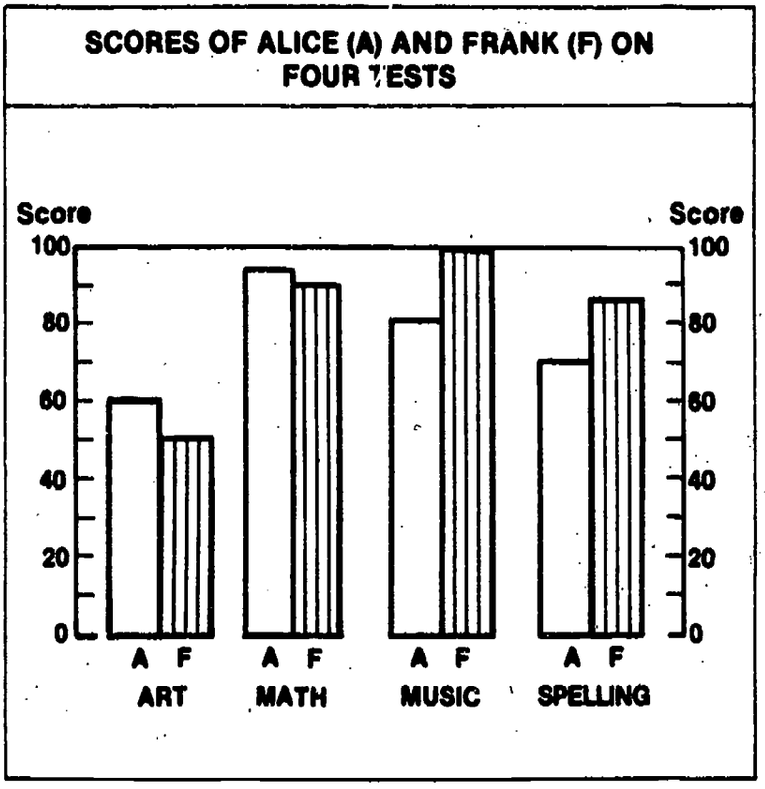
- What is Alice's score on the art test? _____
- What is her score on the music test? _____
- What is her score on the spelling test? _____

Now have me look at your answers.

Notice that 60 and 80 are labeled on the scale. 70 is not labeled. But since it must be the value for the tickmark between 60 and 80, 70 is the spelling score.

Now look at the top of the bar for the score on the math test. It is about halfway between the gridline for 90 and the gridline for 100. So the math score must be about 95. The reading score is a bit harder to figure. The top of the bar for the reading test is between the gridline for 80 and the gridline for 90. But it is nearer to 90 than 80. The score is surely higher than 85 and lower than 90. It is higher than 85 because the top of the bar is nearer to 90 than 80. A good guess is that the reading score is about 87 or 88.

Not all bar graphs are as simple as the one we have been discussing. Let's look at what happens if we want to show scores on several tests taken by Alice and Frank. Because there isn't much space for names when the bars are thin, A will stand for Alice and F will stand for Frank.



The main difference between this bar graph and the other one is that for some questions you look at the Alice bars and for others the Frank bars. Answer these questions:

- On what test did Alice score lowest? _____
- On what test did Frank score highest? _____

Now let me look at your answers.

This completes the review.

WHEN FINISHED, RAISE YOUR HAND.

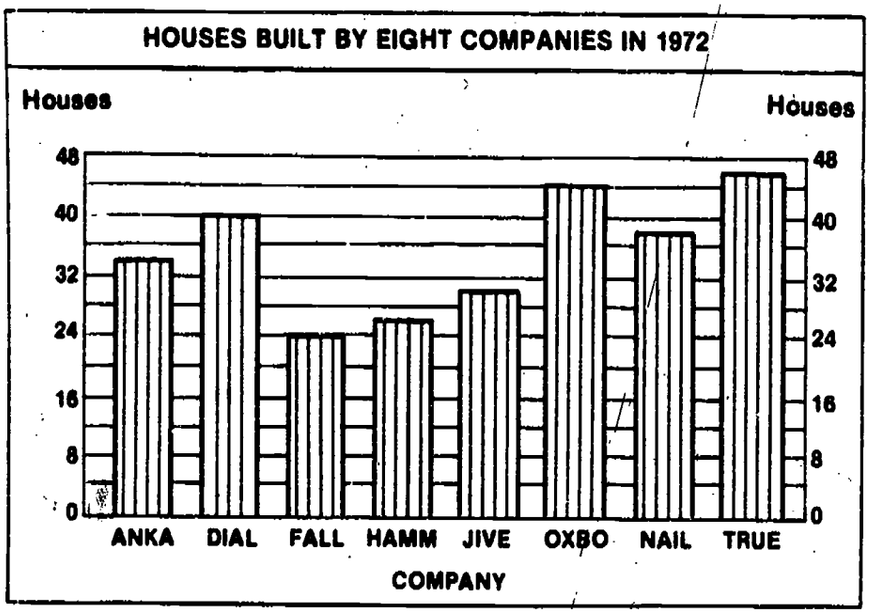
204: Series 80-1

BAR 1 / TASK 1 GR: 4th 6th Acc: _____ Min/Sec: _____

SN: _____ PD: Yes No 60A/Sec: _____ Sec: _____

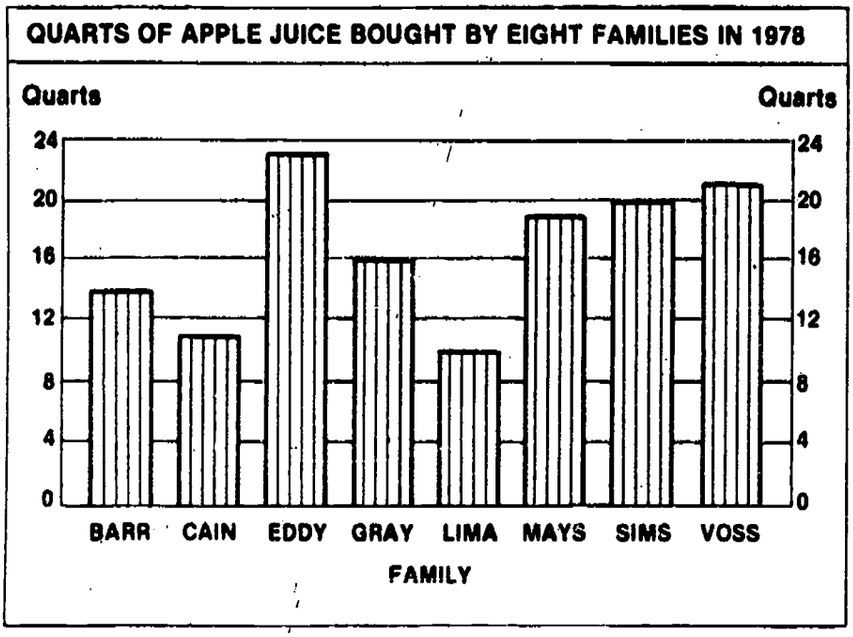
E: 1 2 240/Sec: _____

STUDY THE BAR GRAPH CAREFULLY. USE IT TO ANSWER THE QUESTIONS. CIRCLE THE ANSWER IN THE GRAPH.



1. Who built the largest number of houses in 1972? Circle the company.

2. Who built the smallest number of houses in 1972? Circle the company.



3. Who bought the largest number of quarts of juice in 1978? Circle the family.

4. Who bought the smallest number of quarts of juice in 1978? Circle the family.

RAISE YOUR HAND WHEN FINISHED.

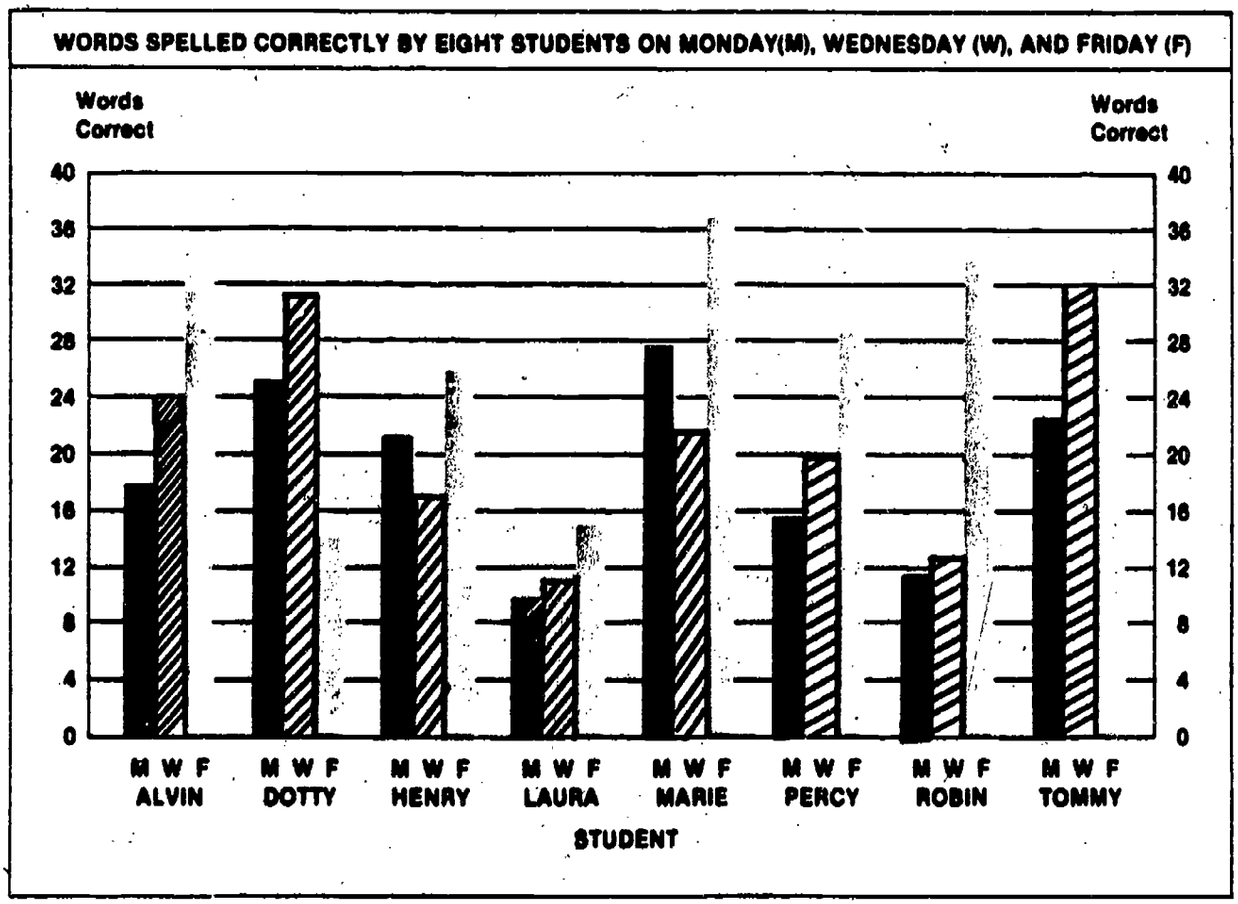
204: Series 80-1

BAR 2 / TASK 1 GR: 4th 6th Acc: _____ Min/Sec: _____

SN: _____ PD: Yes No 60A/Sec: _____ Sec: _____

E: 1 2 240/Sec: _____

STUDY THE BAR GRAPH CAREFULLY. USE IT TO ANSWER THE QUESTIONS.



CIRCLE THE ANSWER IN THE BAR GRAPH.

1. On Monday, who correctly spelled the largest number of words. Circle the student.

2. On Wednesday, who correctly spelled the largest number of words. Circle the student.

UNDERLINE THE ANSWER IN THE BAR GRAPH.

1. On Friday, who correctly spelled the smallest number of words. Underline the student.

2. On Wednesday, who correctly spelled the smallest number of words. Underline the student.

RAISE YOUR HAND WHEN FINISHED.

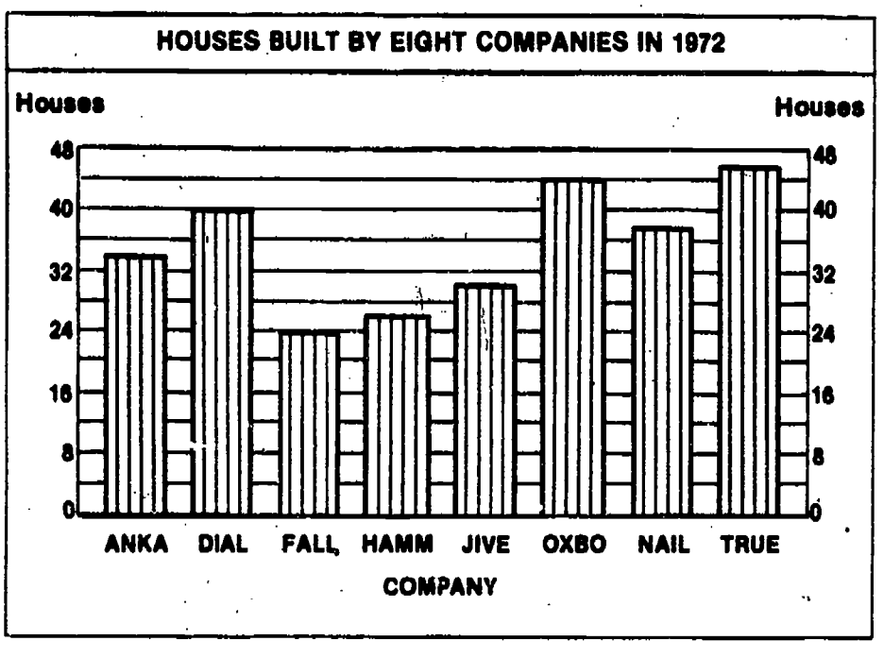
204: Series 80-1

BAR 1 / TASK 2 GR: 4th 6th Acc: _____ Min/Sec: _____

SN: _____ PD: Yes No 60A/Sec: _____ Sec: _____

E: 1 2 240/Sec: _____

STUDY THE BAR GRAPH CAREFULLY. USE IT TO ANSWER THE QUESTIONS.



CIRCLE THE ANSWER IN THE BAR GRAPH.

1. Who built 40 houses in 1972? Circle the company.

2. Who built 26 houses in 1972? Circle the company.

WRITE THE ANSWER IN THE BLANK.

1. How many houses did Oxbo build in 1972? _____

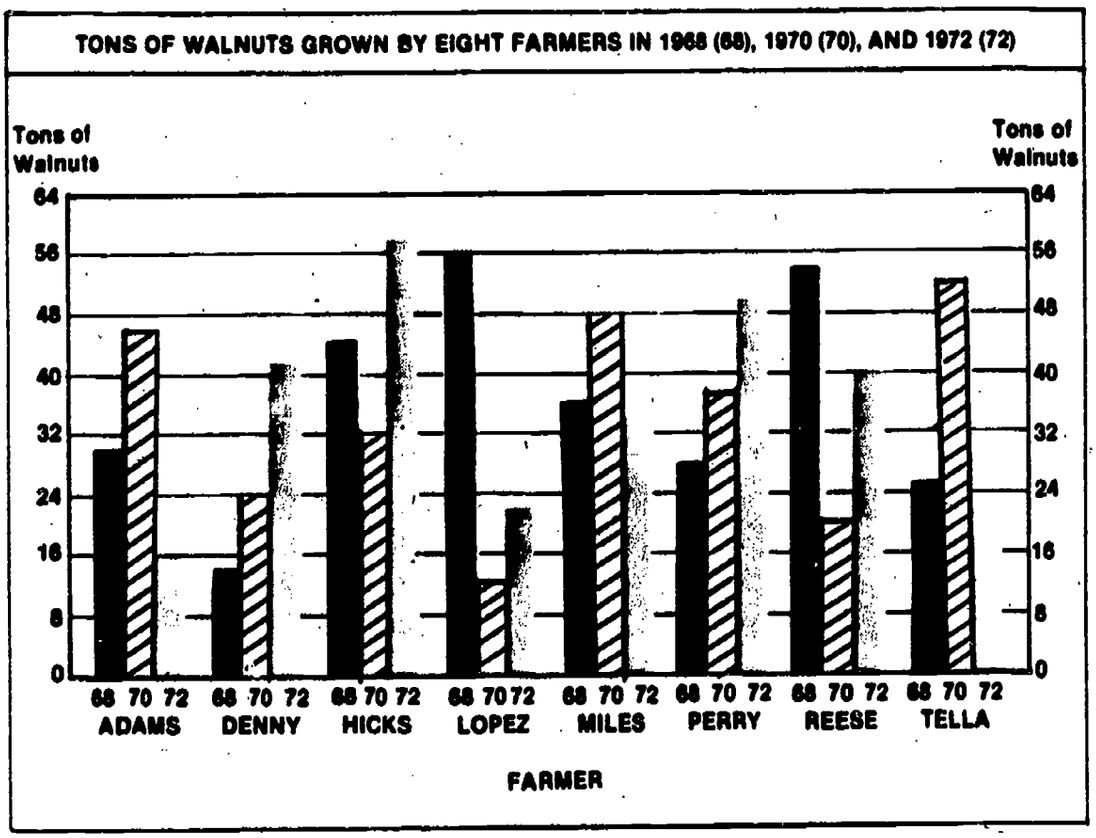
2. How many houses did Anka build in 1972? _____.

RAISE YOUR HAND WHEN FINISHED.

204: Series 80-1

BAR 2 / TASK 2	GR: 4th 6th	Acc: _____	Min/Sec: _____
SN: _____	PD: Yes No	60A/Sec: _____	Sec: _____
	E: 1 2	240/Sec: _____	

STUDY THE BAR GRAPH CAREFULLY. USE IT TO ANSWER THE QUESTIONS.



CIRCLE THE ANSWER IN THE GRAPH.

1. Who grew 48 tons of walnuts in 1970? Circle the farmer.

2. Who grew 28 tons of walnuts in 1968? Circle the farmer.

WRITE THE ANSWER IN THE BLANK.

3. How many tons of walnuts did Lopez grow in 1968? _____

4. How many tons of walnuts did Tella grow in 1972? _____

RAISE YOUR HAND WHEN FINISHED.

204: Series 80-1

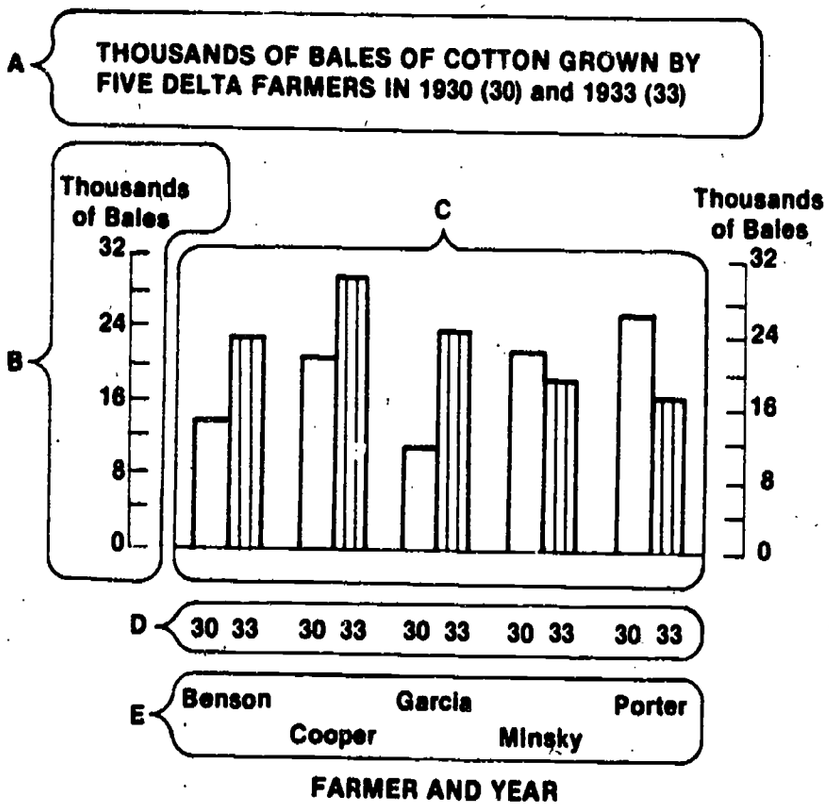
10

BAR / CPHN GR: 4th 6th Acc: _____ Min/Sec: _____

SN: _____ PD: Yes No 60A/Sec: _____ Sec: _____

E: 1 2 480/Sec: _____

STUDY THE BAR GRAPH CAREFULLY. USE IT TO ANSWER THE QUESTIONS.



1. What kind of crop did the farmers grow? _____

2. Locate the number 24 in the part of the bar graph marked B. This number stands for one of the following. Circle the best answer.

   Benson farmers 1930 thousands of bales years

3. What does Garcia do for a living. He is a _____.

4. How many bars are there for the year 1933? _____

The letters A, B, C, and D are codes. These codes stand for parts of the bar graph. You use these codes to answer questions 5 to 8.

5. The different farmers are named in the part of the graph whose code is _____.

6. The different years are shown in the part of the graph whose code is _____.

7. The title of the bar graph is in the part of the graph whose code is _____.

8. How much each farmer grew in each year is shown in the part whose code is

RAISE YOUR HAND WHEN FINISHED.

APPENDIX D: LINE GRAPHS MATERIALS

The materials consist of a cover page, three pages of preliminary directions (the assistance where needed version), four pages of display-using work, and one page of format-comprehension work.

The first and second pages of the display-using work reflect a low complexity display--a linear function. The third and fourth pages reflect a moderate complexity display--an S-shaped function that renders exact interpolation more difficult. The gridlines on the first and third pages ease the interpolation task and so transform the task into one of low complexity. These lines removed on the second and fourth pages, the task becomes one of moderate complexity.

The first-to-fourth page combinations for display/task complexity are 1/1 (low/low), 1/2 (low/mod), 2/1 (mod/low), and 2/2 (mod/mod).

WU 204: SERIES 80-2 LINE GRAPHS GR: 4th 6th PD: Yes No SN: _____

FIRST, FILL IN THE BLANKS. THEN READ THE DIRECTIONS.

Name: _____ Room: _____
First Name First Letter of Last Name

Teacher: _____

Today you will be answering some questions using a line graph. The work you are to do will not be the same for everyone. Most of you should be finished in 30 minutes.

Some of you will receive preliminary directions on how to use line graphs. Some of you will not. We know the work will be harder for those not receiving preliminary directions. But please try hard to figure out how to use the line graph to answer the questions.

All of your work will be timed. But it is more important to understand what you read and to get answers right than to work fast. If someone finishes ahead of you, don't be bothered. There is no prize for finishing first.

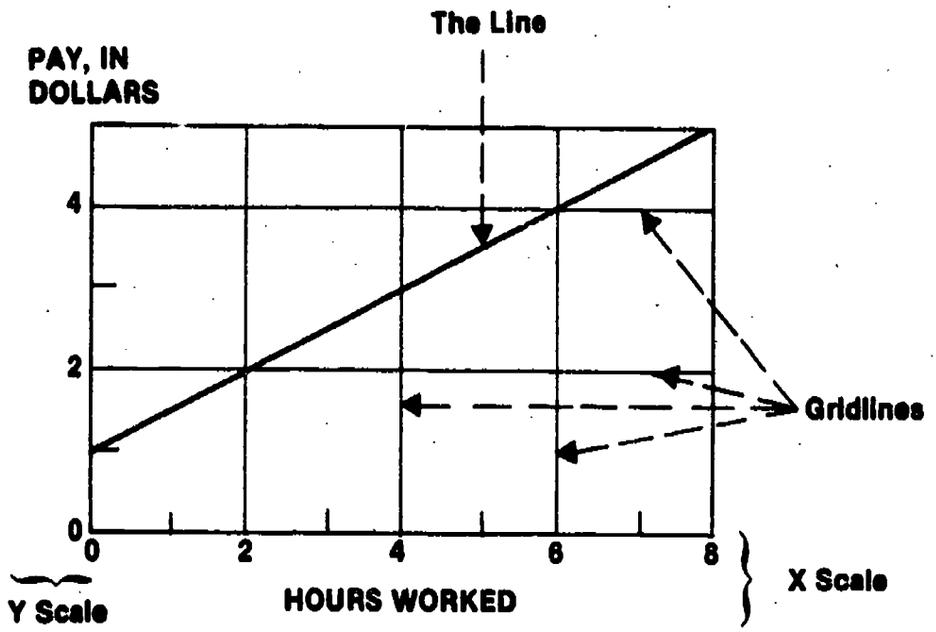
On the pages with questions, there is some coded material at the top—above a line that crosses the page, as on this page. Don't bother with these codes. They just help us keep everything straight.

Read and look at **everything** below the line that crosses the page at the top. In particular, look closely at the line graph. Look at its number scales on the left and bottom. Look at its title below the number scale on the bottom. You are sure to miss the questions if you don't do this.

RAISE YOUR HAND WHEN YOU'VE FINISHED READING THESE DIRECTIONS.

PRELIMINARY DIRECTIONS

You might know something about line graphs. The facts are reviewed here. A line graph has at least four parts. These are the X scale, the Y scale, the line, and the title.



THE RELATION BETWEEN HOURS WORKED AND PAY RECEIVED (BY SAM ON HIS SATURDAY YARD JOB)

The X scale is the bottom one. In the example, it stands for the number of hours Sam might work on any Saturday. Only the even number of hours are labeled. The ticks between the labeled ticks stand for odd numbers of hours. The tick that is halfway between those for 2 and 4 hours stands for 3 hours.

The Y scale is the one on the left side. In the example it stands for the pay Sam might receive for his work on any Saturday.

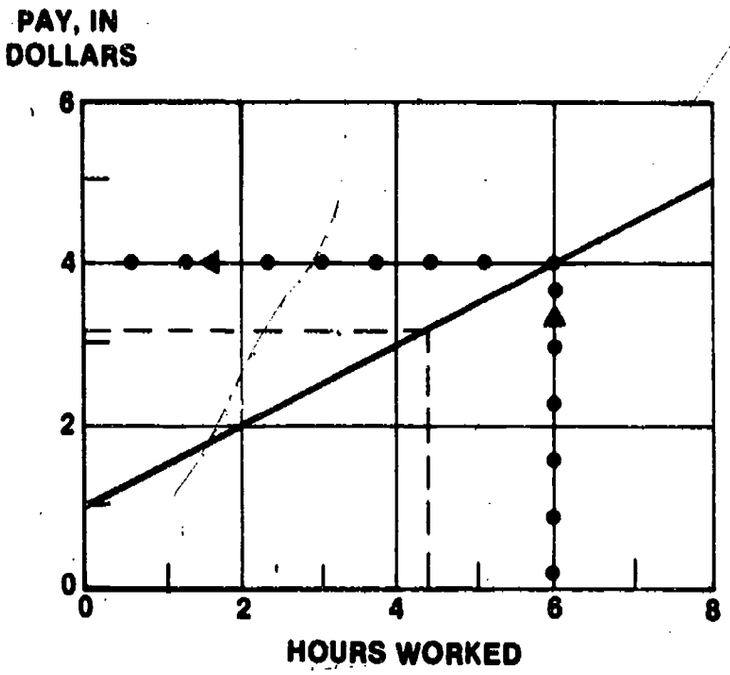
Notice the tick that is halfway between the 0 and the 2 on the Y scale.

- How many dollars does it stand for? _____

Have me look at your answer.

The line shows the relation between number of hours Sam works and money received for this work. The title tells us this.

Not all line graphs have gridlines. When gridlines appear in a line graph, their purpose is to make it easier to use the graph.



On Saturdays, Sam does yardwork for Mr. Wilson. Mr. Wilson has Sam come by every Saturday to see if there is any work. Even if there is none, he pays Sam's bus fare—one dollar for a round trip. That is why the line is at 1 dollar on the Y scale when hours worked are 0 on the X scale. And Sam receives 50 cents for every hour worked.

If Sam works 6 hours, he receives 4 dollars—$1 for bus fare plus $3 (or 6 hours x 1/2 dollar) for the work. If you go **straight up** from 6 (hours) and then go **straight left** when you reach the line, you come to 4 (dollars). Dots and arrows in the line graph show how you get from 6 (hours) to 4 (dollars).

You may use the 3 x 5 inch notecard to draw lines to and from the heavy line when answering questions. To get the right answer, you must work carefully.

Use your notecard to answer these questions.

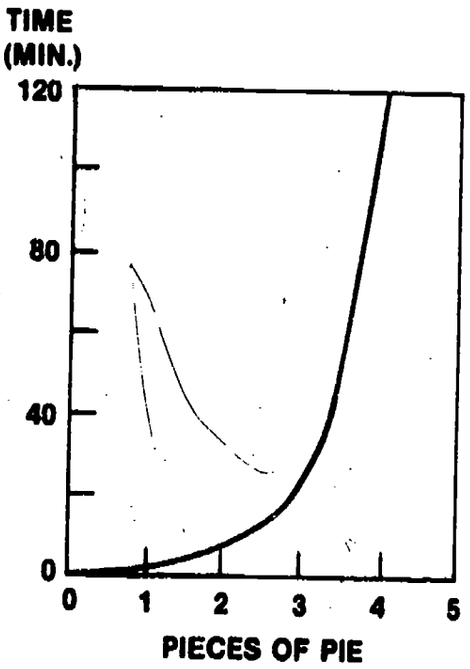
- If Sam works 2 hours, how many dollars does he get? _____
- If he works 4 hours, how many dollars does he get? _____

Have me look at your answers.

If Sam works 3 hours, you will find he gets 2 1/2 dollars. You begin at the tick between 2 and 4 on the hour scale. First, draw a pencil line to the heavy line. Beginning where it crosses, draw a pencil line straight left to the dollar scale. If this is done carefully, you come out halfway between 2 and 3 on the dollar scale. So Sam gets 2 1/2 dollars if he works 3 hours.

The dotted lines show how much Sam gets if he works 4 1/2 hours. You can see that he gets more than 3 dollars but less than 3 1/2 dollars. The right answer actually is 3 1/4 dollars, but it is hard to be that accurate when the answer is between ticks.

You probably have seen some line graphs having curved lines rather than straight ones. One example of this is a fuller-you-get graph. If you saw "Cool Hand Luke," you know that Luke ate the first egg very, very quickly and the last egg very, very slowly. The graph below is an example of this. Sam eats the first piece of pie in 2 minutes, the second in 4, the third in 18, and the fourth in 96. If he goes on at this rate, it would take him 600 minutes—10 hours—to eat a fifth piece of pie. The graph is based on adding 2 and 4 (= 6 minutes) to get the time it takes to eat two pieces of pie, adding 2 and 4 and 18 (= 24 minutes) to get the time it takes to eat three pieces of pie, etc.



A FULLER-YOU-GET GRAPH. THE RELATION BETWEEN HOW MANY PIECES OF PIE SAM EATS AND HOW LONG HE TAKES TO EAT THEM

You use a line graph whose line is curved exactly the same way you use one whose line is straight. Not all line graphs have gridlines, but you can always put your own lines on the graph to help you use it. If the graph is in a book, make your pencil lines light, so you can erase them later. This completes the review.

WHEN FINISHED, RAISE YOUR HAND.

204: 80-2

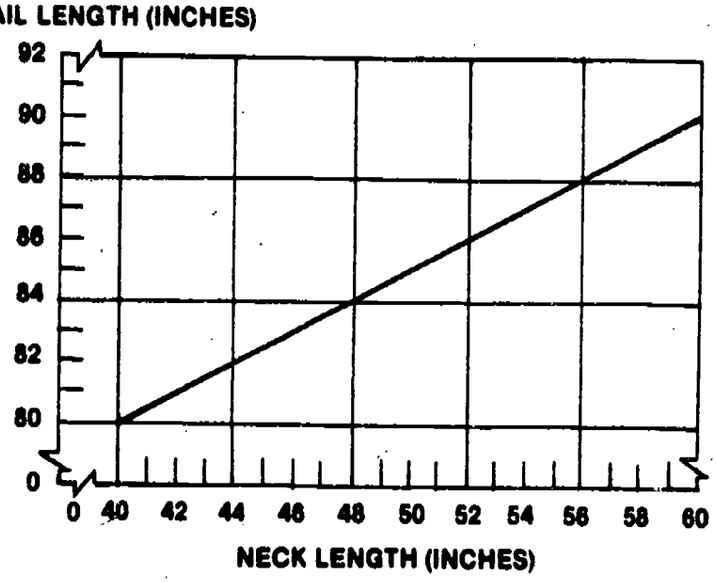
11

LINE 1 / TASK 1 GR: 4th 6th Acc: _____ Min/Sec: _____

SN: _____ PD: Yes No 60A/Sec: _____ Sec: _____

E: 1 2 240/Sec: _____

STUDY THE GRAPH CAREFULLY. USE IT TO ANSWER THE QUESTIONS. YOU MAY USE THE NOTECARD TO DRAW LINES ON THE GRAPH TO HELP YOU OBTAIN ANSWERS.



GRAPH SHOWING HOW LONG A GALLDERN'S TAIL IS IF YOU KNOW HOW LONG ITS NECK IS (AND THE REVERSE)

We kn w how long the necks are for the Gallderns Apra, Babu, Acha, and Boru. For each creature, circle the number showing how long its tail is. Use the graph and work carefully.

1. Apra's neck is 48 inches long.
   Her tail is _____ inches long. 81 82 83 84 85 86

2. Babu's neck is 52 inches long.
   His tail is _____ inches long. 84 85 86 87 88 89

3. Acha's neck is 42 inches long.
   Her tail is _____ inches long. 80 81 82 83 84 85

4. Boru's neck is 58 inches long.
   His tail is _____ inches long. 86 87 88 89 90 91

RAISE YOUR HAND WHEN FINISHED.

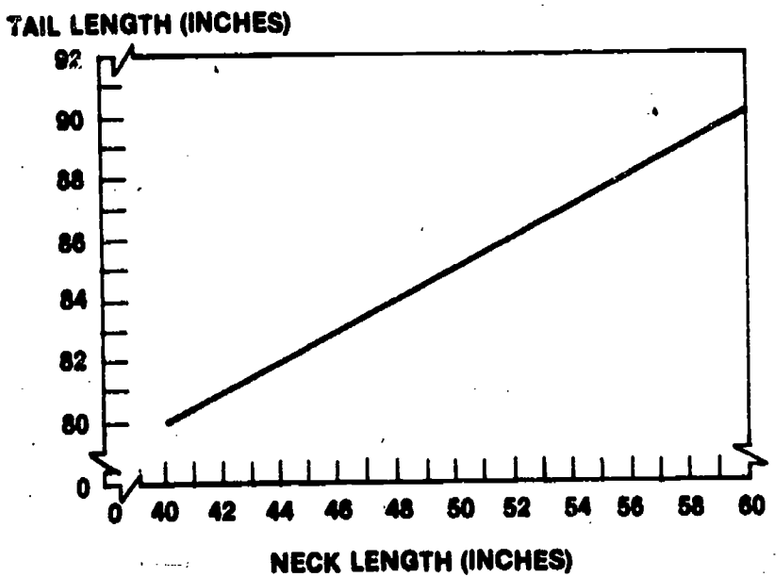
204: 80-2

LINE 1 / TASK 2 GR: 4th 6th Acc: _____ Min/Sec: _____

SN: _____ PD: Yes No 60A/Sec: _____ Sec: _____

E: 1 2 240/Sec: _____

STUDY THE GRAPH CAREFULLY. USE IT TO ANSWER THE QUESTIONS. YOU MAY USE THE NOTECARD TO DRAW LINES ON THE GRAPH TO HELP YOU OBTAIN ANSWERS.



GRAPH SHOWING HOW LONG A GALLDERN'S TAIL IS IF YOU KNOW HOW LONG ITS NECK IS (AND THE REVERSE)

We know how long the necks are for the Gallderns Anka, Bamu, Arta, and Batu. For each creature, circle the number showing how long its tail is. Use the graph and work carefully.

1. Anka's neck is 44 inches long. Her tail is _____ inches long.	80	81	82	83	84	85
2. Bamu's neck is 56 inches long. His tail is _____ inches long.	86	87	88	89	90	91
3. Arta's neck is 46 inches long. Her tail is _____ inches long.	80	81	82	83	84	85
4. Batu's neck is 54 inches long. His tail is _____ inches long.	86	87	88	89	90	91

RAISE YOUR HAND WHEN FINISHED.

204: 80-2

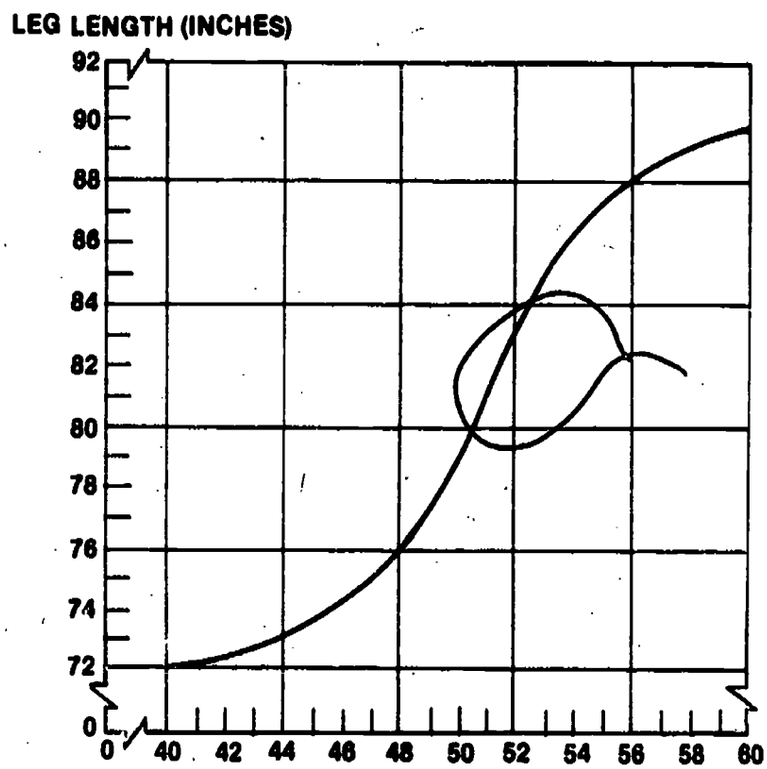
13

LINE 2 / TASK 1 GR: 4th 6th Acc: _____ Min/Sec: _____

SN: _____ PD: Yes No 60A/Sec: _____ Sec: _____

E: 1 2 240/Sec: _____

STUDY THE GRAPH CAREFULLY. USE IT TO ANSWER THE QUESTIONS. YOU MAY USE THE NOTECARD TO DRAW LINES ON THE GRAPH TO HELP YOU OBTAIN ANSWERS.



GRAPH SHOWING HOW LONG A BIG PURPA'S LEGS ARE IF YOU KNOW HOW LONG ITS ARMS ARE (AND THE REVERSE)

We know how long the arms are for the Big Purpas Fala, Musa, Mogu, and Fisa. For each creature, circle the number showing how long its legs are. Use the graph and work carefully.

1. Fala's arms are 46 inches long.
   Her legs are _____ inches long. 72 73 74 75 76 77

2. Musa's arms are 56 inches long.
   His legs are _____ inches long. 85 86 87 88 89 90

3. Mogu's arms are 52 inches long.
   His legs are _____ inches long. 82 83 84 85 86 87

4. Fisa's arms are 50 inches long.
   Her legs are _____ inches long. 75 76 77 78 79 80

RAISE YOUR HAND WHEN FINISHED.

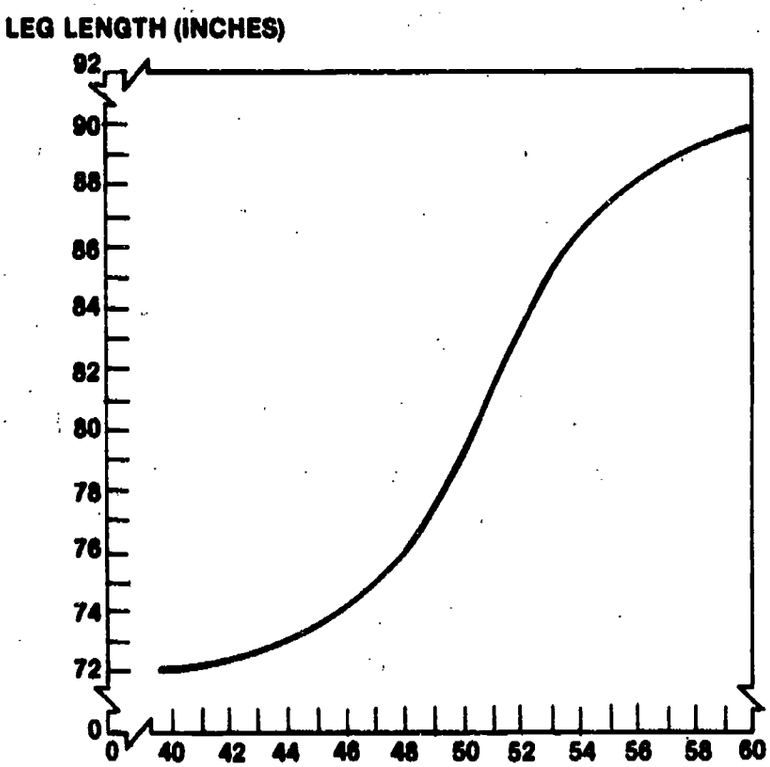
204: 80-2

LINE 2 / TASK 2 GR: 4th 6th Acc: _____ Min/Sec: _____

SN: _____ PD: Yes No 60A/Sec: _____ Sec: _____

E: 1 2 240/Sec: _____

STUDY THE GRAPH CAREFULLY. USE IT TO ANSWER THE QUESTIONS. YOU MAY USE THE NOTECARD TO DRAW LINES ON THE GRAPH TO HELP YOU OBTAIN ANSWERS.



GRAPH SHOWING HOW LONG A BIG PURPA'S LEGS ARE IF YOU KNOW HOW LONG ITS ARMS ARE (AND THE REVERSE)

We know how long the arms are for the Big Purpas Moru, Fina, Faba, and Munu. For each creature, circle the number showing how long its legs are. Use the graph and work carefully.

1. Moru's arms are 54 inches long.
   His legs are _____ inches long. 82 83 84 85 86 87

2. Fina's arms are 48 inches long.
   Her legs are _____ inches long. 74 75 76 77 78 79

3. Faba's arms are 44 inches long.
   Her legs are _____ inches long. 72 73 74 75 76 77

4. Munu's arms are 58 inches long.
   His legs are _____ inches long. 86 87 88 89 90 91

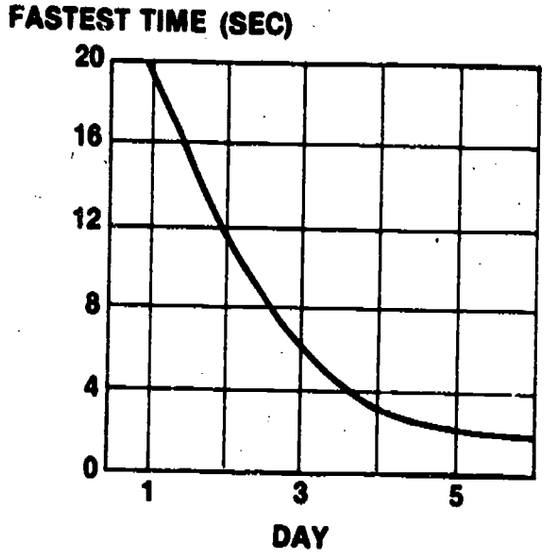
RAISE YOUR HAND WHEN FINISHED.

LINE / CPHN GR: 4th 6th Acc: _____ Min/Sec: _____

SN: _____ PD: Yes No 60A/Sec: _____ Sec: _____

E: 1 2 300/Sec: _____

STUDY THE GRAPH CAREFULLY. USE IT TO ANSWER THE QUESTIONS.



LINE GRAPH SHOWING SAM'S CURVE FOR LEARNING TO THREAD A NEEDLE

CIRCLE THE ANSWER BELOW THE QUESTION.

1. The graph shows Sam's progress when learning to thread a needle. It shows this by giving Sam's _____ times each day.

   average fastest learning slowest studying

2. The number 5 in the graph stands for _____.

   the day number learning needle size Sam seconds

3. The number 8 in the graph stands for _____.

   the day number learning needle size Sam seconds

4. The relation between the days and Sam's times appears in the graph as a _____.

   box curve gridline number square

5. The graph and its title do **not** tell us anything about _____.

   how Sam did on Day 2 size of the needle eye the day Sam's time was 6 seconds what was learned who the learner was

RAISE YOUR HAND WHEN FINISHED.

APPENDIX E: DETAILED RESULTS

Means and standard deviations are presented in Table E-1 for the numerical tables data, Table E-2 for the bar graphs data, and Table E-3 for the line graphs data. ND signifies no directions; PD, written directions only; PD+, written directions with assistance where needed; C1, low display complexity; C2, moderate display complexity; D1, low task complexity; D2, moderate task complexity.

ANOVA results for the three investigations are presented in Tables E-4 through E-6. Sources for which no F-ratio approached significance typically do not appear. All first-order interactions involving the directions factor resulted in simple main effects analyses. Wherever the directions factor had a significant effect, a Newman-Keuls test was performed to determine the locus of this effect.

Table E-1
Numerical Tables: Means and Standard Deviations

Measure	Grade	Directions	Display-Using								Format Comprehension	
			C1		C2		D1		D2		Sum			
			Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
ACC	4th	ND	.72	.34	.66	.36	.75	.32	.63	.39	.69	.34	.71	.24
		PD	.84	.20	.73	.19	.84	.15	.73	.27	.79	.17	.70	.27
		PD+	.85	.16	.72	.25	.81	.20	.76	.20	.79	.17	.65	.27
	6th	ND	.80	.26	.77	.20	.84	.20	.72	.26	.78	.22	.74	.23
		PD	.80	.26	.84	.27	.88	.22	.76	.30	.82	.25	.78	.23
		PD+	.91	.13	.88	.17	.95	.09	.84	.19	.90	.13	.77	.18
RATE	4th	ND	2.4	.7	2.1	.6	2.3	.7	2.2	.6	2.3	.6	2.3	.9
		PD	2.8	.4	2.4	.5	2.7	.6	2.4	.5	2.6	.4	2.4	.9
		PD+	2.7	.7	2.0	.5	2.5	.6	2.2	.5	2.3	.5	1.8	.9
	6th	ND	3.0	.8	2.5	.8	3.0	1.0	2.5	.7	2.8	.7	3.1	.9
		PD	4.0	1.1	3.2	.9	4.0	1.2	3.3	.7	3.6	.9	3.6	1.2
		PD+	4.1	.9	3.5	1.0	4.2	.9	3.4	1.0	3.8	.8	3.7	1.5
A/T	4th	ND	1.7	1.1	1.4	.9	1.8	1.0	1.3	1.0	1.5	.9	1.6	.8
		PD	2.4	.7	1.7	1.1	2.4	.8	1.8	.7	2.1	.5	1.7	1.0
		PD+	2.4	.8	1.4	.9	2.1	.7	1.7	.5	1.9	.4	1.2	.9
	6th	ND	2.5	1.1	1.9	.8	2.5	1.0	1.8	1.0	2.2	.9	2.4	1.2
		PD	3.3	1.3	2.8	1.2	3.5	1.5	2.5	1.1	3.0	1.2	2.9	1.4
		PD+	3.8	1.1	3.1	1.2	4.0	1.0	2.8	1.1	3.4	.9	3.0	1.8

Table E-2
Bar Graphs: Means and Standard Deviations

Measure	Grade	Directions	Display-Using C1 Mean	C1 SD	C2 Mean	C2 SD	D1 Mean	D1 SD	D2 Mean	D2 SD	Sum Mean	Sum SD	Format Comprehension Mean	Format Comprehension SD
ACC	4th	ND	.77	.18	.62	.22	.80	.36	.60	.27	.70	.18	.55	.20
		PD	.79	.16	.62	.23	.82	.14	.59	.28	.71	.18	.40	.24
		PD+	.86	.10	.80	.14	.95	.08	.70	.14	.83	.09	.55	.22
	6th	ND	.88	.12	.85	.17	.93	.11	.80	.17	.87	.11	.69	.20
		PD	.95	.08	.86	.16	.95	.10	.87	.13	.91	.10	.72	.26
		PD+	.87	.12	.82	.13	.93	.10	.76	.15	.84	.09	.71	.19
RATE	4th	ND	3.1	.7	2.3	.6	2.7	.9	2.7	.5	2.7	.6	2.4	.6
		PD	3.3	.9	2.0	.5	2.9	1.0	2.3	.7	2.6	.7	2.2	1.0
		PD+	3.0	.6	1.9	.3	2.7	.6	2.3	.6	2.5	.4	1.6	.6
	6th	ND	3.3	.6	2.5	.4	3.0	.7	2.8	.6	2.9	.4	2.0	.5
		PD	3.3	.7	2.2	.4	2.9	.7	2.5	.4	2.7	.4	2.0	.6
		PD+	3.9	1.0	2.8	.7	3.5	.7	3.1	1.0	3.3	.7	2.2	.8
A/T	4th	ND	2.5	.9	1.4	.7	2.2	1.0	1.6	.7	1.9	.7	1.4	.6
		PD	2.7	1.0	1.2	.6	2.6	1.0	1.3	.7	1.9	.7	.9	.7
		PD+	2.7	.7	1.6	.4	2.6	.6	1.6	.5	2.1	.4	.9	.4
	6th	ND	2.9	.7	2.1	.6	2.8	.8	2.2	.6	2.5	.5	1.4	.6
		PD	3.1	.8	1.9	.6	2.8	.8	2.2	.5	2.6	.5	1.5	.8
		PD+	3.5	1.1	2.3	.6	3.4	.7	2.4	1.1	2.9	.8	1.6	.8

Table E-3
Line Graphs: Means and Standard Deviations

Measure	Grade	Directions	Display-Using C1 Mean	C1 SD	C2 Mean	C2 SD	D1 Mean	D1 SD	D2 Mean	D2 SD	Sum Mean	Sum SD	Format Comprehension Mean	Format Comprehension SD
ACC	4th	ND	.26	.18	.17	.17	.24	.23	.19	.16	.21	.16	.44	.17
		PD	.34	.31	.29	.29	.34	.33	.30	.28	.32	.28	.30	.16
		PD+	.83	.25	.86	.13	.87	.17	.82	.20	.84	.15	.71	.15
	6th	ND	.54	.36	.41	.23	.52	.30	.43	.26	.47	.25	.62	.16
		PD	.62	.34	.54	.31	.62	.34	.54	.26	.58	.28	.51	.15
		PD+	.85	.34	.77	.16	.83	.23	.80	.28	.81	.24	.81	.10
RATE	4th	ND	3.8	2.7	3.3	1.4	3.3	1.5	3.9	2.6	3.6	1.8	2.8	.9
		PD	3.9	2.3	4.1	1.9	4.4	1.8	3.5	1.6	3.9	1.3	2.9	1.1
		PD+	3.2	1.1	3.2	1.8	3.5	1.5	3.0	1.1	3.2	1.2	2.2	1.2
	6th	ND	2.7	1.0	3.1	2.4	3.1	2.1	2.6	.9	2.9	1.4	2.5	.5
		PD	3.0	1.5	2.9	1.3	3.0	.9	2.9	1.4	3.0	1.0	2.5	.5
		PD+	3.1	1.3	3.1	1.4	3.4	1.2	2.7	1.1	3.1	1.0	3.1	1.1
A/T	4th	ND	1.0	.8	.5	.6	.9	.8	.6	.5	.7	.5	1.1	.7
		PD	1.0	1.3	1.2	1.3	1.4	1.3	1.0	1.0	1.2	1.0	.8	.8
		PD+	2.7	1.1	2.7	1.4	3.0	1.2	2.4	1.1	2.7	.8	1.4	.6
	6th	ND	1.5	1.1	1.4	1.3	1.7	1.4	1.2	.8	1.4	1.0	1.5	.6
		PD	2.2	1.7	1.7	1.4	2.1	1.4	1.7	1.5	1.9	1.3	1.3	.7
		PD+	2.8	1.4	2.5	1.1	2.9	1.3	2.3	1.1	2.6	1.1	2.6	1.2

Table E-4
Numerical Tables: ANOVA Results

Source	df	ACC		RATE		ACC/TIME	
		F	p	F	p	F	p
Display-Using							
Grade Level (A)	1,90	2.97	< .10	53.35	< .001	36.87	< .001
Directions (B)	2,90			7.87	< .001	8.06	< .001
A x B Interaction	2,90			3.95	< .05*	2.38	< .10*
Display Complexity (C)	1,90	7.99	< .01	57.51	< .001	47.05	< .001
A x C Interaction	1,90	5.23	< .05				
B x C Interaction	2,90			2.44	< .10		
Task Complexity (D)	1,90	35.02	< .001	29.42	< .001	61.46	< .001
A x D Interaction	1,90			5.94	< .05	6.79	< .05
Format Comprehension							
Grade Level (A)	1,90			36.66	< .001	26.82	< .001
Directions (B)	2,90						
A x B Interaction	2,90			2.50	< .10		

*Simple main effects analyses of directions by grade level were performed for the time-related data. When the measure is RATE or ACC/TIME, directions are effective ($p < .005$) only for 6th graders. Newman-Keuls assessment reveals that minimal and assisted directions do not have significantly different outcomes, although both result in faster performance than the undirected condition.

Table E-5
Bar Graphs: ANOVA Results

Source	df	ACC		RATE		ACC/TIME	
		F	p	F	p	F	p
Display-Using							
Grade Level (A)	1,90	22.84	< .001	10.59	< .01	26.97	< .001
Directions (B)	2,90						
A x B Interaction	2,90	4.51	< .05*	4.84	< .05+		
Display Complexity (C)	1,90	27.41	< .001	175.84	< .001	183.39	< .001
A x C Interaction	1,90	3.78	< .10				
Task Complexity (D)	1,90	65.40	< .001	11.92	< .001	71.63	< .001
A x D Interaction	1,90	5.26	< .05				
Format Comprehension							
Grade Level (A)	1,90	19.87	< .001			12.39	< .001
Directions (B)	2,90						
A x B Interaction	2,90			4.58	< .05#	2.37	= .10

*Simple main effects analyses of directions by grade level were performed for ACC. Directions are effective ($p < .05$) only for 4th graders, who perform significantly better when receiving directions with assistance where needed.

+Simple main effects analyses of directions by grade level were performed for RATE. Directions are effective ($p < .005$) only for 6th graders, who perform significantly better when receiving directions with assistance where needed.

#Directions are "effective" ($p < .01$) only for 4th graders, who perform reliably more slowly when receiving directions with assistance where needed. This is a reasonable finding. Students so directed slowed down consonant with making a serious effort to do the work.

Table E-6
Line Graphs: ANOVA Results

Source	df	ACC		RATE		ACC/TIME	
		F	p	F	p	F	p
Display-Using							
Grade Level (A)	1,90	11.56	< .01	5.45	< .05	4.86	< .05
Directions (B)	2,90	37.86	< .001			21.99	< .001
A x B Interaction	2,90	4.11	< .05*				
Display Complexity (C)	1,90	6.67	< .05				
Task Complexity	1,90	6.25	< .05	4.08	< .05	13.77	< .001
Format Comprehension							
Grade Level (A)	1,90			3.61	< .05	2.77	< .10

*Directions with assistance where needed significantly improve ACC at both grade levels. 6th graders are reliably more accurate than 4th graders when undirected or receiving written directions only, but not when receiving directions with assistance where needed.