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ABSTRACT

Reported are two separate but related longitudinal studies of two variables strongly associated with sex-related differences in mathematics achievement and enrollment, namely spatial visualization and confidence in learning mathematics. First, boys (N=33) and girls (N=36) in grades 6-8 who were discrepant in their spatial and verbal skills were interviewed to determine how they used spatial visualization in solving word and symbolic mathematical problems. Each subject was asked to read a problem, draw a picture to help solve the problem, and explain how the picture was used in the problem situation. In the second study, boys (N=31) and girls (N=32) in grades 6-8 who were above the mean in mathematics achievement and in lower or upper quartile in confidence in learning mathematics were interviewed about two question types (expectations and feelings), different perceived respondents (individual, peers, or teachers), and four mathematical situations (general, spatial, low, or high cognitive level). Among the results and implications reported are: (1) students with high spatial visualization skills tend to use them more than those with lower skills; (2) some differences were found in the ways boys and girls use their spatial skills, with girls who are low in such skills using them less than any other group; and (3) expectation of success in mathematics diminishes for girls from grade 6 to grade 8, while increasing for boys. In addition, technical information and instrumentation (including sample transcripts) are provided as separate reports in two detailed appendices. (JN)

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FINAL REPORT

Research on Relationship of Spatial Visualization and Confidence to Male/Female Mathematics Achievement in Grades 6-8

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University of Wisconsin-Madison
Principal Investigator

National Science Foundation: Research in Science Education SED78-17330, A01

August 1983

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PART II—SUMMARY OF COMPLETED PROJECT *(FOR PUBLIC USE)*

See attached

PART III—TECHNICAL INFORMATION *(FOR PROGRAM MANAGEMENT USES)*

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Elizabeth Fennema		

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PART II - SUMMARY OF COMPLETED PROJECT

In this longitudinal study, two variables strongly associated with sex-related differences in mathematics achievement and enrollment, namely spatial visualization and confidence in learning mathematics, were investigated in order to learn more about their development and stability, and their influence on mathematical problem solving.

Two groups of students were selected for the study. The first group (Thinking Group) had discrepant spatial visualization and verbal skills. The second group (Mathematics Confidence Group) was above the mean in mathematics achievement, but discrepant on confidence. The groups participated in individual, structured interviews in the springs of their 6th, 7th, and 9th grades.

In the interviews, each subject in the Mathematics Thinking Group was asked to draw pictures to solve problems, was provided with pictorial hints as necessary, and then was asked to tell how s/he used the pictures to solve each problem. Each subject in the Confidence Group was given a projective interview concerning their views and their perceptions of the views of their peers and teachers regarding expectations of, feelings about, and causal attributions of success and failure in mathematics. (In both cases, the interviews were audiotaped, transcribed, and the responses coded into categories.)

The influence of spatial visualization on the solving of mathematical problems is subtle. Girls and boys with high spatial visualization skills tend to use them more than those with lower spatial visualization skills. There appears to be some difference in how boys and girls use their spatial skills with girls who are low in such skills using them less than any other group. The instrument developed appears to assess, at least to some extent, how spatial skills are utilized. Developmental trends were difficult to interpret.

Some results of the confidence interview show that expectation of success in mathematics diminishes for girls from grade 6 to grade 8, while increasing for boys, to the point where boys are expected to succeed more often than girls. Also, in grade six, students feel equally positive about boys' or girls' success in mathematics, but by grade 8, they feel much less positive about girls' success than about boys' success.

PART IIIc
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PART IIIe
TECHNICAL DESCRIPTION OF PROJECT AND RESULTS

The project that will be described in this final report is made up of two separate components. There are some similarities between the two components, but many differences. Therefore, a brief overview of the entire project will be presented, followed by a detailed report of each component.

Overview

Females do not achieve as well as do males in mathematics; they do not elect to participate in high school and college mathematics as much as do males; and they do not hold as many mathematics-related career positions. This project is but one in a continuing research effort to find the causes of these inequities. Causes are hypothesized to lie in the cognitive as well as the affective domain of the individual. The first component of the study explored certain attributes of the cognitive domain and the second component of the study explored affective factors that may lead to sex-related differences in mathematics enrollment, achievement and use.

One of the cognitive variables associated with sex-related differences in mathematics is spatial visualization. The first component of the study, hereafter referred to as the Mathematics Thinking study, examined the influences of this variable on mathematics thinking. The affective variable under consideration was confidence in learning mathematics and it was examined in the Confidence Study. The development and the stability of both variables has been studied.

In order to study these two characteristics, i.e., development and stability, a longitudinal study was done. Subjects were studied for a three-year period, beginning when they were in 6th grade. Data collection occurred in the spring of 1979, 1980, and 1981. The principal means of data collection were individual structured interviews.

In the Fall of 1978, the entire sixth-grade population of four middle schools in Madison, Wisconsin was given a battery of tests. (See individual studies for more detail.) From this testing, two samples were selected. The first, for the Math Thinking Study, consisted of girls and boys who were either high in spatial visualization skills and low on verbal skills or low on spatial visualization skills and high on verbal skills. The subjects for the Confidence Study had scores above the mean of the population in mathematics achievement, but they had either high or low confidence scores.

In both studies, the subjects were interviews once each year by trained interviewers using a structured interview format. In the Mathematics Thinking Study, students were asked to solve between 8 and 12 problems, using a pictorial representation of their solution, and giving a verbal explanation of their solution. In the Confidence Study, photographs were utilized in a projective interview, and questions regarding expectations, feelings, and causal attributions were asked. (See the accompanying reports for complete details.) After the third year of interviewing, posttest data was collected on both the subjects and a random sample of the entire eighth grade in the four middle schools where the study was conducted.

The specific results and conclusions of the studies are given in each of attached reports. However, it is possible to draw some broad conclusions here. The influence of spatial visualization on the solving of mathematical problems is subtle. Girls and boys with high spatial visualization skills tend to use them more than those with low spatial visualization skills. There appears to be some differences in how boys and girls use their spatial skills with girls who are low in such skills using them less than any other group. The instrument developed appears to assess, at least to some extent, how spatial skills are utilized. Developmental trends were difficult to interpret.

Some results of the confidence interview show that expectation of success in mathematics diminishes for girls from grade 6 to grade 8, while increasing for boys, to the point where boys are expected to succeed more often than girls. Also, in grade six, students feel equally positive about boys' or girls' success in mathematics, but by grade 8, they feel much less positive about girls' success than about boys' success.

b. PUBLICATIONS

Papers Presented

Fennema, E. & Tartre, L.A. The use of spatial skills in mathematics by girls and boys: A longitudinal study (The Spatial Study).

Fennema, E. & Koehler, M.S. Expectations and feelings about females' and males' achievement in mathematics (The Confidence Study).

Fennema, E. & Tartre, L.A. Spatial visualization, sex-related differences in mathematics. Paper presented at American Educational Research Association annual meeting, New York, March 1982.

Fennema, E. & Koehler, M.S. Influences on the development of confidence in learning mathematics by girls and boys. Paper presented at American Educational Research Association annual meeting, New York, March 1982.

In Progress

Fennema, E. & Tartre, L.A. The use of spatial skills in mathematics by girls and boys: A longitudinal study.

Fennema, E. & Koehler, M.S. The development of confidence in learning mathematics by girls and boys.

Fennema, E. & Reyes, L.H. (Eds.), Influences on females' learning of mathematics. Lawrence Erlbaum Publishing Company, in progress.

THE SPATIAL STUDY

The Use of Spatial Skills in Mathematics by Girls and Boys: A Longitudinal Study

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Running Head: Use of Spatial Skills

The work reported here was made possible by a grant from the National Science Foundation: SED78-17330

*Mary Ann Konsin, Teri Hoch Perl, and William R. Vilberg made significant contributions to this study.

Abstract

Investigated in this three year longitudinal study was how girls and boys who were discrepant in their spatial and verbal skills used spatial visualization in solving word and symbolic mathematical problems. Interviewed yearly during their 6th, 7th, and 8th grade years were 36 girls and 33 boys. Each subject was asked to read a problem, draw a picture to help solve the problem, and to explain how the picture was used in problem solution. The instrument developed did indicate that spatial visualization skills, though subtle, were more often used in problem solving by subjects high in spatial visualization than by subjects low in spatial visualization. Students who differed in spatial visualization skills did differ in how they solved problems, but they did not differ in their ability to solve problems. Girls solved less problems than did boys. Girls tended to use the picture more in problem solution, but this did not enable them to get as many correct solutions as did boys. It also appears that low spatial visualization skills may be more debilitating to girls than to boys.

Sex-Related Differences in the Use of Spatial-Verbal Skills in Mathematics: A Longitudinal Study

Within the last decade, there has been much speculation as well as some research about the relationship of various spatial skills and the learning of mathematics (Clements, 1981). In particular, there has been interest and investigation of one particular spatial skill, spatial visualization, as an explanatory variable of sex-related differences in mathematics. Several recent studies do indicate that spatial skills are related differently to females' and males' learning of mathematics (Sherman, 1979). However, what this differential relationship is has not been explored. In addition, it is unknown how spatial visualization skills are utilized in mathematics thinking and problem solving and what impact verbal skills have on the use of these spatial skills.

Many studies have investigated the direct relationship between spatial visualization and mathematics. These studies have focused on mathematical tasks which have an obvious spatial component, such as the rotation of a cube. Under investigation in the study reported here is the idea that the critical relationship between mathematics learning and spatial visualization is not direct, but quite indirect. It involves the translation of words and/or mathematical symbols into a form (a mental picture) where spatial visualization skills can be used. The purpose of the study was to provide information about how learners, who were discrepant in their spatial and verbal skills, translated mathematical symbols and words into pictures and then used this translation in mathematical thinking.

Specifically, the following questions were investigated. Do females and males who differ on spatial visualization and verbal skills also differ on:

1. the ability to solve mathematical problems?
2. the verbalization of mathematical problems?
3. the amount of information provided independently when translating a mathematics problem into pictures?
4. the use of pictures during mathematical problem solving?
5. the processes used to arrive at correct or incorrect solutions to mathematical problems?
6. change in use of spatial visualization skills in mathematics problem solving over time?

The Study

Subjects

To maximize the possibility of obtaining heuristically useful contrasts, the subjects for this study were selected as being discrepant in spatial and verbal skills. The sixth grade population (N = 669) of four middle schools (grades 6-8) in a midwest city, was divided into thirds based on performances on the Space Relations portion of the Differential Aptitude Test (Bennett, Seashore, & Wesman, 1973), and the Vocabulary Test of the Cognitive Abilities Test: Verbal Battery (Thorndike and Hagen, 1975). Students who scored in the upper third on Space Relations and in the lower third on Vocabulary Test were placed in the High Spatial/Low Verbal groups (High/Low). Those who scored in the lower third on Space Relations and the upper third on Vocabulary Test were placed in the Low/High groups. All students were also given a standardized mathematics achievement test (Naslund, Thorpe, & LeFever, 1971). At the end of Year III of the study, subjects and a random sample of the original population were retested on the spatial test, the verbal test, and another standardized mathematics test (Educational Testing Service, 1979).

Table 1 shows the means, standard deviations, and ns for Year I (6th grade) and Year III (8th grade) of the study. In order to see where these groups scored in relation to the total population, z scores for the groups are shown in Table 2. These z scores reflect the groups' relationship to the total population in Year I and a random sample of the population in Year III ($\underline{n}$ = 103).

Insert Tables 1 & 2 about here.

From inspecting Table 2, some regression to the mean can be seen in Space Relations and Vocabulary. However, the groups were discrepant in the abilities in both Years I and III. Mathematics achievement scores remained comparatively stable with the exception of the Low/High females who lost position.

Instrument*

The Instrument to Measure Mathematical Thinking (IMMT) was composed of word problems and fraction problems (usually stated in mathematical symbols) determined as appropriate each year by a series of pilot tests. Certain problems were included all three years with only minor changes (such as larger numbers) and a few problems were added yearly to account for the maturing abilities of the students. For each problem, a sequence of three pictorial representations or hints were designed. In the hint sequence, the first hint represented the minimal pictorial information that could be used as a starting point for a solution. The second hint included the first hint and also provided additional information from the problem. The third hint expanded or organized the second hint and included a pictorial representation of the answer. If labels were necessary, they were found in the third hint. One word problem which was included each year and hints used with it are in Figure 1. One fraction problem included in Year II and Year III and the corresponding hints are in Figure 2.

*For complete information about the instrument see Fennema and Tartre, in preparation.

Data Collection Procedures

The subjects were asked to solve the problems in the IMMT during individual interviews during the spring of each year. Interviewers were carefully trained and great care was taken to ensure consistency and quality of interview procedures (see Fennema and Tartre, in preparation, for a description of training procedures and quality checks). There were three phases in the interview: Verbalization, Solution, and Explanation. In the Verbalization phase, subjects were asked to read the problem silently and then to state the problem in their own words. If a subject could not state the problem accurately the first time, she/he was asked to reread and restate the problem. This was to ensure that students understood the problem. During the Solution phase, subjects were asked to draw a picture which would help to solve the problem and to use that picture to solve the problem. If subjects could not draw a picture to solve the problem, the hints were furnished as needed. During the Explanation phase, subjects were asked how they had used the picture to solve the problem. The interviews were audio recorded and records were kept of the pictures drawn, the number of hints required for each problem, and the answers given.

Process Dimensions and Coding*

The audiotapes were transcribed and the protocols, pictures, and interview records coded using components defined specifically for each problem. Composite process dimensions were formed by combining codings from certain components and by summing over problem type (word or fraction): Verbal

*For complete coding directions, see Fennema and Tartre, in preparation.

Information, Translation Picture Information, Solution Picture Information, Mental Movement, and Use of Picture. Components of each dimension are shown in Table 3.

Insert Table 3 about here.

Verbal Information came from the Verbalization phase of the interview and indicated the extent to which the subject included the relevant non-numerical and numerical data, stated it appropriately, and asked the problem question correctly. The range of scoring for this dimension was 0-12.

Translation and Solution Picture Information came from pictures the students drew or the hints given to them. The Translation Picture was the picture drawn, or attempted, before any hints were given. It provided data regarding the amount of relevant information the student independently represented in his/her pictorial translation of the problem. The Solution Picture was the last picture (or hint) that the subject had before explaining her/his solution (or attempt at a solution) and provided data regarding the amount of information the student had available in a picture when solving the problem. If a student was able to draw a picture and solve the problem without being given any hints, the Translation and Solution pictures were the same and the Translation and Solution Picture Information was identical. All information from these two dimensions came from the Solution phase of the interview. The range of scoring for each of these dimensions was 0-12.

Mental Movement identified evidence of the subject moving something mentally and was obtained from the verbal information supplied by the student as well as the explanation of the use of the picture in the solution. Evidence which indicated any transformation, change in perspective, or mental manipulation of parts of the problem was categorized as mental movement. Since spatial visualization involves movement mentally (Fennema, 1975) it was assumed that activities categorized as Mental Movement were an indication that spatial visualization skills may have been used.

Use of Picture was a dimension which indicated whether or not the student used the picture to solve the problem. Data about this dimension came from the Explanation phase of the interview. The possible codings were not pictorial solution or pictorial solution and the range of scoring was 0 to 1 for fractions and 0 to 3 for word problems.

Analyses and Results

Mean scores and standard deviations were obtained for each individual for each dimension by problem type (Total, Word, Fraction) and by solution (All, Correct, Incorrect). They were computed for each year and combined across all years. Group data were computed using individual data and analyses of variance were performed using sex and spatial/verbal group as sources of variance. Year was not used because no information was available on the comparability of the IMMT across years. The mean number of Correct Solutions by group are shown in Table 4. Table 5 shows the resulting F-values. The complete source table for the ANOVAs can be constructed from information given in Table 4. The means and standard deviations of the dimensions for All Solutions, Correct Solutions, and Incorrect Solutions by problem type are in Tables 6-8. F-ratios with p-values $\geq .10$ found from the ANOVAs performed with these data are in Tables 9-11.

Insert Tables 4-11 about here.

Several things are apparent from an inspection of these tables.

Sex-related Differences

Males correctly solved more problems than did females and the difference was larger with word problems than with fraction problems. Girls indicated more Use of Picture for both problem types and Correct and Incorrect Solutions. Males had more pictorial information available to them when they correctly solved the fraction problems. Several significant differences between the sexes were found in Year I and Year III. Only two were found in Year II. Girls and boys did not differ significantly on their translation of problems into pictures except for Year II Correct fractions and the amount of Verbal Information for Year II Correct for all problems.

Spatial/Verbal Group Difference

There were no significant differences between the spatial/verbal groups in the number of problems solved correctly. Over the three years, the Low/High groups provided more relevant verbal information and the High/Low groups showed more evidence of Mental Movement. When only correct solutions were considered, the Low/High groups provided more Verbal Information than did the High/Low groups while the High/Low groups more frequently used the pictures (Use of Picture) to solve the problems, particularly the Fraction Problems. The High/Low groups also had more pictorial information (Solution Picture Information) available to them when they provided their solution, while the High/Low groups put in more relevant information when they translated the problems into pictures.

Another interesting trend is seen is one compares the amount of information the spatial/verbal groups had as they solved the problems (Solution Picture Information). The High/Low groups had significantly more relevant pictorial information available when they solved the problems correctly ($F = p < .04$) while the Low/High groups tended to have more relevant pictorial information when they have an incorrect answer ($F = p < .10$).

Discussion and Conclusions

Six questions were identified as being important and each will be discussed.

1. Did the groups differ in the ability to solve problems using the IMMT?

Overall, using a procedure which emphasizes the use of spatial skills, males solved significantly more problems than did females. Why males did better is difficult to say. Male superiority in overall problem solving has been reported by the second National Assessment of Educational Progress (Fennema and Carpenter, 1981). Perhaps the results of this study just confirm the NAEP results. The Low/High groups showed more diversity between the sexes than did the High/Low groups. The Low/High males solved more problems while the Low/High females solved fewer problems that did any other group. Perhaps females are more debilitated by low spatial visualization skills in mathematical problem solving than are males. It appears in solving the problems using the IMMT procedures, sex was a more important determinant in arriving at correct solutions than was level of spatial visualization skills.

There were no differences between the spatial/verbal groups in number of correct solutions. This last finding is somewhat surprising. The IMMT certainly emphasizes the use of processes which appear closely related to spatial skills, yet students with higher spatial skills did no better than students with lower spatial skills. It could be that the provision of hints helped to equalize the groups' problem-solving ability by providing pictorial cues for students dificient in visualization skills.

2. Did the groups differ in their verbalization of problems?

No differential trend could be detected between girls and boys in the amount of verbal information supplied. This once again is somewhat surprising as a commonly accepted belief is that overall, females are superior to males in verbal skills (Maccoby & Jacklin, 1974). Because of the sample selection procedures, there were no sex differences on Vocabulary Test found in Year I of the study. However, in Year III of the study, the High/Low boys scored somewhat lower in verbal skills than did the High/Low girls.

The Low/High groups tended to provide more relevant verbal information for All, Correct and Incorrect solutions which may be a reflection of their higher verbal skills. The means of all the groups were higher for Verbal Information for Correct Solutions than for All Solutions. Certainly, whether a subject correctly solves a word problem depends upon whether or not s/he understands the verbal components of that problem. While having the child state the problem does not completely assess the child's understanding, the higher means for Verbal Information (Correct Solutions) when compared to Incorrect Solutions, indicates a positive relationship between understanding and problem solution. However, just being able to state the problem did not ensure solution as the Low/High groups gave more Verbal Information than the High/Low groups even when they didn't solve the problems.

3. Did the groups differ in the amount of information they provided independently when translating problems into pictures?

For All Solutions, there was a trend ($p \leq .10$) for the High/Low groups to put more information in their Translation Pictures. For Correct Solutions, the High/Low groups included significantly more relevant information ($p < .05$) in their Translation pictures than did the Low/High groups. This finding at least gives credence to the idea that the relationship between spatial visualization and mathematics is in the translation from symbols to pictures on which spatial visualization skills could work.

As far as sex differences were concerned, the only important difference in ability to translate symbols to pictures, was with Correct fraction problems in which males included more relevant information in their Translation pictures than did females. However, for Incorrect Solutions for fractions

Year I, females included more relevant information in their translation picture than did males. Among the groups, the least amount of relevant pictorial information was supplied by the Low/High females for Correct Solutions.

4. Did the groups differ on their utilization of pictures during problem solving?

Females indicated more use of picture than did males for All, Correct and for Incorrect Solutions. This difference was particularly apparent in the Fraction problems. Females are less confident of their ability in mathematics than are males (Fennema, 1982) and feel less in control of their mathematical work than do males (Pedro, Wolleat, Fennema, & Becker, 1980). Does their use of picture reflect these two variables? Although no significant differences were found on the type of spatial skills measured in this study, i.e., visualization, perhaps this sample of boys and girls did differ on another type of spatial skill such as spatial orientation. Perhaps lower spatial orientation skills would demand more reliance on a picture in problem solving. The High/Low groups showed significantly more Use of Picture for Correct Solutions, for All problems, and for Fraction problems. They apparently were able to use their superior spatial visualization skills in problem solving. Keep in mind that the High/Low groups did not solve more problems correctly than the Low/High groups. They just used the picture more as they solved them.

5. Did the groups differ on the processes they used to arrive at correct or incorrect solutions to mathematical problems?

Differences between processes used can be very subtle. Most of the organizing and processing is undoubtedly done in the mind and not easily detected. As is the case with this study, the differences between performance of the various groups was not large and many factors, some examined, some not, undoubtedly contributed to these differences.

Some trends can be identified. When examining only Correct Solutions combined across years, the spatial/verbal groups used somewhat different processes (see Table 12). The High/Low groups tended to score higher on those dimensions which appear to have a spatial component: Translation and Solution Picture Information, Use of Picture and Mental Movement. The Low/High groups tended to score higher on the dimension which appears to have a verbal component, i.e., Verbal Information.

Insert Table 12 about here.

An examination of the processes used by the Low/High females provides some interesting ideas. Recall that the Low/High females correctly solved fewer problems than did any other group. The Low/High females had the highest mean of the groups for Verbal Information and the lowest mean for Translation Picture Information for Correct Solutions. Could it be that they understood the relevant features of the problems, but were less able to translate this information into a picture complete enough to solve the problem? A further indication of this can be seen by examining the difference between the Translation and Solution Picture Information which could be an indication of how much help was needed beyond what was drawn independently (see Figure 3). The Low/High females had a higher mean difference between scores received on the Translation and Solution picture than did the other three groups (Combined and each year). The High/Low females, however, tended to have the smallest difference between their Translation picture and Solution picture information. The male groups were more similar and tended to have mean differences between the two female groups, but differed in the same direction as did the female groups.

When Incorrect solutions were examined, the data showed that females tended to use the picture more than did males for Fraction problems (see Figure 4). In Figure 4, we see that this difference becomes even more pronounced if we look at just the Low/High females and males. Here we see that it is not so much that the Low/High females used the picture more, but rather that Low/High males began to use the picture much less for incorrect solutions to fraction problems. The High/Low females and males tended to use pictures similarly over the years.

Insert Figures 3 and 4 about here.

6. Did the groups differ in change in the use of spatial visualization skills in problem solving over time?

To answer this question, more qualitative procedures were used. Mean scores of the groups on each dimension were plotted for the three years of the study and several plots showed interesting trends. Translation Picture Information plots for both Word and Fraction problems are in Figures 5 and 6. The girls with low spatial/high verbal skills consistently put less information in their pictures than did any other group. However, girls with high spatial/low verbal skills tended to put more information in their pictures for Word problems than any other group in both Year I and Year III. However, when one looks at only correct solutions, Fractions (Figure 7), a different trend is evident. High spatial girls put the most information in their translation pictures in Year I, but by Year III, high spatial boys are putting much more information in pictures when they correctly solve fraction problems. Does this mean that boys with high spatial skills develop their ability to visualize symbolic mathematics more than do girls with similar visualization skills?

Insert Figures 5, 6, and 7 about here.

Use of Picture also provides some interesting information (Figures 8-9), particularly with Fractions. Boys in almost all cases reported less Use of Picture, but the split between High/Low and Low/High boys was particularly dramatic in Fraction problems, Year II.

Conclusions

While the vitality of children's responses over a three year period cannot be captured in a report of this kind, several conclusions appear valid. The use of spatial visualization skills in solving word and fraction problems is subtle. Dramatic differences between students high or low in spatial skills did not emerge even though the study was specifically designed to maximize the possibility of differences. One major reason that few differences were found is that a broad definition of mathematics was used. Problems were not selected that had an obvious spatial component. In addition, symbolic fraction problems were included. One concern of the study was to see if spatial visualization skills impacted mathematics achievement, broadly defined. After three years of study, we must conclude that while students differing in spatial visualization skills do differ in how they solve problems, they do not differ in their ability to solve problems.

The IMMT does provide a procedure for studying this variation in problem-solving processes. Those students who were high in spatial skills tended to use the process dimensions that were logically related to spatial skills while students high in verbal skills tended to use those process dimensions more closely related to verbal skills.

Sex-related differences that were found give some credibility to the belief that sex-related differences in problem-solving ability may be due to how girls and boys use the spatial visualization skills that they have. Girls and boys with equivalent spatial visualization skills did not solve the same number of problems, nor did they use the same processes in solving those problems. Girls tended to use their pictures more, but this did not necessarily ensure they arrived at correct solutions. Boys tended to translate mathematics into pictures somewhat better, but then they did not appear to use the pictures as much while solving problems. Using the picture did not appear to help girls arrive at correct solutions; in fact, using the picture often led to incorrect solutions. One other fact must be kept in mind. The mathematics achievement gain over a three-year period of girls with low spatial skills and high verbal skills was less than any other group. It appears that low spatial visualization may be more debilitating for girls than for boys.

One comment must be the ending statement of this study. All differences between girls and boys that were found were small and the intra-sex differences larger than the inter-sex differences. While use of spatial visualization skills may indeed help explain sex-related differences in mathematics, one must never say, think, or most of all, believe that all females are less able than all males to use their spatial visualization skills appropriately in mathematics. While such a statement appears simplistic, too often researchers and interpretsrs of research have not made it clear. As a result, too many believe that large differences between the sexes exist where they do not.

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Table 1

Means, Standard Deviations, and ns for Space Relations, Vocabulary Test, and Mathematics Concepts Year I and III

Sex	Group[4]	n	Space Relations[1] Year I $\bar{X}$ (s.d.)	Space Relations[1] Year III $\bar{X}$ (s.d.)	Vocabulary Test[2] Year I $\bar{X}$ (s.d.)	Vocabulary Test[2] Year III $\bar{X}$ (s.d.)	Mathematics Concepts[3] Year I $\bar{X}$ (s.d.)	Mathematics Concepts[3] Year III $\bar{X}$ (s.d.)
Female	High/Low	18	31.39 (4.31)	37.83 (7.25)	13.78 (1.56)	15.11 (3.76)	23.28 (6.41)	38.00 (5.42)
	Low/High	18	15.94 (2.29)	28.83 (6.63)	19.89 (1.23)	18.06 (2.24)	23.56 (4.19)	32.67 (13.11)
Male	High/Low	17	31.71 (4.63)	41.41 (8.67)	12.41 (2.45)	13.24 (6.04)	22.53 (4.65)	35.41 (13.83)
	Low/High	16	17.06 (5.29)	28.50 (8.05)	20.88 (1.78)	18.69 (2.55)	25.88 (5.04)	39.06 (11.13)

[1] Space Relations of the Differential Aptitude Test (Bennett, Seashore, & Wesman, 1973).

[2] Vocabulary Test of the Cognitive Abilities Test: Verbal Battery (Throndike & Hagen, 1975).

[3] Year I: Mathematics Concepts subtest of the Science Research Associates (Naslund, Thorpe, & LeFever, 1971).
Year III: Mathematics Basic Concepts (Level I, Form X) subtest of the Sequential Test of Educational Progress (Educational Testing Service, 1979).

[4] First word of group name describes spatial visualization and the second describes verbal skills.

Table 2

Comparison of Sample Groups with Population:[1] z-scores

		Space Relations		Vocabulary Test		Mathematics Concepts	
		Year I	Year III	Year I	Year III	Year I	Year III
Sex	Group	z	z	z	z	z	z
Female	High/Low	.76	.36	-.67	-.49	-.07	.08
	Low/High	-1.00	-.50	.74	.33	-.03	-.56
Male	High/Low	.80	.70	-.98	-1.01	-.19	-.23
	Low/High	-.87	-.53	.97	.50	.33	.21

[1]Population Year I: n = 669
Random Sample Population Year III: n = 103

Table 3

Process Dimension Components by Problem Type

Word	Fraction
VERBAL INFORMATION	
Numerical Completeness Numerical Placement Non-numerical Completeness Question Correctness	Numerical Completeness Knowledge of Consequence of Operation
TRANSLATION PICTURE INFORMATION	
Numerical Completeness Numerical Placement Non-numerical Completeness Non-numerical Relation*	Pictorial Common Denominator Symbolic Operation Pictorial Completeness Form of Solution
SOLUTION PICTURE INFORMATION	
Numerical Completeness Numerical Placement Non-numerical Completeness Non-numerical Relation	Pictorial Common Denominator Symbolic Operation Pictorial Completeness Form of Solution
MENTAL MOVEMENT	
Non-numerical Data Transformed Question Transformed Evidence of Mental Movement	Evidence of Mental Movement
USE OF PICTURE	
Student Use of Picture in Solution	

*E.g., for pole problem in Figure 1, did the picture show the pole related to the top and bottom of the river in appropriate proportions?

Table 4

Means and Standard Deviations of Number of Correct Solutions by Problem Type

Problem Type		Total[1]				Word[2]				Fraction[3]			
Year		I	II	III	Comb.*	I	II	III	Comb.*	I	II	III	Comb.*
		$\bar{X}$	$\bar{X}$	$\bar{X}$	$\bar{X}$	$\bar{X}$	$\bar{X}$	$\bar{X}$	$\bar{X}$	$\bar{X}$	$\bar{X}$	$\bar{X}$	$\bar{X}$
Sex	Group	(s.d.)	(s.d.)	(s.d.)	(s.d.)	(s.d.)	(s.d.)	(s.d.)	(s.d.)	(s.d.)	(s.d.)	(s.d.)	(s.d.)
Female	High/Low	4.56 (1.65)	8.83 (2.94)	8.61 (3.18)	7.33 (2.36)	30.6 (1.16)	5.61 (1.58)	5.39 (2.33)	4.69 (1.49)	1.50 (1.20)	3.22 (1.66)	3.22 (1.17)	2.65 (1.11)
	Low/High	4.78 (2.18)	8.39 (2.66)	8.78 (2.78)	7.31 (2.32)	3.11 (1.23)	5.44 (1.29)	5.89 (1.49)	4.81 (1.19)	1.67 (1.37)	2.94 (1.66)	2.89 (1.45)	2.50 (1.32)
Male	High/Low	5.59 (1.50)	9.29 (1.93)	9.71 (2.37)	8.20 (1.62)	3.71 (.69)	5.94 (1.20)	6.41 (1.70)	5.35 (.81)	1.88 (1.17)	3.35 (1.32)	3.29 (1.10)	2.84 (.97)
	Low/High	5.94 (1.69)	10.13 (1.82)	9.63 (2.58)	8.56 (1.66)	3.69 (.95)	6.19 (1.11)	6.25 (1.65)	5.38 (1.03)	2.25 (1.06)	3.94 (1.06)	3.38 (1.20)	3.19 (.84)

[1]Total Number of Problem: Year I = 8; Year II = 12; Year III = 12

[2]Number of Word Problems: Year I = 5; Year II = 7; Year III = 8

[3]Number of Fraction Problems: Year I = 3; Year II = 5; Year III = 4

*Combined across years

Table 5

Significant F-ratios for ANOVAs: Correct Solutions

Problem Type								
Total			Word			Fraction		
Year	F-ratios	Higher	Year	F-ratios	Higher	Year	F-ratios	Higher
I	6.50***[b]	Male	I	6.05**	Male	Cmb	2.82*	Male
Cmb	4.59**	Male	II	2.84*	Male			
			Cmb	4.77**	Male			

[a]degrees of freedom = 1,65

[b]*** $\leq$ .01
** $\leq$ .05
* $\leq$ .10

Table 6

Means and Standard Deviations of Dimensions for All Solutions

Dimension			Verbal Infor.				Translation Picture Infor.				Solution Picture Infor.				Mental Movement				Use of Picture			
Year			I $\bar{x}$ (sd)	II $\bar{x}$ (sd)	III $\bar{x}$ (sd)	Cmb $\bar{x}$ (sd)	I $\bar{x}$ (sd)	II $\bar{x}$ (sd)	III $\bar{x}$ (sd)	Cmb $\bar{x}$ (sd)	I $\bar{x}$ (sd)	II $\bar{x}$ (sd)	III $\bar{x}$ (sd)	Cmb $\bar{x}$ (sd)	I $\bar{x}$ (sd)	II $\bar{x}$ (sd)	III $\bar{x}$ (sd)	Cmb $\bar{x}$ (sd)	I $\bar{x}$ (sd)	II $\bar{x}$ (sd)	III $\bar{x}$ (sd)	Cmb $\bar{x}$ (sd)
Problem Type	Sex	Group																				
Total	Female	High/Low	5.73 (1.53)	6.64 (.92)	6.70 (1.12)	6.36 (.95)	7.04 (2.16)	4.74 (1.03)	5.70 (1.20)	5.83 (1.11)	8.61 (1.26)	5.38 (.60)	6.76 (.70)	6.92 (.64)	.13 (.18)	.12 (.13)	.17 (.13)	.14 (.09)	.91 (.11)	.75 (.16)	.88 (.10)	.85 (.06)
		Low/High	6.07 (1.07)	6.76 (1.05)	7.10 (.61)	6.64 (.63)	6.20 (1.79)	4.33 (1.45)	4.92 (1.41)	5.15 (1.33)	8.41 (.57)	5.36 (.69)	6.65 (.54)	6.81 (.42)	.15 (.16)	.07 (.09)	.16 (.13)	.13 (.07)	.89 (.18)	.67 (.22)	.84 (.14)	.80 (.14)
	Male	High/Low	5.56 (1.40)	(6.51) (1.01)	7.16 (.47)	6.41 (.66)	7.11 (2.07)	5.03 (.85)	5.52 (1.05)	5.89 (.98)	8.97 (1.18)	5.49 (.60)	6.83 (.86)	7.10 (.57)	.17 (.25)	.13 (.11)	.23 (.12)	.18 (.09)	.78 (.17)	.72 (.19)	.83 (.10)	.78 (.10)
		Low/High	6.40 (1.10)	6.72 (1.03)	7.35 (.89)	6.82 (.75)	6.62 (2.33)	4.85 (1.28)	5.38 (1.45)	5.62 (1.38)	8.80 (1.21)	5.16 (.77)	6.75 (.72)	6.90 (.66)	.14 (.13)	.12 (.12)	.11 (.11)	.12 (.07)	.78 (.24)	.59 (.20)	.83 (.12)	.73 (.14)
Word	Female	High/Low	8.30 (2.11)	10.36 (1.48)	9.50 (1.71)	9.39 (1.41)	7.41 (2.10)	5.44 (1.17)	5.56 (1.30)	6.14 (1.07)	9.57 (.89)	6.21 (.99)	7.15 (.59)	7.64 (.60)	.12 (.20)	.12 (.17)	.06 (.07)	.10 (.08)	.89 (.16)	.73 (.20)	.88 (.12)	.83 (.07)
		Low/High	8.81 (1.42)	10.60 (1.65)	10.10 (.87)	9.84 (.88)	6.65 (2.09)	5.14 (1.74)	4.67 (1.26)	5.49 (1.31)	9.80 (.82)	6.17 (1.05)	6.85 (.57)	7.61 (.38)	.13 (.17)	.06 (.10)	.08 (.10)	.09 (.06)	.88 (.21)	.64 (.25)	.83 (.14)	.78 (.13)
	Male	High/Low	8.01 (2.08)	10.13 (1.59)	10.10 (.71)	9.41 (.97)	7.19 (2.27)	5.92 (.92)	5.09 (.92)	6.06 (1.04)	9.73 (1.08)	6.28 (.74)	6.79 (.98)	7.60 (.67)	.15 (.26)	.14 (.18)	.15 (.14)	.15 (.11)	.81 (.16)	.65 (.22)	.82 (.12)	.76 (.11)
		Low/High	9.34 (1.79)	10.37 (1.65)	10.64 (1.33)	10.11 (1.16)	6.74 (2.52)	5.49 (1.62)	5.08 (1.56)	5.77 (1.44)	9.59 (.78)	5.90 (.78)	6.91 (.76)	7.47 (.47)	.09 (.13)	.14 (.10)	.10 (.13)	.11 (.07)	.78 (.27)	.61 (.20)	.84 (.13)	.74 (.15)
Fraction	Female	High/Low	1.22 (.52)	1.44 (.24)	1.10 (.21)	1.25 (.21)	6.38 (2.96)	3.78 (1.14)	6.00 (1.54)	5.39 (1.51)	7.02 (2.48)	4.23 (.68)	6.00 (1.34)	5.75 (1.17)	.14 (.27)	.11 (.20)	.38 (.36)	.21 (.21)	.94 (.13)	.77 (.28)	.89 (.21)	.87 (.12)
		Low/High	1.35 (.40)	1.54 (.29)	1.08 (.26)	1.32 (.16)	5.38 (2.22)	3.30 (1.40)	5.43 (2.33)	4.70 (1.67)	6.09 (1.17)	4.23 (.79)	6.24 (1.41)	5.52 (.73)	.19 (.28)	.09 (.12)	.32 (.32)	.20 (.14)	.91 (.25)	.72 (.30)	.86 (.27)	.83 (.19)
	Male	High/Low	.94 (.67)	1.59 (.32)	1.26 (.36)	1.27 (.30)	6.61 (2.92)	4.04 (1.48)	6.40 (2.16)	5.63 (1.62)	7.73 (2.58)	4.39 (.82)	6.90 (1.43)	6.34 (1.14)	.22 (.35)	.13 (.16)	.40 (.34)	.25 (.14)	.72 (.32)	.81 (.34)	.85 (.22)	.79 (.18)
		Low/High	1.06 (.44)	1.49 (.32)	1.11 (.27)	1.24 (.29)	6.31 (2.95)	3.96 (1.14)	5.97 (1.96)	5.41 (1.63)	7.52 (2.49)	4.13 (1.03)	6.42 (1.65)	6.02 (1.23)	.22 (.22)	.08 (.18)	.14 (.22)	.15 (.09)	.77 (.29)	.55 (.33)	.80 (.19)	.71 (.17)
Range of Scores Per Problem			0 - 12				0 - 12				0 - 12				0 - 1				0 - 1			

Table 7

Means and Standard Deviations of Dimensions for Correct Solutions

Dimension			Verbal Infor.				Translation Picture Infor.				Solution Picture Infor.				Mental Movement				Use of Picture			
Year			I	II	III	Cmb	I	II	III	Cmb	I	II	III	Cmb	I	II	III	Cmb	I	II	III	Cmb
			$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)
Problem Type	Sex	Group																				
Total	Female	High/Low	6.29 (2.85)	7.46 (1.56)	6.66 (1.62)	6.80 (1.24)	7.44 (2.55)	5.05 (1.28)	5.84 (1.20)	6.11 (1.23)	9.18 (1.57)	5.54 (.82)	6.38 (.95)	7.03 (.86)	.18 (.24)	.11 (.14)	.20 (.18)	.16 (.12)	.91 (.18)	.69 (.22)	.91 (.11)	.84 (.08)
		Low/High	7.28 (2.92)	7.96 (1.63)	7.72 (1.36)	7.56 (1.67)	6.50 (1.73)	4.62 (1.76)	5.09 (1.51)	5.40 (1.26)	8.45 (.99)	5.68 (1.07)	6.23 (.68)	6.79 (.64)	.18 (.26)	.10 (.12)	.18 (.19)	.15 (.11)	.90 (.18)	.63 (.24)	.65 (.16)	.79 (.16)
	Male	High/Low	6.35 (2.01)	7.03 (1.45)	7.45 (1.42)	6.94 (1.00)	7.48 (2.31)	5.37 (1.04)	5.71 (1.28)	6.19 (.94)	9.45 (1.46)	5.73 (.83)	6.77 (1.06)	7.32 (.58)	.17 (.26)	.13 (.14)	.24 (.15)	.18 (.10)	.80 (.15)	.68 (.22)	.84 (.12)	.78 (.12)
		Low/High	6.65 (1.45)	6.97 (1.17)	7.50 (1.24)	7.04 (.70)	6.65 (2.53)	4.96 (1.26)	5.39 (1.58)	5.66 (1.52)	8.87 (1.34)	5.24 (.86)	6.39 (1.13)	6.83 (.77)	.17 (.17)	.12 (.13)	.13 (.18)	.14 (.09)	.78 (.24)	.53 (.22)	.83 (.17)	.71 (.16)
Word	Female	High/Low	8.70 (3.51)	10.58 (1.57)	10.16 (1.23)	9.81 (1.53)	7.38 (2.97)	5.62 (1.59)	5.67 (1.69)	6.22 (1.51)	9.75 (1.03)	6.25 (1.19)	6.74 (.97)	7.58 (.80)	.16 (.25)	.12 (.20)	.07 (.09)	.12 (.11)	.91 (.19)	.69 (.27)	.92 (.10)	.84 (.11)
		Low/High	9.43 (3.08)	10.91 (1.39)	10.63 (1.30)	10.32 (1.24)	7.33 (1.96)	5.35 (1.89)	4.84 (1.46)	5.84 (1.25)	9.68 (.95)	6.45 (1.48)	6.25 (.70)	7.46 (.57)	.14 (.26)	.08 (.13)	.11 (.17)	.11 (.10)	.91 (.18)	.63 (.26)	.85 (.17)	.80 (.14)
	Male	High/Low	8.39 (1.91)	10.13 (1.69)	10.48 (.84)	9.67 (.96)	7.41 (2.60)	6.05 (.98)	5.12 (1.22)	6.19 (1.10)	9.82 (1.23)	6.41 (.81)	6.56 (1.07)	7.59 (.66)	.17 (.27)	.12 (.16)	.14 (.14)	.14 (.12)	.80 (.18)	.61 (.24)	.82 (.15)	.74 (.12)
		Low/High	9.50 (1.63)	10.33 (1.65)	11.07 (.80)	10.30 (.94)	6.60 (3.02)	5.70 (1.59)	5.24 (1.54)	5.84 (1.60)	9.51 (1.15)	6.05 (.79)	6.41 (1.48)	7.32 (.64)	.11 (.19)	.15 (.14)	.11 (.15)	.12 (.11)	.77 (.30)	.57 (.24)	.81 (.25)	.72 (.22)
Fraction	Female	High/Low	1.15 (.56)	1.59 (.34)	1.09 (.22)	1.34 (.29)	7.50 (2.94)	3.73 (1.58)	5.89 (1.71)	5.36 (1.71)	7.86 (2.65)	3.94 (1.14)	5.82 (1.59)	5.50 (1.55)	.17 (.30)	.08 (.25)	.37 (.38)	.20 (.23)	.96 (.14)	.66 (.40)	.91 (.19)	.85 (.17)
		Low/High	1.35 (.43)	1.66 (.35)	1.06 (.25)	1.40 (.22)	5.28 (2.71)	2.95 (2.03)	5.42 (2.57)	4.08 (2.34)	5.92 (1.64)	3.79 (1.40)	5.96 (1.91)	4.86 (1.55)	.14 (.25)	.15 (.27)	.35 (.39)	.22 (.20)	.86 (.30)	.62 (.42)	.83 (.29)	.74 (.29)
	Male	High/Low	.81 (.68)	1.67 (.35)	1.26 (.34)	1.32 (.28)	7.13 (3.17)	4.35 (1.94)	6.92 (2.52)	5.85 (1.83)	8.19 (3.00)	4.41 (1.56)	7.21 (1.95)	6.29 (1.63)	.22 (.38)	.17 (.22)	.40 (.36)	.27 (.18)	.78 (.24)	.79 (.36)	.86 (.19)	.84 (.19)
		Low/High	1.08 (.45)	1.56 (.28)	1.11 (.27)	1.27 (.27)	6.71 (2.87)	3.79 (1.26)	5.60 (2.38)	5.23 (1.69)	7.74 (2.59)	3.93 (1.22)	6.42 (1.87)	5.95 (1.35)	.32 (.39)	.08 (.19)	.20 (.34)	.20 (.15)	.74 (.30)	.48 (.36)	.88 (.16)	.69 (.20)

Table 8

Means and Standard Deviations of Dimensions for Incorrect Solutions

Problem Type	Sex	Group	Verbal Infor. I	Verbal Infor. II	Verbal Infor. III	Verbal Infor. Cmb	Translation Picture Infor. I	Translation Picture Infor. II	Translation Picture Infor. III	Translation Picture Infor. Cmb	Solution Picture Infor. I	Solution Picture Infor. II	Solution Picture Infor. III	Solution Picture Infor. Cmb	Mental Movement I	Mental Movement II	Mental Movement III	Mental Movement Cmb	Use of Picture I	Use of Picture II	Use of Picture III	Use of Picture Cmb
Dimension / Year			$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)
Total	Female	High/Low	4.43 (2.19)	4.10 (2.19)	7.10 (3.04)	5.20 (2.04)	6.31 (2.57)	3.91 (1.94)	5.95 (2.85)	5.89 (1.90)	7.84 (1.43)	4.79 (1.19)	7.70 (1.38)	7.30 (1.57)	.06 (.17)	.18 (.31)	.08 (.17)	.08 (.12)	.92 (.14)	.93 (.12)	.89 (.16)	.93 (.10)
		Low/High	5.77 (2.50)	4.81 (2.39)	6.85 (3.46)	6.19 (2.59)	5.69 (3.19)	3.60 (1.93)	3.97 (1.76)	4.57 (1.70)	8.97 (1.81)	4.95 (.65)	8.04 (1.59)	7.55 (1.38)	.11 (.20)	.03 (.13)	.11 (.24)	.09 (.13)	.90 (.23)	.79 (.29)	.90 (.18)	.88 (.16)
	Male	High/Low	4.14 (2.60)	4.36 (3.82)	6.22 (3.57)	4.86 (2.39)	5.68 (2.44)	3.93 (2.13)	5.19 (1.92)	5.02 (1.44)	7.86 (1.00)	4.48 (1.28)	7.49 (1.80)	6.56 (.59)	.11 (.28)	.09 (.26)	.19 (.28)	.13 (.15)	.77 (.38)	.92 (.17)	.74 (.35)	.78 (.26)
		Low/High	6.39 (4.05)	4.06 (2.94)	8.75 (3.74)	6.75 (3.54)	6.19 (3.36)	3.92 (1.99)	4.31 (2.13)	5.00 (1.39)	8.47 (2.28)	4.68 (.61)	7.60 (1.58)	7.51 (1.80)	.05 (.13)	.07 (.14)	.10 (.29)	.07 (.14)	.75 (.41)	.91 (.22)	.83 (.24)	.83 (.19)
Word	Female	High/Low	6.81 (3.35)	8.83 (2.29)	8.44 (2.45)	7.65 (2.51)	6.96 (2.77)	4.95 (1.62)	5.86 (3.01)	6.32 (1.83)	9.22 (1.67)	5.96 (1.79)	8.04 (1.23)	8.20 (1.26)	.00 (.00)	.18 (.32)	.02 (.09)	.04 (.09)	.88 (.27)	.94 (.18)	.89 (.19)	.92 (.12)
		Low/High	7.77 (2.62)	9.60 (2.94)	8.87 (3.00)	8.79 (2.10)	5.24 (3.42)	4.12 (2.39)	3.98 (1.76)	4.51 (1.83)	9.83 (1.52)	5.84 (.96)	8.66 (1.34)	8.41 (1.12)	.07 (.18)	.00 (.00)	.01 (.04)	.02 (.05)	.88 (.26)	.64 (.39)	.86 (.22)	.84 (.19)
	Male	High/Low	6.43 (3.55)	10.78 (2.19)	8.66 (2.80)	7.99 (2.74)	6.17 (2.80)	5.26 (2.02)	5.19 (1.92)	5.58 (1.98)	9.37 (1.25)	5.72 (1.33)	7.93 (1.71)	8.14 (1.17)	.00 (.00)	.13 (.35)	.11 (.21)	.06 (.12)	.88 (.30)	.94 (.14)	.76 (.32)	.82 (.27)
		Low/High	8.58 (4.20)	10.00 (2.45)	9.63 (2.83)	9.22 (3.42)	6.40 (3.96)	3.58 (2.28)	3.76 (2.07)	5.29 (2.31)	9.54 (2.14)	5.14 (1.00)	7.92 (1.57)	8.47 (1.95)	.04 (.14)	.08 (.20)	.08 (.29)	.07 (.15)	.75 (.40)	.83 (.41)	.90 (.18)	.81 (.30)
Fraction	Female	High/Low	1.27 (.61)	1.33 (.40)	1.04 (.12)	1.24 (.32)	4.67 (1.13)	3.10 (2.10)	5.57 (2.61)	4.40 (1.29)	5.63 (.78)	3.92 (.96)	5.91 (.60)	5.15 (.50)	.12 (.30)	.19 (.36)	.42 (.50)	.20 (.23)	.94 (.16)	.93 (.14)	.81 (.37)	.92 (.14)
		Low/High	1.37 (.46)	1.49 (.40)	1.07 (.22)	1.41 (.36)	6.15 (2.14)	2.92 (1.66)	3.74 (2.35)	4.11 (2.10)	6.40 (.70)	4.16 (.82)	5.75 (1.19)	5.18 (1.17)	.17 (.28)	.08 (.28)	.37 (.40)	.19 (.28)	1.00 (.00)	.90 (.20)	.89 (.33)	.93 (.20)
	Male	High/Low	1.07 (.70)	1.40 (.49)	1.29 (.49)	1.27 (.49)	4.40 (1.78)	3.01 (2.22)	4.82 (2.28)	3.66 (1.44)	6.24 (.92)	3.89 (1.20)	5.89 (1.76)	4.75 (1.34)	.18 (.35)	.10 (.29)	.39 (.45)	.19 (.28)	.64 (.46)	.82 (.40)	.71 (.49)	.65 (.39)
		Low/High	1.08 (.49)	1.25 (.42)	1.00 (.00)	1.23 (.43)	3.53 (1.86)	3.92 (2.03)	5.08 (3.80)	3.98 (1.59)	5.67 (.82)	4.30 (1.25)	5.50 (2.08)	4.93 (.58)	.11 (.27)	.03 (.11)	.17 (.33)	.08 (.14)	.83 (.41)	.88 (.23)	.42 (.50)	.75 (.33)

Table 9

Significant F-ratios for ANOVAs: Dimensions for All Solutions

Dimension	Source	Problem	Year	F	degrees of freedom	Higher Mean
Verbal Information	Sex	Total	III	3.30*	1,65	Male
		Word	III	3.75*	1,65	Male
		Fraction	I	5.23**	1,63	Female
	Spatial/Verbal Group	Total	I	3.41*	1,65	L/H[a]
		Total	Cmb[1]	3.62*	1,65	L/H
		Word	I	4.02**	1,65	L/H
		Word	III	3.79*	1,65	L/H
		Word	Cmb	4.42**	1,65	L/H
Translation Picture Information	Sex			- N O N E -		
	Spatial/Verbal Group	Total	Cmb	2.75*		H/L[b]
Solution Picture Information	Sex	Fraction	I	3.86**	1,65	Male
		Fraction	Cmb	4.40**	1,65	Male
	Spatial/Verbal Group			- N O N E -		
Mental Movement	Sex	Word	III	3.95**	1,65	Male
	Spatial/Verbal Group	Total	III	4.49**	1,65	H/L
		Total	Cmb	2.93*	1,65	H/L
		Fraction	III	3.96**	1,65	H/L
Use of Picture	Sex	Total	I	7.70***	1,65	Female
		Total	Cmb	6.50***	1,65	Female
		Word	I	3.51*	1,65	Female
		Word	Cmb	4.01**	1,65	Female
		Fraction	I	8.81***	1,65	Female
		Fraction	Cmb	6.02**	1,65	Female
	Spatial/Verbal Group	Total	II	5.09**	1,65	H/L
		Total	Cmb	3.10	1,65	H/L
		Fraction	II	4.02**	1,65	H/L

[a] L/H - Low Spatial/High Verbal

[b] H/L - High Spatial/Low Verbal

[1] Cmb = Combined years

*p $\leq$ .10

**p $\leq$ .05

***p $\leq$ .01

Table 10

Significant F-ratios for ANOVAs: Dimensions for Correct Solutions

Dimension	Source	Problem Type	Year	F	Degrees of Freedom	Higher Mean
Verbal Information	Sex	Total	II	3.95**	1,65	Female
		Fraction	I	4.15**	1,49	Female
	Spatial/Verbal Group	Total	III	2.87*	1,65	L/H[a]
		Total	CMB	2.78*	1,65	L/H
		Word	III	4.22**	1,65	L/H
		Word	CMB	3.85**	1,65	L/H
Translation Picture Information	Sex	Fraction	II	2.96*	1,63	Male
		Fraction	CMB	3.05*	1,64	Male
	Spatial/Verbal Group	Total	CMB	4.21**	1,65	H/L[b]
		Fraction	CMB	4.28**	1,64	H/L
Solution Picture Information	Sex	Fraction	III	4.23**	1,61	Male
		Fraction	CMB	6.41***	1,64	Male
	Spatial/Verbal Group	Total	I	4.07**	1,65	H/L
		Total	CMB	4.30**	1,65	H/L
Mental Movement	Sex			- N O N E -		
	Spatial/Verbal Group			- N O N E -		
Use of Picture	Sex	Total	I	6.13**	1,65	Female
		Total	CMB	4.79**	1,65	Female
		Word	I	6.03**	1,65	Female
		Word	CMB	5.87**	1,65	Female
		Fraction	I	4.41**	1,48	Female
	Spatial/Verbal Group	Total	II	3.81*	1,65	H/L
		Total	CMB	2.97*	1,65	H/L
		Fraction	II	3.42*	1,61	H/L
		Fraction	CMB	6.00**	1,64	H/L

[a] L/H = Low Spatial/High Verbal
[b] H/L = High Spatial/Low Verbal

*$p \leq .10$
**$p \leq .05$
***$p \leq .01$

Table 11

Significant F-ratios for ANOVAs: Dimensions for Incorrect Solutions

Dimension	Source	Problem Type	Year	F	Degrees of Freedom	Higher Mean
Verbal Information	Sex		- N O N E -			
	Spatial/Verbal Group	Total	I	6.06**	1,59	L/H[a]
		Total	CMB	4.72**	1,63	L/H
		Word	I	2.84*	1,56	L/H
		Word	CMB	3.18*	1,62	L/H
Translation Picture Information	Sex	Fraction	I	4.66**	1,34	Female
	Spatial/Verbal Group	Total	III	6.82***	1,55	H/L[b]
		Total	CMB	3.26*	1,62	H/L
		Word	II	2.80*	1,34	H/L
		Word	III	7.65***	1,50	H/L
		Word	CMB	5.36**	1,61	H/L
Solution Picture Information	Sex		- N O N E -			
	Spatial/Verbal Group	Total	I	4.64**	1,60	L/H
		Total	CMB	2.86*	1,63	L/H
Mental Movement	Sex	Word	III	2.96*	1,50	Male
	Spatial/Verbal Group	Word	I	3.43*	1,54	L/H
Use of Picture	Sex	Total	I	3.56*	1,56	Female
		Total	III	3.22*	1,55	Female
		Total	CMB	4.84**	1,62	Female
		Fraction	I	6.64***	1,36	Female
		Fraction	CMB	8.96***	1,49	Female
	Spatial/Verbal Group	Word	II	3.74*	1,26	H/L

[a] L/H = Low Spatial/High Verbal

[b] H/L = High Spatial/Low Verbal

$^{*}p \leq .10$

$^{**}p \leq .05$

$^{***}p \leq .01$

Table 12

Trends of Dimension Scores for Correct Solutions: Combined Years

		Highest Mean of the Four Groups	Lowest Mean of the Four Groups
Female	High/Low	Use of Picture (Fraction) Use of Picture (Word) Translation Picture Information	- N O N E -
	Low/High	Verbal Information (Fraction) Verbal Information (Word)	Translation Picture Information (Fraction) Translation Picture Information (Word) Solution Picture Information (Fraction) Mental Movement (Word) (Correct Solutions)
Male	High/Low	Translation Picture Information (Fraction) Solution Picture Information (Fraction) Solution Picture Information (Word) Mental Movement (Fraction) Mental Movement (Word)	Verbal Information (Word)
	Low/High	(Correct Solutions)	Verbal Information (Fraction) Solution Picture Information (Word) Use of Picture (Fraction) Use of Picture (Word) Mental Movement (Fraction)

Figure Caption

A post 12 feet long is pounded into the bottom of a river near its bank. Two and a half feet of the post is below the bottom of the river and 1/2* foot is above the surface of the water. How deep is the river at that point?

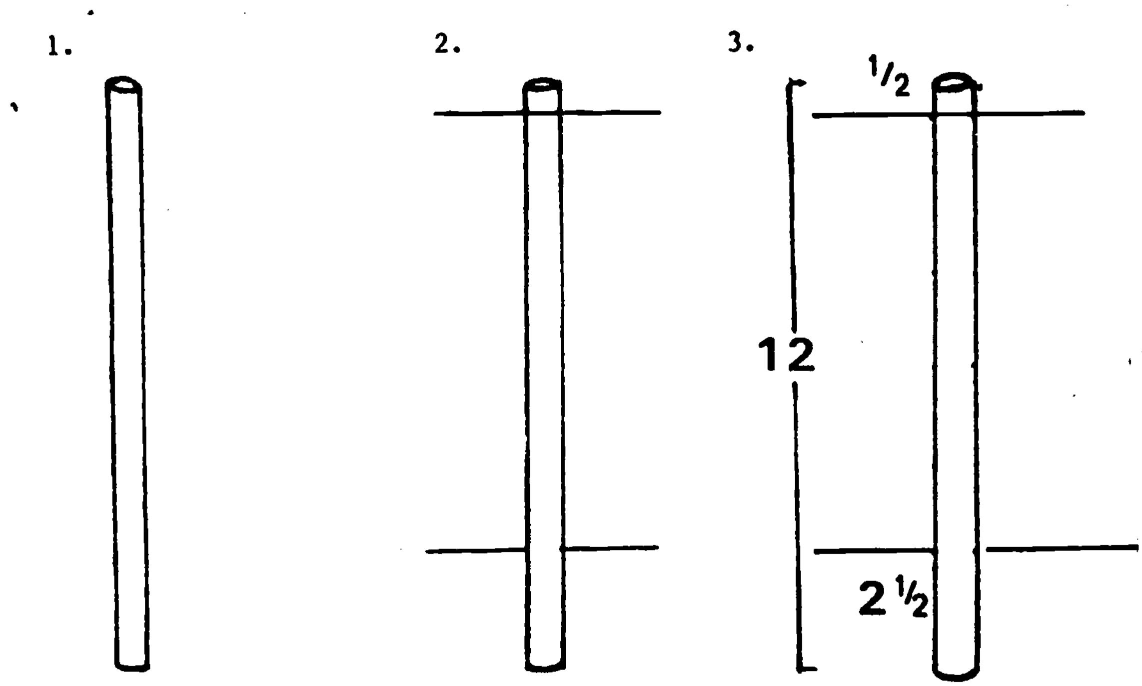
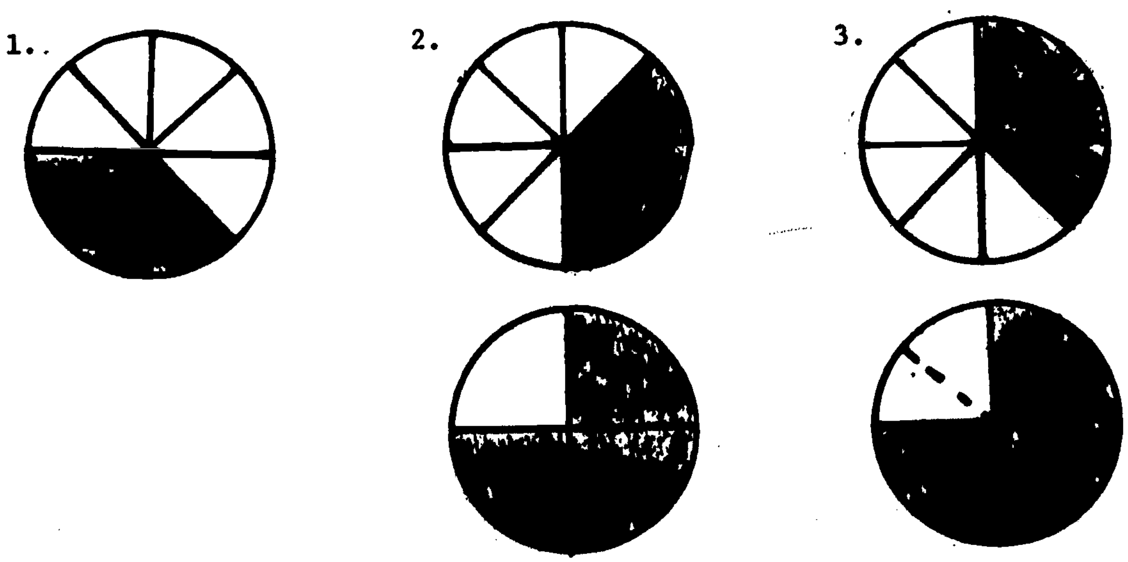


Figure 1

3/8 + 3/4 =



*In Year II, the numbers were identical and in Year III, the numbers were 25, 8-1/4, and 3/4, respectively.

Figure 2

THE CONFIDENCE STUDY

Expectations and Feelings about Females' and Males' Achievement in Mathematics

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Running Head: Expectations and Feelings

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Expectations and Feelings about Females' and Males' Achievement in Mathematics

Abstract

Interviewed yearly during grades 6, 7, and 8 were 31 boys and 32 girls who were above the mean in mathematics achievement and in the lower or upper quartile in confidence in learning mathematics. Using a projective technique, the subjects were interviewed about two question types (expectations and feelings) different perceived respondents (individual, peers, or teachers) and four mathematical situations (general, spatial, low, or high cognitive level). Resulting data were analyzed by ANOVA techniques and group means plotted over years to determine developmental trends. Few group differences in responses were found. Overall, there were higher expectations for females than for males, but a substantial trend of diminishing expectations for females was found. The groups felt equally positive about females' or males' success in grade 6, but by grade 8, less positive feelings about females' success than about males' success were expressed.

Females are neither achieving nor persisting in mathematics at the same level as are males (Fennema & Carpenter, 1981). This is a serious problem for those who believe that equity in education should exist. Lack of adequate mathematical preparation prohibits entrance into many post high school options and career advancement or change. During the last ten years, there have been many studies which have investigated the problem and while we are more knowledgeable than we were ten years ago, the problem is far from alleviated.

The main rationale for why females learn and persist in mathematics at lower levels than do males is related to the belief that sex-role is a mediator of cognitive functioning and that the learning of mathematics is stereotyped as male. The rationale goes something like this:

> *Sex role identity is important to everyone. A portion of that sex role identity is achievement in domains seen as appropriate for one's sex. Mathematics is <u>not</u> seen as an appropriate domain for females. Therefore, achievement by a female in the mathematical domain results in her not fulfilling her sex role identity adequately. She perceives that teachers and peers have lowered expectations of her mathematical success because she is a girl. She also perceives that others see her as somewhat less feminine when she achieves in mathematics, and she becomes increasingly uncomfortable with her achievement. Success is not valued because she thinks others have negative feelings about her success.*

The purpose of the longitudinal study reported here was to investigate some of the components of this rationale. The major questions addressed were:

1. Do girls and boys[a] differ in their expectations of success/failure of males and females in mathematics, and do they perceive that peers and teachers have different expectations for success/failure for females and males?

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[a]When the subjects of the study are referred to in this paper, they are called boys and girls. When a more generalized idea is under consideration, the words females and males are used.

2. Do girls and boys differ in positive and negative feelings about success and failure of others in mathematics and do they perceive that peers' feelings are different about females' and males' successes and failures?

3. Are developmental trends apparent in expectations and feelings about success/failure of females and males in mathematics?

Mathematics is a complex discipline composed of ideas of varying cognitive complexity and in different content areas. Females, as a group, perform less well in mathematics of higher cognitive complexity and, in the mathematical areas of measurement and geometry (spatial) (Fennema & Carpenter, 1981). Because of this, the questions asked above were investigated using mathematical items of different cognitive complexity in spatial and non-spatial areas.

Procedures

Sample

Because it was known that getting information about the above questions was difficult, a very specialized sample was chosen in order to maximize the possibility of obtaining useful information. Girls and boys, who were high achievers but differed in their confidence in learning mathematics, were selected. Confidence was a particularly important variable to use in selection of the sample due to its known relationship to sex-related differences in mathematics. Confidence, or the belief that one can learn and perform well in mathematics, is one of the most important affective variables related to the learning of mathematics and is correlated with both mathematics achievement and mathematics course selection ($r \sim .45$). Males tend to have more confidence in their ability to perform well in mathematics than do females, even when there are no sex-related differences in mathematics performance (Fennema & Sherman, 1978).

In addition, some believe that confidence may be more important to females' achievement in mathematics than it is to males' (Fox, 1982). It seemed reasonable to assume that high and and low confidence students might provide the most useful information about expectations and feelings.

In the fall of 1978, the entire sixth grade population of four middle schools in a Midwest city were given a battery of tests. Of interest to the study being reported here was a mathematics achievement test (Mathematics Concepts subtest of the Science Research Associates [Naslund, Thorpe, & LeFever, 1971]) and the Confidence in Learning Mathematics Scale of the Fennema-Sherman Mathematics Attitude Scales (Fennema & Sherman, 1976). Girls and boys who scored above the mean of the population on the achievement test and who scored either above the 75th percentile or below the 25th percentile on the confidence scale were selected. Thus, four groups were identified that varied by sex and confidence level and these groups were studied over a three-year period. During the third year of the study when the subjects were in the eighth grade, the subjects plus a random sample of the original population were retested on mathematics achievement (ETS Sequential Test of Educational Progress, 1979) and Confidence in Learning Mathematics. In Table 1 are the descriptive statistics of the four sample groups in grades 6 and 8. Also in Table 1 are z scores computed with the entire population in grade 6 and with the random sample in grade 8.

Insert Table 1 about here.

Analyses of variance (ANOVAs) using sex and confidence level as sources revealed no significant differences in achievement between the sexes in either grade 6 or 8. However, even though the difference was not statistically significant, the pattern deserves comment. In grade 6 the girls scored somewhat higher than the boys in mathematics achievement. By grade 8, the boys scored somewhat higher than the girls. The high confidence girls had the highest score in mathematics achievement in the sixth grade, but the high confidence boys had the highest score in the eighth grade. There was a significant difference in mathematics achievement between the confidence groups in both 6th and 8th grade (grade 6: $F(1,59) = 9.99$, $p \leq .00$; grade 8: $F(1,59) = 8.25$, $p \leq .01$).

Data Collection

Data collection was done utilizing a projective technique in an individual interview each year. Interview materials included a set of photographs with corresponding sets of script and problem cards. The pictures depicted students in typical mathematics classroom situations. While the scenes were approximately equivalent from year to year, new photos were taken each year to update the ages of the females and males pictured to a comparable grade level as the subjects being interviewed. (For a complete description, see Fennema and Koehler, in progress.)

There were three main dimensions to the interview, each of which had several levels: 1) Question Type; 2) Perceived Respondent; and 3) Mathematical Situation. The Question Type included questions regarding the <u>expectation</u> of success or failure ("Who will succeed?" or "How will this girl/boy do?"), and questions regarding <u>feelings</u> about success or failure. The Perceived Respondents were depicted or inferred and included a single student (individual), a group of students (peers), or a teacher. The Mathematical Situation considered in the questions and shown on cards was one of four types: lower level (rote computational skills), higher level (some problem solving), spatial (problems involving a figure or diagram) or general (mathematical lesson or test). (See Figure 1 for examples of these Mathematical Situations).

Insert Figure 1 about here.

To clarify the three dimensions, consider the following examples of photograph descriptions and questions asked about each photograph.

Photograph A

Two girls and two boys are pictured in a classroom sitting at desks. All are attending to a teacher.

Problem Card

38 x 4 =

Questions

"Who will the teacher call on for the right answer to this problem?" (Success expectation question, teacher as perceived respondent, lower level mathematical situation)

Photograph B

Two girls and two boys are seated at a table working on a mathematics lesson.

Question

"How do the others expect this girl (interviewer points to a specific girl) to do on their math lesson?" (Expectation of female, peers as perceived respondent, general mathematical situation)

Photograph C

Two boys and two girls are seated at a table looking at their mathematics tests which have been returned to them.

Questions

The interviewer says that one student had done very well, two had done pretty well, and one had done poorly. The interviewer then asks: "Which of these four students did most poorly on the math test?" (Failure expectation question, individual as perceived respondent, general mathematical situation)

"How do the others feel about the one who did most poorly?" (Failure feelings question, peers as perceived respondent, general mathematical situation)

Photograph D

A girl and a boy are shown working on a problem.

Problem Card

Pat mowed half of the lawn before lunch and two-fifths in the afternoon. How much does Pat have left to mow?

Questions

The interviewer says "The two students have different answers to this problem. Which of these two students will have the right answer?" (Success expectation question, individual as perceived respondent, higher level mathematical situation)

How does the one who got the problem wrong feel about himself/herself? (Failure feelings question, individual as perceived respondent, higher level mathematical situation)

All subjects were interviewed three times during the spring when they were in 6th, 7th, and 8th grade. Each interview was private, audiotaped, and lasted between 30 and 45 minutes. In order to ensure objectivity and reliability of procedures, interviewers were carefully trained using videotapes, practice interviews, and analyses of transcripts of past interviews (see Fennema & Koehler, in progress, for a thorough discussion of training procedures). Interviewers did several practice interviews with children of the same age as the subjects and these interviews were critiqued. Once the data gathering began, tapes were checked periodically to ensure the use of correct procedures. During the interviews, pictures and in some cases, a problem card, were shown and questions asked in a specified order.

If a subject's response was not clear, the interviewer was trained to probe until it was. (See Figure 2 for one photograph and script card used by the interviewer.)

Insert Figure 2 about here.

Coding

After the interviews were completed, the tapes were transcribed and coded. Coders were advanced graduate or post-doctoral students who were trained in several separate sessions. For a coder agreement check after training, eight designated interviews were coded by each coder and the percent of coder agreement was calculated (Table 2). As can be seen, coder agreement varied from 84% to 98.9%.

Insert Table 2 about here.

Expectation questions were categorized according to perceived respondent and mathematics situations, and responses to the questions were coded either male or female, or success or failure, depending on the form of expectation question asked. For example, consider the following:

Interviewer: "Here's picture number two. This guy and girl are working on a plain arithmetic problem like this one: 27 divided by 1/3. Now they've gotten different answers. Who would probably have the right answer?"

STUDENT: "PROBABLY THE GIRL." (coded: success student-female; perceived respondent-individual; mathematical situation-low level)

Interviewer: "Let's go on to picture number 4. Um, let's see, this is a girl here, and this is a girl in the striped shirt. And these two are guys. OK? (OK) How, how might the others expect this girl in the blue overalls to do on the math lesson?"

STUDENT: THEY EXPECT HER TO DO PRETTY WELL. (coded: performance expectation-female success; perceived respondent-peers; mathematical situation-general)

Interviewer: "All right now, this boy in the white T-shirt. How might the others expect him to do on the math lesson?"

STUDENT: PRETTY BAD. (coded: performance expectation-male failure; perceived respondent-peers; mathematical situation-general)

Responses to Feelings questions were coded as positive (+1), neutral (0), or negative (-1); perceived respondent and mathematical situation. For example:

(A male has been chosen by subject to get the right answer and a female has been chosen to get the wrong answer to a high level mathematical problem.)

Interviewer: "OK. Um, how does the girl feel about herself since she got the wrong answer? What sort of feelings does she have about herself?"

STUDENT: "WELL...SHE FEELING A LITTLE BIT, YOU KNOW, KIND OF DUMB AND UH, SHE'S A BIT OF ASHAMED THAT SHE GOT IT WRONG." (coded: feelings about failure for a female-negative; perceived respondent-individual; mathematical situation-high level)

Interviewer: "OK. Um, now...how does the boy feel about himself since he got the right answer to the problem?"

STUDENT: HE'S PROUD OF HIMSELF BECAUSE HE GOT A BETTER...OR, HE GOT THE RIGHT ANSWER. (coded: feelings about success for a male-positive; perceived respondent-individual; mathematical situation-high level)

Although almost all responses fit into one of the coding categories, occasionally a response would not fit. Such a response was omitted from analysis.

Analyses and Results

For both types of questions, means and standard deviations of responses were computed. Analyses of variance were carried out with sex and confidence level as the factors.

Expectations

Perceived Respondent

Were there differences in how the various groups responded to the Expectation questions and did the groups' responses differ when the perceived respondent differed? To obtain answers to these questions, responses about all mathematical situations were combined. For each grade, the percentage of times each subject picked success in response to "How will female/male do?" or each subject picked male in response to "Who will succeed?" was calculated. Means and standard deviations by group were obtained from individual statistics and are in Table 3. These means were plotted across years and appear in Figures 3-6. Analyses of variance were calculated and F-ratios with $p \leq .05$ are in Table 4. Only six F-ratios with a $p \leq .05$ were found: three when sex was the source, none when confidence group was the source, and three sex x confidence group interactions. Overall, these data indicate a remarkable consistency in how girls and boys of different confidence levels responded to questions about expectations of success of females and males.

Were expectations of success in mathematics higher for females or for males? An examination of the data from the "Who will succeed?" question shows that in grades 6 and 7, when all perceived respondents were combined (Anyone) the groups selected males to succeed less than 50% of the time and conversely selected females to succeed more than 50% of the time (shown most clearly in Figure 3). In grade 6, there was a significant sex difference and the boy

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Insert Figure 3 about here.

---

groups said that males would succeed about 43% of the time while the girl groups reported that males would succeed only about 27% of the time. By grade 8, three groups (high and low confidence girls, high confidence boys) said that males would succeed more than 50% of the time.

When an individual was the perceived respondent in the 6th grade, all four groups thought males would succeed less often than females, and girls selected males to succeed less often than the boys selected males to succeed. A change from 6th to 7th grade should be noted. The girl groups actually did not change in their perception of who would be successful, while the boy groups reduced their expectancy of males' success (from 42% in 6th grade to only 21% in grade 7). By grade 8, all groups have made a dramatic jump in the percentage of times they selected males over females to be successful. There is a significant sex by confidence interaction in this year, with the girl low and the boy high groups selecting males to succeed more than 50% of the time. In contrast, the girl high and the boy low groups selected males to succeed less than 50% of the time.

When one examines the teacher as perceived respondent, the same trend of expectations is evident with teachers perceived as expecting females to succeed more than males in grades 6 and 7, and males more than females in grade 8. The trend of rising teacher expectations for males in comparison to expectations by individuals is even more dramatic. Also, in all grades, the two groups of boys perceived that teachers expected males to be successful more often than the two groups of girls did with the difference being significant in grade 6. All groups reported teachers' expectations of males became higher from 6th to 8th grade while expectations of females became lower.

The second type of expectation question, "How will female/male do?" produced similar results. Tables 3 and 4 also show the means, standard deviations, and F-ratios with a p of $\leq .05$ of the percentages of time success was chosen by the four groups. The means are plotted across years in Figures 4-6. Once again, there is remarkable consistency in how the groups responded. Only three F-ratios with a $p \leq .05$ were found: two interactions and one with sex as source.

Insert Tables 3 & 4 and
Figures 4-6 about here.

There was also consistency between responses to this question type and the first Expectation question type as to whether females or males were expected to succeed. In grade 6 when all perceived respondents were combined (Anyone) (Figure 4), the four groups thought females would be successful 66% to 81% of the time and in contrast, thought males would be successful only 50% to 62% of the time. Note also that all but one group (the high confidence boys) expect females to be successful less often in grade 8 than in grade 6. On the other hand, all groups expect males to succeed more often in grade 8 than they did in grade 6. The high confidence boys increased their expectations of male success from 57% to 70%; the low confidence boys from 62% to 68%. The groups of girls increased their expectations of males' success more dramatically with the high confidence girls increasing expectations of males from 53% to 78% and the low confidence girls going from 50% to 81%.

When peers are the perceived respondents (Figure 5), one can clearly see the higher expectation of females than of males. With the exception of the low confidence boys, in grade 6, females are expected to succeed at much higher levels than are males. When teachers are the perceived respondent, girls perceive higher expectations of males by teachers

(Figure 6) as they progress from grades 6 to 8, with the increase particularly clear with the low confidence girls. The differences between girls' perception of teacher expectations of females and males is dramatic with expectations of males continually increasing and expectations of females decreasing. Boys did not appear to see as much difference between teachers' expectation of females and males as did the girls.

In summary, these data indicate higher expectations of females overall. However, by 8th grade, in all groups except the low confidence boys, there is evidence that expectations of males is approaching and sometimes surpassing expectations of females. Girls, more so than boys, believe that teachers, by 8th grade, have higher expectations of males than of females.

Mathematical Situation

Does the type of mathematics considered make a difference in success expectations of females and males? Means and standard deviations of the groups' responses by mathematical situation (combined across perceived respondent) are in Table 5 and significant F-ratios computed with the means are in Table 6. Once again, the four groups gave surprisingly similar responses. Only two F-ratios with $p \leq .05$ were found, one with sex as source and one with confidence group as source.

Insert Tables 5 & 6 about here.

Were these differences in expectations of males and females for high level, low level, or spatial mathematical situations? Means of the groups are plotted across years and shown in Figures 7 and 8.

Insert Figures 7 & 8 about here.

In response to "Who will succeed?" - low level in the 6th grade, the boy groups selected males between 40% and 45% of the time and the girl groups selected males between 25% and 30% of the time. There continued to be a difference in the 7th grade, but the direction reversed and the girls were selecting males to be successful about 30% of the time, while the boys were selecting males about 17% of the time. Also, it is interesting to note that the boy groups behaved similarly to each other, while the girl groups did not, with the high confidence girls being consistent in their selection of males to succeed and the low confidence girls increasing their selection of males to succeed. The responses to "Who will succeed?" in a high level mathematics situation are similar to the responses in a low level mathematical situation in the sense that across all three years, all groups selected males to succeed less than 50% of the time.

The responses to "Who will succeed?" in a spatial mathematical situation are quite interesting. In grade 6, these responses are similar to those given for both low and high level mathematical situations. That is, it would be safe to say that the sample groups did not differentiate their expectations of success according to mathematical situation. However, in grade 7 and in grade 8, there is a dramatic increase in the number of times that males are selected to be successful in spatial problems. In grade 7, it ranges from 46% to 75% of the time and in grade 8, it ranges from 52% to 81% of the time.

The second type of question gives another look at expectations in various mathematical situations. When the plots (Figure 8) for "How will a female do?" and "How will a male do?" in a low level mathematical situation are compared, some striking patterns emerge. Overall, the groups think females will succeed considerably less in grade 8 than they did in grade 6. In contrast, they think males will succeed considerably more in grade 8 than they did in grade 6. Furthermore, by grade 8, the groups think males will succeed much more often than females will succeed. In fact, the 8th grade entire group mean for females' success is only 45.19%, while it is 81.71% for males' success. The pattern of the two low confidence groups is strongest as the combined means from these groups illustrate. Their expectation of success for a female drops from 80% to 27% from grade 6 to 8, while their expectation of success for a male increases from 27% to 84%. The results of the "How will female (or male) do?" question in high level, spatial, and general mathematical situation were also examined, but they added no new information to the already mentioned results.

In summary, the responses to Expectation questions in a variety of mathematical situations partially support the other expectation analyses. In the "Who will succeed?" question type, females are expected overall to be more successful in high and low level problems. The responses to the "Who will succeed?" in Spatial situation as well as the "How will male/female do?" show rising expectations for males and decreasing expectations for females.

Feelings

Responses to the various feelings questions were coded negative (-1), neutral (0), or positive (+1). The mean response for each individual was computed and then mean responses for each group were ascertained. Table 7 shows the descriptive statistics by perceived respondent; Table 8 shows similar statistics for mathematical situatior; and Table 9 shows the significant F-ratios. Figures 9 and 10 are plots o means by grade for success questions. Once again, the consistency of results for the various groups is quite striking, with few statistically significant differences found.

Insert Tables 7 - 9 and Figures 9 & 10 about here.

Overall, the groups felt negative about failure (negative means) and positive about success (positive means). Because so few statistically different group responses were found, the data were combined. Means and standard deviations for feelings about female and male success are in Table 10. As can be seen, the subjects felt positive about success for both females and males when the perceived respondents are combined in the Anyone category, but the positive feelings about female success decrease steadily from grades 6-8. There is a drop in grade 7 for positive feelings about male success, but it rises again in grade 8. Both female and male success is more positively valued when individual is the perceived respondent than when peers are the perceived respondents.

Insert Table 10 about here.

Perceived Respondent

There were a few interesting trends that can be seen by inspecting the graphs of the four groups' mean responses by years. When "Anyone" is the perceived respondent (Figure 9), both high confidence groups felt less positive about females' success than did the low confidence groups. In contrast, the confidence groups did not behave similarly when expressing feelings about success of males. In grade 6, the girl and boy groups behave similarly, but by grade 8, the high confidence girls behaved more like the low confidence boys. Another interesting point is that the low confidence boys felt most positive about males' success in all three years, and the low confidence girls felt most positive about females' success in all three years.

Insert Figures 9 & 10 about here.

Looking more closely at just one group, the high confidence girls, another intriguing yet disturbing pattern jumps out. When considering the success of females by peers (Figure 10), the high confidence girls not only felt the least positive of all groups, they felt negative about female success in the 6th grade. In contrast, they felt much more positive about males' success.

There were many similiarites among the groups' feelings about success and their feelings about failure. As expected, the groups felt negative about failure regardless of the perceived respondent. As with the feelings about success, there is no major difference between feelings about females' failure or males' failure. Also, as in the feelings about success, a similar distinction between feelings between perceived respondents (individual and peers) was found. On the whole, the groups felt more negative about an individual's failure than they perceived their peers felt about that failure. The means for the entire group on either female or male failure range from -.59 to -.73 for individual and -.20 to -.44 for peers.

Again, it is interesting to note particularly the high confidence girls. They felt more negative about both males' and females' failure than the other groups did. The contrast between the high confidence girls and the high confidence boys is especially dramatic when individuals are the perceived respondents.

Mathematical Situation

Feelings questions about both low level and high level mathematical situations were also asked and analysed (see Table 8). In general, subjects felt positive about success and negative about failure in all situations. No dramatic distinctions were noticed between these mathematical situations either by sex, by success or failure, or perceived respondent.

The findings of the feelings data can be summarized by saying that the groups feel positive about success and negative about failure. The groups start out feeling the same about females' success as about males' success. However, by grade 8, the groups feel considerably less positive about females' success than about males' success. The groups exhibit a difference between perceived belief of an individual and their perceived beliefs of peers. They perceive peers as being less positive about success, as well as less negative about failure.

The low confidence groups feel most positive about same-sex success. The high confidence girls are, in contrast, least positive about same-sex (or in this case, females') success. They feel more positive about males' success. The high confidence girls also feel more negative about males' and females' failure than the other groups.

General Summary and Conclusions

After examining the expectation and feelings data and analyses, some results become quite apparent. Some of these results are somewhat dramatic, most are quite subtle. Overall, there were higher expectations for females than for males. However, a trend of diminishing expectations for females is clear. Given a particular male or female, the female was expected to succeed less often in eighth grade than in sixth grade while the male was expected to succeed more often in eighth grade than in sixth grade. In terms of feelings, the groups felt about equally positive about females' or males' success in grade 6, but by grade 8, they felt much less positive about females' success than they did about males' success. Peers are perceived to feel less positive about success than individuals do.

One must also question how much the expectation results reflected reality. The girls' mathematics achievement scores decreased in relation to the total group score more than did the boys' scores. However, a decrease in achievement does not adequately explain more negative feelings about females' success.

The contrast between high and low confidence girls' expectations and feelings is worth noting. Low confidence girls' feelings about success were similar to low confidence boys', while high confidence girls felt more negative about females' success. An exact opposite result was expected. In contrast, the boys, and in particular, low confidence boys, increased their positive feelings about male success. It seems reasonable to say that positive feelings by boys and increased expectations of males will help ensure that boys will continue working in mathematics.

When asked "Who will succeed?" there were no discernable differences between the confidence groups within sex. That is, the high confidence girls responded similarly to the low confidence girls, and the high confidence boys responded similarly to the low confidence boys. However, when the expectation question was changed, and when the focus was on a particular student, as in "How will this female/male do?" the confidence groups within sex did respond differently. The high confidence girls did not expect a female to succeed as often as the low confidence girls did. This was true whether the perceived respondent was anyone, peers or teacher. In a similar response pattern, the high confidence boys did not expect males to be successful as often as the low confidence boys did, when either anyone or peers were the perceived respondent. Thus, even though the overall responses to "Who will succeed?" and "How will male/female do?" were equivalent (i.e. both showed females would succeed less often by eighth grade and males would succeed more often), not all males nor all females were responding to them identically.

The feelings data also shows that there are intra-sex differences. When feelings about the success of a female are considered, low confidence girls are more positive than high confidence girls. Similarly, when feelings about the success of a male are considered, low confidence boys are more positive than high confidence boys.

The 7th grade data are interesting as this year appeared to be a transitional one. Could this have been due to the learning environment in which the subjects found themselves? While the subjects did not change schools, the organizational structure of the instructional program did change. The sixth grade was taught mainly by teacher teams trained to be elementary teachers and the environment reflected the nurturant atmosphere of an elementary school. Most of the 7th grade teachers were trained as secondary mathematics teachers, and they taught only mathematics in departmentalized settings. It appeared the emphasis changed to one in which mathematics became, if not more important, at least as important as the individual. Could these teachers have communicated their belief that mathematics was more congruent with the male than the female sex-role?

We do know that the mathematics classroom environment of these girls and boys differed. In a study conducted during the same time frame, differential teacher-student interactions by sex were observed in a variety of ways. This differential treatment, which appeared to favor males contributed to the differences found here (Reyes & Fennema, in progress). In addition, by 8th grade, society is putting more pressure on boys and girls to conform to sex role standards. There are 8th grade dances, different gym classes, sex education classes, as well as marked physiological changes.

At the beginning of the article, a rationale was given for achievement in mathematics being somewhat dependent upon the perception of mathematics achievement as being congruent with one's sex role identity. The evidence presented here appears to at least partially support that rational. During the highly critical middle school years when sex role identity becomes increasingly important due to physiological change and societal pressures, mathematics achievement for girls in relationship to boys decreases. It appears that with these subjects, perceived expectations and feelings also decreased for females during the middle school years.

In summary, while the overall results of the study that indicates higher expectations of females appear to be in conflict with the rationale, the trend of decreasing expectations of females and more negative feelings about female success supports the rationale. The importance of the early adolescent years on girls' continued learning and persisting in mathematics cannot be overemphasized. Professionals within schools must be made aware of the relationship between sex role identity and achievement in mathematics. Programs must be developed and used which combat the idea that achievement in mathematics is not a part of the female sex role identity. Such programs must focus not just on the female, but on the total environment which contributes to her perception of her sex role identity (Fennema, Wolleat, Pedro, & Becker, 1981).

One other important idea should be noted. The intra-sex differences were dramatic in some cases. A study which focused on only girl vs. boy differences would not have picked up these differences. Important, alterable variables, such as confidence level or achievement level, should always be included in studies focusing on sex-related differences.

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Table 1

Descriptive and Comparative Statistics of Sample Groups

Sex	Group	n	Mathematics Achievement[a]						Confidence Scale[b]					
			6th			8th			6th			8th		
			Mean	s.d.	z^c	Mean	s.d.	z^d	Mean	s.d.	z^c	Mean	s.d.	z^d
Girl	High	15	30.7	3.6	1.07	42.8	3.4	.67	56.6	2.3	1.31	52.5	5.5	.46
	Low	17	26.7	4.0	.46	39.5	4.9	.26	38.1	5.9	-.89	45.5	8.9	-.31
Boy	High	16	29.1	4.0	.83	43.6	3.0	.76	56.4	2.5	1.29	51.8	6.8	.38
	Low	15	26.9	3.9	.49	40.0	6.8	.33	37.6	4.0	-.96	44.8	9.9	-.40

[a]Year I: Mathematics Concepts subtest of the Science Research Associates (Naslund, Thorpe, & LeFever, 1971)
Year III: Mathematics Basic Concepts (level I, form X) subtest of the Sequential Test of Educational Progress (Educational Testing Service, 1979)

[b]Fennema, E. & Sherman, J. Fennema-Sherman Mathematics Attitude Scales. JSAS Catalog of Selected Documents in Psychology, 1976, 6(1), 31. (Ms. No. 1225)

[c]Population 6th grade, n = 699

[d]Population Random Sample 8th grade, n = 103

Table 2

Percent of Agreement Between Coders

Question Type	Grade 6	Grade 7	Grade 8
Expectations	98.9	98.6	97.7
Feelings	89.1	86.0	84.4

Table 3

Success Expectations: By Perceived Respondent[a]

Sex	Conf. Group	Perceived Respondent	Who will succeed?[c] 6 Mean (s.d.)	7 Mean (s.d.)	8 Mean (s.d.)	Perceived Respondent	How will female do?[b] 6 Mean (s.d.)	7 Mean (s.d.)	8 Mean (s.d.)	How will male do?[b] 6 Mean (s.d.)	7 Mean (s.d.)	8 Mean (s.d.)
Girl	High	Anyone	27.11	34.44	53.78	Anyone[d]	66.67	68.00	62.89	53.33	62.75	77.89
			(18.81)	(17.21)	(13.79)		(36.73)	(34.57)	(25.34)	(27.96)	(20.16)	(26.81)
	Low		27.45	34.71	56.08		81.11	75.83	75.39	50.49	65.57	81.27
			(21.75)	(16.16)	(21.64)		(30.77)	(23.90)	(18.58)	(31.38)	(25.53)	(21.04)
Boy	High		44.69	35.42	58.33		72.40	68.00	81.56	57.81	69.80	70.21
			(26.42)	(20.07)	(14.91)		(36.86)	(33.33)	(19.04)	(33.95)	(26.61)	(34.72)
	Low		41.78	31.11	48.33		81.67	79.22	75.00	62.78	76.57	68.56
			(19.63)	(17.67)	(20.46)		(24.84)	(29.00)	(18.68)	(30.35)	(19.65)	(29.97)
Girl	High	Individual	32.22	31.11	48.89	Peers	73.33	80.00	80.00	73.33	60.00	73.33
			(35.89)	(26.6)	(17.21)		(45.77)	(41.40)	(41.40)	(45.77)	(50.71)	(45.77)
	Low		32.35	33.33	60.78		93.33	88.24	88.24	81.25	41.18	76.47
			(35.59)	(20.41)	(29.43)		(25.82)	(33.21)	(33.21)	(40.31)	(50.73)	(43.72)
Boy	High		43.75	22.92	54.17		87.50	68.75	87.50	75.00	43.75	81.25
			(40.31)	(26.44)	(26.87)		(34.16)	(47.87)	(34.16)	(44.72)	(51.23)	(40.31)
	Low		42.22	20.00	37.78		93.33	78.57	100.00	93.33	80.00	80.00
			(37.20)	(27.60)	(33.01)		(25.82)	(42.58)	(.00)	(25.82)	(41.40)	(41.40)
Girl	High	Teacher	22.22	37.78	58.89	Teacher	66.67	57.14	53.33	75.00	62.89	80.00
			(24.12)	(17.21)	(22.60)		(57.74)	(43.71)	(39.82)	(45.23)	(21.08)	(28.14)
	Low		23.53	37.25	50.98		75.00	69.44	68.23	58.33	69.31	82.94
			(28.30)	(33.09)	(26.66)		(50.00)	(28.11)	(27.59)	(51.49)	(28.61)	(19.74)
Boy	High		45.83	47.92	62.50		85.71	72.33	77.08	44.44	80.67	66.15
			(31.91)	(27.13)	(20.64)		(37.80)	(34.12)	(29.58)	(52.70)	(29.57)	(35.81)
	Low		40.00	42.22	60.00		66.67	84.52	58.93	66.67	74.22	59.05
			(28.73)	(32.04)	(25.82		(51.64)	(29.57)	(32.60)	(50.00)	(26.93)	(34.51)

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[a]Combined across all mathematical situations

[b]Percentage of times success was chosen

[c]Percentage of times male was chosen

[d]All respondents combined

Table 4

Analyses of Variance of Responses to Expectation Questions by Perceived Respondents F-ratios $p \leq .05$

Perceived Respondent	Grade	Source	F	$p\leq$	d.f.[c]	Group
		Who will succeed?				
Teacher	6	Sex	7.75	.01	1,59	Boys[a]
Anyone	6	Sex	8.28	.01	1,59	Boys[a]
Individual	8	Sex X Conf.	4.20	.05	1,59	
		How Will Female Do?				
Teacher	8	Sex X Conf.	3.91	.05	1,57	
		How Will Male Do?				
Peers	7	Sex X Conf.	5.00	.03	1,59	
Teacher	8	Sex	6.12	.02	1,58	Girls[b]

[a] Group with higher choice of male success

[b] Group with higher choice of success

[c] d.f. varies because occasionally a question was omitted because of a previous response.

Table 5

Success Expectations by Mathematical Situation[a]

Mathematical Situation	Sex	Question Grade Group	Who will succeed?[b] 6 Mean (s.d.)	7 Mean (s.d.)	8 Mean (s.d.)	How will female do?[c] 6 Mean (s.d.)	7 Mean (s.d.)	8 Mean (s.d.)	How will male do?[c] 6 Mean (s.d.)	7 Mean (s.d.)	8 Mean (s.d.)
Low Level	Girl	High	30.00	30.00	30.00	40.00	62.50	50.00	50.00	55.77	80.00
			(25.35)	(31.62)	(41.40)	(54.77)	(25.00)	(43.85)	(52.70)	(32.52)	(42.16)
		Low	26.47	32.35	41.18	75.00	68.75	18.18	30.77	58.89	92.86
			(25.72)	(24.63)	(44.14)	(50.00)	(37.20)	(33.71)	(48.04)	(38.12)	(18.16)
	Boy	High	40.63	18.75	34.38	66.67	72.22	71.43	60.00	79.17	75.00
			(41.71)	(30.96)	(47.32)	(51.64)	(26.35)	(32.31)	(51.64)	(27.87)	(37.80)
		Low	43.33	16.67	40.00	83.33	71.88	34.62	22.22	58.33	72.22
			(32.00)	(30.86)	(47.06)	(40.82)	(45.19)	(42.74)	(44.10)	(34.27)	(44.10)
High Level	Girl	High	26.67	30.00	30.00	66.67	60.00	70.00	8.33	71.15	76.92
			(32.00)	(31.62)	(31.62)	(57.74)	(41.83)	(48.30)	(28.87)	(26.70)	(33.01)
		Low	26.47	47.06	38.24	50.00	59.85	95.83	15.38	84.62	65.38
			(35.87)	(37.38)	(37.62)	(57.74)	(41.64)	(14.43)	(37.55)	(21.74)	(37.55)
	Boy	High	50.00	31.25	37.50	55.56	77.50	95.45	14.29	87.50	57.69
			(36.51)	(30.96)	(34.16)	(52.70)	(34.26)	(15.08)	(37.80)	(19.94)	(40.03)
		Low	43.33	30.00	23.33	57.14	100.00	93.75	12.50	86.54	45.83
			(37.16)	(31.62)	(25.82)	(53.45)	(.00)	(17.68)	(35.35)	(29.96)	(39.65)
Spatial	Girl	High	20.00	60.00	60.00	66.67	66.67	50.00	75.00	100.00	100.00
			(41.40)	(50.71)	(50.71)	(57.74)	(50.00)	(53.45)	(45.23)	(.00)	(.00)
		Low	23.53	52.94	52.94	75.00	75.00	100.00	58.33	77.78	100.00
			(43.72)	(51.45)	(51.45)	(50.00)	(46.29)	(.00)	(51.49)	(44.10)	(.00)
	Boy	High	43.75	75.00	81.25	85.71	75.00	84.62	44.44	100.00	66.67
			(51.23)	(44.72)	(40.31)	(37.80)	(45.23)	(37.55)	(52.70)	(.00)	(57.74)
		Low	40.00	46.67	64.29	66.67	87.50	100.00	66.67	100.00	80.00
			(50.71)	(51.64)	(49.72)	(51.64)	(35.36)	(.00)	(50.00)	(.00)	(44.72)

[a]Combined across all perceived respondents

[b]Percentage of times male was chosen

[c]Percentage of times success was chosen

Table 6

Analyses of Variance of Responses to Expectation Questions by Mathematical Situation: F-ratios $p \leq .05$

Mathematical Situation	Grade	Source	F	$p \leq$	d.f.[c]	Group
		<u>Who Will Succeed?</u>				
High Level	6	Sex	5.02	.03	1,59	Boys[a]
		<u>How Will Female Do?</u>				
Low Level	8	Confidence	10.21	.00	1,48	High[b]

[a]Group with higher choice of male success

[b]Group with higher choice of success

[c]d.f. varies because occasionally a question was omitted because of a previous response.

Table 7

Descriptive Statistics
Feelings about Success/Failure by Perceived Respondent[a]

	Grade	Feelings about Success[b] of female 6 Mean (s.d.)	of female 7 Mean (s.d.)	of female 8 Mean (s.d.)	of male 6 Mean (s.d.)	of male 7 Mean (s.d.)	of male 8 Mean (s.d.)	Feelings about Failure of female 6 Mean (s.d.)	of female 7 Mean (s.d.)	of female 8 Mean (s.d.)	of male 6 Mean (s.d.)	of male 7 Mean (s.d.)	of male 8 Mean (s.d.)
Individual													
Girl	High	.79	.55	1.00	.67	1.00	1.00	-.67	-1.00	-.91	-.85	-.75	-.70
		(.28)	(.82)	(.00)	(.43)	(.00)	(.00)	(.52)	(.00)	(.30)	(.32)	(.46)	(.37)
	Low	.76	.92	.96	.62	.91	1.00	-.38	-.67	-.84	-.72	-.63	-.57
		(.25)	(.28)	(.14)	(.59)	(.30)	(.00)	(.52)	(.58)	(.35)	(.35)	(.52)	(.46)
Boy	High	.86	.94	.88	.79	.71	.83	-.50	.00	-.55	-.54	-.31	-.53
		(.22)	(.19)	(.31)	(.30)	(.49)	(.36)	(.53)	(1.41)	(.65)	(.50)	(.88)	(.52)
	Low	.82	1.00	.90	.84	1.00	.92	-.81	c	-.56	-.82	-.83	-.66
		(.28)	(.00)	(.28)	(.35)	(.00)	(.18)	(.37)		(.46)	(.34)	(.41)	(.46)
Peers													
Girl	High	-.23	.06	.13	.43	.11	.57	-.70	-.30	-.35	-.54	-.35	-.45
		(.83)	(.74)	(.93)	(.79)	(.78)	(.68)	(.45)	(.67)	(.62)	(.45)	(.52)	(.48)
	Low	.56	.46	.53	.38	.25	.03	-.31	-.05	-.46	-.31	-.46	-.32
		(.64)	(.64)	(.63)	(.52)	(.89)	(.70)	(.46)	(.50)	(.67)	(.63)	(.45)	(.62)
Boy	High	.35	.26	.39	.07	.13	.44	-.17	-.27	-.14	-.23	-.33	-.34
		(.82)	(.68)	(.84)	(.73)	(.88)	(.65)	(.71)	(.72)	(.60)	(.52)	(.49)	(.64)
	Low	.14	.46	.49	.60	.75	.62	-.44	-.25	-.28	-.18	-.59	-.30
		(.95)	(.63)	(.71)	(.70)	(.42)	(.53)	(.73)	(.50)	(.62)	(.56)	(.38)	(.59)
Anyone													
Girl	High	.64	.30	.32	.57	.53	.75	-.65	-.43	-.59	-.62	-.40	-.59
		(.31)	(.56)	(.24)	(.42)	(.48)	(.39)	(.44)	(.50)	(.41)	(.30)	(.50)	(.34)
	Low	.75	.69	.40	.54	.56	.45	-.42	-.23	-.65	-.54	-.49	-.44
		(.21)	(.34)	(.20)	(.53)	(.54)	(.50)	(.47)	(.41)	(.46)	(.32)	(.46)	(.36)
Boy	High	.70	.51	.34	.71	.38	.64	-.33	-.25	-.35	-.34	-.32	-.44
		(.30)	(.51)	(.23)	(.33)	(.55)	(.42)	(.44)	(.75)	(.56)	(.42)	(.46)	(.40)
	Low	.72	.63	.37	.75	.79	.77	-.63	-.25	-.42	-.56	-.60	-.48
		(.34)	(.43)	(.21)	(.41)	(.40)	(.29)	(.64)	(.50)	(.50)	(.33)	(.37)	(.40)

[a] Combined across all mathematical situations

[b] 1=positive; 0=neutral; -1=negative

[c] Number of responses too small to analyze

Table 8

Descriptive Statistics
Feelings about Success/Failure by Mathematical Situation[a]

		Feelings about Success[b]						Feelings about Failure[b]					
		of female			of male			of female			of male		
	Grade	6	7	8	6	7	8	6	7	8	6	7	8
Math Situation[c]		Mean (s.d.)	Mean (s.d.)	Mean (s.d.)	Mean (s.d.)	Mean (s.d.)	Mean (s.d.)	Mean (s.d.)	Mean (s.d.)	Mean (s.d.)	Mean (s.d.)	Mean (s.d.)	Mean (s.d.)
Low Level													
	High	.42	.20	.65	.58	1.00	.50	-.50	-.33	-.70	-.76	-.40	-.50
Girl		(.60)	(.79)	(.47)	(.67)	(.00)	(.50)	(.50)	(.58)	(.45)	(.39)	(.74)	(.47)
	Low	.77	.50	.72	.70	1.00	.50	-.42	.00	-.56	-.54	-.42	-.39
		(.29)	(.73)	(.44)	(.46)	(.00)	(.46)	(.66)	(.00)	(.50)	(.39)	(.76)	(.41)
	High	.72	.46	.68	.56	.25	.80	-.38	.00	-.50	-.45	-.35	-.32
Boy		(.39)	(.63)	(.46)	(.54)	(1.06)	(.27)	(.44)	(1.41)	(.50)	(.44)	(.63)	(.56)
	Low	.69	.42	.55	.79	1.00	.90	-.72	.00	.00	-.62	-.46	-.40
		(.37)	(.73)	(.50)	(.45)	(.00)	(.22)	(.70)	(.00)	(.35)	(.40)	(.52)	(.46)
High Level													
	High	.51	.11	.67	.21	.00	.58	-.80	-.40	-.50	-.43	-.50	-.50
Girl		(.71)	(.60)	(.43)	(.81)	(.82)	(.80)	(.45)	(.55)	(.45)	(.42)	(.46)	(.56)
	Low	.76	.67	.67	.69	.44	.56	-.21	-.25	-.56	-.55	-.64	-.44
		(.37)	(.41)	(.56)	(.37)	(.58)	(.42)	(.39)	(.46)	(.56)	(.58)	(.48)	(.46)
	High	.60	.06	.44	.67	.00	.44	-.24	-.25	-.25	-.25	-.20	-.69
Boy		(.63)	(.73)	(.50)	(.47)	(.00)	(.56)	(.69)	(.50)	(.60)	(.55)	(.59)	(.37)
	Low	.70	.44	.82	.64	.67	.75	-.67	.00	-.88	-.41	-.64	-.36
		(.59)	(.73)	(.40)	(.64)	(.58)	(.50)	(.52)	(.00)	(.25)	(.62)	(.45)	(.55)

[a]Combined across all perceived respondents

[b]1=positive; 0=neutral; -1=negative

[c]No spatial questions in this category

Table 9

Analyses of Variance of Responses to Feelings Questions[a]

Perceived Respondent	Grade	Source	F	p≤	d.f.[c]	Group[b]
		Success of Females				
Anyone	7	Conf.	4.56	.04	1,57	Low
Peers	6	Sex X Conf.	4.47	.04	1,43	
		Success of Males				
Individual	8	Sex	5.17	.03	1,50	Girls
Peers	8	Sex X Conf.	3.93	.05	1,52	

[a]Combined across mathematical situations

[b]Group who reported higher positive feeling

[c]d.f. varies because occasionally a question was omitted because of a previous response

Table 10

Success Feelings of Entire Group by Perceived Respondent[a]

Perceived Respondent	Grade	Female Success			Male Success		
		6 mean (s.d.)	7 mean (s.d.)	8 mean (s.d.)	6 mean (s.d.)	7 mean (s.d.)	8 mean (s.d.)
Anyone		.70 (.28)	.54 (.48)	.35 (.22)	.64 (.43)	.55 (.50)	.64 (.43)
Individual		.81 (.25)	.86 (.45)	.94 (.22)	.73 (.43)	.90 (.31)	.44 (.21)
Peers		.20 (.84)	.31 (.67)	.39 (.79)	.31 (.68)	.27 (.80)	.39 (.68)

[a]Combined across all mathematical situations

Figure Captions

Low Level Problems

$3\frac{1}{2}$ $+4\frac{1}{4}$

38 x .4

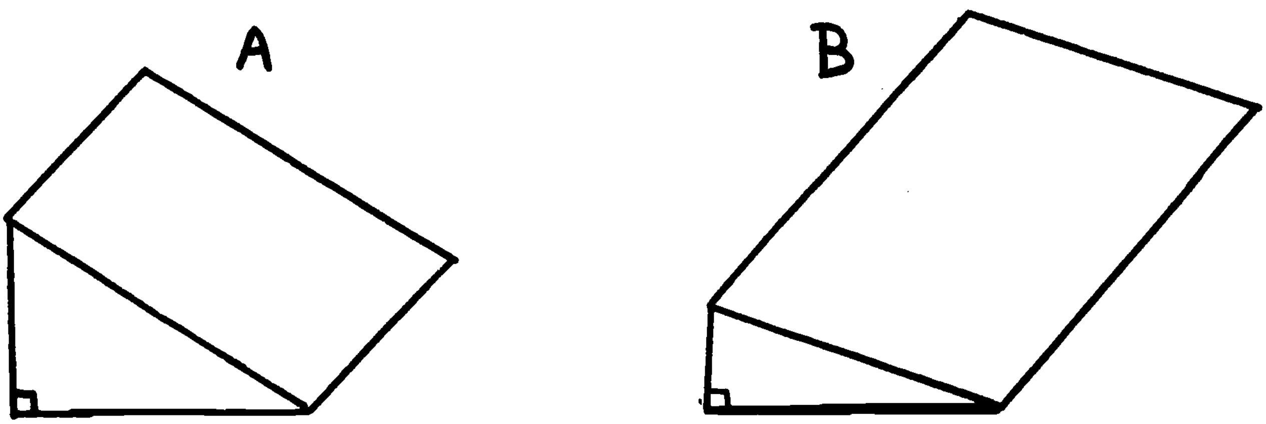
High Level Problems

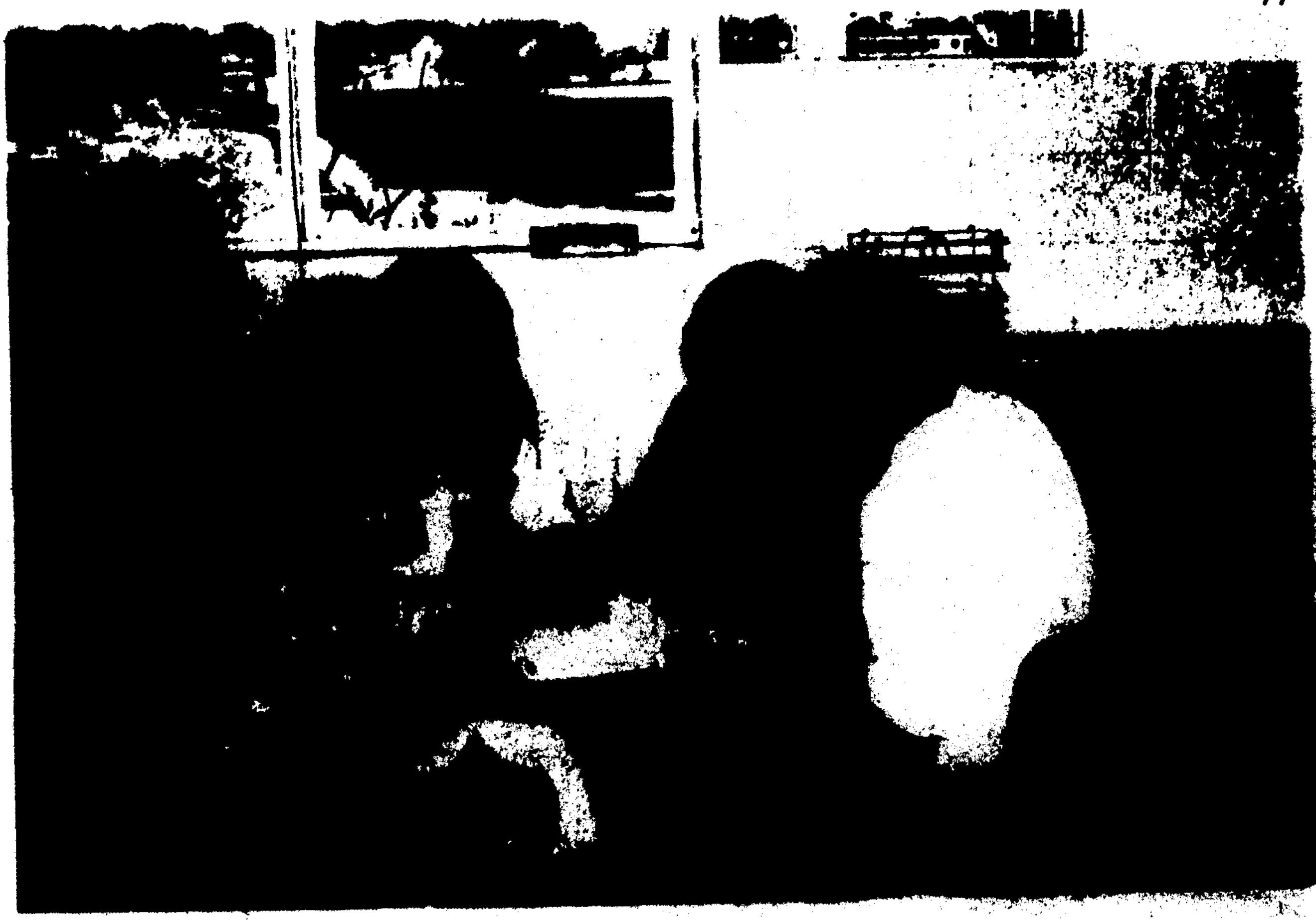
PAT MOWED 1/2 OF THE LAWN BEFORE LUNCH AND 2/5 IN THE AFTERNOON. HOW MUCH DOES PAT HAVE LEFT TO MOW?

THE RAINBOW TELEVISION COMPANY HAS ITS PORTABLE COLOR TELEVISION SETS ON SALE AT 25 PERCENT OFF THE REGULAR PRICE. WHAT IS THE SAVING ON A SET THAT REGULARLY SELLS FOR $390?

Spatial Problem

WEDGE A IS TWICE AS HIGH AND JUST AS WIDE AS B. WEDGE B IS TWICE AS LONG AS A SO THAT A AND B HAVE THE SAME VOLUME. IS THE AREA OF THE BOTTOM OF WEDGE A THE SAME AS THE AREA OF THE BOTTOM OF WEDGE B?



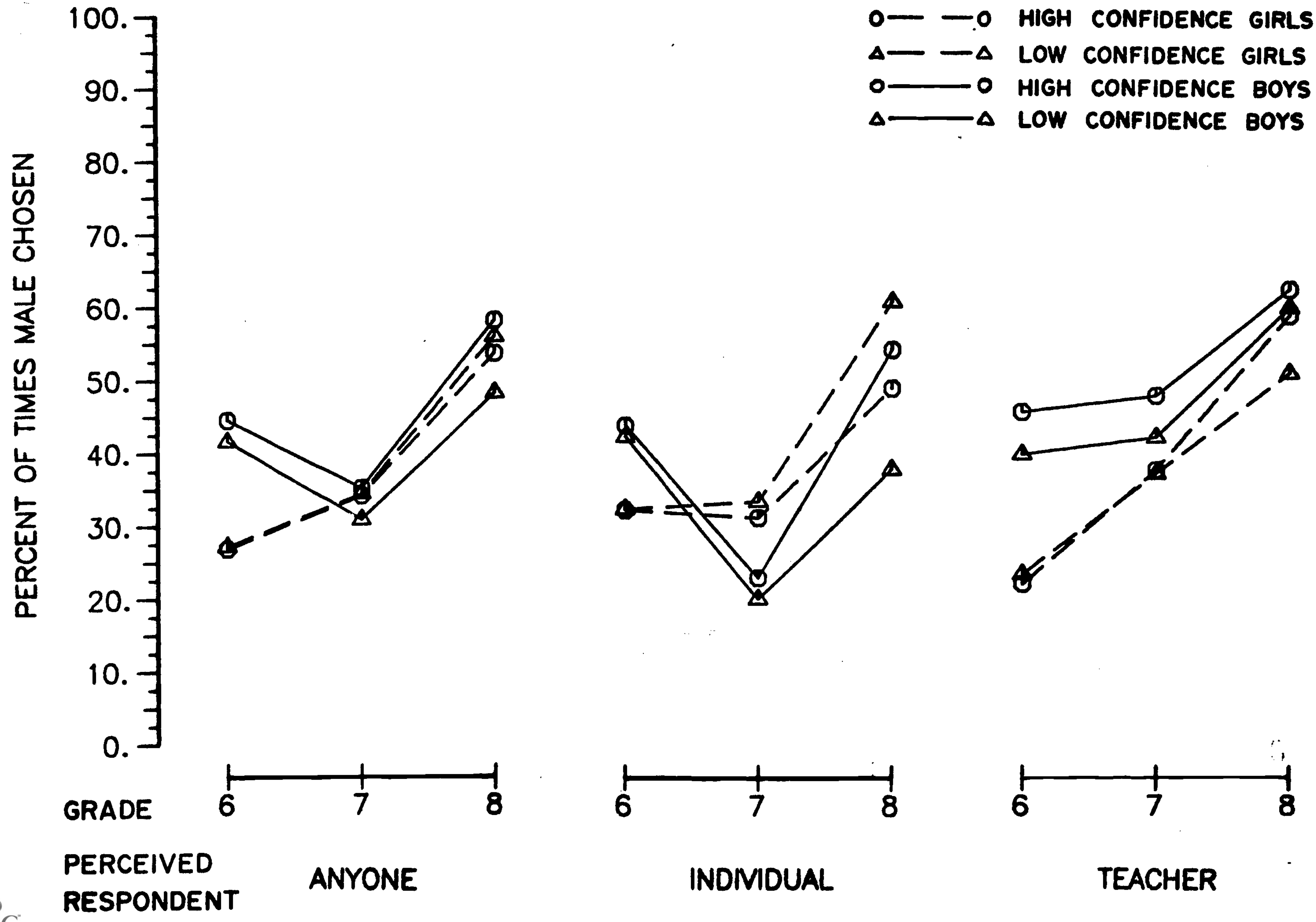


HERE'S PICTURE 3

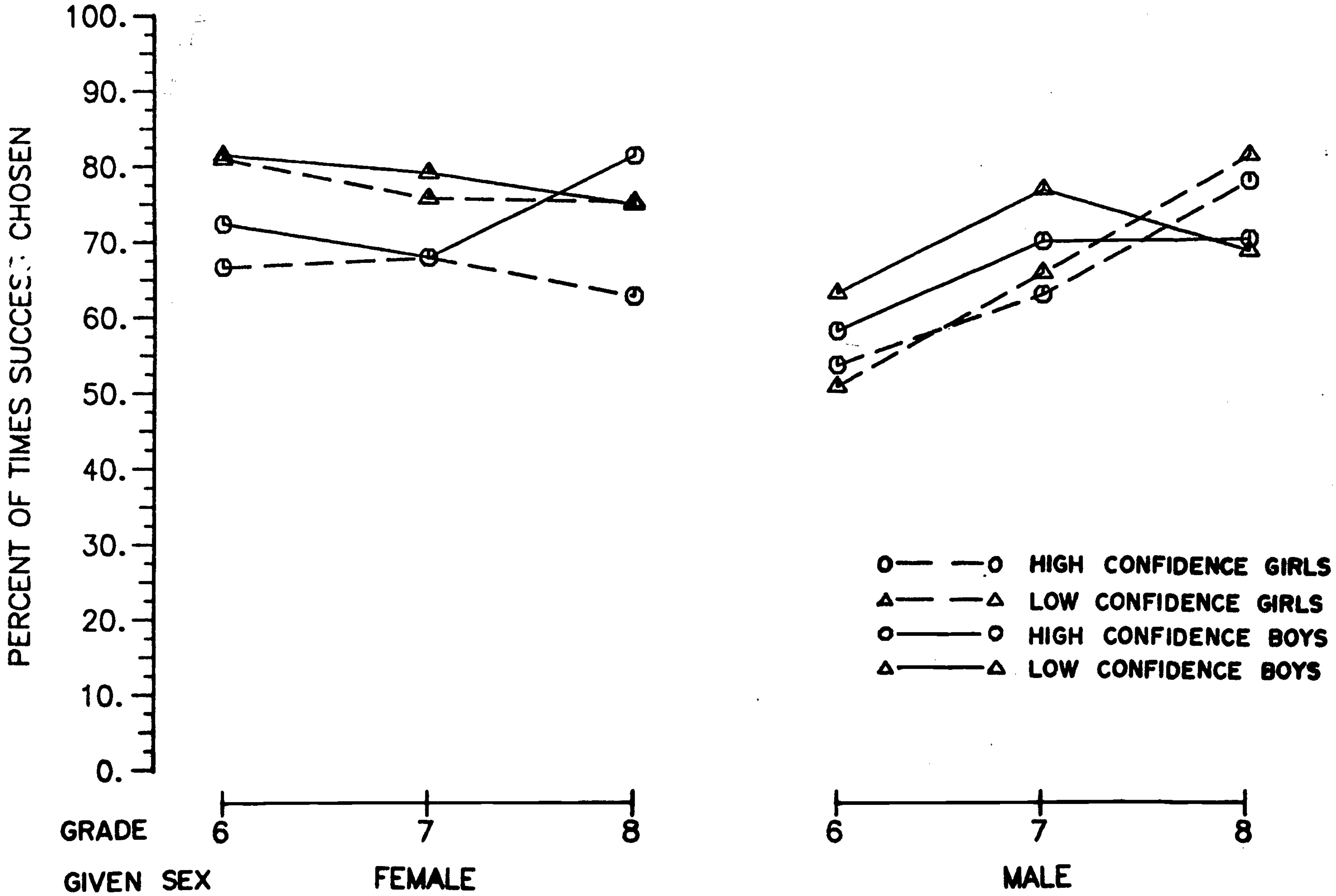
BOTH
3

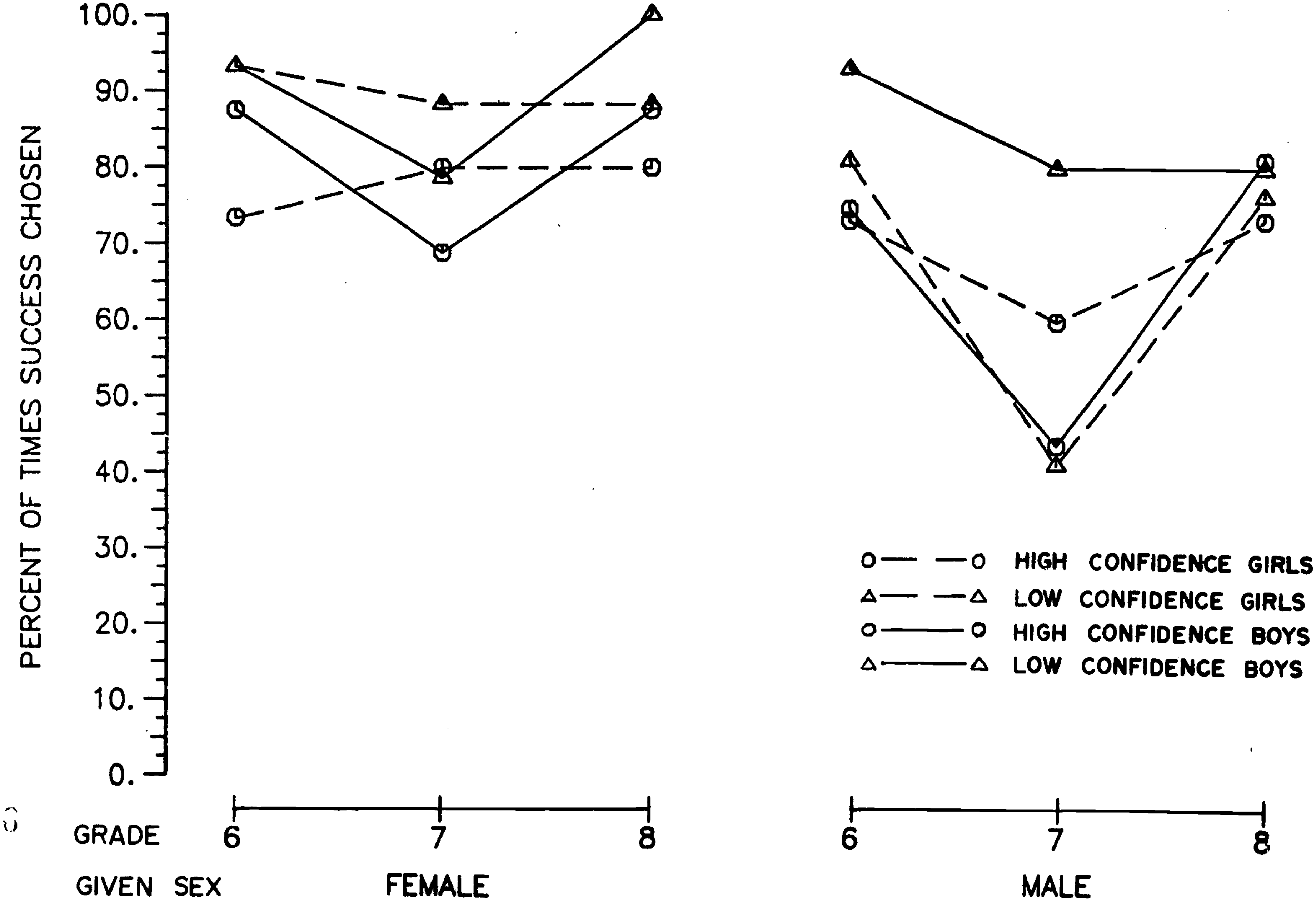
HERE ARE TWO GIRLS AND TWO BOYS LOOKING OVER A MATH TEST.
ONE DID POORLY, TWO DID PRETTY WELL, AND ONE DID VERY WELL.

1. WHICH ONE DID VERY WELL?
2. (Point to student who did best) HOW DOES THE ONE WHO DID WELL FEEL ABOUT HER/HIMSELF?
3. HOW DO THE OTHERS FEEL ABOUT THE ONE WHO DID WELL?
4. WHO DID MOST POORLY?
5. HOW DOES THE ONE WHO DID MOST POORLY FEEL ABOUT HIM/HERSELF?
6. HOW DO THE OTHERS FEEL ABOUT THE ONE WHO DID POOREST?

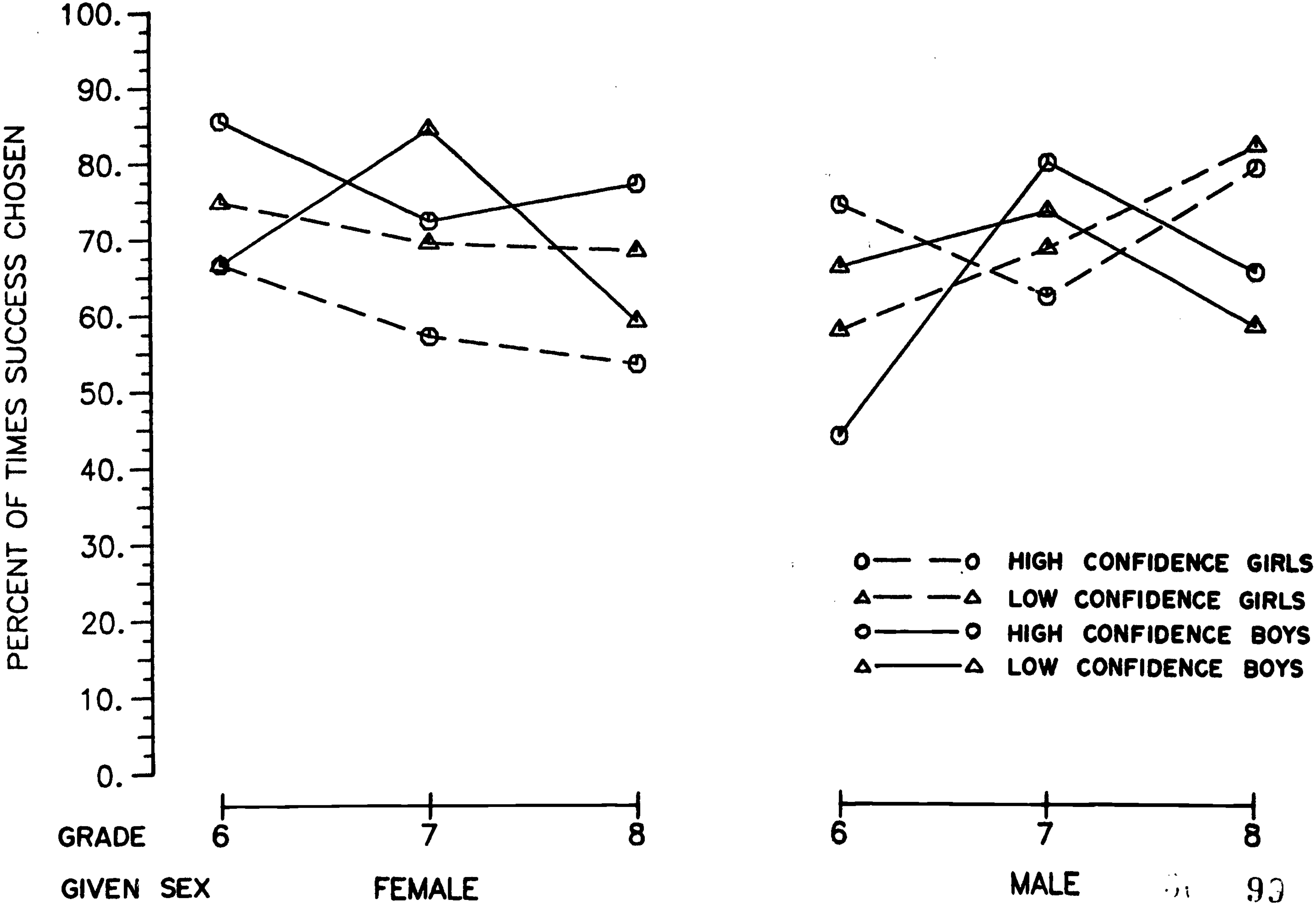


HIGH CONFIDENCE GIRLS
LOW CONFIDENCE GIRLS
HIGH CONFIDENCE BOYS
LOW CONFIDENCE BOYS
PERCENT OF TIMES MALE CHOSEN
100.
90.
80.
70.
60.
50.
40.
30.
20.
10.
0.
GRADE
6
7
8
6
7
8
6
7
8
PERCEIVED RESPONDENT
ANYONE
INDIVIDUAL
TEACHER


100.
90.
80.
70.
60.
50.
40.
30.
20.
10.
0.
PERCENT OF TIMES SUCCESS CHOSEN
HIGH CONFIDENCE GIRLS
LOW CONFIDENCE GIRLS
HIGH CONFIDENCE BOYS
LOW CONFIDENCE BOYS
GRADE 6 7 8 6 7 8
GIVEN SEX FEMALE MALE



PERCENT OF TIMES SUCCESS CHOSEN
100.
90.
80.
70.
60.
50.
40.
30.
20.
10.
0.
GRADE 6 7 8 6 7 8
GIVEN SEX FEMALE MALE
HIGH CONFIDENCE GIRLS
LOW CONFIDENCE GIRLS
HIGH CONFIDENCE BOYS
LOW CONFIDENCE BOYS


100.
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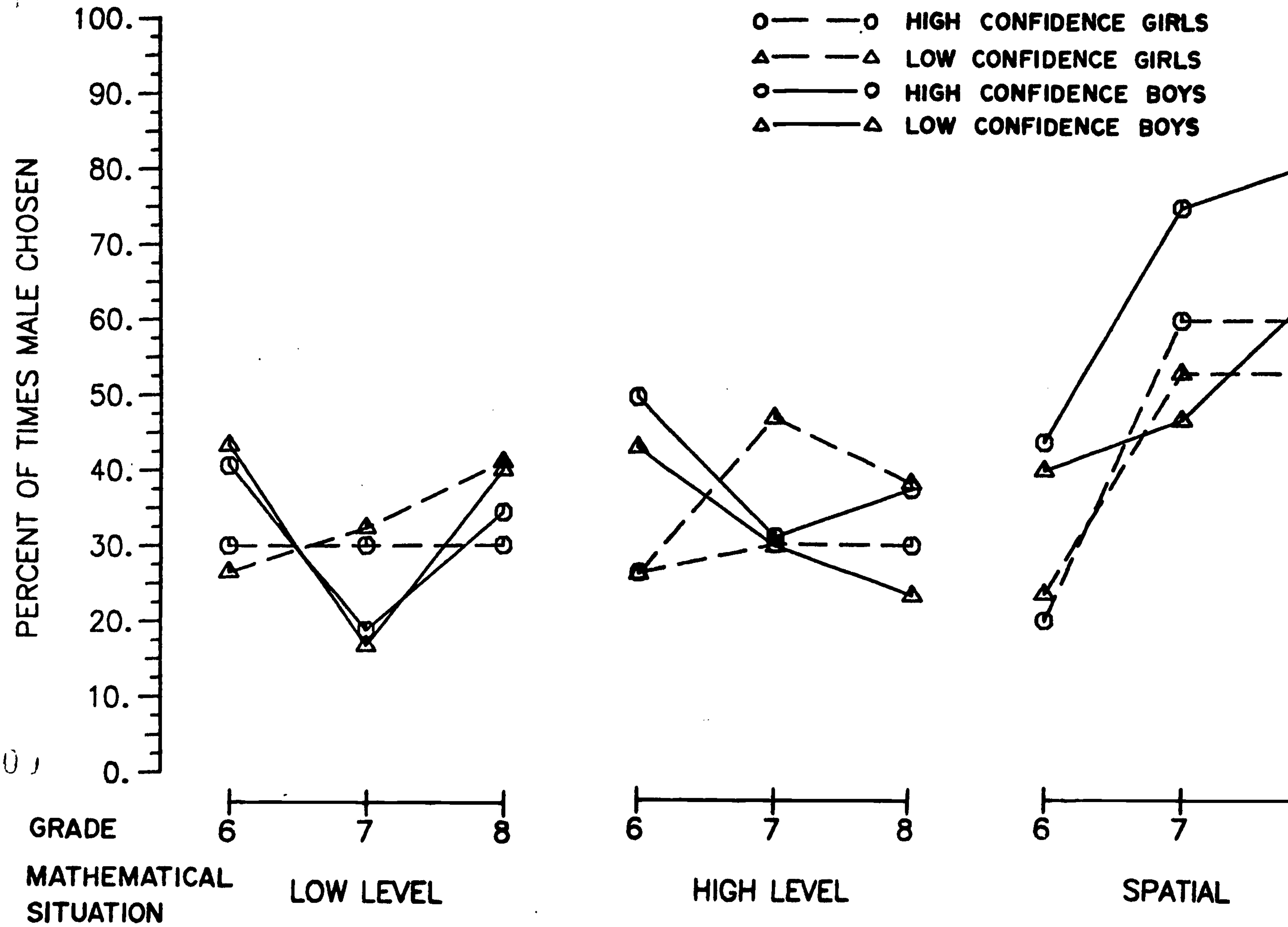
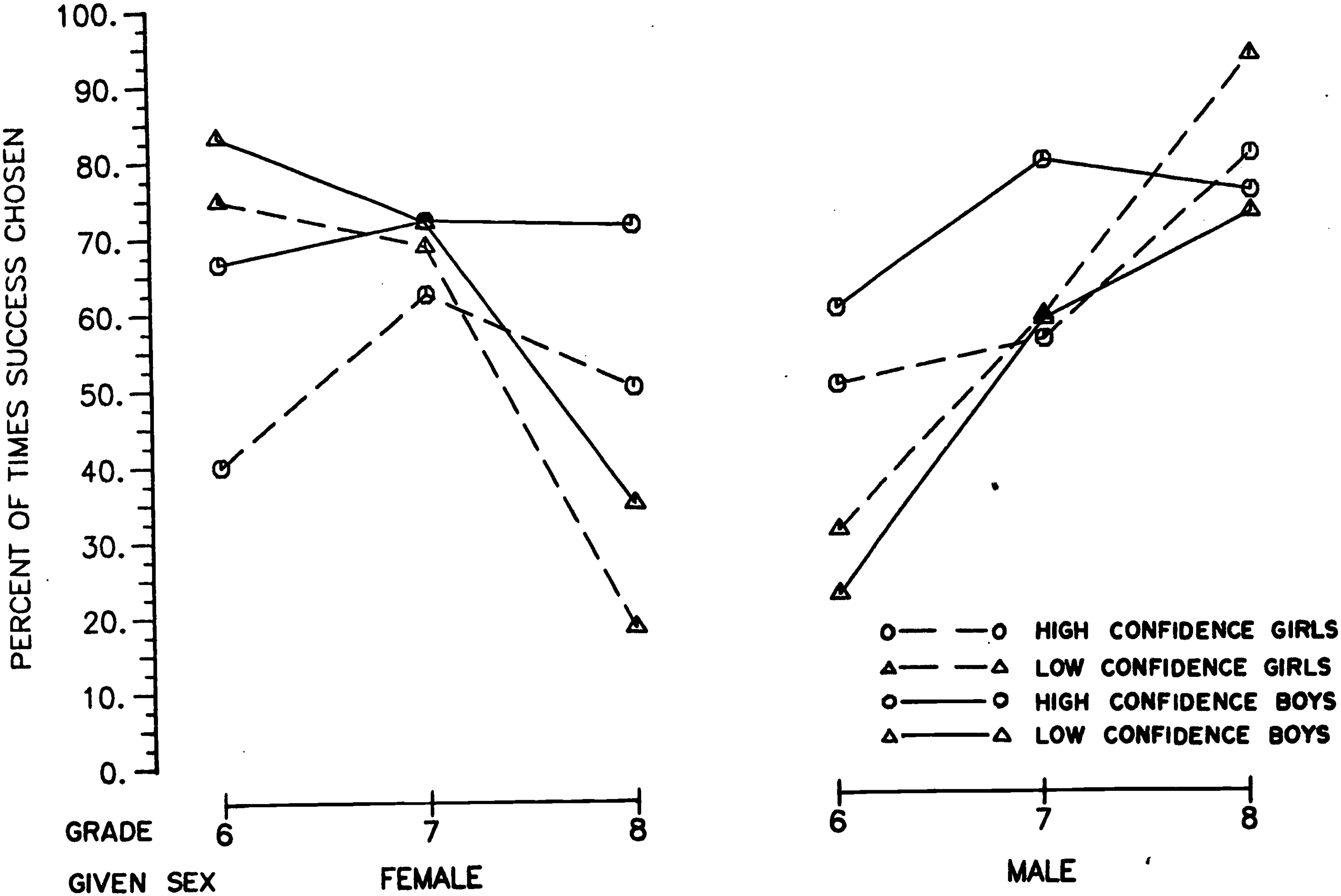
20.
10.
0.
PERCENT OF TIMES SUCCESS CHOSEN
HIGH CONFIDENCE GIRLS
LOW CONFIDENCE GIRLS
HIGH CONFIDENCE BOYS
LOW CONFIDENCE BOYS
GRADE 6 7 8 6 7 8
GIVEN SEX FEMALE MALE


HIGH CONFIDENCE GIRLS
LOW CONFIDENCE GIRLS
HIGH CONFIDENCE BOYS
LOW CONFIDENCE BOYS
PERCENT OF TIMES MALE CHOSEN
100.
90.
80.
70.
60.
50.
40.
30.
20.
10.
0.
GRADE
6
7
8
6
7
8
6
7
8
MATHEMATICAL SITUATION
LOW LEVEL
HIGH LEVEL
SPATIAL


PERCENT OF TIMES SUCCESS CHOSEN
100.
90.
80.
70.
60.
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20.
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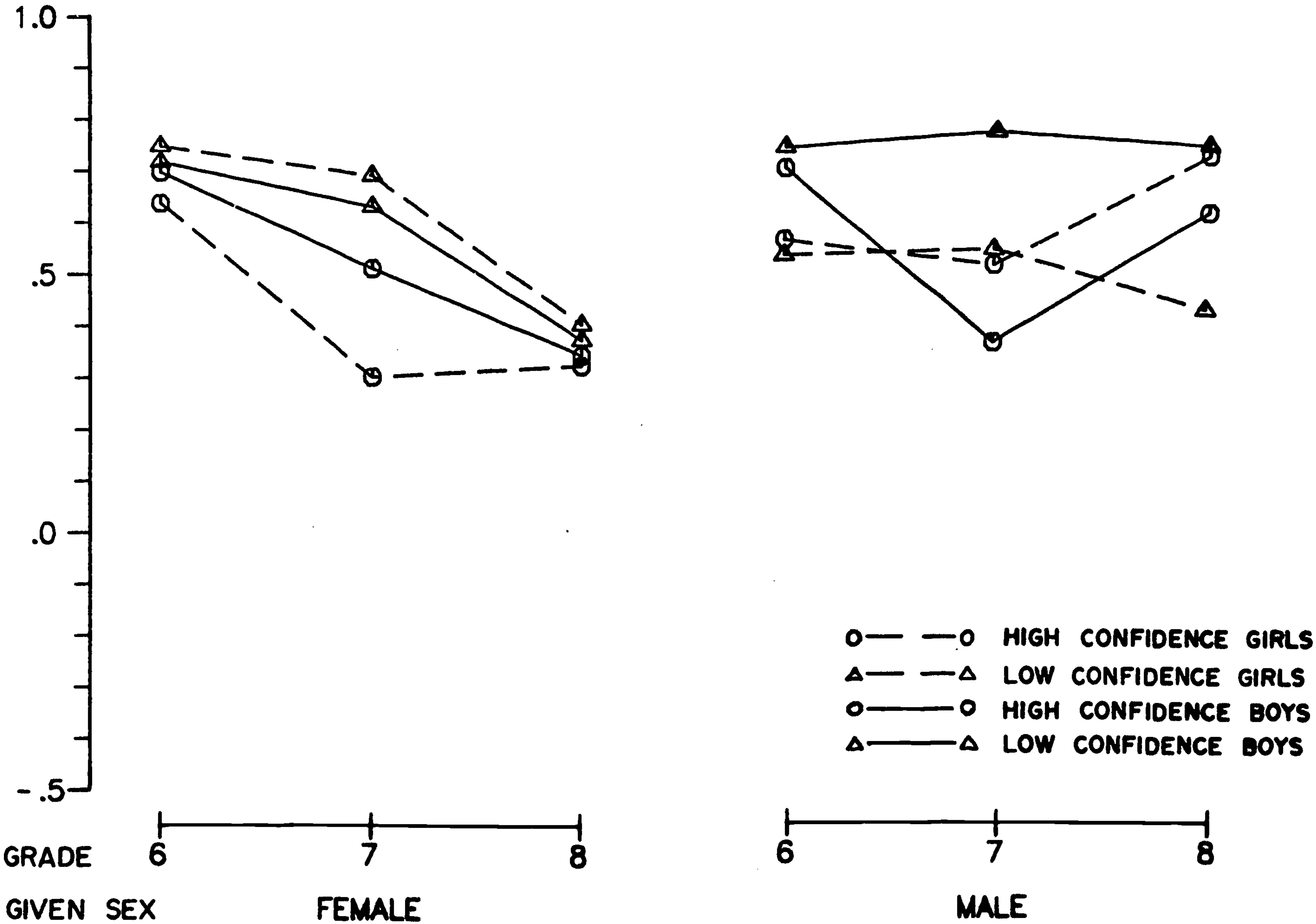
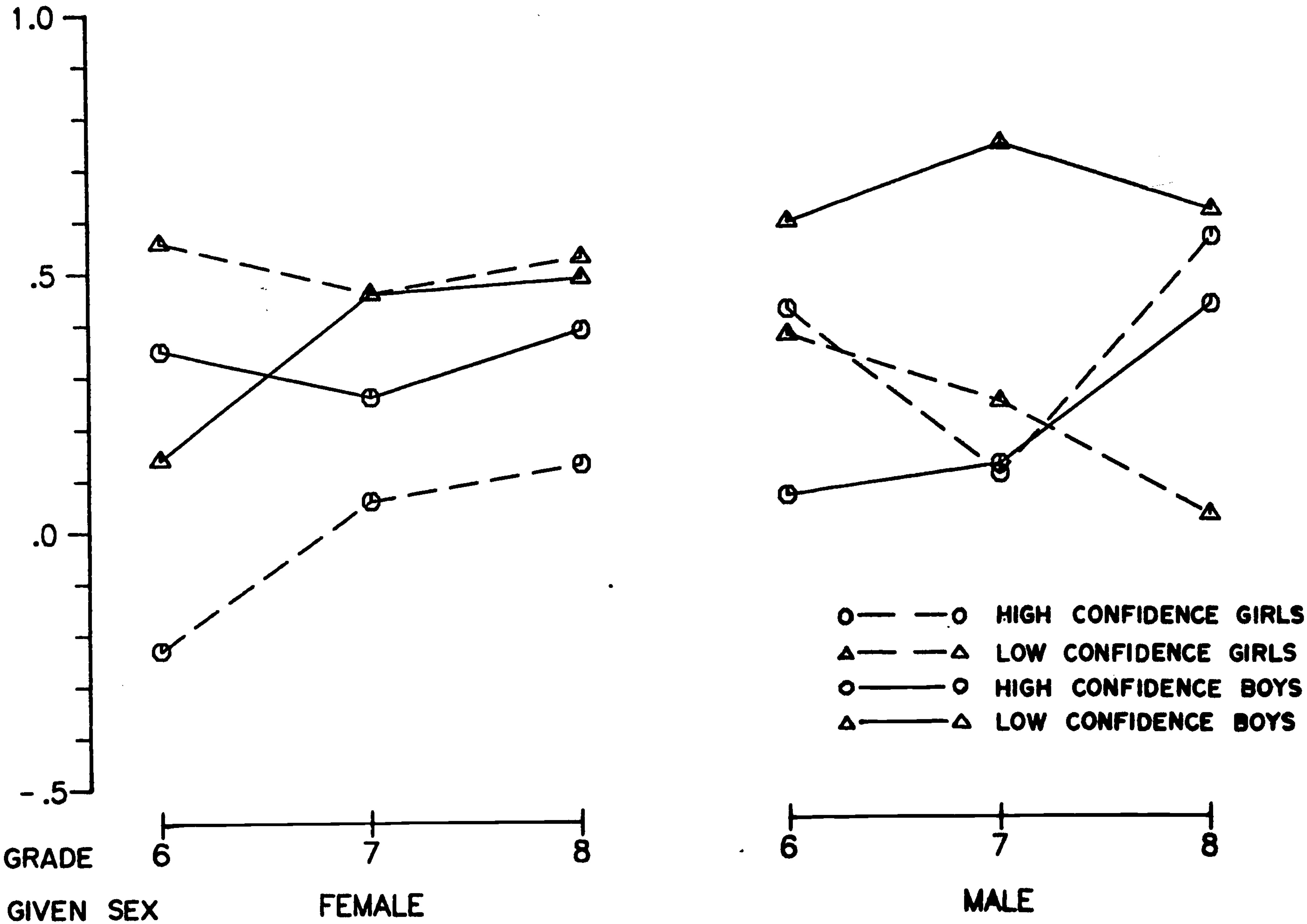
0.
HIGH CONFIDENCE GIRLS
LOW CONFIDENCE GIRLS
HIGH CONFIDENCE BOYS
LOW CONFIDENCE BOYS
GRADE
6
7
8
6
7
8
GIVEN SEX
FEMALE
MALE


1.0
.5
.0
-.5
HIGH CONFIDENCE GIRLS
LOW CONFIDENCE GIRLS
HIGH CONFIDENCE BOYS
LOW CONFIDENCE BOYS
GRADE
6
7
8
6
7
8
GIVEN SEX
FEMALE
MALE

85


1.0
.5
.0
-.5
HIGH CONFIDENCE GIRLS
LOW CONFIDENCE GIRLS
HIGH CONFIDENCE BOYS
LOW CONFIDENCE BOYS
GRADE
6
7
8
6
7
8
GIVEN SEX
FEMALE
MALE

APPENDIX A

Technical Report and Instrumentation of the

Spatial Component

Longitudinal Study

Table of Contents

The Mathematical Thinking Study was designed to explore the relationship between spatial and verbal skills and the solution of mathematics problems worked pictorially. The Instrument to Measure Mathematical Thinking was developed for this three year longitudinal study with middle school students. The specific questions of interest were:

1. How do students translate verbal and symbolic problems into pictorial representations?

2. How do students use pictorial representations in solving mathematics problems?

3. What relationship exists between a student's spatial skill and the use of pictorial representations in solving mathematics problems?

This report describes the following parts of the study:

a. the instruments;

b. the three phases of the interview procedure;

c. the training of interviewers;

d. the transcription of the audio recorded interviews;

e. the variables of interest and the coding of the transcriptions

Description of the Instrument to Measure Mathematical Thinking

The Instrument to Measure Mathematical Thinking consists of two types of mathematics problems: word problems and fraction problems. The problems involve whole numbers and fractions. The problems selected each year were similar in content and level of difficulty to those that students solved in their mathematics classes. A few of the problems were given to the students more than one year of the study to gain information about developmental trends. Many of the problems, however, were new to the students each year. An attempt was made to give problems to students each year which corresponded to those given in their mathematics classes. Sample problems also were given to orient the student to the procedure to be followed during the interview.

A series of three pictorial representations for each problem are included as hints to help in the problem solution. Hint #1 is always the least detailed of the pictorial representations. It shows only the minimum information needed to start to solve the problem. Hint #2 expands Hint #1 and is a more complete pictorial representation of the problem. Hint #3 expands or organizes Hint #2 and includes a representation of the answer. Usually if labels occur (numerals/names) they are found only on Hint #3.

The instruments are included in Appendices A-C. The year I instrument was given to the students in the 6th grade (see Appendix A); the year II instrument to 7th graders (see Appendix B); and the year III instrument to 8th graders (see Appendix C). Some problems to be solved nonpictorially were included in the year I instrument (see Year I Analytic Problems in Appendix D) but were dropped because little information appeared to be generated from them.

Procedure for Administration of the Instrument

The instrument was administered to students in individual structured interviews. The procedure has three phrases for each problem: verbalization of the problem, solution of the problem, and explanation of the solution. An overview of the procedure is described in Figure 1.

The Verbalization Phase

The Verbalization Phase (see Figure 1) is an attempt to get the student to focus on the relevant information in the problem. This phase begins when the student is given a copy of the problem and is asked to read the problem silently. When the student has finished reading the problem silently, the interviewer asks the student to state the problem in his/her own words. The student may respond by repeating the problem verbatum or by giving some general description of the problem. If the student describes the problem incorrectly, the interviewer asks the student to reread the problem and once again try to state the problem in his/her own words. The rereading occurs once and then the interview continues.

The Solution Phase

The Solution Phase (see Fig. 1) is the heart of the instrument. In it, we attempt to discover how the student uses pictures to solve the problem. In this phase of the interview, the student receives a blank piece of paper and is asked to draw a picture and use it to solve the problem. If the student draws a picture one of two things will occur: either the student obtains the correct answer and the interview continues at the Explanation Phase or the student obtains an incorrect answer or no answer and the interviewer removes the student's picture and determines which hint should be given to aid the student. If the student obtains the correct answer with this hint or has been given Hint #3 the interview

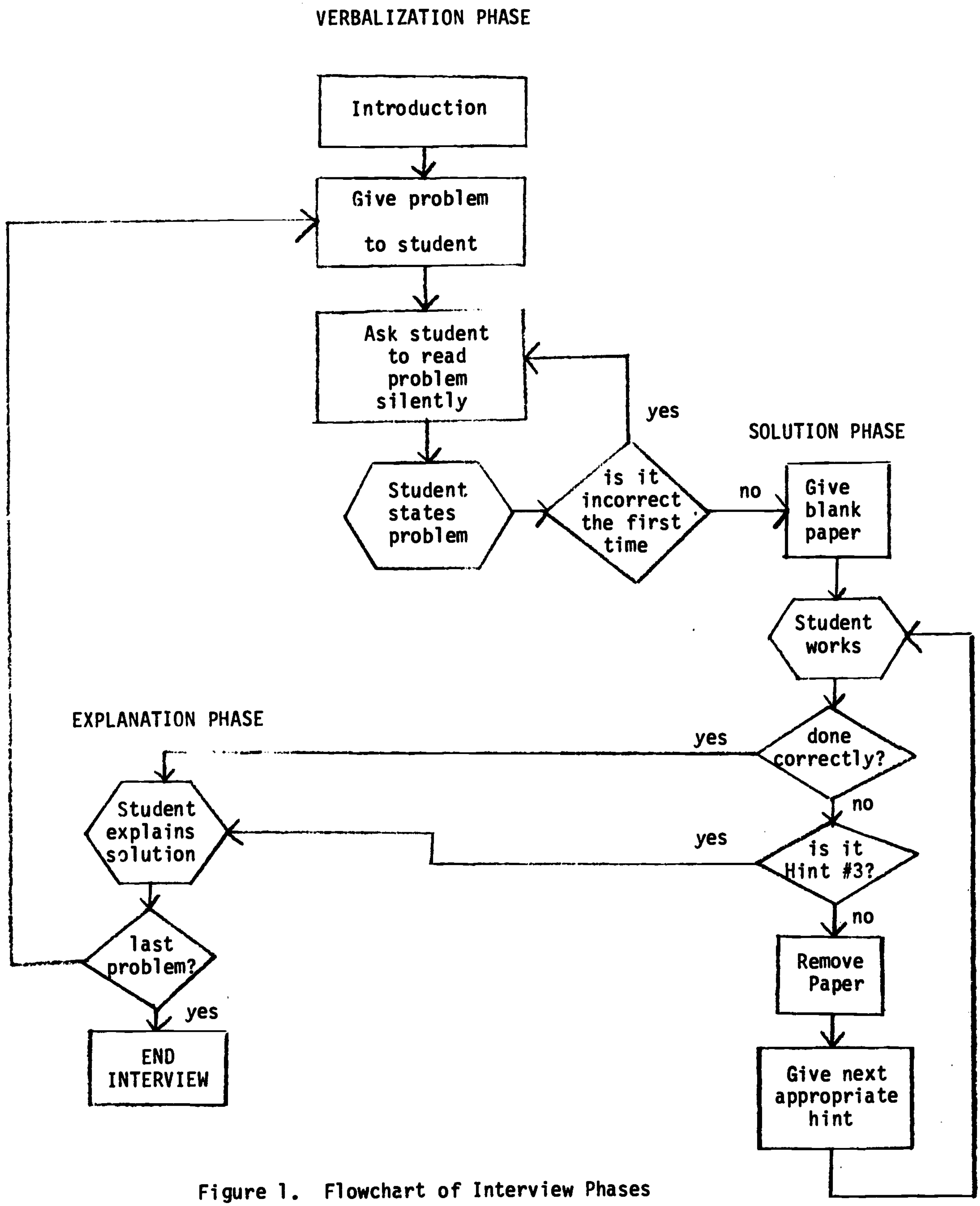


Figure 1. Flowchart of Interview Phases

continues at the Explanation Phase. If the appropriate hint was Hint #1 or Hint #2 and the student is still unable to get the correct answer a more detailed hint is given to the student. This process is continued until the student gets the correct answer or has had an opportunity to try to get an answer with the final hint, Hint #3. If the student cannot draw a picture to get started the blank piece of paper is removed and the student is given Hint #1 and the procedure described above is followed. If the student indicates that she/he knows the answer without drawing anything the student is asked to explain her/his solution and then the interviewer asks the student to draw a picture to solve the problem. The same procedure for giving hints indicated above is followed in this case also.

There are some general guidelines for determining the appropriate hint to give the student. The student is given the lowest numbered hint which is more complete than what the student has drawn or used. If there is more than one possible arrangement of objects every attempt is made to match the arrangement on the hint with what the student has already drawn or used (for example, see the a, b, and c hints for PR5 in Appendix C). Specific guidelines for the use of hints can be found in Appendix E.

The Solution Phase ends when the interviewer is satisfied that the student has obtained the correct solution using a pictorial representation or the student has gone as far as she/he is able to in reaching a solution using the last hint.

Explanation Phase

The Explanation Phase (see Fig. 1) is an attempt to understand more clearly the process the student used to solve the problem. In this phase of the interview, the student is asked to explain his/her solution procedures. If the student has drawn a picture and has the correct solution without the aid of any hints, the interviewer asks the student to explain the picture and how it was used in the solution. If the student used a hint to solve the problem, the interviewer asks the student to explain how she/he used the particular hint in obtaining the solution. If the student does not obtain the correct solution after using the last hint, Hint #3, the interviewer asks the student to explain how she/he tried to solve the problem. After the student has completed the explanation, the interview continues with the next problem. The same procedures are followed for each of the problems in the instrument (see Figure 1).

Because of the desire for consistency among interviewers, it was important that they follow the same procedure and use the same words to ask each question. A Flowchart in Prose Form which describes the specific instructions each interviewer followed can be found in Appendix F.

Training of Interviewers

The training of interviewers was a very important portion of this study. Great care was taken to insure consistency and quality in the interviews. A possible training program for interviewers is offered below (see outline in Appendix G).

First session - orientation to instrument (approximately 2 hours)

The purpose of this session is to orient the interviewers to the problems and hints in the instrument. Each interviewer is given the opportunity to solve each problem. The discussion which follows the solution of each problem centers on the different solutions which are generated as well as others which may not have been used. The use of hints is also explained after each problem. This gives the interviewers an understanding of what the hints are and how to decide which hint to give. The assignment for the next meeting is to read the purpose and procedures involved in this interview. The Flowchart in Prose Form (see Appendix F) is also helpful for interviewers to read.

Second session - procedure orientation (approximately 2 hours)

This session is designed to acquaint the interviewers with the specific procedures involved in the interview. An overview of the purposes and procedures is appropriate at this time. The person conducting the training could work through the procedure several times using the specifics of the problems and perhaps the Flowchart in Prose Form (see Appendix F). The interviewers should then have a chance to practice in pairs with several problems. The Cue Cards for Interviewers (see Figure 2) contain the essence of the procedure and could be used for this practice. The Interviewer Problem Summary Sheet (see Figure 3) was developed to help the interviewers remember the specifics of the problem so they could identify a correct verbalization of the problem. The answers were also provided. This summary sheet was taped to clipboards and used so that the student was unable to see the information on it.

After each interviewer has had the opportunity to use the procedure for several problems, the group could reassemble to discuss questions and problems encountered.

Third session - interviewer's tasks (approximately 2 hours)

This session is designed to explain the written tasks that the interviewer must do and also give any other specific information needed concerning the equipment, the schools and scheduling.

The Interviewer Coding Sheet (see Fig. 4) consists of two main sections. The top of the form is used to record the Student ID number, the Mathematical Thinking Booklet number, the day and time of the interview, and the name (or initials) of the interviewer. The second part of the form

Figure 2. Cue Cards for Interviewers (Year III)

TODAY I'M GOING TO ASK YOU TO WORK SOME MATHEMATICS PROBLEMS. THIS IS THE LAST YEAR OF THE STUDY. YOU HAVE WORKED SOME OF THE PROBLEMS BEFORE. WE ARE INTERESTED IN LEARNING ABOUT HOW STUDENTS YOUR AGE SOLVE MATHEMATICS PROBLEMS. WHATEVER YOU SAY TO ME DURING THE INTERVIEW WILL NOT BE REPORTED TO YOUR MATHEMATICS TEACHER OR ANY OTHER TEACHER OR ANY OTHER PERSON. BECAUSE I WILL BE ASKING YOU CERTAIN QUESTIONS, I'M GOING TO RECORD THE INTERVIEW SO I WON'T HAVE TO TAKE A LOT OF NOTES. I'LL GIVE YOU TWO SAMPLE PROBLEMS AND EXPLAIN WHAT I WANT YOU TO DO USING THE SAMPLE PROBLEMS.

2 2nd sample explanation:

THIS THIRD HINT SHOWS A CIRCLE WITH 3/4 OF IT SHADED AND ANOTHER CIRCLE WITH 1/2 SHADED. TO FIND THE ANSWER, WE TAKE A PIECE THE SIZE OF THE HALF AWAY FROM THE 3/4 (point to 2/4 of the 3/4 shaded) LEAVING THIS SMALL PIECE (point to the 1/4 left) WHICH IS 1/4. DO YOU UNDERSTAND?

1st sample explanation:

THIS THRID HINT SHOWS A RECTANGLE REPRESENTING THE GARDEN AND BLACK DOTS REPRESENTING THE POSTS PLACED 2 FEET APART. WHEN WE COUNT THE DOTS, WE FIND THAT THERE ARE 10 POSTS AROUND LOU'S GARDEN. DO YOU UNDERSTAND?

3

I WANT YOU TO READ THE PROBLEM SILENTLY, JUST READ IT, DON'T TRY TO SOLVE IT. WHEN YOU HAVE FINISHED READING IT, TURN THE PAPER OVER.

NOW, TELL ME THE PROBLEM.

HERE'S A BLANK PIECE OF PAPER. I WANT YOU TO DRAW A PICTURE TO SOLVE THE PROBLEM.

OKAY, LET ME GIVE YOU A HINT. HERE'S HINT ___ : TRY TO USE IT TO SOLVE THE PROBLEM.

5 PLEASE TELL ME YOUR ANSWER.

a) GOOD, PLEASE TELL ME WHAT YOUR PICTURE SHOWS AND AND HOW YOU USED IT TO SOLVE THE PROBLEM.

b) GOOD, PLEASE TELL ME HOW YOU USED HINT ___ TO GET THAT ANSWER.

c) ALRIGHT EXPLAIN TO ME HOW YOU TRIED TO SOLVE THE PROBLEM.

6

The Procedure

a) READ THE PROBLEM SILENTLY.

b) TELL ME THE PROBLEM IN YOUR OWN WORDS.

c) DRAW A PICTURE AND USE IT TO SOLVE THE PROBLEM... HINTS WILL BE GIVEN WHEN NECESSARY, BUT IT IS IMPORTANT THAT YOU TRY TO DRAW A PICTURE.

d) ALRIGHT, EXPLAIN TO ME HOW YOU TRIED TO SOLVE THE PROBLEM.

Figure 3. Interviewer Problem Summary Sheet (Year III)

SP1. LOU'S GARDEN, 6 FT. LONG 4 FT. WIDE, POSTS 2 FT. APART. HOW MANY POSTS ?

ANS: 10 POSTS.

SP2. 3/4 - 1/2 =

ANS: 1/4

PR1. RUBBER BALL, REBOUNDS ½, DROPPED FROM 100 FT., HOW FAR TOTAL THE 4th TIME?

ANS: 275 FEET

SY2. 5 x 1/3 =

ANS: 5/3 or 1-2/3

PR3. MIKE AND PETER, FOUND ½ CAKE, MIKE ATE ½ THERE, PETER ATE 1/3 LEFT. HOW MUCH OF WHOLE CAKE LEFT?

ANS: 1/6 OF CAKE

PR4. POST 25 FT. LONG, INTO RIVER BOTTOM, 8¼ FT. BELOW BOTTOM, 3-3/4 FT. ABOVE SURFACE. HOW DEEP IS RIVER?

ANS: 13 FEET

PR5. BUS SEATS 60, 1 OUT OF 5 EMPTY, HOW MANY PASSENGERS ON BUS?

ANS: 48 PASSENGERS

MODELS:

a) 5x12 b) 4x15 c) 6x10

SY6. 1-1/3 - 1/2=

ANS: 5/6

PR7. PAT STARTED CAKE AND LAUNDRY AT SAME TIME. CAKE BAKED 35 MIN. DONE 6:00, LAUNDRY TAKES 1¼ HRS. WHEN IS IT DONE?

ANS: 6:40

HINTS: a) 35 1st b) 1¼ 1st

SY8. 5/6 +2/3 =

ANS: 1½

PR9. 4 PEOPLE PIZZA. ONE 1/3 AND LEFT, REMAINING DIVIDED EQUALLY AMONG 3. HOW MUCH OF WHOLE PIZZA EACH GET?

ANS: 2/9 OF PIZZA

SY10. 3/8 + 3/4 =

ANS: 1-1/8

PR11. PAPERS TO 4-STORY WITH 40 APARTMENTS. 3 OUT OF 5 GET PAPER, HOW MANY PAPERS RECEIVED DAILY?

ANS: 24 NEWSPAPERS

MODELS:

a) 5x8 b) 4x10

PR12. SQUARE 3 IN. LONG CUT FROM CORNERS OF RECTANGULAR CARDBOARD 12 IN. WIDE, 18 IN. LONG. FOLDED UP, MAKE BOX, WHAT IS PERIMETER (How far around) OF BOTTOM OF BOX?

ANS: 36 INCHES

Student ID.________________ Mathematical Thinking Booklet________________

Date:________________ Time:________________ Interviewer:________________

Problem	Hint Sequence	Correctness	Use of Picture	Arrangement and Comments
	B 1 2 3	Yes No	High (Pictorial) Medium (Both) Low (Computational)	
	B 1 2 3	Yes No	High (Pictorial) Medium (Both) Low (Computational)	
	B 1 2 3	Yes No	High (Pictorial) Medium (Both) Low (Computational)	
	B 1 2 3	Yes No	High (Pictorial) Medium (Both) Low (Computational)	
	B 1 2 3	Yes No	High (Pictorial) Medium (Both) Low (Computational)	
	B 1 2 3	Yes No	High (Pictorial) Medium (Both) Low (Computational)	
	B 1 2 3	Yes No	High (Pictorial) Medium (Both) Low (Computational)	
	B 1 2 3	Yes NO	High (Pictorial) Medium (Both) Low (Computational)	
	B 1 2 3	Yes No	High (Pictorial) Medium (Both) Low (Computational)	
	B 1 2 3	Yes No	High (Pictorial) Medium (Both) Low (Computational)	
	B 1 2 3	Yes No	High (Pictorial) Medium (Both) Low (Computational)	
	B 1 2 3	Yes No	High (Pictorial) Medium (Both) Low (Computational)	

Figure 4. Interviewer Coding Sheet

identifies the problems (number), gives the order of the problems, the sequence of hints used, correctness of numerical answers, level of picture use in the solution, model or arrangement of the student drawing (specific to some problems), and comments.

Each student is given a different random order of problems. This order is recorded on the outside of the booklet and in the first column of the Interviewer Coding Sheet.

In the Hint sequence column the B (for blank) is circled when the blank paper is given to the student. If the student DOES NOT draw a picture, 'B' is crossed out (~~B~~). Other hint numbers are circled as the hints are given during the interview. If a hint is NOT given of the student, the number is crossed out. When each problem is completed by the student, the correctness of the solution is indicated by circling either 'yes' or 'no'.

The Use of Picture category is completed by circling the appropriate response immediately after the student has finished the explanation of the solution. This category classifies whether the solution was described as being primarily pictorial, primarily computational or a combination of both methods.

High (Pictorial) is usually characterized by some indication by the student of mental manipulation of parts of the picture. (Example: [Pictorial explanation - "I split the pie in half and then I split it again in half. Then I colored in one of those fourths because that's what Mike ate. Then I split the other fourth up into 3 pieces and saw that it would never work out unless I put all those lines in. So I put in all those lines and then I colored in another piece for Peter. There was only these two left. Since there are twelve pieces, all the way around their are 2/12 left or 1/6."

Low (Computation) is usually characterized by the use of primarily symbolic or algorithmic means to solve the problem. (Example: [Symbolic explanation. "Mike ate 1/4 of the whole cake, leaving 1/4. 1/3 of 1/4 is 1/12 so there is 2/12 left or 1/6."]) This method is to be actively discouraged by the interviewer because of the desire to observe the use of picture in the solution, but sometimes the student persists anyway.

Medium is indicated by use of both methods. (Example: [Medium explanation: "Here is the half that's left. Mike ate 1/2 of that or 1/4 of the whole cake. This piece which is 1/3 of the 1/4 that's left is 1/12 because 12ths is the common denominator. So 2/12 or 1/6 is left."])

Interviewers were asked to code this category for two reasons. First, because the interviewers were there during the solution process, it was considered important that their perspective of the solution process be represented. Second, having the interviewers code this category helped them understand the kind of information sought and therefore make sure that the student's explanation of the solution was clear. It was felt that having the student talk more about her/his solution process would result in more accurate coding of the transcription of that solution.

The last column on the Interviewer Coding Sheet contains two kinds of information. For some of the problems, the students may draw a rectangular array to represent the problem. For example, in PR5, the students may use an array to represent the seats on a bus (see Appendices A-C). The interviewer is to write in the last column the kind of pattern the student draws. For PR5 (Year III) the choices are: 60X1, 30X2, 20X3, 15X4, 12X5, 10X6, other (some other discernable pattern) or random (no discernable pattern). Any other comments which owuld assist in understanding the student's solution process are also included in the space provided for each problem.

The interviewers can practice filling out the Interviewer's Coding Sheet using a sample transcript (see Appendix H).

This session also orients the interviewers to the equipment that they will use. They need to become familiar with the tape recorder, microphone, the schedule, tapes, stapler, pens, etc. Working in pairs, the interviewers can practice several problems with all the necessary equipment.

After each interviewer has had an opportunity to practice, discussion of the Specific Directions Prior to Interview (see Figure 5) is appropriate. Before the next session, each interviewer should have an opportunity to practice using the instrument with a student of the appropriate age.

<u>Fourth session</u> - discussion of first practice (approximately one hour)

This session is designed to allow the interviewers to discuss their first practice interview. For the next session, each interviewer should practice with two students of the appropriate age. The trainer of interviewers should listen and critique the first tapes before the fifth session.

<u>Fifth session</u> - discussion of second practice (approximately one hour)

This last session as a group is an opportunity for the trainer to provide feedback and suggestions after hearing the first tape. The interviewers can also ask any other questions which have arisen since the fourth session. Individual meetings between trainer and interviewers are also set up at this time. Before those individual meetings (one or two as needed) the interviewer should practice with a student of the appropriate age. The trainer should listen and critique the second practice tapes before the individual meetings.

A. Assemble Instrument to Measure Mathematical Thinking

1. Record order of problems on cover and the Booklet number corresponding to that order

2. Put problems in specified random order with blanks and hints. Use paper clips.

B. Prepare Tape

1. Write the student's ID number on the tape.

2. Write the school, the date, and your initials on the tape. Example:
   a. MT 5231 c. 6/10/79
   b. Marquette d. M.A.K.

C. Confirm Field Arrangements

1. Check with our staff interview coordinator regarding the contact person at the school.
   a. Where you should meet student
   b. What student should do at the end of the interview
   c. Where you should put your materials (if you are doing more than Mathematical Thinking Interview)

2. Check on school, student's name, scheduled date, and time of interview

D. Verify Equipment

1. Before leaving office
   a. Check equipment is in working order
   b. Bring tape recorder with cord for electric outlet
   c. Bring microphone
   d. Bring Mathematical Thinking Instrument - pencils, erasers, extra blank papers, extra problems and hints

2. Before starting interview
   a. Check equipment is in working order
   b. Check microphone is "plugged" completely into socket
   c. Check that tape has passed the "lead".

3. During Interview
   a. Keep materials neat
   b. Keep hints and summary sheet out of sight of student
   c. Staple each problem together. Include the following in order:
      1. the problem
      2. the student's drawing on the blank paper
      3. last hint seen
      4. other hints used

E. Returning completed interview

1. Put your initials and date on verification list

2. Put completed instrument and rewound tape in envelope. Put ID and date on envelope

3. Leave in box for transcriber

Figure 5. Specific Directions Prior to Interview

Individual meetings - These meetings are set up to provide time for interviewers to meet individually with the trainer. More specific feedback and suggestions can be given by the trainer in these one-to-one meetings.

Transcriptions

The audiotapes of the interviews were transcribed by problems using forms of the type in Figure 6. Each problem solution was put on a separate page with the problem identified at the top of the page. The transcribers were instructed to type every word spoken. They were told that it was very important that they listen very carefully to make sure that nothing was left out. The student's words were typed using only capital letters to differentiate them from those of the interviewers. Information about the interview (i.e., student number, booklet number, interviewer, and when and by whom it was transcribed) was also included at the top of each page.

PR3. When Mike and Peter came home from school, they found half of a chocolate cake. Mike ate half of what was there and Peter at a third of what Mike had left. How much of the whole cake was left after Peter ate his piece?

Student #:______________ Booklet #:______________ Interviewer:____________

Transcribed: Date:____________ By:____________ Page_____ of _____

Figure 6. Transcription Form

Coding of Individual Categories

Each year coding of the transcripts was accomplished by two people. Each person coded transcripts which included a representation of each of the groups under study.

For each transcript coded, the problems were separated into two groups: Word problems and Fraction problems. The Word problems were those which were written in prose form (i.e., A bus has seats for 60 passengers. If one out of every five seats is empty, how many passengers are on the bus?). The Fraction problems included those problems given to the students using only mathematical symbols (i.e., 5/6 + 2/3 =).

Word Problems

The categories for coding the word problems are in four groups: Information from the Verbalization Phase, Information from the Translation Picture, Information from the Solution Picture, and other Information from the Transcript or Interviewer's coding. For the information specific to each problem, see Appendix I.

Information from the Verbalization Phase: This is coded from that part of the transcript which represents the student's oral explanation of the problem.

Verbal Non-numerical Completeness: classifies whether or not the student has indicated all of the relevant non-numerical problem information in the oral translation of the problems. The possible codings are complete or incomplete.

Verbal Non-numerical Data Transformed: classifies whether the non-numerical data has been transformed by changing the perspective of the problem which leaving it logically correct. The possible codings are as stated or transformed.*

Verbal Numerical Completeness: classifies whether or not the student has indicated all of the relevant numerical problem information in the oral translation of the problem. The possible coding are complete or incomplete.

Verbal Numerical Placement: classifies whether or not all of the relevant numerical information has been matched correctly with the appropriate objects (non-numerical data). The possible codings are all appropriately placed or not all appropriately placed.

Verbal Question Correctness: classifies whether or not the oral statement of the question is correct. The possible codings are completely correct or not completely correct.

Verbal Question Transformed: classifies whether or not the oral statement of the question has been transformed by the student. A question has been transformed when it is logically equivalent to the original question but is looking from a different perspective or for something different (For example, "How much pole is in the water?" rather than "How deep is the river" for problem PR4).

Information from the Translation Picture: This is coded from what the student has drawn on the blank sheet of paper. It represents the student's attempt to translate the problem into some kind of pictorial representation.

Translation Picture Non-numerical Completeness: This measures the amount of relevant non-numerical data included in the student's translation picture. Relevant information consists of that information necessary to

*An example of transformed from PR5 Year I is: "Okay. They want you to figure out like if, out of every, well, what it said was out of every four if you take one row, if you only have one sittin' there, and you take away the other three, how many do you have altogether. So they want you to take three out of every four on there, and then add up the total of how many would be on there."

represent the problem pictorially. The possible codings are complete information, some information, minimum information, no information (for more specific information, see below).

# of items possible in picture	Coding of include following number of items complete	some	minimum	none
2	2	1	0	0
3	3	2	1	0
4	4	2,3	1	0
5	5	4,3	1,2	0

Translation Picture Non-numerical Relation: This indicates the degree to which a non-numerically complete picture shows an accurate spatial representation of the appropriate mathematical relationship among the non-numerical parts of the problem. Relation with metric indicated some kind of reasonably accurate measurement is also included. The possible codings are no relation, relation, relation with metric.

Translation Picture Numerical Completeness: This measures the amount of relevant numerical data included in the student's translation picture. The numbers must appear in words or symbols, but may appear anywhere on the paper and need not be labels on the picture. If there are only two pieces of numerical data, the possible codings are none or some. If there are more than two pieces of numerical data, the possible codings are none or one piece of numerical data, or more than one piece of numerical data.

Translation Picture Numerical Placement: This classifies whether or not the translation picture are positioned to label the appropriate part of the picture. The possible codings are all correctly placed or not all correctly placed.

Information from the Solution Picture: The Solution Picture is the last picture or hint that the student had before explaining her/his solution. It can be the same as Translation Picture if the correct solution is obtained from the translation picture. Otherwise it is the highest numbered hint given to the student.

The same four categories are coded for the Solution Picture as were coded for the Translation Picture. The codings are based on the amount of relevant information available either already on the hint or drawn by the student.

Other Information from the Transcript or Interviewer's Coding

Information for coding is obtained either from the Explanation phase or the problem transcript or from the Interviewer Coding Sheet.

Evidence of Mental Movement: classifies whether or not the student's explanation of the solution indicates that the student moved objects in the problem mentally. The motion must be more than is described in the problem or drawn in the picture. An example would be: "I picked this piece up and moved it over here with this other part." The possible codings are no mental movement or mental movement indicated.

Use of Picture: classifies whether or not the student used the picture to solve the problem as indicated by the explanation of his/her solution. The medium Use of Picture coded by the interviewer was combined with high Use of Picture in the coder's assessment of Use of Picture making the possible codings by the coder not pictorial solution or pictorial solution. For examples, see the section on coding Use of Picture under Training (p. 7).

Correctness: This classifies whether or not the student's solution of the problem is correct. The possible codings are incorrect or correct.

Hints: This describes the specific hint sequence given to the student for each problem. The possible codings are no hints given, only hint 1 given, only hint 2 given, only hint 3 given, hints 1 and 2 given, hints 1 and 3 given, hints 2 and 3 given, or all hints given. This information was obtained from the Interviewer's Coding Sheet (See Figure 4).

Highest hint - classifies which hint was the final or highest numbered hint used by the student in the solution of the problem. The possible codings are no hints given, hint 1 last, hint 2 last or hint 3 last.

Problem order - classifies the order in which each word problem was presented to the student Year III there were 8 word problems so the possible codings are 1, 2, 3, 4, 5, 6, 7, or 8. This information was obtained from the Interviewer's Coding Sheet.

Model - classifies the rectangular arrangement the student used in her/his Translation Picture. It is only coded for some of the problems. Year III it only applied to PR5 and and PR11. The possible codings are as follows:

- PR5 -- 1x60, 2x30, 3x20, 4x15, 5x12, 6x10, other (not random), or random.

- PR11 -- 1x40, 2x20, 4x10, 5x8, other (not random) or random.

(for more on this category see Training, p. 7).

Fraction Problems

The categories for coding the Fraction problems are in four groups: Information from the Verbalization Phase, Information from the Translation picture, Information from the Solution Picture, and other Information from the Transcript or Interviewer's coding.

Information from the Verbalization Phase

Translated into story: This indicates whether or not the student translated the information in the problem into a story. The possible codings are not translated or translated into story.

Verbal Numerical Completeness: This assesses whether or not the student stated completely both fractions in the problem. The possible codings are complete or incomplete.

Aware of Result: This assesses whether or not the student gives evidence orally that there will be a consequence of operating on the fractions. This is usually indicated by saying "equals" or "to get an answer." The possible codings are aware or not aware.

Order of Presentation - This classifies whether the student has stated the fractions in the order given in the problem or has stated them in the reverse order. The possible codings are not transformed or transformed.

Information from the Translation Picture

Translation Picture Pictorial Common Denominator - This assesses whether or not the student has represented an appropriate common denominator on the translation picture. The possible codings are no common denominator or common denominator shown. This category is automatically coded no common denominator if the problem involves multiplication or division of fractions.

Translation Pictures Symbolic Operation - This classifies whether or not the mathematical operation symbol appears appropriately on the picture. It must be shown between the two pictorial representations of the fractions. The possible codings are no operation or operation shown. This category is automatically coded no operation if the problems involves multiplication or division of fractions.

Translation Picture Pictorial Completeness - This measures how completely and correctly the student has represented the fractions in the problem. The mathematical relationships need not be represented exactly to qualify. For example, to represent thirds, the student may draw a circle and divide it in half and then divide half of the circle in half making three parts. It is also possible for the student to have drawn something but not to have represented either fraction. The possible codings are <u>no picture</u>, <u>picture with no fraction correct</u>, <u>one fraction correct</u>, or <u>both fractions correct</u>.

<u>Translation Picture Form of Solution</u>: This classifies whether or not the student drew a separate figure to represent the solution to the problem. This figure would appear in addition to the representations of the fractions in the problem. The possible codings are <u>not pictorial</u> or <u>pictorial</u>.

<u>Information from the Solution Picture</u>: As is the case with Word Problems the categories coded from the solution picture are the same as those coded from the translation picture. The codings are based on the amount of relevant information available either already on the last hint given or drawn by the student.

<u>Other information from the Transcript or Interviewer's Codings</u>: The categories in this section are the same as those for the Word Problems. In the Year III instrument there are four fraction problems so the order of the problems ranges from one to four.

Composite Variables

After each of the individual categories were coded for each problem, five composite categories were constructed. These categories combine individual categories and are summed across problem type (word or fraction). These composite variables are Verbal Information Translation Picture Information, Solution Picture Information, Mental Movement, and Use of Picture.

Verbal Information is the amount of information presented by the student during the verbalization of the problem.

For word problems, this combines the following individual categories: Verbal Non-numerical Completeness, Verbal Numerical Completeness, Verbal Numerical Placement, and Verbal Question Correctness. For fraction problems, this combines the following individual categories: Verbal Numerical Completeness and Aware of Result.

Translation Picture Information represents the amount of relevant information written or drawn by the student on the translation picture. For word problems, this combines the following individual categories: translation picture non-numerical completeness, translation picture non-numerical relation, translation picture numerical completeness, and translation picture numerical placement. For fraction problems, this combines the following individual categories: translation picture pictorial common denominator, translation picture symbolic operation, translation picture pictorial completeness and translation picture form of solution.

Solution Picture Information indicates the amount of relevant information available to the student when the final answer is presented. This includes both information given on the final hint as well as information added by the student. For word problems this combines the following individual categories: solution picture non-numerical completeness, solution picture non-numerical relation, solution picture numerical completeness and solution picture numerical placement. For fraction problems this combines the following individual categories: solution picture pictorial common denominator, solution picture symbolic operation, solution picture pictorial completeness and solution picture form of solution.

Mental Movement indicates transformations, changes in perspective and mental manipulations of parts of the problems. For word problems this combines the following individual categories: verbal non-numerical data transformed, verbal question transformed and evidence of mental movement. For fraction problems this involved only the evidence of mental movement category.

Use of Picture indicates the degree to which the picture available to the student was used by the student in the solution process as determined by the student's explanation of the solution. Although the variable was considered a composite, for both word and fraction problems it included only the use of picture individual category.

Appendices

Appendix A

Year I Instrument

1979
year I

PROBLEM ORDER:

Sample Verbal-Pictorial
Sample Symbolic-Pictorial

MATHEMATICAL THINKING

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BOOKLET

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SCHOOL

Sample Verbal-Analytic

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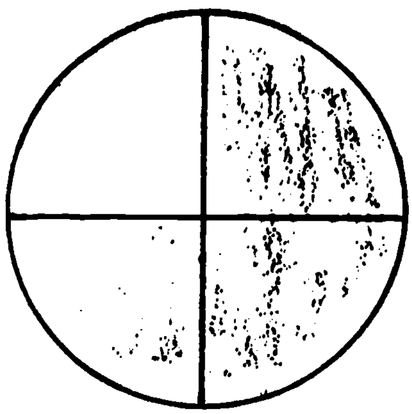
Cover Designed by: Mary Ann Kohsin

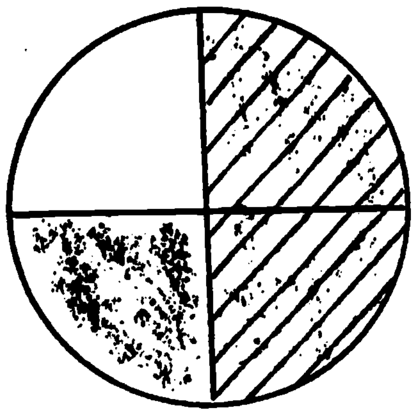
SAMPLE PROBLEM SPR:

$$\frac{3}{4} - \frac{1}{2} =$$

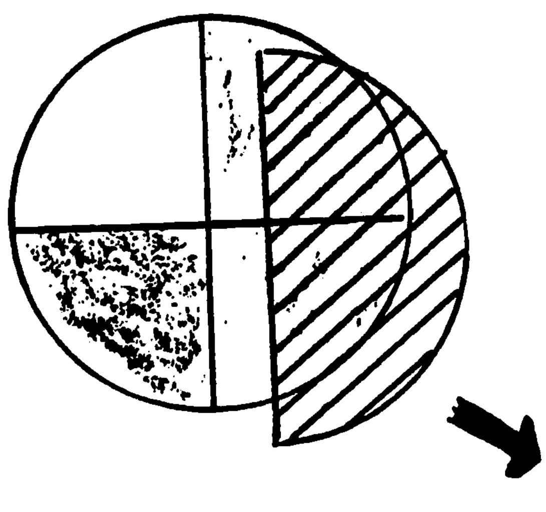
PR.FS.H1



PRFS.H2



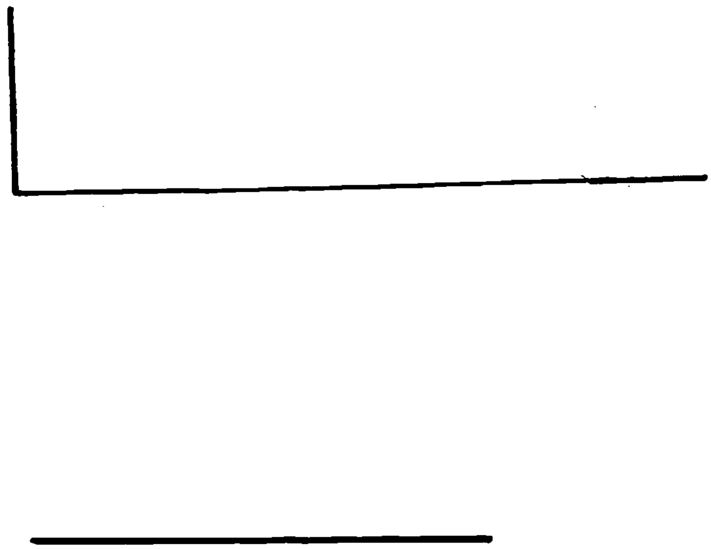
P.R.F.S.



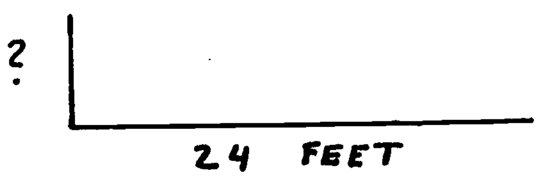
PR.1. A FLAGPOLE IS 9 FEET TALL. IT HAS A SHADOW 36 FEET LONG. ANOTHER FLAGPOLE HAS A SHADOW THAT IS 24 FEET LONG. HOW TALL IS THE SECOND FLAGPOLE?

PR.1.1

PR.1.2



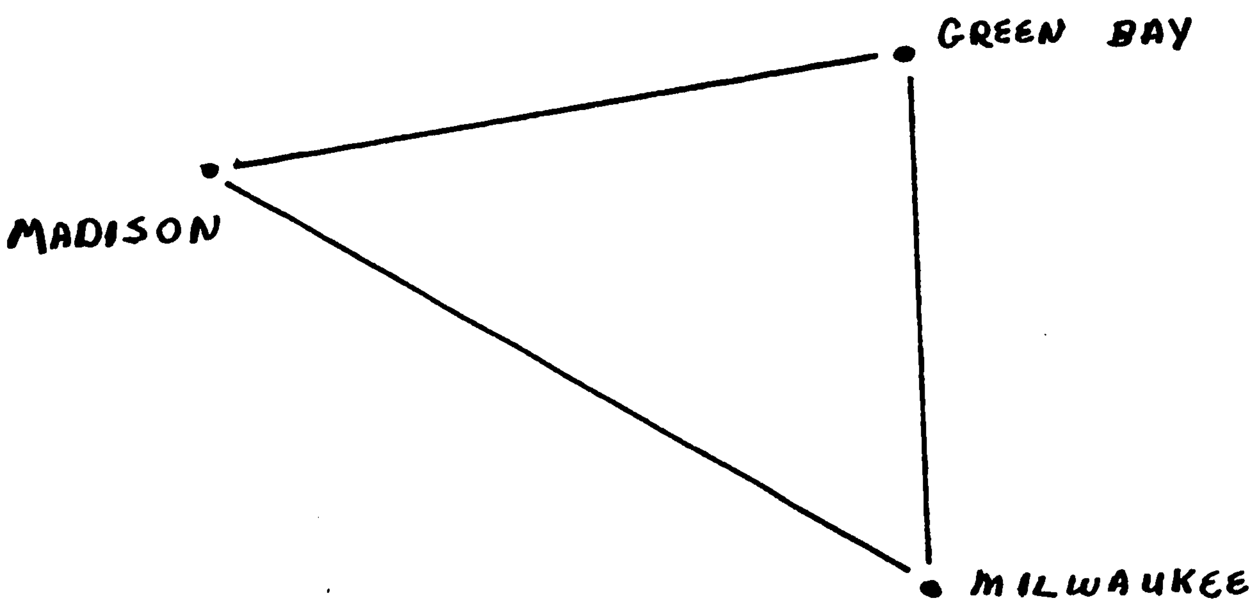
P.R.1.3.



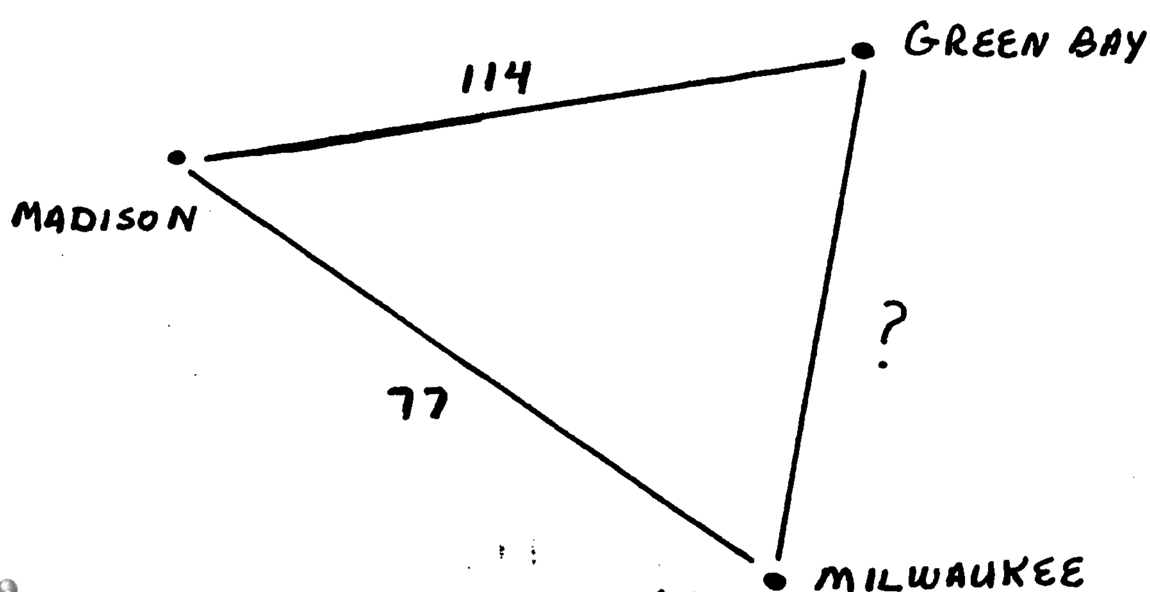
PR.2. CHRIS DROVE FROM MADISON TO MILWAUKEE TO GREEN BAY AND THEN RETURNED TO MADISON WITHOUT GOING BACK TO MILWAUKEE. ALTOGETHER SHE DROVE 323 MILES. THE DISTANCE FROM MADISON TO GREEN BAY IS 114 MILES AND THE DISTANCE FROM MADISON TO MILWAUKEE IS 77 MILES. WHAT IS THE DISTANCE BETWEEN MILWAUKEE AND GREEN BAY?

PR.2.1.

PR.2.2.

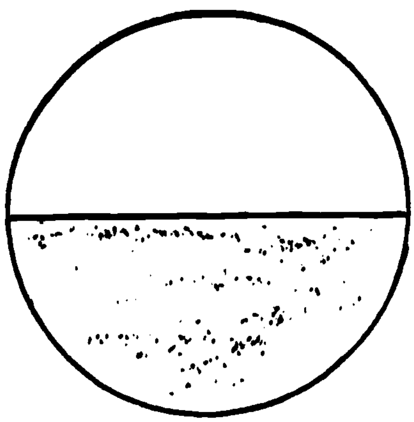

GREEN BAY
MADISON
MILWAUKEE

PR.2.3.

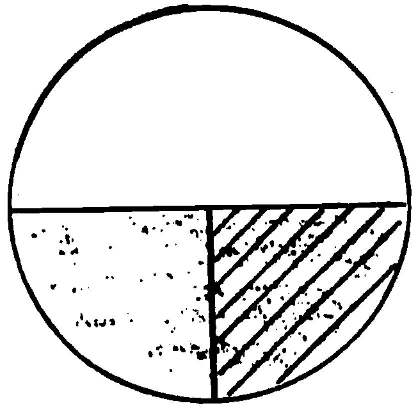

GREEN BAY
114
MADISON
?
77
MILWAUKEE

PR.3. WHEN MIKE AND PETER CAME HOME FROM SCHOOL THEY FOUND HALF OF A CHOCOLATE CAKE. MIKE ATE HALF OF IT AND PETER ATE ONE THIRD OF WHAT MIKE HAD LEFT. HOW MUCH OF THE CAKE WAS LEFT AFTER PETER ATE HIS PIECE?

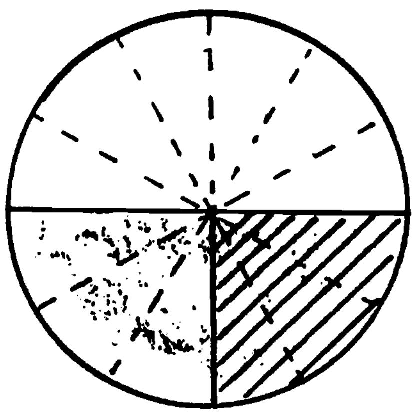
PR.3.1



PR.3.2



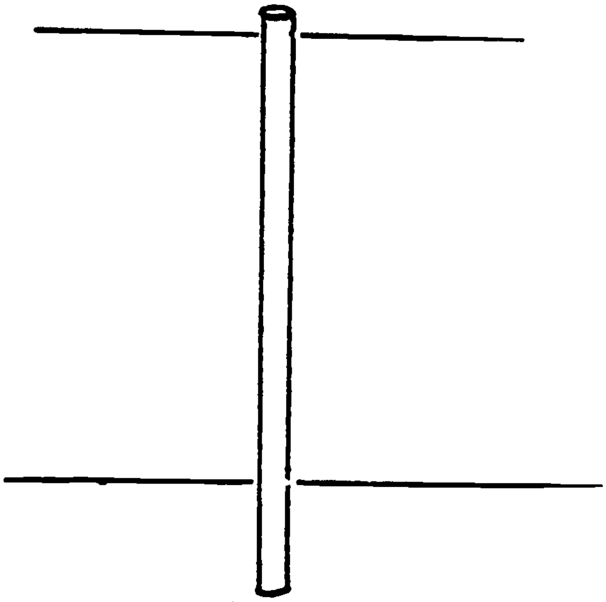
PR.3.3.



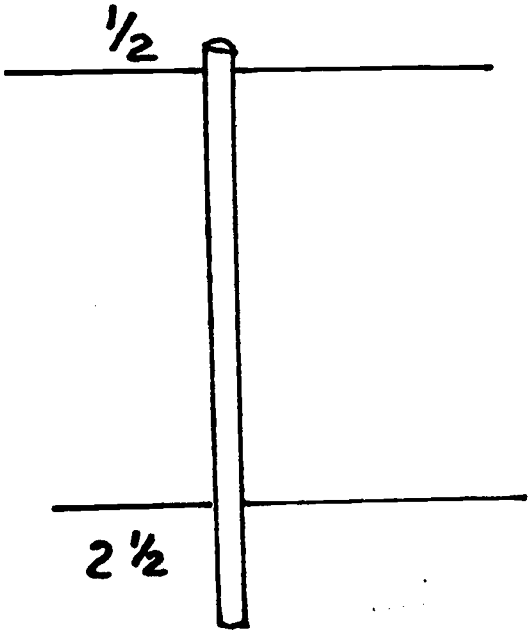
PR.4. A POST 12 FEET LONG IS POUNDED INTO THE BOTTOM OF A RIVER NEAR ITS BANK. TWO AND A HALF FEET OF THE POST IS BELOW THE BOTTOM OF THE RIVER AND 1/2 FOOT IS ABOVE THE SURFACE OF THE WATER. HOW DEEP IS THE RIVER AT THAT POINT?

PR.4.1

PR. 4. 2.



PR. 4. 3.



PR.5. A BUS HAS SEATS FOR 36 PASSENGERS. IF ONE OUT OF EVERY FOUR WAS EMPTY, HOW MANY PASSENGERS WERE ON THE BUS?

P.R.5.1

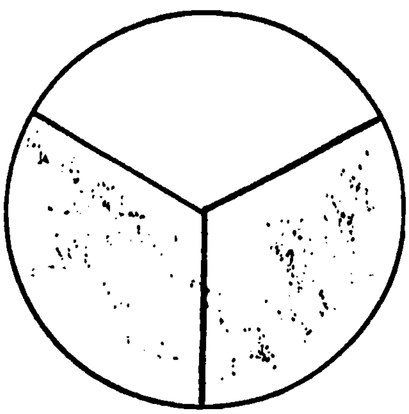
P.R.5.2.

P.R.5.3.

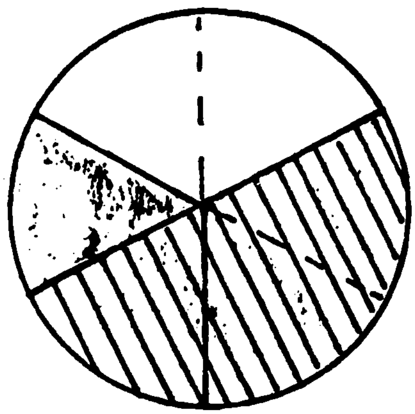
PR. 6.

$$\frac{2}{3} - \frac{1}{2} =$$

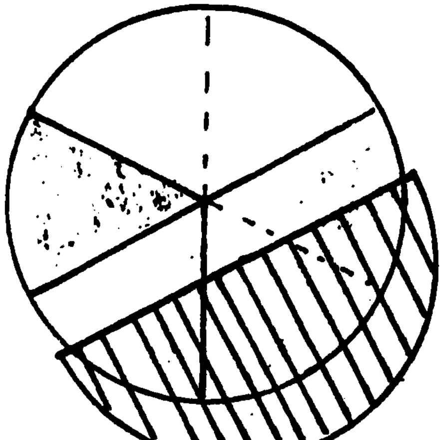
P.R.6.1



K.6.2.



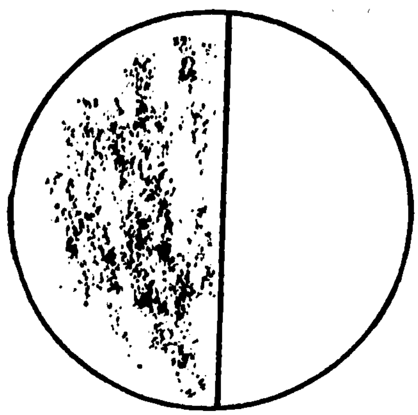
PR.6.3.



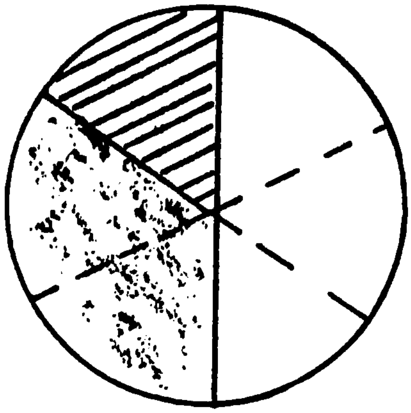
PR. 7.

$$\frac{1}{2} + \frac{1}{6} =$$

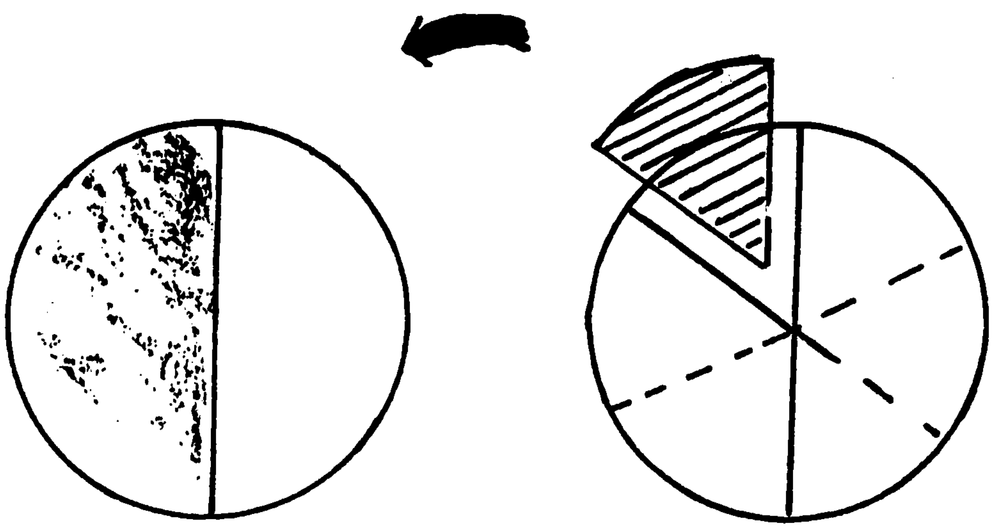
PR.7.1



PR.7.2.

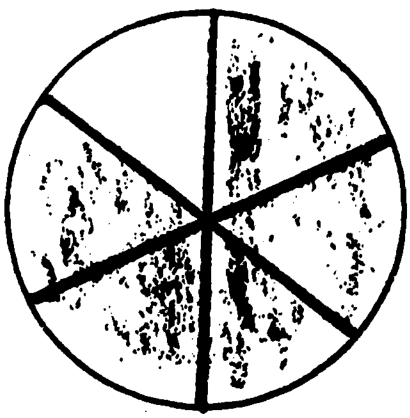


PR.7.3.

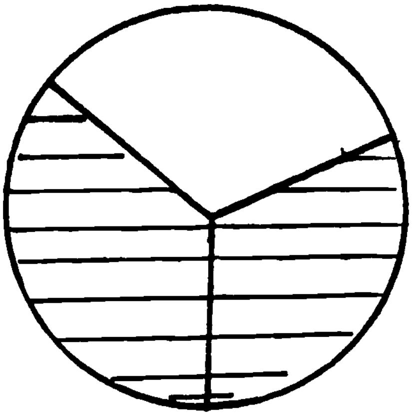


PR.8. $\frac{5}{6} + \frac{2}{3} =$

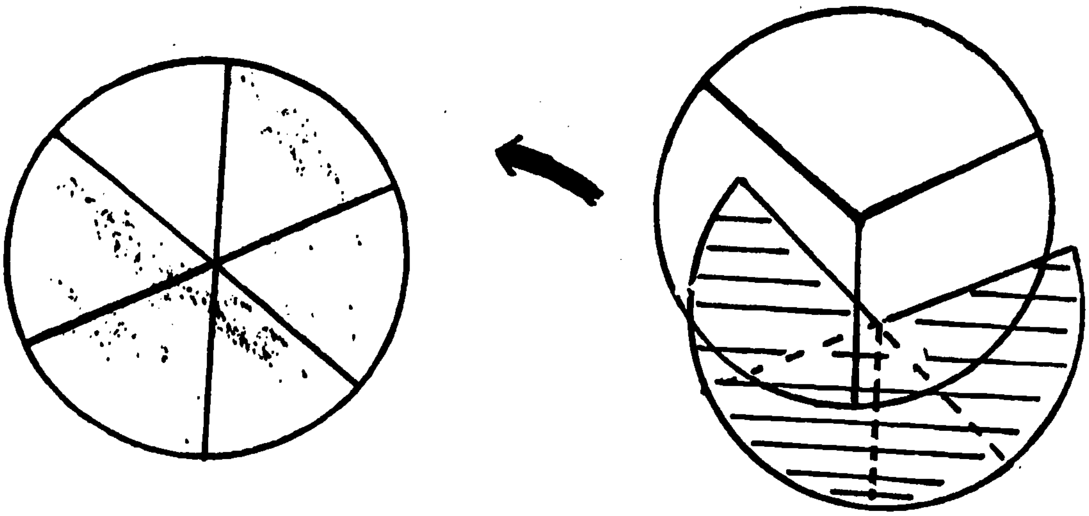
PR.8.1



PR.8.2.



PR.8.3



Appendix B

Year II Instrument

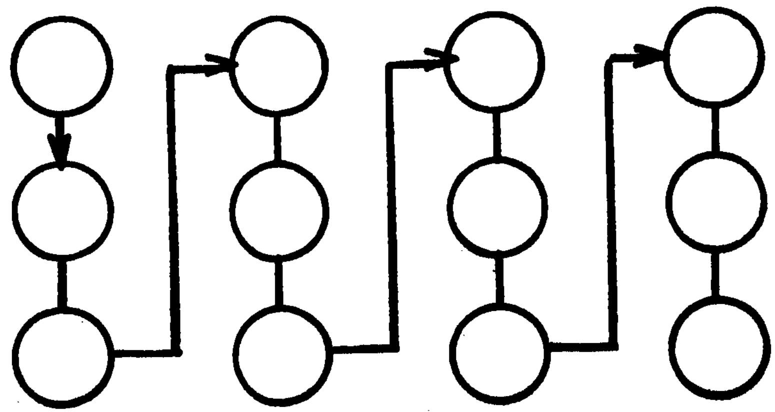
1980

MATHEMATICAL THINKING

BOOKLET

STUDENT ID

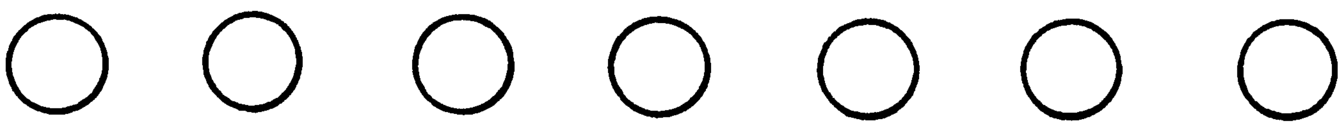
INTERVIEWER



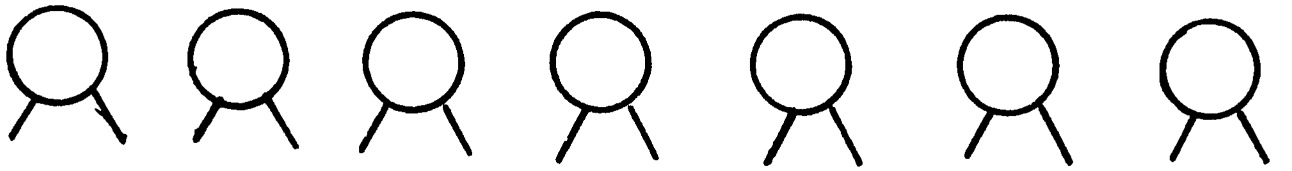
KONSIN/FENNEMA

SAMPLE PROBLEM: Pam counted 7 heads and 24 legs on her pet gerbils and parakeets. How many of Pam's pets are gerbils and how many are parakeets?

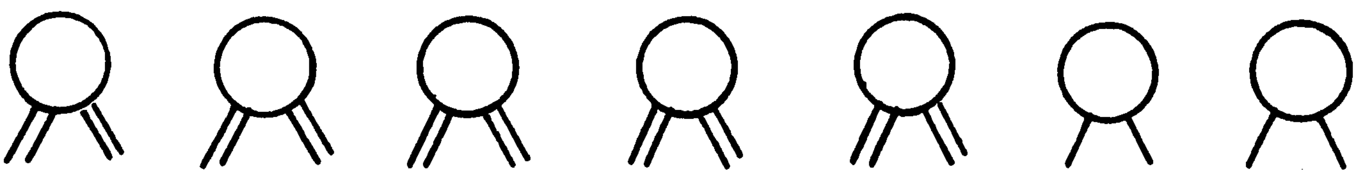
SP: H1.



SP: H2.

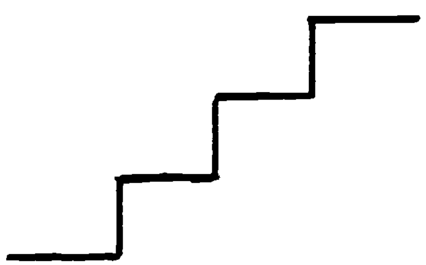


SP: H3.



PR1. A baby came to a staircase; climbed up five steps, climbed down three steps and then climbed up six steps and was at the top. How many steps were in the staircase?

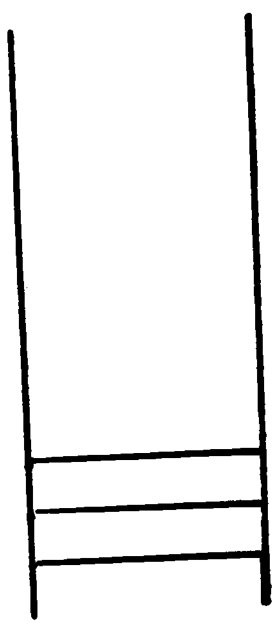
PR1: H1.



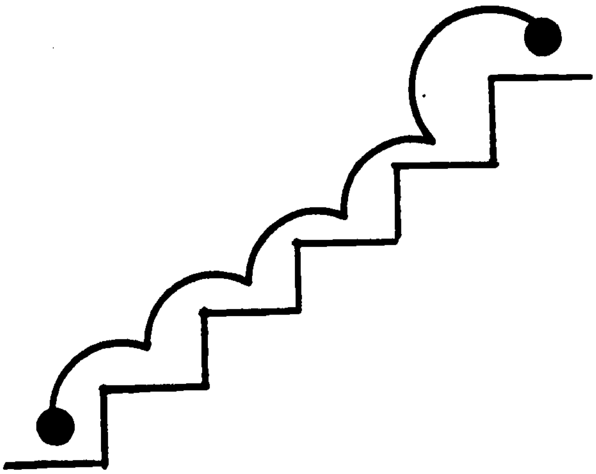
SAMPLE PROBLEM CODING SHEET:

Problem	Hint Sequence	Correctness	Translation Picture
Sample/ Pets	B 1 2 3	YES NO	

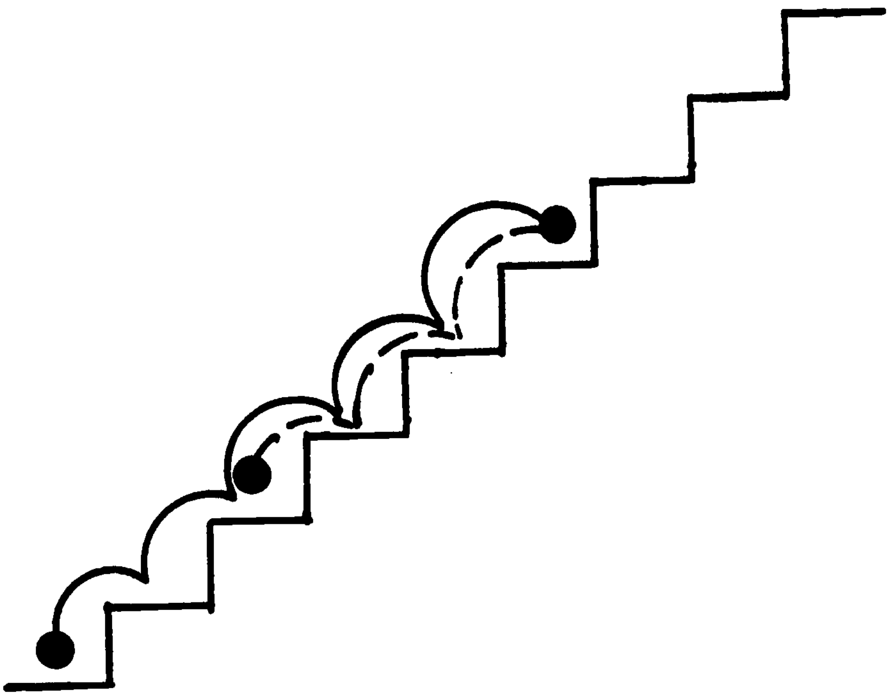
PR1: H1.



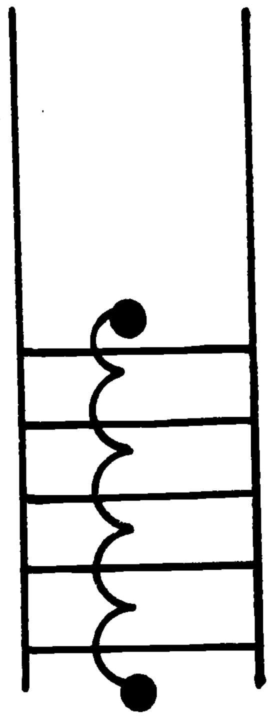
PR1: H2.



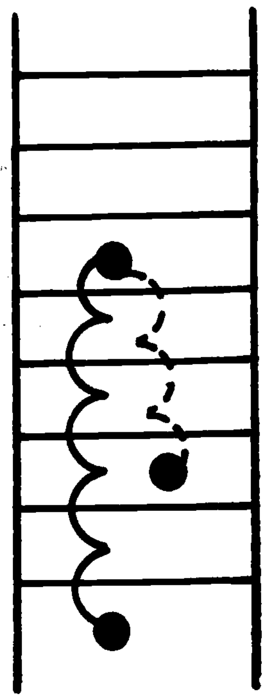
PR1: H3.



PR1: H2.

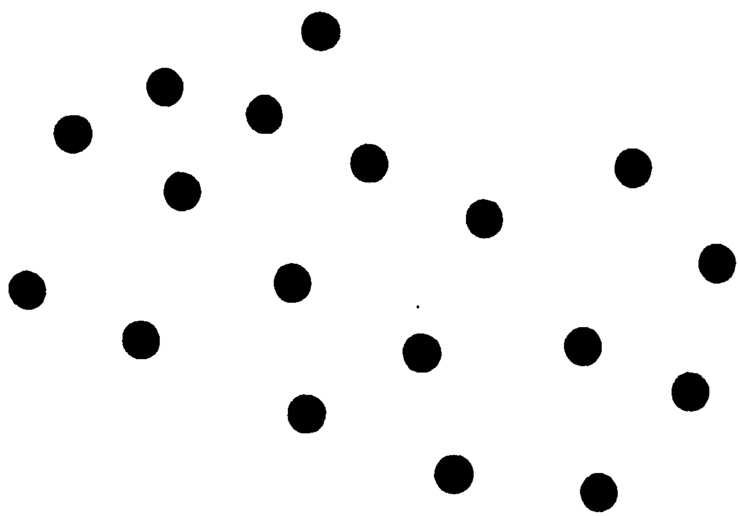


PR1: H3.

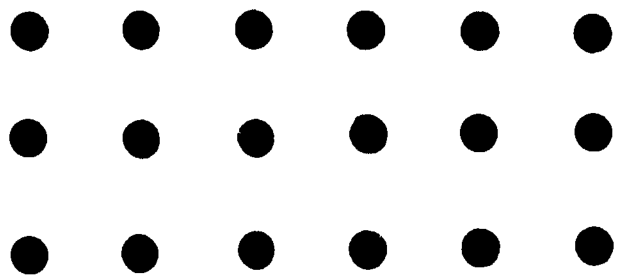


SY2. 2/3 of 18 =

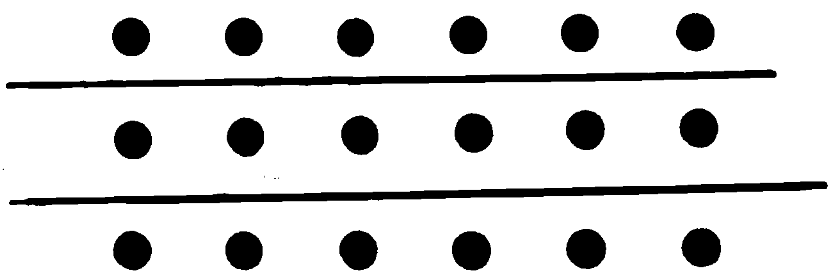
SY2: H1.



SY2: H2.

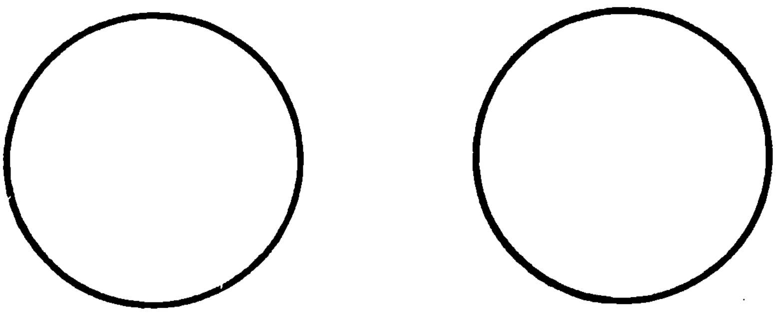


SY2: H3.

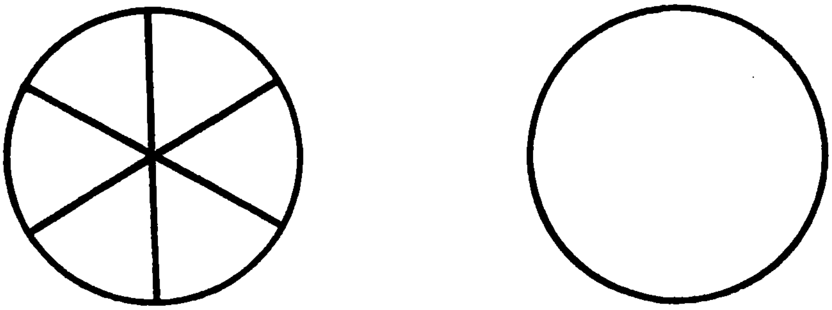


PR6. How many sixths are there in 2 ?

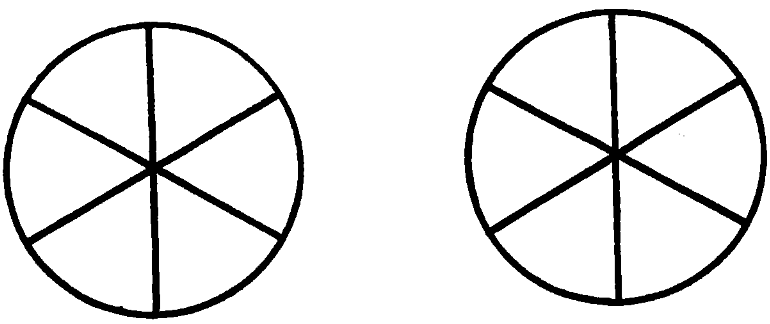
PR6: H1.



PR6: H2.

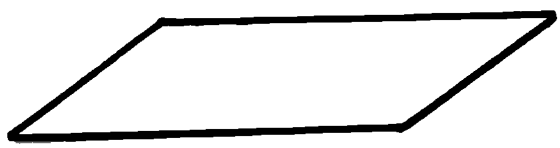


PR6: H3.

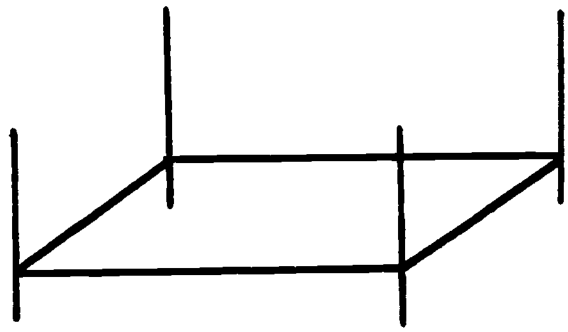


PR7. How many yards of barbed wire are needed to make a 3-wire fence around a field 200 yards long and 100 yards wide?

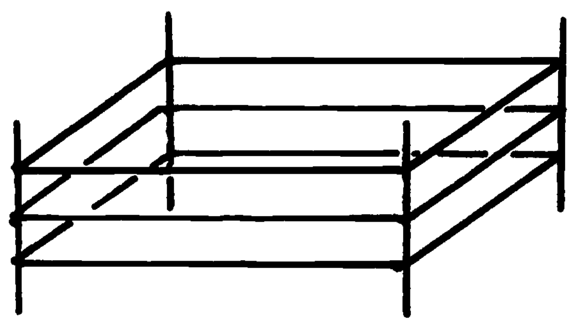
PR7: H1.



PR7: H2.

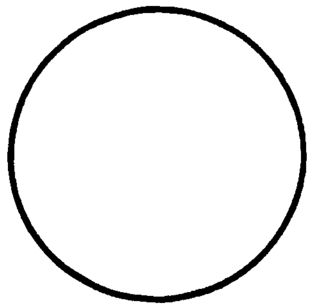


PR7: H3.

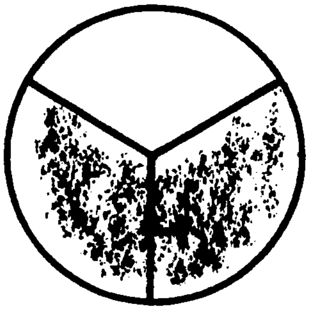


PR9. Five people ordered a pizza. One person ate 1/3 of the pizza and left before anyone else had a piece. The remaining pizza as divided equally among the four people. How much of the pizza did each of the four get?

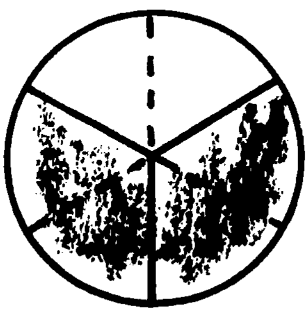
PR9: H1.



PR9: H2.

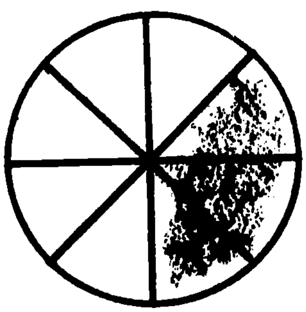


PR9: H3.

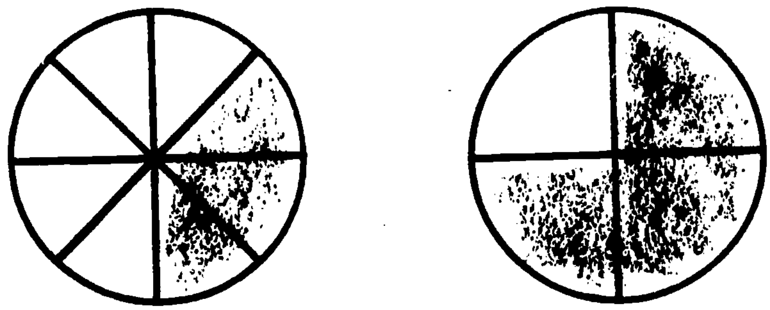


SY10. $3/8 + 3/4 =$

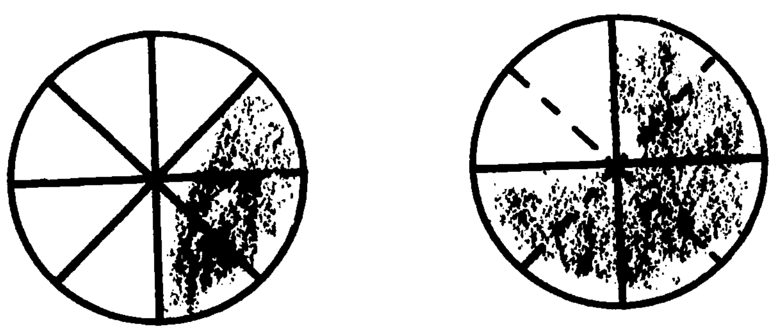
SY10: H1.



SY10: H2.



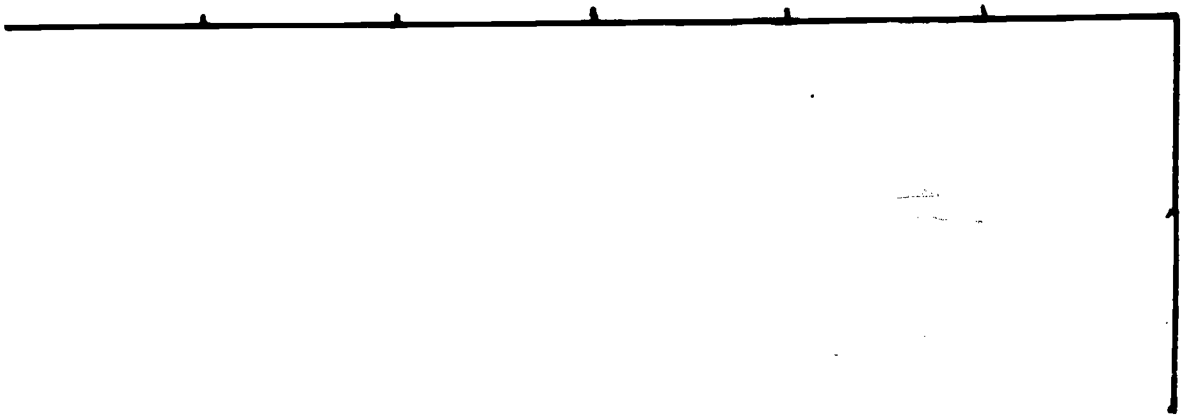
SY10: H3.



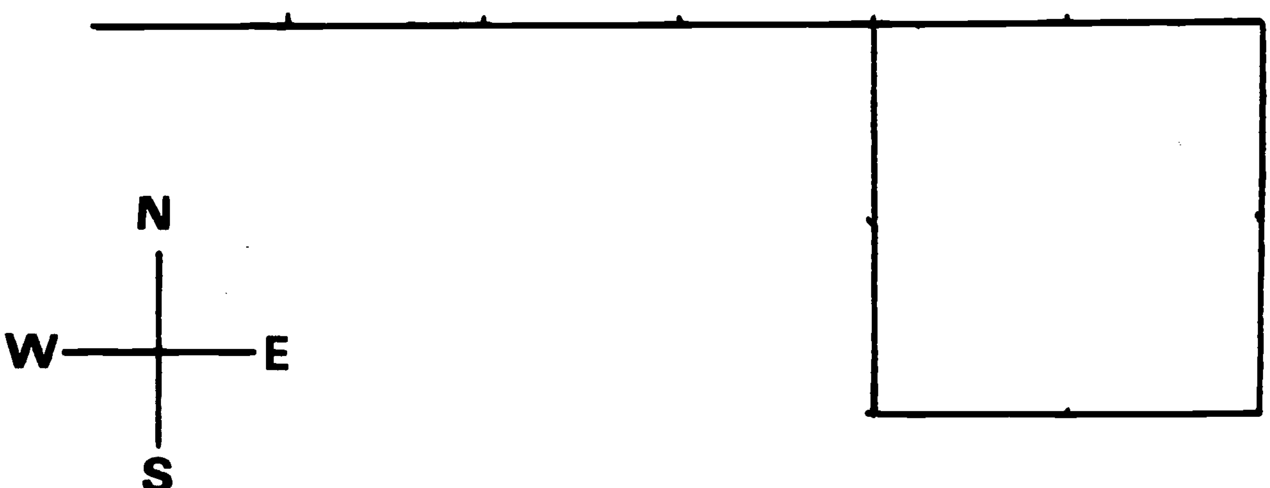
PR11. Lou started at home and walked 6 blocks east, two blocks south, 2 blocks west, and then 2 blocks north. All the blocks were the same length. At the end of the trip how far was Lou from home?

PR11: H1.

PR11: H2.

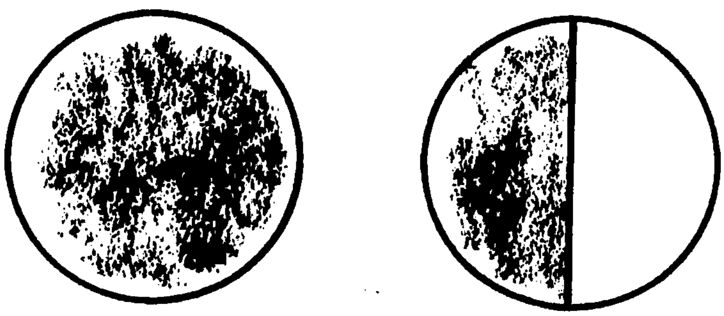


PR11: H3.

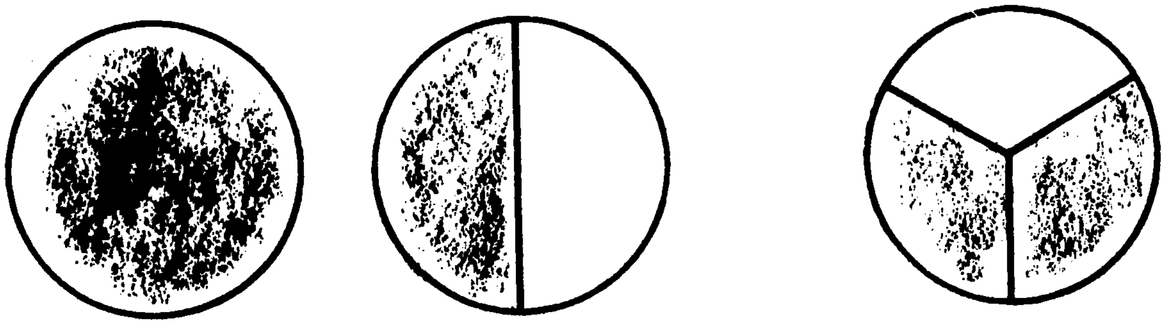


SY12. 1 1/2 - 2/3 =

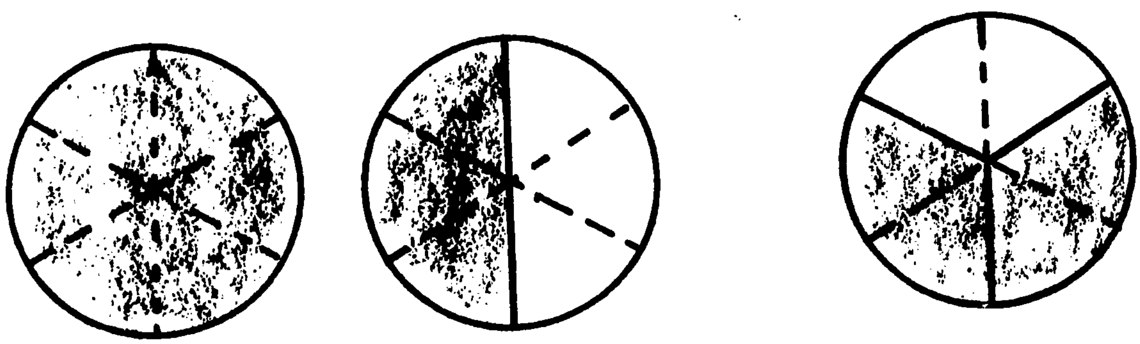
SY12: H1.



SY12: H2.



SY12: H3.



Appendix C

Year III Instrument

Year III

1981

MATHEMATICAL THINKING

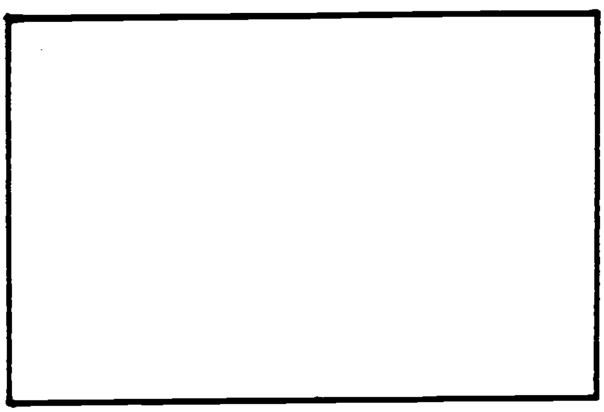
STUDENT ID

BOOKLET

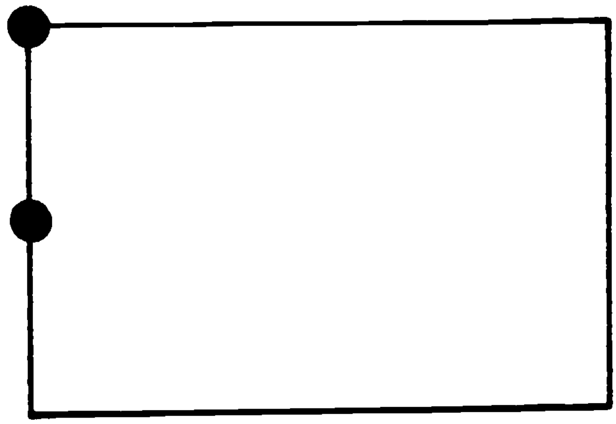
INTERVIEWER

SAMPLE PROBLEM 1: LOU WANTS TO FENCE IN A GARDEN 6 FEET LONG AND 4 FEET WIDE WITH POSTS FOR THE FENCE 2 FEET APART. HOW MANY POSTS WILL BE NEEDED FOR THE FENCE?

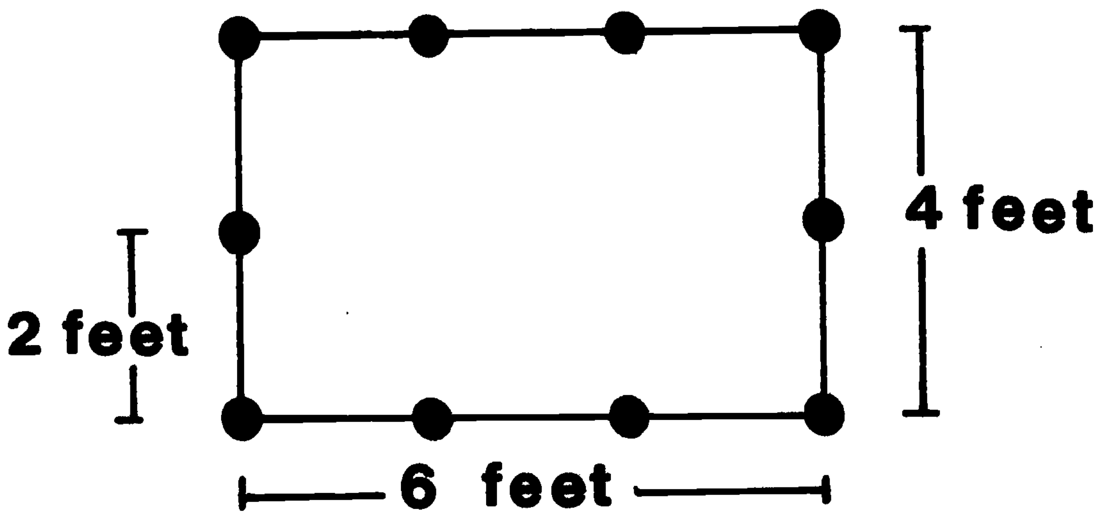
SP1; H1.



SP1; H2

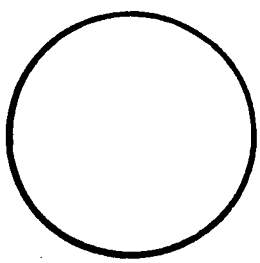


SP1; H3.



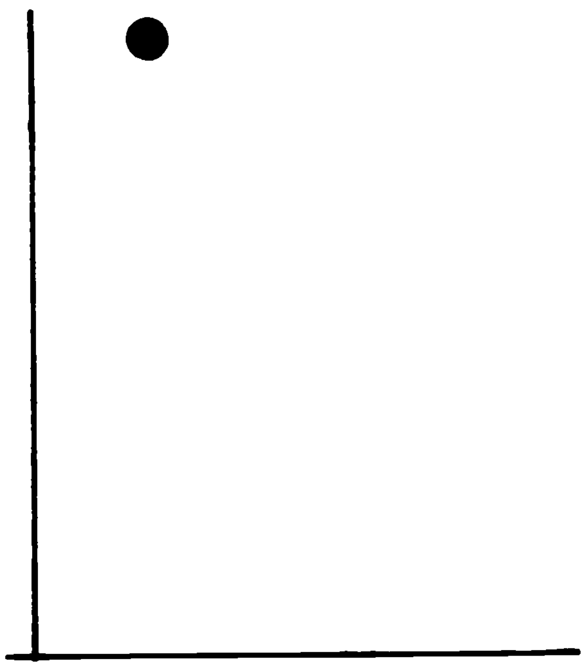
SP2; SY: H3.

SP2; SY: H1.

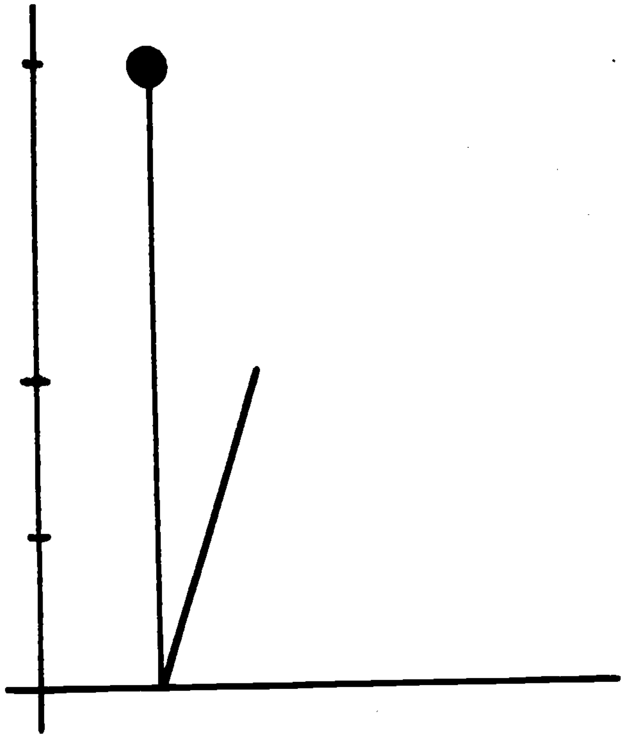


PR1: A RUBBER BALL BOUNCES BACK UP HALF THE HEIGHT IT FALLS. IF THE BALL IS DROPPED FROM A HEIGHT OF 100 FEET, HOW FAR WILL IT HAVE TRAVELED, ALTOGETHER, UP AND DOWN, WHEN IT HITS THE GROUND FOR THE FOURTH TIME?

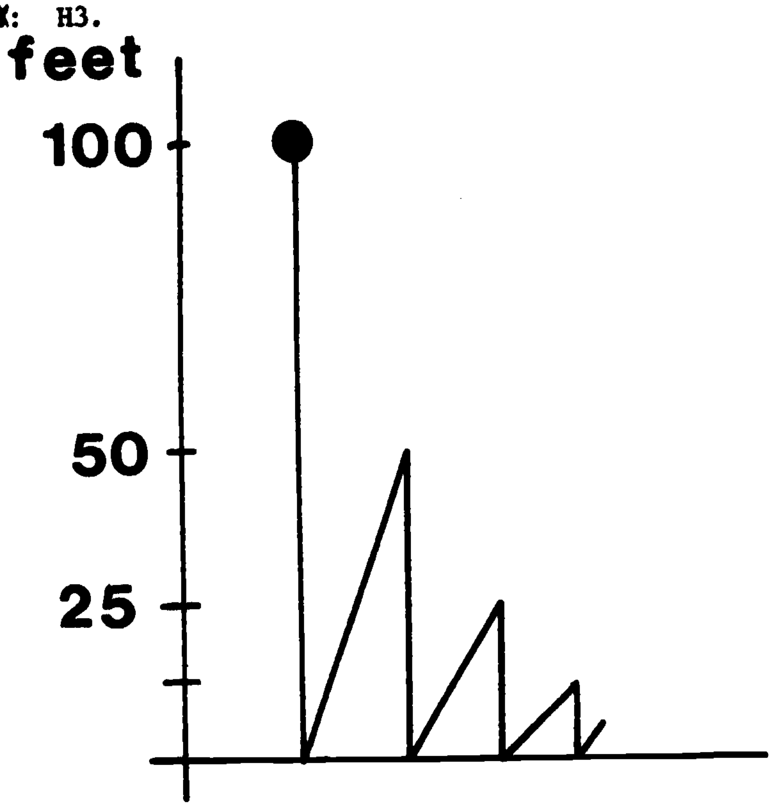
PR1: H1.



PRX: H2.

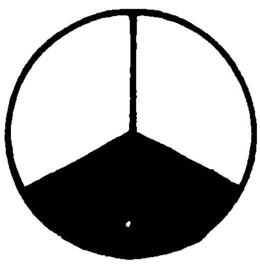


PRX: H3.

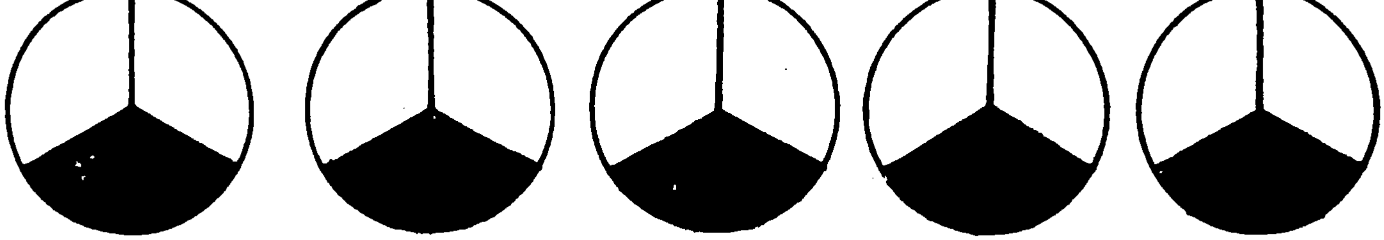


SY2: 5 X 1/3 =

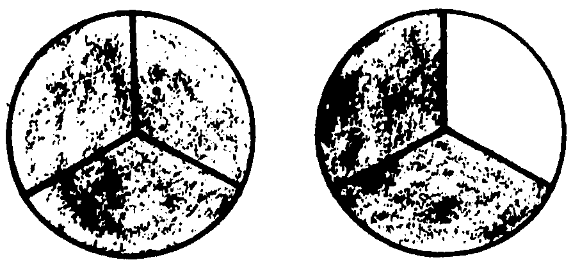
SY2: H1.



SY2: H2.

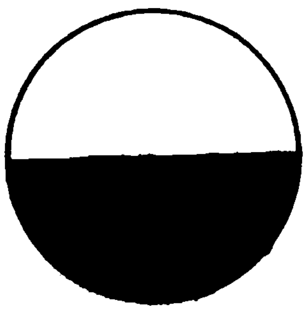


SY2: H3.

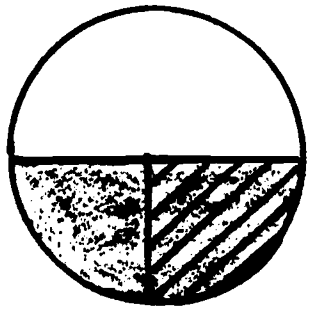


PR3. WHEN MIKE AND PETER CAME HOME FROM SCHOOL THEY FOUND HALF OF A CHOCOLATE CAKE. MIKE ATE HALF OF WHAT WAS THERE AND PETER ATE A THIRD OF WHAT MIKE HAD LEFT. HOW MUCH OF THE WHOLE CAKE WAS LEFT AFTER PETER ATE HIS PIECE?

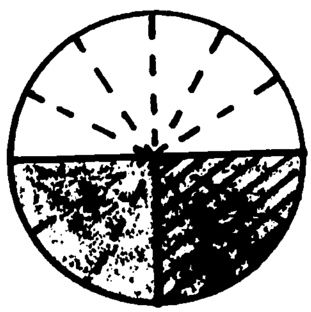
PR3: H1.



PR3: H2.



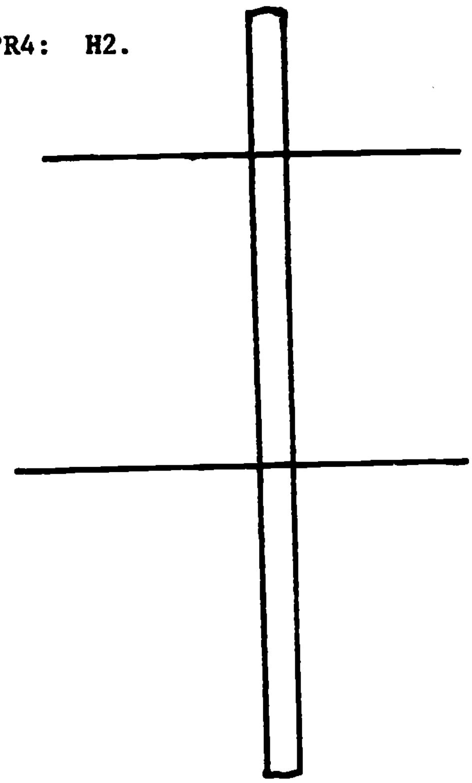
PR3: H3.



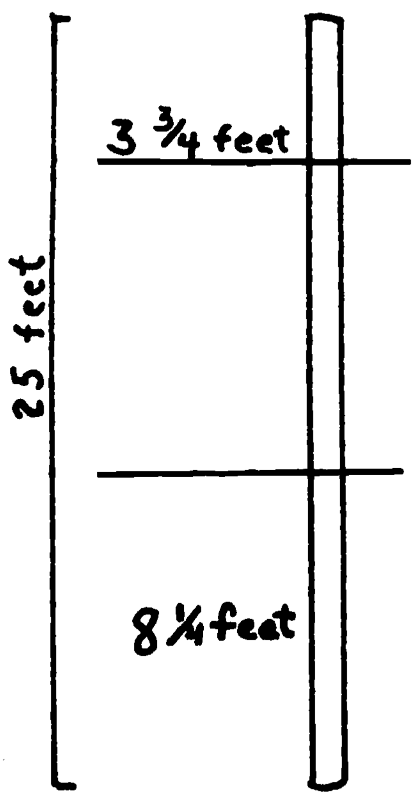
PR4: A POST 25 FEET LONG IS POUNDED INTO THE BOTTOM OF A RIVER NEAR ITS BANK. EIGHT AND A FOURTH FEET OF THE POST IS BELOW THE BOTTOM OF THE RIVER AND THREE AND THREE FOURTHS FEET IS ABOVE THE SURFACE OF THE WATER. HOW DEEP IS THE RIVER AT THAT POINT?

PR4: H1.

PR4: H2.



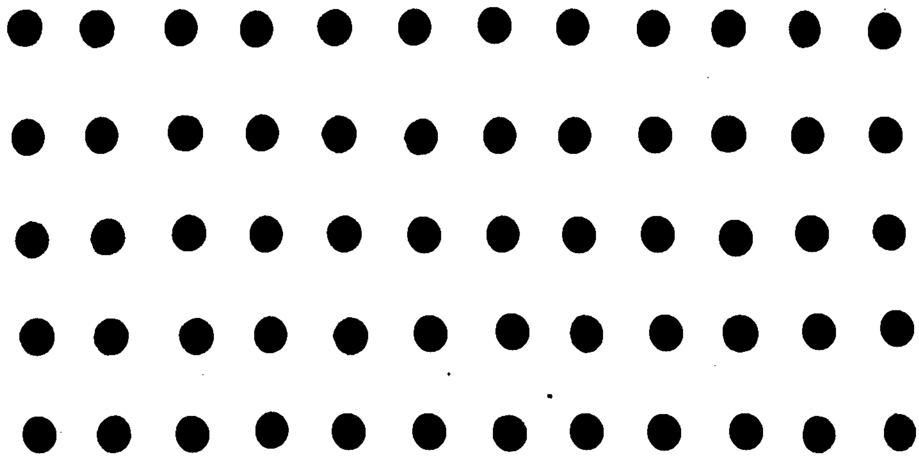
PR4: H3.



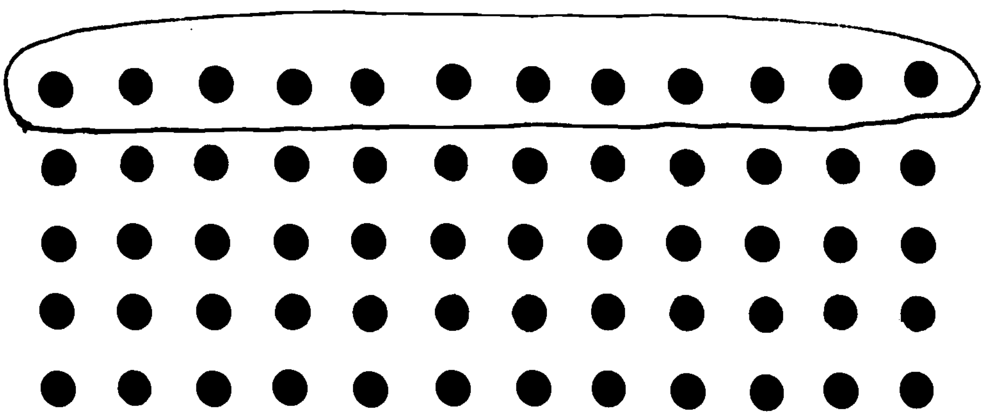
PR5: A BUS HAS SEATS FOR 60 PASSENGERS. IF ONE OUT OF EVERY FIVE SEATS IS EMPTY, HOW MANY PASSENGERS ARE ON THE BUS?

PR5: H1.

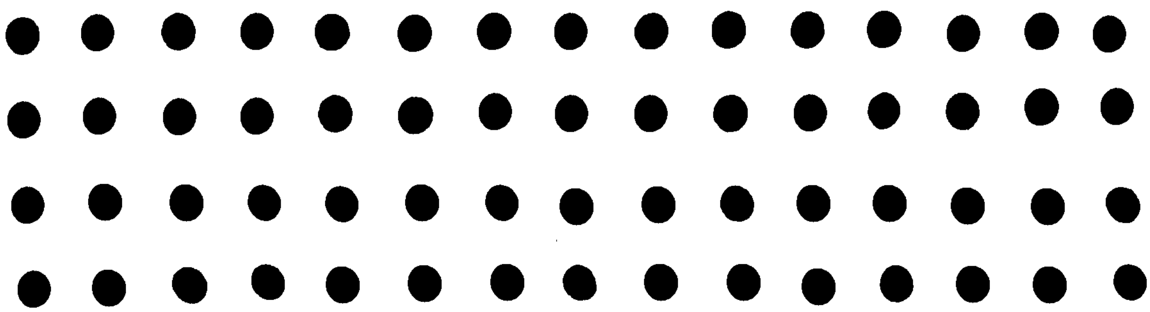
PR5: H2a.



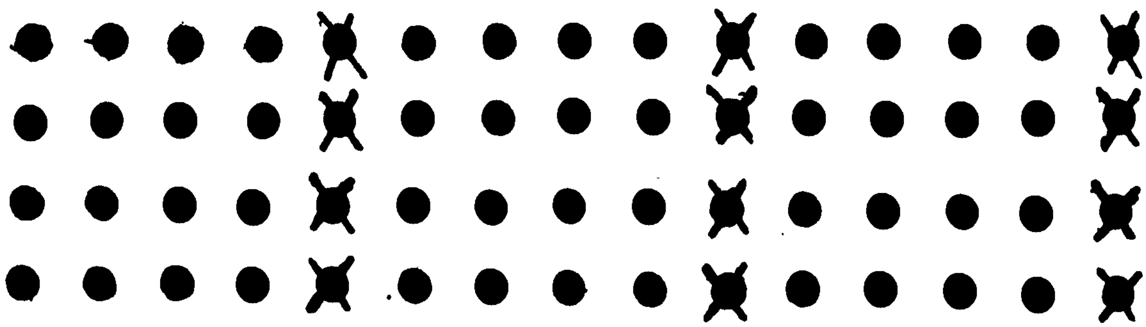
PR5: H3a.



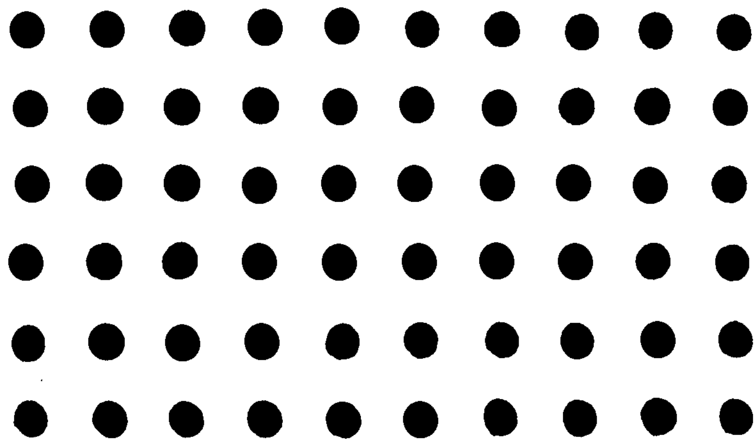
PR5: H26.



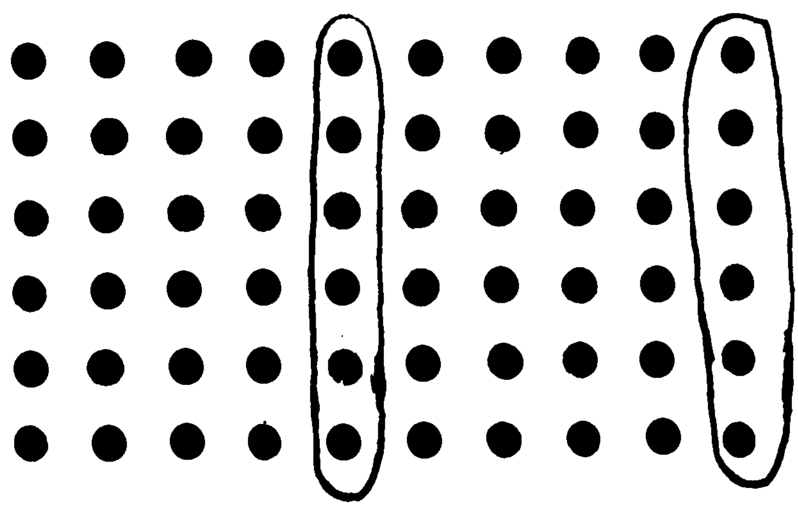
PR5: H36.



PR5: H2a.

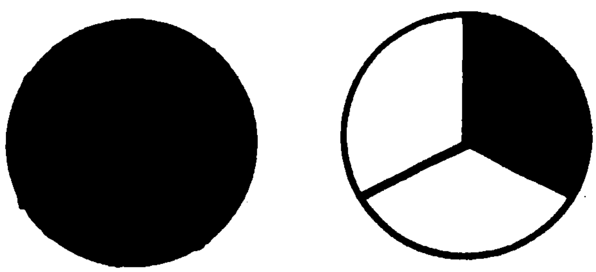


PR5: H3a.

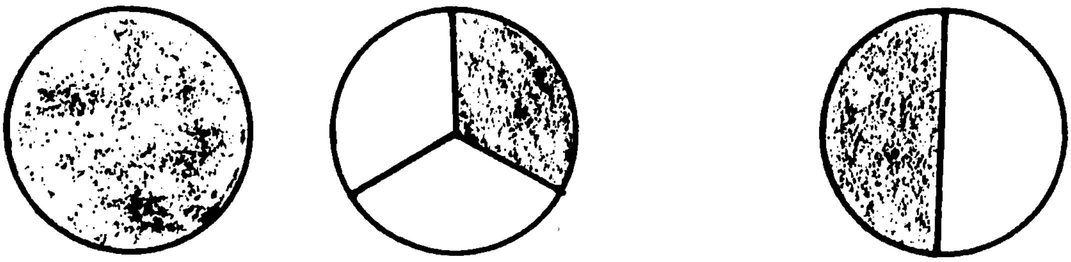


SY6: $1\frac{1}{3} - \frac{1}{2} =$

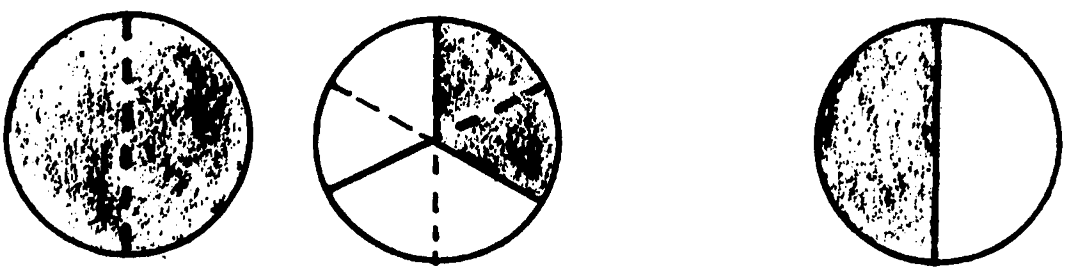
SY6: H1.



SY6: H2.

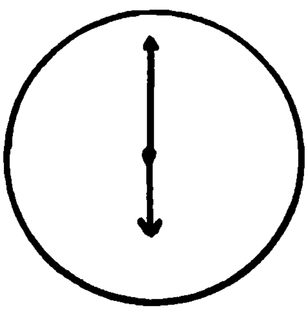


SY6: H3.

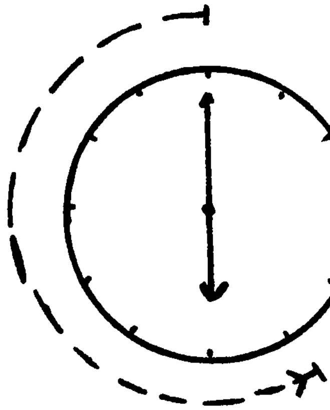


PR7: PAT STARTED BAKING A CAKE AND DOING A LOAD OF LAUNDRY AT THE SAME TIME. THE CAKE BAKED FOR THIRTY-FIVE MINUTES AND WAS FINISHED AT 6:00. IF THE LAUNDRY TAKES AN HOUR AND FIFTEEN MINUTES TO WASH AND DRY, AT WHAT TIME WILL IT BE DONE?

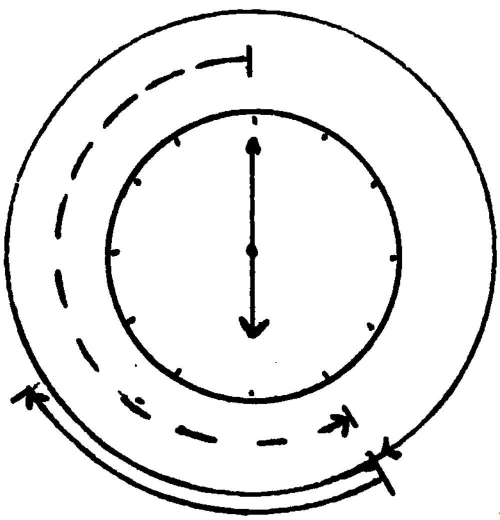
PR7: H1.



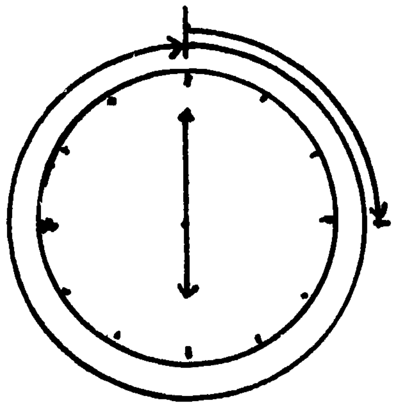
PR7: H2a.



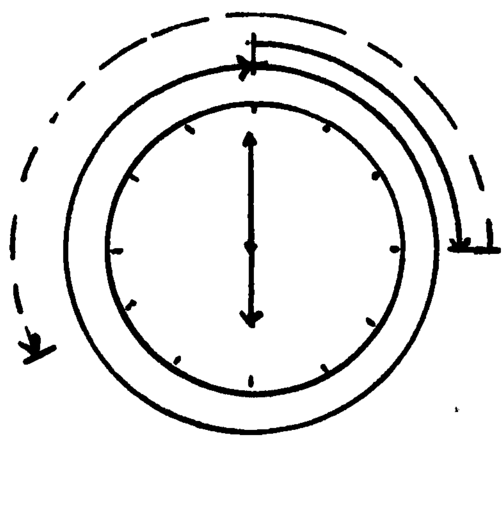
PR7: H3a.



PR7: H2b.

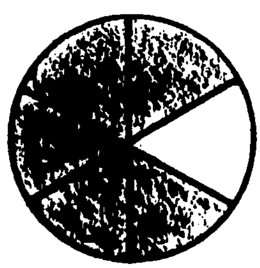


PR7: H3b.

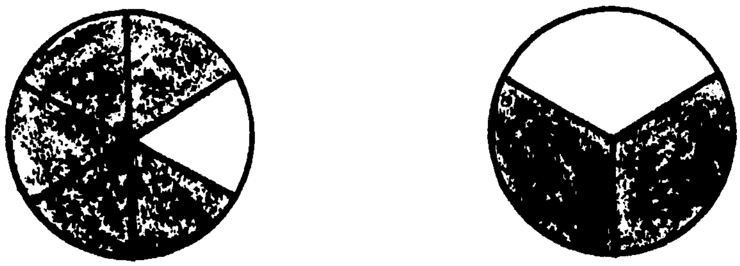


SY8: $5/6 + 2/3 =$

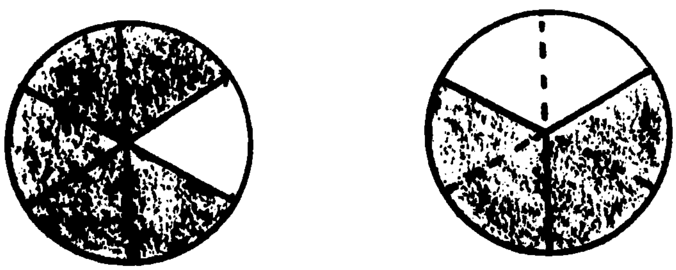
SY8: H1.



SY8: H2.

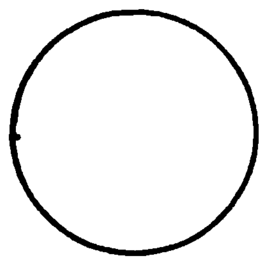


SY8: H3.

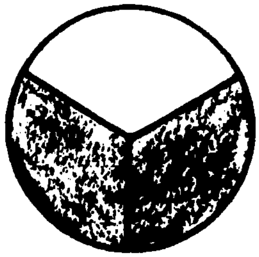


PR9: FOUR PEOPLE ORDERED A PIZZA. ONE PERSON ATE 1/3 OF THE PIZZA AND LEFT BEFORE ANYONE ELSE HAD A PIECE. THE REST OF THE PIZZA WAS DIVIDED EQUALLY AMONG THE OTHER THREE PEOPLE. HOW MUCH OF THE WHOLE PIZZA DID EACH OF THESE THREE GET?

PR9: H1.



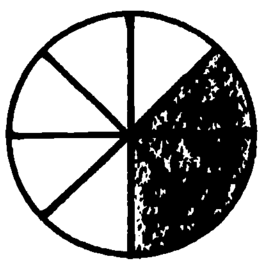
PR9: H2.



PR9: H3.

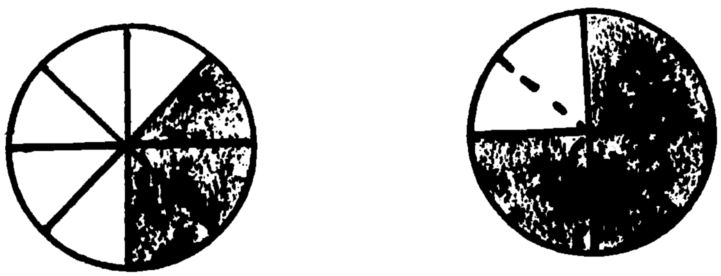
SY10: 3/8 + 3/4 =

SY10: H1.



SY10: H2.

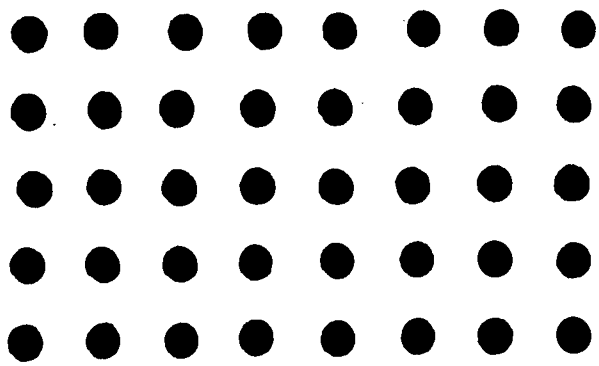
SY10: H3.



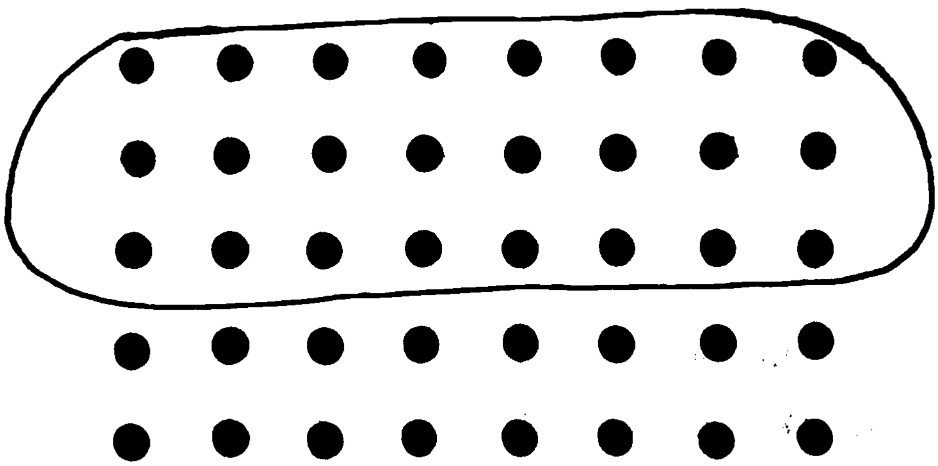
PR11: NEWSPAPERS ARE DELIVERED TO A FOUR-STORY BUILDING WHICH HAS 40 APARTMENTS. IF THREE OUT OF EVERY FIVE APARTMENTS GET A PAPER, HOW MANY PAPERS ARE DELIVERED TO THE BUILDING EACH DAY?

PR11: H1.

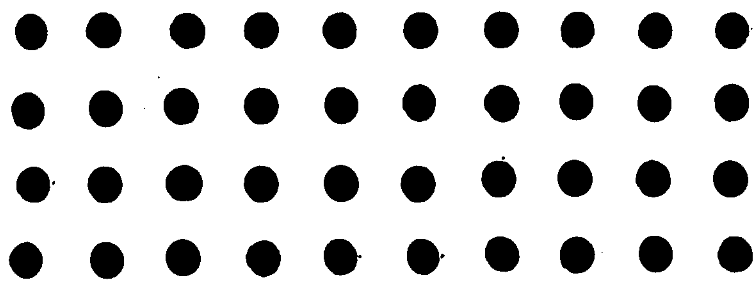
PR11: H2a.



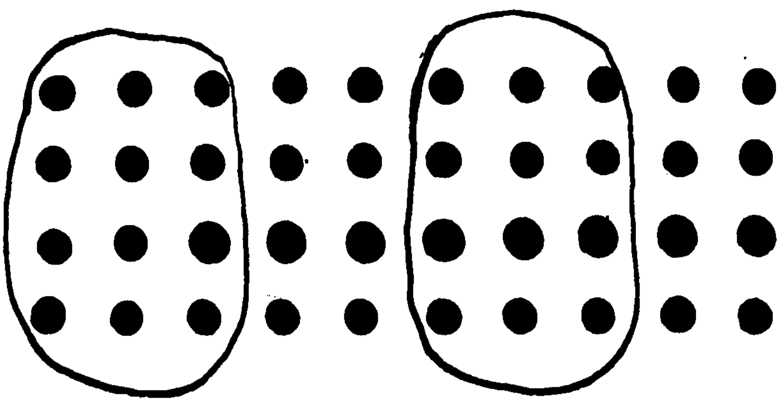
PR11: H3a.



PR11: H2b

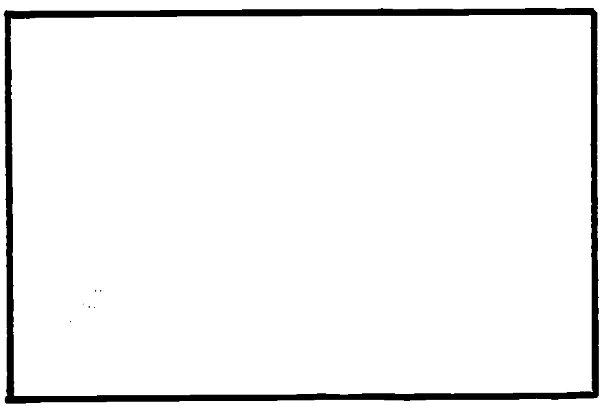


PR11: H3b

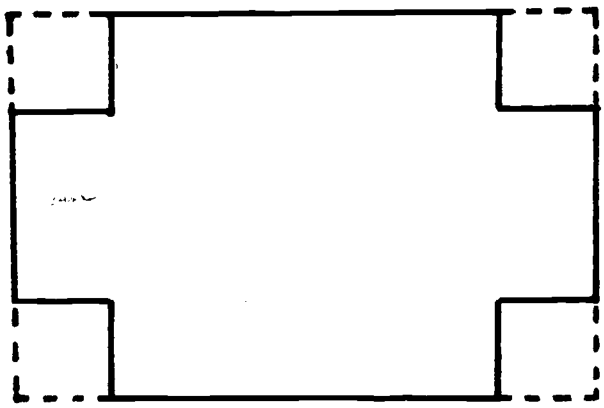


PR12: A SQUARE WHOSE SIDE IS THREE INCHES LONG IS CUT FROM EACH CORNER OF A RECTANGULAR PIECE OF CARDBOARD 12 INCHES WIDE AND 18 INCHES LONG. IF THE CARDBOARD IS THEN FOLDED UP TO MAKE A BOX, WHAT IS THE PERIMETER OF THE BOTTOM OF THE BOX?

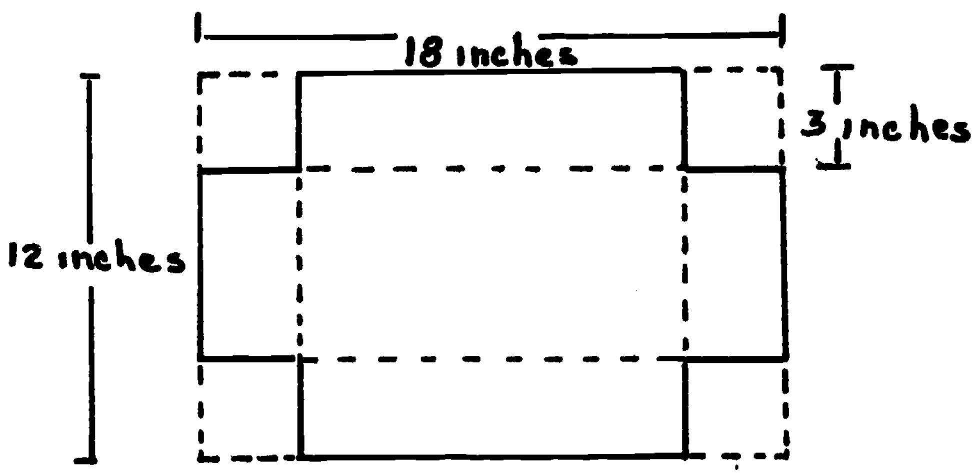
PR12: H1.



PR12: H2.



PR12: H3.



Appendix D

Year I Analytic Problems

SAMPLE PROBLEM: ANALYTIC

MARY HAS $2.05 IN DIMES AND NICKELS. IF SHE HAS 13 NICKELS, HOW MUCH MONEY DOES SHE HAVE IN DIMES?

SP.A.1

13 NICKELS

P.A.2

13 NICKELS

$\times$ .05 VALUE OF ONE NICKEL

☐ VALUE OF 13 NICKELS

P.A.3

13 NICKELS

$\times$ .05 VALUE OF ONE NICKEL

☐ VALUE OF 13 NICKELS

$ 2.05

A.1. A SIX INCH PIECE OF RUBBER STRETCHES TO 24 INCHES WITHOUT BREAKING. IF AN 8 INCH PIECE OF RUBBER WERE CUT FROM THE SAME BATCH OF RUBBER, HOW FAR COULD IT BE STRETCHED WITHOUT BREAKING?

A.1.1

$$6 \rightarrow 24$$

.1.2

$$6 \rightarrow 24$$

$$8 \rightarrow \square$$

.1.3

$$6 \times 4 = 24$$

$$8 \times \triangle = \square$$

A.2. GERRI WENT TO THE SPORTING GOODS STORE AND BOUGHT A $24.98 SLEEPING BAG AND A $2.39 CANTEEN. GERRI GAVE THE CLERK $30.00. HOW MUCH CHANGE DID THE CLERK GIVE BACK TO GERRI?

A.2.1.

$24.98 $2.39

1.2.2.

COST OF BAG $24.98
COST OF CANTEEN 2.39

.2.3.

$$
\begin{array}{r}
\$\,24.98 \\
\underline{+\quad 2.39}
\end{array}
$$

$30.00

A.3. TWO PIRATES FOUND A BAG CONTAINING 600 GOLD COINS. AFTER THEY WENT TO BED, THE FIRST PIRATE GOT UP AND TOOK ONE THIRD OF THE COINS. LATER, THE SECOND PIRATE GOT UP AND TOOK ONE HALF OF THE COINS THAT WERE LEFT. HOW MANY COINS WERE LEFT IN THE BAG AFTER THE SECOND PIRATE RETURNED TO BED?

A.3.1 600 COINS $\frac{1}{3}$ OF COINS

.3.2.

$$600 \div 3 = \square$$

.3.3.

$$600 \div 3 = \square$$

$$600 - \square = \triangle$$

A.4. A GROUP OF BIKE RIDERS PLANNED A THREE DAY TRIP. ON THE FIRST DAY THEY TRAVELED 14 MILES MORE THAN THEY HAD PLANNED. ON THE SECOND DAY THE BIKE RIDERS TRAVELED 8 MILES LESS THAN THEY HAD PLANNED AND ON THE THIRD DAY THEY TRAVELED 16 MILES MORE THAN THEY HAD PLANNED. IF THE BIKE RIDERS TRAVELED A TOTAL OF 184 MILES IN THREE DAYS, HOW MANY MILES DID THEY PLAN TO BIKE?

A.4.1

14 MILES MORE

8 MILES LESS

16 MILES MOR

A.4.2

14 MILES MORE
+16 MILES MORE

.4.3.

14 MILES MORE
+16 MILES MORE
30 MILES MORE
- 8 MILES LESS

184 TOTAL MILES

A.5. IN A PARKING LOT YOU CAN PARK CARS AND TRUCKS. EACH TRUCK TAKES THE SPACE OF THREE CARS. THE PARKING LOT IS COMPLETELY FILLED WITH 12 TRUCKS. IF THERE ARE FOUR ROWS IN THE PARKING LOT, HOW MANY CARS COULD BE PARKED IN EACH ROW?

A.5.1

12 TRUCKS 4 ROWS

15.2

12 TRUCKS 4 ROWS

12 ÷ 4 = $\square$ TRUCKS IN A ROW

.5.2.

12 TRUCKS 4 ROWS

12 ÷ 4 = $\square$ TRUCKS IN ROW

$\square$ X 3 = $\triangle$ CARS IN ROW

Appendix E

Guidelines for the Use of Hints

A. GUIDELINES FOR DECISION MAKING REGARDING HINTS

Hints are given under three circumstances

1. The student asks for help. Here the hint level depends upon the criteria given for each problem.

2. The interviewer observes student's difficulty and determines help is needed.

   a. Fraction problems - student attempts to solve problem analytically.

   b. Other problems - student does not ask for help but is making no progress. Hint level criteria is the same used as when the student asks for help.

3. Student is unable to draw any pictorial representation of the given problem.

B. GUIDELINES FOR EACH PROBLEM FOR DECISION MAKING REGARDING HINTS (Year III)

Sample Problem 1: Lou wants to fence in a garden 6 feet long and 4 feet wide with posts for the fence 2 feet apart. How many posts will be needed for the fence?

ANSWER: 10 posts

HINTS AND WHEN GIVEN:

Hint #1a. when the student is unable to draw any picture

b. when the student's picture does not include a rectangular region.

Hint #2a. when the student asks for a hint and/or the student's picture includes a rectangular region but no representation of posts.

b. when the student is unable to use Hint #1 to solve the problem.

Hint #3a. when the student asks for a hint and/or the student's picture includes a rectangular region and some representation of posts.

b. when the student is unable to use Hint #2 to solve the problem.

Hint #1 ---------- a rectangular region

Hint #2 ---------- a rectangular region with 2 black dots representing posts.

Hint #3 ---------- a rectangular region with 10 black dots representing the posts, labels for length (6 feet), width (4 feet) and distance between posts (2 feet)

Sample Problem 2: 3/4 - 1/2 =

ANSWER: 1/4

HINTS AND WHEN GIVEN:

Hint #1 when student is unable to draw any picture.

Hint #2a. when the student asks for a hint and/or the student's picture includes some representation of a unit, but does not show 3/4.

b. when the student is unable to use Hint #1 to solve the problem.

Hint #3a. when the student asks for a hint and/or student's picture shows 3/4 but is unable to solve the problem.

b. student is unable to use Hint #2 to solve the problem.

Hint #1 ---------- a circular region

Hint #2 ---------- a circular region divided into fourths with 3/4 shaded.

Hint #3 ---------- 2 circular regions with 3/4 shaded in the first region and 1/2 shaded in the second region.

1. A rubber ball bounces back up half the height it falls. If the ball is dropped from a height of 100 feet, how far will it have travelled altogether up and down when it hits the ground for the fourth time?

ANSWER: 275 feet

HINTS AND WHEN GIVEN:

Hint #1 when student is unable to draw any picture.

Hint #2a. when student asks for a hint and/or student's picture does not show path of ball.

b. if student is unable to solve the problem using Hint 1.

Hint 3a. when student asks for a hint and/or student's picture shows partial path of the ball, but incorrect solution.

b. if student is unable to use Hint #2 to solve the problem.

Hint #1 ---------- ball, vertical distance axis, ground

Hint #2 ---------- ball, vertical distance axis with some metric, ground, partial path of ball.

Hint #3 ---------- ball, vertical distance axis with all metric, ground, complete path of ball and labels.

2. $5 \times 1/3 =$

ANSWER: <u>5/3 or 1-2/3</u>

HINTS AND WHEN GIVEN:

Hint #1 when student is unable to draw any picture.

Hint #2a. when student asks for a hint and/or student's picture does not have region in thirds with one third shaded.

b. student is unable to solve the problem with Hint #1.

Hint #3a. when student asks for a hint

b. student is unable to use Hint #2 to solve the problem.

Hint #1 ---------- circle in thirds, 1/3 shaded

Hint #2 ---------- 5 circles in thirds, 1/3 shaded in each

Hint #3 ---------- 2 circles in thirds, 1-2/3 or 5/3 shaded

3. When Mike and Peter came home from school, they found half of a chocolate cake. Mike ate half of what was there and Peter ate a third of what Mike had left. How much of the whole cake was left after Peter ate his piece?

ANSWER: 1/6 of the cake

HINTS AND WHEN GIVEN:

Hint #1a. when student is unable to draw any picture.

b. when student's picture doesn't show half of a cake.

Hint #2a. when student asks for a hint and/or student's picture shows no division of half the cake into two parts.

b. student is unable to solve problem with Hint #1.

Hint #3a. when student asks for hint and/or student's picture doesn't show cake divided into twelfths.

b. when student is unable to solve problem with Hint #2.

Hint #1 ---------- one circle with a half shaded

Hint #2 ---------- one circle with a half shaded and a fourth shaded.

Hint #3 ---------- one circle with a half shaded, a fourth shaded, a third shaded and the circle divided into twelfths

4. A post 25 feet long is pounded into the bottom of a river near its bank. Eight and a fourth feet of the post is below the bottom of the river and three and three-fourths feet is above the surface of the water. How deep is the river at that point?

ANSWER: <u>13 feet</u>

Hint #1 when student is unable to draw any picture.

Hint #2a. when student asks for a hint and/or student's picture shows incorrect placement of surface or water and bottom of river.

b. when student is unable to solve problem with Hint #1.

Hint #3a. when student asks for hint and/or student's picture has lengths above and below the water labelled incorrectly.

b. when student is unable to solve the problem with Hint #2

Hint #1 ---------- a pole

Hint #2 ---------- a pole with markings for the top of the surface and bottom of the river

Hint #3 ---------- a pole with markings for the top of the surface and bottom of the river with the numbers correctly placed.

5. A bus has seats for 60 passengers. If one out of every five seats is empty, how many passengers are on the bus?

ANSWER: 48 passengers

HINTS AND WHEN GIVEN:

Hint #1a. when student is unable to draw any picture

b. when student's picture has incorrect number of seats represented

Hint #2a. when student asks for a hint and/or student's picture shows no representation of a pattern for the seats

b. when student is unable to solve problem with Hint #1

Hint #3a. when student asks for hint and/or student's picture shows no representation of one out of every five being empty (four out of five being filled)

b. student is unable to solve problem with Hint #2

Hint #1 ---------- four seats (circle as representation)

Hint #2 ---------- a. a five by twelve array of dots

b. a four by fifteen array of dots

c. a six by ten array of dots

Hint #3 ---------- a. a five by twelve array of dots with the first row circled

b. a four by fifteen array of dots with the fifth, tenth, and fifteenth columns crossed out

c. a six by ten array of dots with the fifth and tenth columns circled.

6. 1-1/3 - 1/2 = Answer: 5/6

HINTS AND WHEN GIVEN:

Hint #1a. when student is unable to draw any picture

b. when student's picture doesn't show 1-1/3

Hint #2a. when student asks for a hint and/or student's picture does not show both 1-1/3 and 1/2

b. student is unable to use Hint #1 to solve the problem.

Hint #3a. student asks for a hint and/or student's picture doesn't show 1-1/3 or 1/2 divided into 6ths.

b. student is unable to solve the problem with Hint #2

Hint #1 ---------- 2 circles, 1-1/3 shaded

Hint #2 ---------- 2 circles, 1-1/3 shaded, another circle, 1/2 shaded

Hint #3 ---------- 3 circles, the first circle completely shaded and divided in half, the second circle divided into sixths with one-third shaded, the third circle divided in half and one half shaded.

7. Pat started baking a cake and doing a load of laundry at the same time. The cake baked for thirty-five minutes and was finished at 6:00. If the laundry takes an hour and fifteen minutes to wash and dry, when will it be done? Answer: 6:40 or 20 minutes to 7

HINTS AND WHEN GIVEN:

Hint #1 when student is unable to draw any picture or when student's picture doesn't show 6:00.

Hint #2a. when the student asks for a hint and/or student's picture does not indicate correctly either i) the 35 minute baking time (if a partial counter clockwise path give appropriate Hint #2), ii) the 1-1/4 hour laundry time (if a partial clockwise path give appropriate Hint #2)

b. when student's picture shows no path or is unable to solve the problem using Hint #1 (give Hint #2 which shows the 35 minute counter-clockwise path in this case).

Hint #3a. when student asks for a hint and/or student's picture shows one of the time periods but not the other time period (give the Hint #3 which completes the student's picture)

b. when the student is unable to solve the problem using Hint #2 (give corresponding Hint #3).

Hint #1 ---------- clock with hands indicating the time 6:00

Hint #2 ---------- clock with hands indicating the time 6:00 and 5 minutes markings

a) arrow from top counter-clockwise around 35 minutes

b) arrow from top clockwise around 1-1/4 hour

Hint #3 ---------- clock with hands indicating the time 6:00 and 5 minute markings

a) arrow from top counter-clockwise around 35 minutes, another arrow from ending of other clockwise around 1-1/4 hour

b) arrow from top clockwise around 1-1/4 hour, another arrow from ending of other counter-clockwise around 35 minutes

8. 5/6 + 2/3 =

ANSWER: 1-1/2

HINTS AND WHEN GIVEN:

Hint #1a. when student is unable to draw any picture

when student's picture does not show sixths

Hint #2a. when student asks for a hint and/or student's picture does not show both five sixths and two thirds

b. when student is unable to use Hint #1 to solve the problem

Hint #3a. when student asks for a hint and/or student's picture does not show five sixths and two thirds divided into sixths

b. when student is unable to solve problem with Hint #2

Hint #1 ---------- one circle, five sixths shaded

Hint #2 ---------- two circles, one showing five sixths and the other two thirds

Hint #3 ---------- two circles, one showing five sixths and the other showing two thirds divided into sixths

9. Four people ordered a pizza. One person ate 1/3 of the pizza and left before anyone else had a piece. The remaining pizza was divided equally among the other three people. How much of the whole pizza did each of these three get?

ANSWER: 2/9 of the pizza

HINTS AND WHEN GIVEN:

Hint #1 when student is unable to draw any picture

Hint #2a. when student asks for help and/or student's picture doesn't show two thirds shaded

b. if student is unable to solve the problem with Hint #1

Hint #3a. when student asks for help and/or student's picture shows two thirds shaded and is unable to solve the problem.

b. if the student is unable to solve the problem with Hint #2

Hint #1 ---------- circular region

Hint #2 ---------- circular region with two thirds shaded

Hint #3 ---------- circular region with two thirds shaded and divided into nine parts

10. 3/8 + 3/4 =

ANSWER: <u>1-1/8</u>

HINTS AND WHEN GIVEN:

Hint #1a. when student is unable to draw any picture

b. when student's picture does not show eighths

Hint #2a. when student asks for a hint and/or student's picture does not show both three eighths and three fourths

b. when student is unable to use Hint #1 to solve the problem

Hint #3a. when student asks for a hint and/or student's picture does not show three eighths and three fourths divided into eighths

b. when student is unable to solve problem with Hint #2

Hint #1 ---------- one circle, three eights shaded

Hint #2 ---------- two circles, one showing three eighths and the other three fourths

Hint #3 ---------- two circles, one showing three eights and the other showing three fourths divided into eighths

11. Newspapers are delivered to a four-story apartment building with 40 apartments. If three out of every five apartments get a paper, how many papers are received each day?

ANSWER: <u>24 newspapers</u>

HINTS AND WHEN GIVEN:

Hint #1a. when student is unable to draw any picture

b. when student's picture has incorrect number of apartments represented

Hint #2a. when student asks for a hint and/or student's picture shows no representation of a pattern for the apartments

b. student is unable to solve the problem with Hint #1

Hint #3a. when student asks for a hint and/or student's picture shows no representation of three out of five marked (or 2 out of 5 marked)

b. student is unable to solve the problem with Hint #2

Hint #1 ---------- five apartments (dot as representation)

Hint #2 ---------- a) a five by eight array of dots

b) a four by ten array of dots

Hint #3 ---------- a) a five by eight array of dots with first three rows circled

b) a four by ten array of dots with the first three and the 6th, 7th, and 8th column circled

12. A square whose side is three inches long is cut from each corner of a rectangular piece of cardboard 12 inches wide and 18 inches long. If the cardboard is then folded up to make a box, what is the perimeter of the bottom of the box?

ANSWER: 36 inches

HINTS AND WHEN GIVEN:

Hint #1 when student is unable to draw any picture

Hint #2a. when student asks for a hint and/or student's picture doesn't show corners to be cut from the cardboard

b. when student is unable to solve the problem using Hint #1

Hint #3a. when student asks for a hint and/or student's picture has no markings to indicate the bottom of the box

b. student has no labels for 12 and/or 18 lengths or has labeled them incorrectly

c. when student is unable to solve the problem using Hint #2

Hint #1 ---------- rectangle

Hint #2 ---------- rectangle, squares in corners indicated

Hint #3 ---------- rectangle, squares in corners marked, bottom of box marked, labels for length and width of original cardboard and side of small square

Appendix F

Flowchart in Prose Form

Greet student cordially and have student sit in a place where you can observe his/her work.

Say to student:

TODAY I'M GOING TO ASK YOU TO WORK SOME MATHEMATICS PROBLEMS. THIS IS THE LAST YEAR OF THE STUDY. YOU HAVE WORKED SOME OF THE PROBLEMS BEFORE. WE ARE INTERESTED IN LEARNING ABOUT HOW STUDENTS YOUR AGE SOLVE MATHEMATICS PROBLEMS. WHATEVER YOU SAY TO ME DURING THIS INTERVIEW WILL NOT BE REPORTED TO YOUR MATHEMATICS TEACHER OR ANY OTHER TEACHER OR ANY OTHER PERSON. BECAUSE I WILL BE ASKING YOU CERTAIN QUESTIONS, I'M GOING TO RECORD THE INTERVIEW SO I WON'T HAVE TO TAKE A LOT OF NOTES. I'LL GIVE YOU TWO SAMPLE PROBLEMS AND EXPLAIN WHAT I WANT YOU TO DO USING THE SAMPLE PROBLEMS.

1 Give sample problem:

Then say:

I WANT YOU TO READ THE PROBLEM SILENTLY, JUST READ IT, DON'T TRY TO SOLVE IT, JUST READ IT. WHEN YOU HAVE FINISHED READING IT, TURN THE PAPER OVER.

Observe the student.

Make sure the student is not trying to solve the problem. If student seems to be taking an extremely long time, say:

REMEMBER, JUST READ THE PROBLEM. DON'T TRY TO SOLVE IT. WHEN YOU'RE FINISHED READING, TURN THE PAPER OVER.

When the student finishes reading the problem say:

NOW, IN YOUR OWN WORDS PLEASE TELL ME THE PROBLEM. DON'T TELL ME HOW TO SOLVE IT, JUST TELL ME THE PROBLEM.

If the student CORRECTLY describes the problem, <u>GO TO A</u>.

If the student is incorrectly describing the problem, let the student finish, then say:

NO, THAT'S NOT CORRECT, PLEASE READ IT AGAIN AND TURN THE PAPER OVER WHEN YOU'VE FINISHED.

When the student finishes reading the problem, say:

NOW, IN YOUR OWN WORDS, PLEASE TELL ME THE PROBLEM. DON'T TELL ME HOW TO SOLVE IT, JUST TELL ME THE PROBLEM.

If the student CORRECTLY describes the problem, <u>GO TO A</u>.

If the student is incorrectly describing the problem, let the student finish and then continue the interview by saying:

THAT'S NOT QUITE RIGHT, BUT LET'S CONTINUE. PLEASE TURN THE PAPER OVER.

<u>GO TO A</u>

A Give student a blank piece of paper and say:

HERE'S A BLANK PIECE OF PAPER. I WANT YOU TO DRAW A PICTURE TO SOLVE THE PROBLEM.

GO TO B ---------- Student gives answer without working problem.

GO TO C ---------- Student draws a picture.

GO TO D ---------- Student DOESN'T draw a picture.

If the student indicates he/she knows the answer, say:

PLEASE TELL ME THE ANSWER.

B If the student is CORRECT, say:

GOOD, PLEASE TELL ME HOW YOU FOUND THAT ANSWER.

After the student explains his/her procedure, say:

NOW USE THE BLANK PAPER TO DRAW A PICTURE TO SOLVE THE PROBLEM.

GO TO C ---------- Student draws a picture.

GO TO D ---------- Student DOESN'T draw a picture.

If the student is INCORRECT, say:

NO, YOUR ANSWER IS WRONG. PLEASE TRY TO DRAW A PICTURE TO SOLVE THE PROBLEM.

GO TO C ---------- Student draws a picture.

GO TO D ---------- Student DOESN'T draw a picture.

C If the student draws a picture and solves the problem, say:

PLEASE TELL ME YOUR ANSWER.

If the student gives the CORRECT answer, say:

THAT'S CORRECT. PLEASE TELL ME WHAT YOUR PICTURE SHOWS AND HOW YOU USED IT TO SOLVE THE PROBLEM.

Listen to the student's explanation. Encourage the student to 'speak up' when giving the explanation. After the student finishes, ask if there are any questions about what you expect throughout the interview. Then because these are sample problems, take the time to show the student all of the hints at this point and briefly explain each.

Say: *NOW, IF YOU COULDN'T DRAW A PICTURE, I WAS GOING TO GIVE YOU SOME HELP. LET ME SHOW YOU THE HINTS I WOULD HAVE GIVEN YOU.*

For the first sample problem:

Show Hint #1 and say:

HERE'S THE FIRST HINT. IT SHOWS A RECTANGLE WHICH I USED TO REPRESENT THE GARDEN. IF YOU COULDN'T GET THE ANSWER WITH THIS, I WOULD HAVE GIVEN YOU ANOTHER HINT.

Show Hint #2 and say:

HERE'S THE SECOND HINT. IT SHOWS THE RECTANGLE AND TWO BLACK DOTS REPRESENTING TWO OF THE POSTS. IF YOU COULDN'T GET THE ANSWER WITH THIS HINT, I WOULD HAVE GIVEN YOU MY LAST HINT.

Show Hint #3 and say:

HERE'S THE LAST HINT. IT SHOWS THE RECTANGLE AND DOTS REPRESENTING ALL THE POSTS AND LABELS FOR EACH OF THE LENGTHS MENTIONED IN THE PROBLEM.

GO TO 1

For the second sample problem:

Show Hint #1 and say:

HERE'S THE FIRST HINT. IT SHOWS A CIRCLE THAT COULD BE USED TO SHOW THE FRACTIONS IN THE PROBLEM. IF YOU COULDN'T GET THE ANSWER WITH THIS, I WOULD HAVE GIVEN YOU ANOTHER HINT.

Show Hint #2 and say:

HERE'S THE SECOND HINT. IT SHOWS THE CIRCLE DIVIDED INTO 4 EQUAL PARTS AND 3/4 OF THE CIRCLE IS SHADED. IF YOU COULDN'T GET THE ANSWER WITH THIS HINT, I WOULD HAVE GIVEN YOU MY LAST HINT.

Show Hint #3 and say:

HERE'S THE LAST HINT. IT SHOWS THE FIRST CIRCLE WITH 3/4 OF IT SHADED. IT ALSO SHOWS ANOTHER CIRCLE DIVIDED INTO TWO EQUAL PARTS WITH HALF OF IT SHADED.

I DO HAVE A SERIES OF HINTS LIKE THESE FOR EACH OF THE PROBLEMS YOU'LL BE SOLVING, SO IF YOU NEED HELP, I'LL GIVE YOU THIS KIND OF HELP.

<u>GO TO E</u>

If the student gives the INCORRECT answer, say:

OKAY, LET ME GIVE YOU A HINT. HERE'S HINT _____: TRY TO USE IT TO SOLVE THE PROBLEM.

(WHILE YOU ARE SAYING THE ABOVE, EXCHANGE THE STUDENT'S PICTURE FOR THE FIRST HINT <u>OR</u> THE HINT AT THE NEXT LEVEL ABOVE THE STUDENT'S PICTURE <u>OR</u> THE LAST HINT IF THE STUDENT'S PICTURE LOOKS LIKE OUR LAST HINT. IF LAST, GO TO 3.)

H If the student solves the problem with the given hint, say:

PLEASE TELL ME THE ANSWER.

If the student gives the CORRECT answer, say:

GOOD. PLEASE TELL ME HOW YOU USED HINT _____ TO GET THAT ANSWER.

Listen to the student's explanation. Encourage the student to 'speak up' when giving the explanation. After the student finishes, ask if there are any questions about what you expect throughout the interview.

Because this is the sample problem, take the time to show the student all of the hints at this point and briefly explain each.

Say:

NOW IF YOU DIDN'T GET THE RIGHT ANSWER WITH THIS HINT, I WOULD HAVE GIVEN YOU HINT _____ (SEE ABOVE AND CONTINUE AT THE APPROPRIATE PLACE IN THE EXPLANATION OF THE HINTS.)

2 If the student is INCORRECT, say:

OKAY, LET ME GIVE YOU THE NEXT HINT. HERE'S HINT _____: TRY TO USE IT TO SOLVE THE PROBLEM.

(WHILE YOU ARE SAYING THE ABOVE, EXCHANGE THE PREVIOUS HINT WITH THE HINT FOR THE NEXT LEVEL. CONTINUE THIS PROCEDURE UNTIL YOU HAVE GIVEN THE THIRD HINT.)

3 If the student solves the problem with the third hint, say:

PLEASE TELL ME THE ANSWER.

If the student gives the CORRECT answer, say:

GOOD. PLEASE TELL ME HOW YOU USED HINT THREE TO GET THAT ANSWER.

Listen to the student's explanation. Encourage the student to 'speak up' when giving the explanation. After the student finishes, ask if there are any questions about what you expect throughout the interview. In this situation, go over the three hints with the student as described above. If it is the first sample problem GO TO ①. If it is the second sample problem, GO TO E.

If the student does not solve the problem with the third hint, say:

ALRIGHT. EXPLAIN TO ME HOW YOU TRIED TO SOLVE THE PROBLEM.

Listen to the student's explanation. Encourage the student to 'speak up' when giving the explanation. After the student finishes, ask if there are any questions about what you expect throughout the interview. In this situation, go over the solution of the problem with the student using the third hint in the following manner:

For the first sample problem say:

THIS THIRD HINT SHOWS A RECTANGLE REPRESENTING THE GARDEN AND BLACK DOTS REPRESENTING THE POSTS PLACED 2 FEET APART. WHEN WE COUNT THE DOTS, WE FIND THAT THERE ARE 10 POSTS AROUND LOU's GARDEN. DO YOU UNDERSTAND?

GO TO ①

For the second sample problem, say:

THIS THIRD HINT SHOWS A CIRCLE WITH 3/4 OF IT SHADED AND ANOTHER CIRCLE WITH 1/2 SHADED. TO FIND THE ANSWER, WE TAKE A PIECE THE SIZE OF THE HALF AWAY FROM THE 3/4 (POINT TO 2/4 OF THE 3/4 SHADED) *LEAVING THIS SMALL PIECE* (POINT TO THE 1/4 LEFT) *WHICH IS 1/4. DO YOU UNDERSTAND?*

D If the student does not draw any picture or indicates an inability to draw a picture, or appears puzzled, give the first hint. REMOVE THE BLANK PAPER, replace it with the first hint and say:

HERE'S THE FIRST HINT. TRY TO USE IT TO SOLVE THE PROBLEM.

GO TO H

E MAKE SURE THE STUDENT UNDERSTANDS WHAT IS EXPECTED OF HER/HIM DURING THE INTERVIEW. GO OVER THE PROCEDURE.

a. Read the problem silently.
b. Tell me the problem in your own words.
c. Draw a picture and use it to solve the problem - hints will be given where necessary, but it is important that you try to draw a picture.
d. Explain to me how you solved the problem with the picture.

GO TO I

I YOU ARE NOW READY TO PROCEED WITH THE MATHEMATICAL THINKING INTERVIEW.

After you have answered any questions the student has regarding the procedure, say:

I1 *NOW WE'RE GOING TO DO __________ PROBLEMS. HERE'S PROBLEM NUMBER _____.*

(Give student the problem as indicated on your record sheet and indicate number.)

Then say:

I WANT YOU TO READ THE PROBLEM SILENTLY, JUST READ IT, DON'T TRY TO SOLVE IT, JUST READ IT. WHEN YOU HAVE FINISHED READING IT, TURN TEH PAPER OVER.

Observe the student. If the student seems to be taking an extremely long time, say:

REMEMBER, JUST READ THE PROBLEM, DON'T TRY TO SOLVE IT. WHEN YOU'VE FINISHED READING, TURN THE PAPER OVER.

When the student finishes reading the problem, say:

NOW, IN YOUR OWN WORDS PLEASE TELL ME THE PROBLEM. DON'T TELL ME HOW TO SOLVE IT, JUST TELL ME THE PROBLEM.

If the student CORRECTLY describes the problem, <u>GO TO IA</u>.

If the student INCORRECTLY describes the problem, let the student finish, then say:

NO, THAT'S NOT CORRECT. PLEASE READ IT AGAIN AND TURN THE PAPER OVER WHEN YOU'VE FINISHED.

When the student finishes reading the problem, say:

NOW, IN YOUR OWN WORDS PLEASE TELL ME THE PROBLEM. DON'T TELL ME HOW TO SOLVE IT, JUST TELL ME THE PROBLEM.

If the student CORRECTLY describes the problem, <u>GO TO IA</u>.

If the student is incorrectly describing the problem, let the student finish and then continue the interview by saying:

THAT'S NOT QUITE RIGHT, BUT LET'S CONTINUE. PLEASE TURN THE PAPER OVER. <u>GO TO IA</u>.

IA Give the student a blank piece of paper and say:

HERE'S A BLANK PIECE OF PAPER. I WANT YOU TO DRAW A PICTURE TO SOLVE THE PROBLEM.

GO TO IB ---------- Student gives answer without working problem (i.e. VOLUNTEERS answer)

GO TO IC ---------- Student draws a picture.

GO TO ID............Student DOES NOT draw a picture.

IB If the student indicates he/she knows the answer, say:
PLEASE TELL ME THE ANSWER.

If the student is CORRECT, say:
GOOD, PLEASE TELL ME HOW YOU FOUND THAT ANSWER.

After the student explains his/her procedure, say:
NOW, USE THE BLANK PAPER TO DRAW A PICTURE TO SOLVE THE PROBLEM.
GO TO IC............Student draws a picture.
GO TO ID............Student DOES NOT draw a picture.

If the student is INCORRECT, say:
NO, YOUR ANSWER IS WRONG, PLEASE TRY TO DRAW A PICTURE TO SOLVE THE PROBLEM.
GO TO IC............Student draws a picture.
GO TO ID............Student DOES NOT draw a picture.

IC If the student draws a picture and solves the problem, say:
PLEASE TELL ME YOUR ANSWER.

If the student gives the CORRECT answer, say:
GOOD, PLEASE TELL ME WHAT YOUR PICTURE SHOWS AND HOW YOU USED IT TO SOLVE THE PROBLEM.

Listen to student's explanation. Collect materials for problem; problem statement and student's picture. Staple materials and put aside. Continue at I1. If this is the last problem, GO to S.

If the student gives the INCORRECT answer, say:
OKAY. LET ME GIVE YOU A HINT. HERE'S HINT________________: TRY TO USE IT TO SOLVE THE PROBLEM.

(WHILE YOU ARE SAYING THE ABOVE, EXCHANGE THE STUDENT'S PICTURE FOR THE FIRST HINT OR THE HINT AT THE NEXT LEVEL ABOVE THE STUDENT'S PICTURE OR THE LAST HINT IF THE STUDENT'S PICTURE LOOKS LIKE OUR LAST HINT.)
IF YOU GIVE THE STUDENT THE LAST HINT GO TO I3.

If the student solves the problem with the given hint, say:
PLEASE TELL ME THE ANSWER.

If the student gives the CORRECT answer, say:

GOOD. PLEASE TELL ME HOW YOU USED HINT ___________ TO GET THAT ANSWER.

Listen to the student's explanation. When the student finishes, collect materials used; problem, translation picture, and hint(s). Staple, set aside. Continue at I1. If last problem GO TO S.

If the student is INCORRECT, say:

OKAY. LET ME GIVE YOU THE NEXT HINT. HERE'S HINT______________: TRY TO USE IT TO SOLVE THE PROBLEM.

(WHILE YOU ARE SAYING THE ABOVE, EXCHANGE THE PREVIOUS HINT WITH THE HINT FOR THE NEXT LEVEL. CONTINUE THIS PROCEDURE UNTIL YOU HAVE GIVEN THE THIRD HINT.)

If the student solves the problem with the third hint, say:

PLEASE TELL ME THE ANSWER.

If the student gives the CORRECT answer, say:

GOOD, PLEASE TELL ME HOW YOU USED HINT THREE TO GET THAT ANSWER.

Listen to the student's explanation. When the student finishes, collect materials used; problem, translation picture, and hint(s). Staple, set aside. Continue at I1. If last problem, GO TO S.

If the student does not solve the problem with the third hint, say:

ALRIGHT. EXPLAIN TO HE HOW YOU TRIED TO SOLVE THE PROBLEM.

Listen to the student's explanation. When the student finishes, collect materials used; problem, translation picture, and hint(s). Staple, set aside. Continue at I1. If last problem, GO TO S.

ID If the student does not draw any picture or indicates an inability to draw a picture, or appears puzzled, give the first hint. REMOVE THE BLANK PAPER, replace it with the first hint and say:

LET ME GIVE YOU SOME HELP, HERE'S THE FIRST HINT: TRY TO USE IT TO SOLVE THE PROBLEM.

GO TO IH

S When you have completed the interview, thank the student for his/her cooperation, then say:

THERE'S ONE THING I MUST ASK YOU TO DO. PLEASE DO NOT DISCUSS ANY OF THE PROBLEMS THAT YOU'VE DONE TODAY WITH YOUR FRIENDS SINCE I'LL BE INTERVIEWING OTHER STUDENTS AND THEY'LL BE DOING THE SAME PROBLEMS.

Send student back to appropriate place or person. If you are interviewing another student, put all of the materials away from the previous interview. Remove the tape from the recorder, if you have time, rewind it; put all unused hints away; put the booklet away; and get necessary equipment ready for the next student. Begin interview as above.

When you finish interviewing, make sure you have collected all of your materials; leave the room in the same order that you found it; if you are leaving for the day, stop at the appropriate place to indicate you have finished and indicate when you will return. Thank them for their cooperation.

Appendix G

Outline of Training Sessions

Training Sessions for Interviewers

I. First session - orientation to instrument (approximately 2 hours)

A. Work through problems with hints

a) discuss mathematics of each problem

b) discuss hints and when given

B. assignment for next session: read training procedures

II. Second session - procedure orientation (approximately 2 hours)

A. Review - Questions about instrument

B. Manual - Questions about purpose and procedures

C. Work through procedure - use summary sheet and cue cards

a) discuss three phases of interview

b) go through each problem with hints

D. Interviewers in pairs practicing with each other

E. Discuss practice

III. Third session - interviewer's tasks approximately 2 hours)

A. Review - Questions

B. Written record

1. Explain each part with examples

2. Do examples from transcript or with volunteer

C. Interviewers in pairs to practice recording

D. Discuss practice

E. Specific details about schools, equipment and scheduling

F. For next session: practice entire instrument with a student

IV. Fourth session - discussion of first practice (approximately 1 hour)

A. Review - Questions

B. Questions about practice

C. For next session: practice instrument with two students

V. Fifth session - discussion of second practice (approximately 1 hour)

A. Feedback after listening to first tapes

B. Questions about first practice

C. Set up individual meetings (one or two as needed) with interviewer

D. For individual meetings: practice with one or two schools

VI. Individual meetings with interviewers

A. Feedback after listening to second and third tapes

B. Questions about second practice

C. Decision about need for further practice

Appendix H

Year III Sample Transcript

Student ID. 3166 Mathematical Thinking Booklet 007

Date: 3/25/81 Time: 9:00 Interviewer: LT

Problem	Hint Sequence	Correctness	Use of Picture	Arrangement and Comments
2	1 2 3	Yes No	High (Pictorial) Medium (Both) Low (Computational)	
3	1 2 3	Yes No	High (Pictorial) Medium (Both) Low (Computational)	
8	1 2 3	Yes No	High (Pictorial) Medium (Both) Low (Computational)	
12	1 2 3	Yes No	High (Pictorial) Medium (Both) Low (Computational)	with [illegible]
7	1 2 3	Yes No	High (Pictorial) Medium (Both) Low) (Computational)	when discussing solution made circular (clockwise thing)
6	1 2 3	Yes No	High (Pictorial) Medium (Both) Low (Computational)	put 1/2 [illegible]
9	1 2 3	Yes No	High (Pictorial) Medium (Both) Low (Computational)	generalized oral 1st [illegible]
10	1 2 3	Yes NO	High (Pictorial) Medium (Both) Low (Computational)	
5	1 2 3	Yes No	High (Pictorial) Medium (Both) Low (Computational)	solved before picture needed picture over 20 × 3
4	1 2 3	Yes No	High (Pictorial) Medium (Both) Low (Computational)	
11	1 2 3	Yes No	High (Pictorial) Medium (Both) Low (Computational)	(2 hints) 4X10 would have given (b) but she fixed it made [illegible]
1	1 2 3	Yes No	High (Pictorial) Medium (Both) Low (Computational)	

Sample Problem 1: Lou wants to fence in a garden 6 feet long and 4 feet wide with posts for the fence 2 feet apart. How many posts will be needed for the fence?

Student #: 3166 Booklet #: 007 Interviewer: Lindsay

Transcribed: Date: 4/29/81 By: CLS

I: Okay,today I'm going to ask you to work some math problems. This is the last year of the study. Ah, you've worked some of these problems before. We are interested in learning how students your age solve math problems. Whatever you say to me during this interview will be, will not be reported to your math teacher or ~~xxxx~~ any other teacher or any other person. Because I will be askingyou certain questions I'm going to record the interview so I won't have to take a lot of notes... I'll give you two sample problems. And explain with I want you to do using the sample problems. If you don't know the meaning of a particular word, please ask, okay? So much for that. This ??? so you know where you were (I think that's right). Okay, first is, sample problem one. And what I'd like for you to do is just read the problem silently, don't try to solve it, just read it and when you're finished reading it, turn the paper over..........Okay, tell me the problem.

S: UM...THIS GUY WANTS TO, UM, MAKE A GARDEN WITH, THAT'S SIX FEET LENGTH AND FOUR FEET WIDE AND THEY WANNA KNOW HOW MANY POSTS HE'S GONNA HAVE. IF THE POSTS ARE TWO FEET APART.

I: Okay, good. Now here's a blank piece of paper. And what I'd like for you to do is draw a picture to solve theproblem. And that's an erasable pen (OKAY).........(pause)

S: DO I SOLVE IT OR NO.

I: Yes I'd like for you to s, use that picture to solve the problem......(pause)

S: ~~XXXXXXXXXXXXXXXXXXXXXXX~~ (mumbling:) IS THAT RIGHT?

I: Okay, let me give you a hint. Let me give you hint number two. See if you can use hint two to solve the problem.........

S: OKAY I KNOW, DO I WRITE IT DOWN ON THIS ONE?

I: You don't have to if it, if you just tell me what the problem is you won't have to write on,

S: UM, TEN FEET? I MEAN TEN POSTS ??.

I: Okay, could you tell me how you used hint two to solve that problem?

S: OH BECAUSE IT'S, IT'S SIX AND SIX AND FOUR AND FOUR AND YOU HAVE TO ADD EM UP AND I TIMESED EM ON THE OTHER ONE.

I: What's six and six and,

S: UM, SIX AND SIX AND FOUR AND FOUR.

I: Oh, the length of the sides.

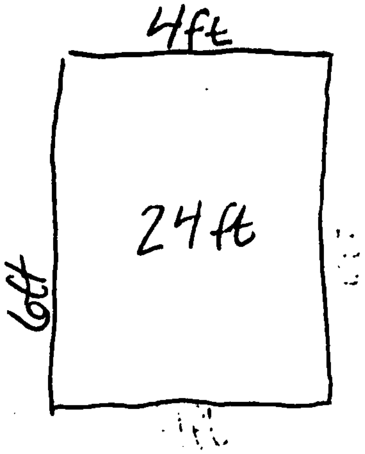
S: AND YOU HAVE TO ADD EM ALL UP AND IT EQUALS 20 AND THEN YOU DIVIDE BY TWO.

I: Oh I see. Okay. Good Now I have um, hints like these for all of the, you didn't [ne]ed hint one cuz you had drawn the rectangle to get you started. (UMHUM) And hint

I: (continued) three is the complete picture with all the little posts and the, all of the numbers and everything, and now. I have hints like this for all of the problems that you're going to be doing today. And tommorrow. And so if you need help, that's the kind of help I'm going to be giving you. I'm going to give you another sample problem.

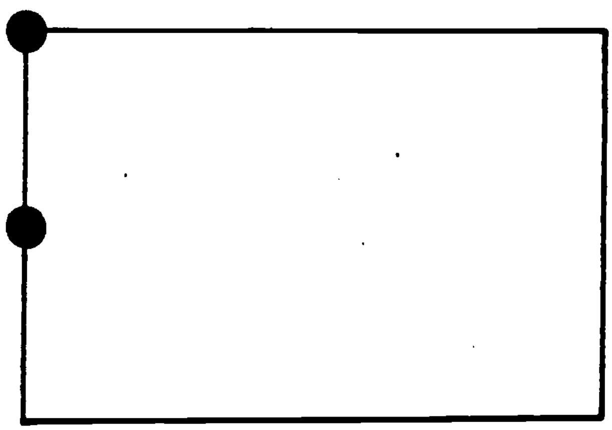
SP1: Blank

3166



12 posts

SP1; H2



Sample Problem 2: 3/4 - 1/2 =

Student #: 3166 Booklet #: 007 Interviewer: Lindsay

Transcribed: Date: 4/29/81 By: CLS Page 1 of 1

I: This is sample problem 2. All right first I'd like for you to just read it silently, and when you're finished reading it, turn the paper over...... Okay, tell me the problem.

S: THREE FOURTHS TAKE AWAY ONE HALF.

I: Good....Okay, here is a blank piece of paper. And I'd like for you to draw a picture, ?? so you can see it, to solve the problem...........Okay tell me the answer.

S: ONE FOURTH.

I: Okay good! Could you tell me what your picture shows and how you used it to solve the problem.

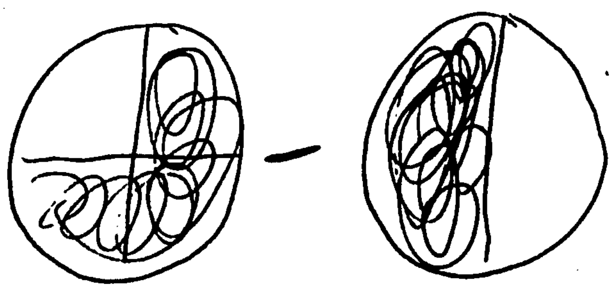
S: UM IT SHOWS THREE FOURTHS AND ONE HALF AND THEN, UM, I JUST TOOK THE ONE HALF AND PUT IT OVER THE THREE FOURTHS AND THERE'S ONE FOURTH LEFT.

I: Okay, good! Very good. Okay ah, for this one I also had a series of hints. Ah, the first you didn't need cuz you got the right answer, with out it. And these hints look very much like what you did first one's a circle, the second one uhm, is, a circle into three fourths, one with three fourths shaded. Then we have the three fourths shaded and the one half shaded in hint three. And again I have hints just like these if you get stuck someplace and you need some help that's, the kind of help I'll give you. Okay. Let me review for you the kind of thing I'm going to have you do. First I'm going to ask you to read the problem silently. And then after you've read the problem silently I'll have you tell me the problem. And then I'll ask you to draw a picture to solve the problem. Then I'll ask you to tell me how you solved the problem (OKAY). Okay?..Okay, first,

3166

SAMPLE PROBLEM 2: SY: 3/4 - 1/2 =

SP2: Oank



1/4

SY2. 5 x 1/3 =

Student #: 3166 Booklet #: 007 Interviewer: Lindsay

Transcribed: Date: 4/29/81 By· CLS Page 1 of 1

I: is problem 2. And I'd like for you to read prob, if I can get it out of here. Read problem 2 silently and when you're finisehd reading it, turn the paper over....... Okay tell me the problem.

S: FIVE TIMES ONE THIRD.

I: Okay good. Here is a blank piece of paper and I'd like for you to draw a picture to solve the problem.....(pause)

S: IS IT ONE AND ONE HALF?

I: Okay, let me give you hint, two. See if you can use hint two, to solve the problem...

S: ....FIVE THIRDS.

I: Okay, good.

S: BUT WOULDN'T YOU REDUCE IT, I MEAN MAKE IT INTO,

I: You can if you want.

S: NUMBER, WOULDN"T THAT BE ONE AND ONE HALF? OR NO. ONE AND...AND TWO THIRDS?

I: Okay good. You don't have to. (OKAY) But you can. All right, ah can you tell me how you used hint two to get that answer?

S: WELL IT JUST, (both laugh a bit) LOOKS LIKE IT,

I: Okay, well tell me,

S: CUZ THERE WAS FIVE, AND THEY WERE ALL SHADED IN THIRDS.

I: Okay. And so how, so what'd you do.

S: JUST PUT FIVE ON TOP OF THIRD AND GOT,

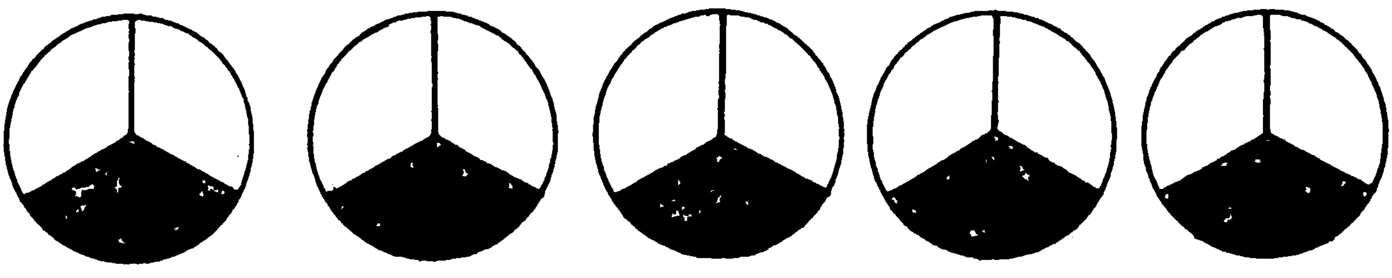
I: Okay, that's good...All right ah,...that's good. Ah,

#316a

SY2: Blank

1½

SY2: H2.



PR3. When Mike and Peter came home from school, they found half of a chocolate cake. Mike ate half of what was there and Peter at a third of what Mike had left. How much of the whole cake was left after Peter ate his piece?

Student #: 3166 Booklet #: 007 Interviewer: Lindsay

Transcribed: Date 4/29/81 By: CLS Page 1 of 1

I: Next is problem 3. And I'd like you to read problem 3 silently and when you're finished reading it, turn the paper over......(pause) Okay tell me the problem.

S: UM, THESE TWO KIDS CAME HOME FROM SCHOOL AND FOUND A HALF OF CAKE AND ONE OF EM ATE HALF OF THE HALF AND ONE OF EM ATE, A THIRD OF WHAT, THE OTH, WHAT WAS LEFT FROM THE OTHER KID EATING IT....IS THAT RIGHT?

I: Do you remember, do you remember anything else about the problem?

S: UM, HOW MUCH WAS LEFT.

I: Okay, good. (Chuckle). All right, here's a blank piece of paper. And I'd like for you to draw a picutre to solve the problem.......(pause)

S: UM.........TWO SIXTHS?

I: Okay, let me giveyou a hint...Why don't I give you hint number three. See if you can use hint three to solve the problem.......(pause)

S: UM, ONE SIXTH? (Chuckle)

I: Okay, good. Can you tell me how you used hint three to get that answer?

S: WELL THEY DIVIDED IT INTO 12THS. AND THAT, EQUALED TWO TWELFTHS. AND THEN I REDUCED IT TO ONE SIXTH.

I: Okay, run through exactly what you did. Tell me about hint three and then whatyou did cuz I, I'm, (UM) don't miss anything.

S: ...I JUST ADDED ON WHAT PETER ATE, AND, THEN, FIGURED OUT WHAT WAS LEFT.

I: How. What'd you do.

S: I COUNTED.

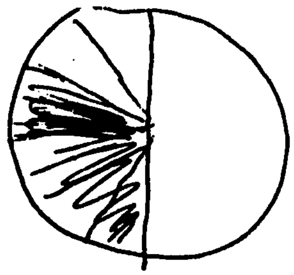
I: Okay, what did, what did you count.

S: THE TWO, LEFT.

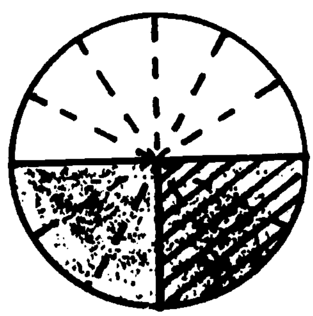
I: Oh, the two left, okay, that's, that's really what I wanted you ???, how you got the, two. Sort of sort of dropped out of the sky. (UH) I didn't know where you got it. Okay.

\#3166

PR3: Blank



PR3: H3.



SY8. 5/6 + 2/3 =

Student #: 3166 Booklet #: 007 Interviewer: Lindsay

Transcribed: Date: 4/29/81 By: CLS Page 1 of 1

I: Here is, problem 8. I'd like you to read problem 8 silently and when you're finished reading it, turn the paper over.....Okay tell me the problems

S: FIVE SIXTHS PLUS TWO THIRDS.

I: Good. Here is a blank piece of paper. And I'd like for you to draw a picture, to solve the problem...(pause)

S: UM, NINE SIXTHS.

I: Okay, good. Couldyou tell me what your picture shows and how you used it to solve

S: IT SHOWS

I: the problem.

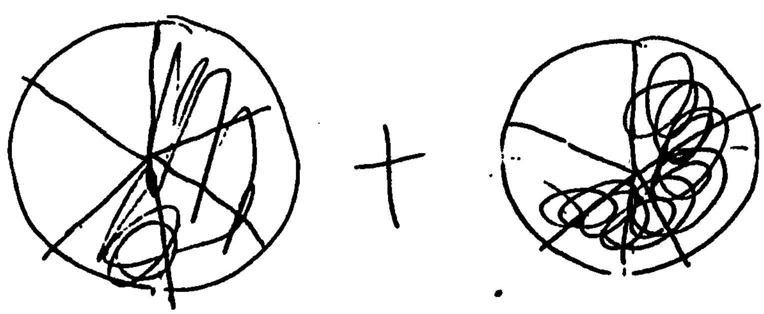
S: UM, TWO THIRDS, AND, FIVE SIXTHS. AND THEN SO THEN I DIVIDED IT INTO THIRDS INTO SIXTHS BECAUSE THEY WILL HAVE TO BE THE SAME. AND THEN I JUST ADDED FIVE, AND ANOTHER FOUR SIXTHS. AND FIVE AND FOUR IS NINE.

I: Oh. Okay...Good..... Very good.

#3166

SY8: 5/6 + 2/3 =

SY8: Blank



PR 12. A square whose side is three inches long is cut from each corner of a rectangular piece of cardboard 12 inches wide and 18 inches long. If the cardboard is then folded up to make a box, what is the perimeter of the bottom of the box?

Student #: 3166 Booklet #: 007 Interviewer: Lindsay

Transcribed: Date: 4/29/81 By: CLS Page 1 of 2

I: Okay next is problem number 12. I'd like for you to read problem 12 silently and when you're finished reading it, turn the paper over.......(pause) (OKAY) Okay tell me the problem.

S: THEY CUT THREE INCH SQUARES OUT OF, OUT OF LONG PIECE OF CARDBORD AND THEY WANNA KNOW UM, WHAT THE PERIMETER IS AFTER THEY FOLD IT UP? INTO A BOX.

I: Okay now that's not exactly correct. Why don't you read it again and when you're finished reading it, turn the paper over...........(pause) Okay tell me the problem.

S: UM, THERE'S A BIG RECTANGULAR PIECE OF CARDBOARD AND THEY CUT THREE INCH SQUARES OUT OF EVERY, CORNER AND THEN THEY FOLD IT UP INTO THE BOX AND THEY WANNA KNOW THE PERIMTER OF THE BOTTOM (Okay) OF THE BOX.

I: Okay...Ah, here's a blank piece of paper. ..And I'd like for you to draw a picture, to solve the problem.....(pause)

S: UM.......SIX INCHES?

I: Okay, let me give you a hint...Three. And that rem, I, was looking over here and I remember that I forgot to say that, the perimeter means how far around (OKAY) okay? Here's hint three. See if you an use hint three to solve the problem.......(pause)

S: ??? SIX BY FOUR?

I: Okay have you got, to, tell me the answer?

S: HUH?

I: Tell me what your answer is? I couldn't hear you.

S: OH. OH...OH I GOT TO ADD IT ALL UP RIGHT?...

I: Okay I,

S: ALL THE WAY AROUND.

I: I don't know, let me know when you're, when, I can't give you any help,

S: OH OKAY.

I: Okay? Perimeter means how far around. That's, that's the only thing I can tell you.

S: OKAY UM,

I: And ah,

S: TWENTY INCHES.

I: When you're...you, we're not in any hurry now, (NO), whenever you, okay. Tell me your answer.

S: TWENTY INCHES.

I: Okay, tell me how you used hint three to get that answer.

S: .....WELL I JUST LOOKED AT IT. SO (both laugh a bit)

I: You just looked at it and then 20 just sort of lifted off the paper did it?

S: YEH. (Both laugh a bit) I DID 18 TAKE AWAY UM, SIX, IS 12.....NO WAIT....I DID, UM, 18 DIVIDED BY THREE, IS SIX AND 12 DIVIDED BY THREE IS FOUR...

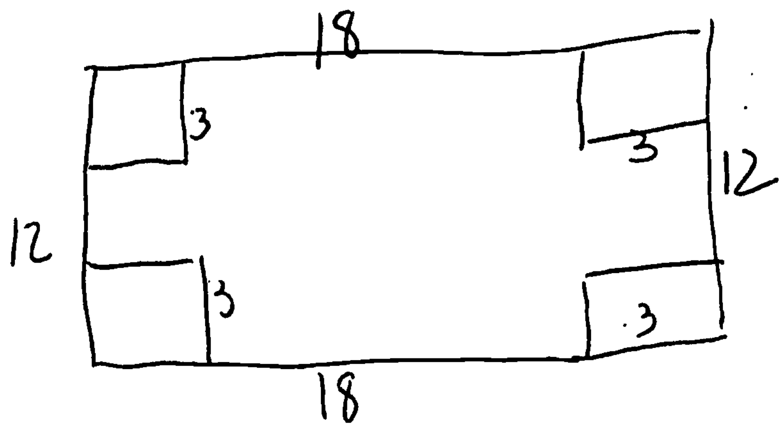
I: Umhum.

S: AND THEN I ADDED EM UP.

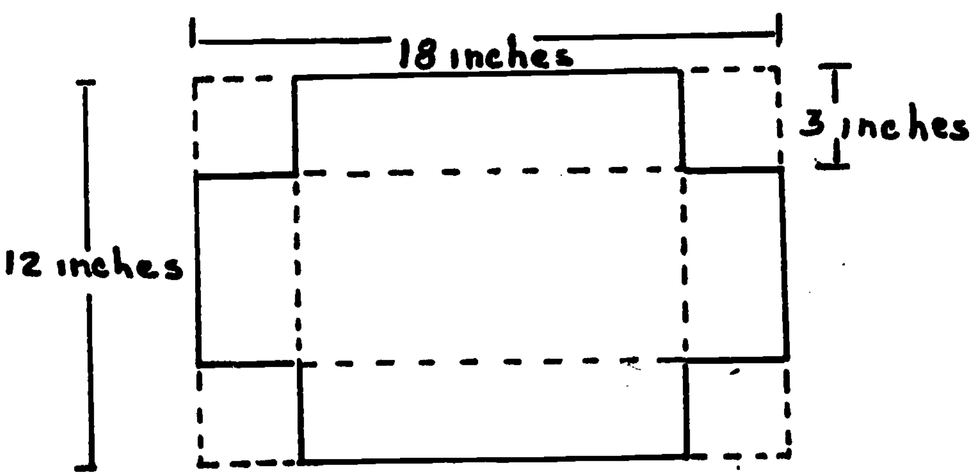
I: Oh, okay. Okay good.....

3166

PR12: Blank



PR12: H3.



PR 7. Pat started baking a cake and doing a load of laundry at the same time. The cake baked for thirty-five minutes and was finished at 6:00. If the laundry takes an hour and fifteen minutes to wash and dry, when will it be done?

Student #: 3166 Booklet #: 007 Interviewer: Lindsay

Transcribed. Date: 4/29/81 By: CLS Page 1 of 1

I: And give you the next one which is problem 7. I'd like you to read problem 7 silently, and when you're finished reading it, turn the paper over.......... (pause) (OKAY) Tell me the problem.

S: OKAY A LADY, BAKED A CAKE AND STARTED WASH AT THE SAME TIME. AND THE CAKE BAKES FOR 35 MINUTES, AND SHE WA, AND IT WAS FINISHED AT SIX O'CLOCK. AND THEY WANNA KNOW, UM, WHAT TIME SHE'S GOING TO GET DONE WITH THE WASH CUZ THAT TAKES AN HOUR AND FIFTEEN MINUTES.

I: Okay good. Here's a blank piece of paper. And I'd like for you to draw a picture to solve thatproblem......(pause)

S: I COULD DO IT IF I DIDN'T HAVE TO DRAW THEM PICTURE........(pause)

I: If you get stuck I can give you some hints. (UM) ???. There's no hurry. I just, want you to know that.........

S: ......UM..........SIX FORTY.

I: Okay could you tell me what your picture shows and how you used that picture to solve the problem?

S: SHOWS THE CAKE GETTING, UM, BAKING FOR 35 MINUTES AND THE, I MEAN, YEH AND THIS IS THE WASH. AND IT'S, WASHING FOR AN HOUR AND FIFTEEN MINUTES. AND I, ADDED EM IN MY HEAD.

I: Added (I DON'T KNOW) what. Okay. I realize you must havedone something in your head,

S: ??

I: becuase (YEH) it doesn't look obvious from what you go tthere.

S: I DIDN'T KNOW I DIDN"T KNOW WHAT TO DRAW.

I: Well what exactly did you do?

S: OKAY I WENT SIX TAKE AWAY THIRTY FIVE IS, FIVE 25 PLUS AN HOUR IS SIX TWENTY FIVE PLUS FIFTEEN MINUTES IS SIX FORTY.

I: Okay....Okay. That's good...That's fine. ???. I realize that some of these are hard but we'd like for you to try to draw a picture. THat's, the main point, (UMHUM)

#316c

PR7: PAT STARTED BAKING A CAKE AND DOING A LOAD OF LAUNDRY AT THE SAME TIME. THE CAKE BAKED FOR THIRTY-FIVE MINUTES AND WAS FINISHED AT 6:00. IF THE LAUNDRY TAKES AN HOUR AND FIFTEEN MINUTES TO WASH AND DRY, AT WHAT TIME WILL IT BE DONE?

PR7: Blank

$\boxed{\text{35min}}$

1h 15min

SY 6. 1-1/3 - 1/2 =

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I: Okay this is, next one is problem six. And I'd like for you to draw a picture and solve use, no I'd like for you to read the problem silently. That's what I'd like for you to do. (Chuckle)

S: OH ??. (Somebody mumbles something here, can't understand who or what was said)...

I: ..Okay, tell me the problem.

S: ONE AND ONE THIRD TAKE AWAY ONE HALF.

I: Okay, good. Now, I'm going to give you a blank piece of paper and draw a pic, draw a picture, and solve the problem......(pause)

S: FIVE SIXTHS.

I: Okay, good. Could you tell me what your picture shows and how you used it to solve the problem.

S: IT SHOWS, ONE AND ONE THIRD TAKE AWAY ONE HALF AND THEN I DIVIDED IT INTO SIXTHS. (umhum) AND UM, SUBTRACTED.

I: How.

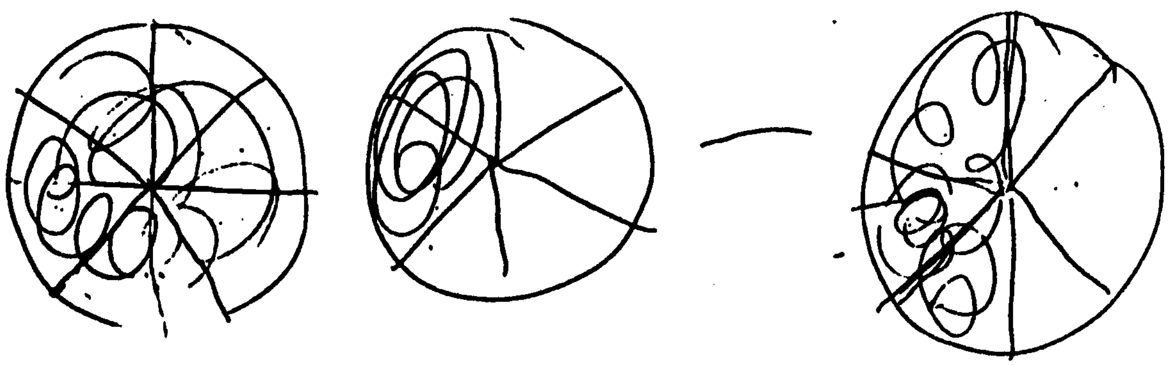
S: WELL, IF YOU PUT THIS...THIS OVER THIS, THEN THERE'S ONE TWO THREE FOUR FIVE, FIVE SIXTHS LEFT.

I: Okay. That's that's the re, that's really what I was interested in. ??? what you did ??. Okay, good. Plenty of time.

#3166

SY6: $1\frac{1}{3} - \frac{1}{2} =$

SY6: Blank



PR 9. Four people ordered a pizza. One person ate 1/3 of the pizza and left before anyone else had a piece. The remaining pizza was divided equally among the other three people. How much of the whole pizza did each of these three get?

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I: All right next is problem 9. And I'd like for you to read problem 9 silently and when you're finished, turn the paper over......(pause) (OKAY) Okay tell me the problem.

S: WELL SOME PEOPLE ORDERED A PIZZA AND ONE PERSON ATE A THIRD OF IT AND THEY WANNA KNOW, UM, THEN THEY'RE GONNA DIVIDE THE PIZZA UP EQUALLY BETWEEN THEM SO THEY WANNA KNOW, HOW MUCH EACH ONE'S GONNA GET. HOW MUCH PIZZA. HOW THEY,

I: Okay. Ah, that's not exactly right. Let me, ask you to read the problem again and when you're finished reading it, turn the paper over..........(pause) Okay, tell me the problem.

S: OKAY FOUR PEOPLE ORDERED A PIZZA AND ONE PERSON ATE A THIRD OF IT AND THEN LEFT. AND THEN THE REST OF THEM, NEEDED TO DIVIDE IT UP AND UM, THEY'RE GONNA DIVIDED IT UP EQUALLY, SO THEY WANNA KNOW HOW MUCH EACH PERSON ELL GET.

I: Okay. Good...Here's a blank piece of paper andI'd like for you to draw a picture, to solve the problem.........(long pause)

S: OKAY, EACH PERSON'S GONNA GET ONE SIXTH.

I: Okay, let me give you ah, ahint. If I can get it out of there. Let me giveyou hint three. See if you can use hint three to solve the problem....(pause)

S: TWO NINTHS.

I: Okay. Good. Could you tell me how you used hint three to get that answer.

S: CUZ THERE WAS NINE OF EM. AND THEN,...I DON'T KNOW, I JUST DIVIIDED IT BY THREE. ER...

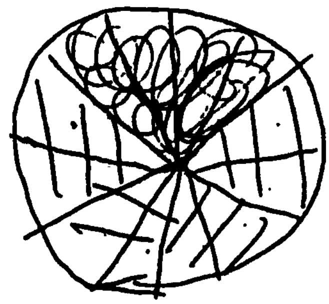
I: What did you divide by three.

S: WELL THERE'S ONE ????, CUZ THERE'S THREE OF EM. WELL THERE'S SIX THINGS THAT ARE SHADED IN AND THEN, DIVIDE THAT BY THREE, AND THAT'S TWO AND THEN YOU PUT IT OVER NINE CUZ THERE WAS NINE IN ALL.

I: Oh okay. Good......Okay, goodi ...

#3166

PR9: Blank



PR9: H3.

SY10. 3/8 + 3/4 =

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I: All right next is problem number 10. I'd like for you to read problem 10 silently, and when you're finished reading it, turn the paper over......Okay tell me the, problem.

S: THREE EIGHTHS PLUS THREE FOURTHS.

I: Good...Okay, here's a blank piece of paper and I'd like for you to draw a picture to solve the problem.....(pause)

S: NINE EIGHTHS.

I: Okay good. Could you tell me whatyour picture shows and how you used it to solve the problem.

S: UM IT SHOWS, THREE EIGHTHS AND THREE FOURTHS, BUT THE FOURTHS ARE DIVIDED INTO EIGHTHS, AND THEN I JUST ADDED EM.

I: Added what.

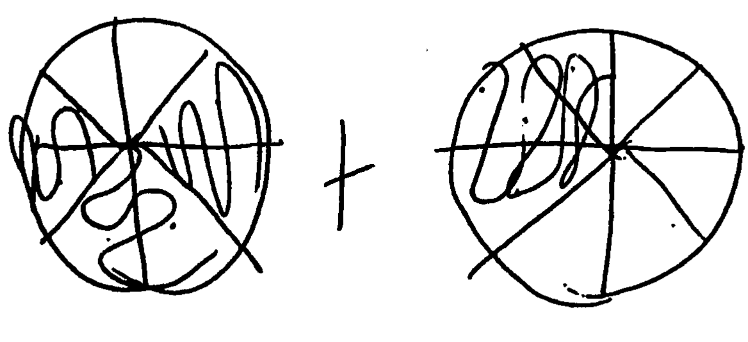
S: OH COUNTED THE SHADED PARTS IN.

I: Okay, good........

#3166

SY10: 3/8 + 3/4 =

SY10: Blank



PR 5. A bus has seats for 60 passengers. If one out of every five seats is empty, how many passengers are on the bus?

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I: Next is problem number 5. Id like you to read problem 5 silenlty and when you're finished reading it, turn the paper over......Okay tell me the problem.

S: THERE'S, THIS WELL BUS CAN HOLD SIXTY PEOPLE. AND THERE'S ONE PERSON IN EVERY FIVE SEATS. OR ONE, EVERY FIVE SEATS THERE"S A PERSON SITTING IN IT. AND, THEY WANNA KNOW HOW MANY PEOPLE ARE ON THE BUS.

I: Okay, that's not exactly right. What I'd like for you to, to read it again and when you're finished reading it, turn the paper over......

S: OH I.......ONE OUT OF EVERY FIVE SEATS IS EMPTY.

I: Okay start from the top.

S: UM THERE'S, THIS BUS CAN HOLD SIXTY PEOPLE AND ONE OUT OF FIVE SEATS IS EMPTY SO THEY WANNA KNOW HOW MANY PEOPLE ARE ON THE BUS.

I: Okay good. Here's a blank piece of paperand I'd like for you to draw a picture, and solve that problem............

S: HOW MANY PEOPLE ARE IN A SEAT?......

I: It can be which ever, any way you like for it, tobe.

S: BUT IS THERE THREE PEOPLE IN A SEAT OR TWO PEOPLE IN A SEAT...

I: Okay I can't (OH) I can't add any more information. You can make this to be, any way you'd like for it to be (OKAY). Okay?.........That's the right idea just, just do it the way (OKAY) you want........(pause)

S: FORTY EIGHT?

I: (Laughs a bit)...That's a,

S: OH I HAVE TO DRAW A PICTURE.

I: Yeh (laughing) that would be nice. Ah okay. First of all, you've got the answer. (UMHUM) Ah, could you tell me how you got that answer there's absolute nothing on (I KNOW) your paper right now so, somewhere on the paper this answer came from something other than the piece of paper. Could you tell me how you got the answer.

S: I JUST ADD, I MEAN I JUST, OKAY, IF ONE OUT OF EVERY FIVE SEATS IS EMPTY THATMEANS TWELVE SEAT CUZ SIXTY DIVIDED BY FIVE IS 12. (Uhuh) AND SO THEN SIXTY TAKE AWAY TWELVE IS FORTY EIGHT.

I: Okay. All right now what I'm going to ask you to do is, draw a picture.

S: ??

 at you could use to solve the problem.....(pause)

S: I DON'T KNOW HOW TA DRAW A PICTURE.

I: You don't, don't have any idea how to get started?

S: I GUESS I'LL DRAW SOME SEATS.

I: (Chuckle) Yeh, just draw some, draw a picture that would help you solve the problem. It's a little harder after you've solve the problem (Both laugh a bit).......

S: (mumbles something).........OH I KNOW.................(pause) (chuckle)

I: Okay. ?? (mumbles something).......

S: UM.....I DON'T KNOW HOW TA DRAW.

I: Well tell me about your picture.

S: IT'S GOT TWENTY SEATS CUZ OF SIXTY PASSENGERS AND THERE'S, THREE PASSENGERS ON A SEAT.

I: Okay then what, what else have you done.

S: SO IT'S 20. AND SO I, PUT AN "X" ON THE ONE THAT'S EMPTY AND A CIRCLE ON THE ONE THAT'S FULL.

I: Okay, that's fine. Good. And then what would you have done to get the answer.

S: UM...COUNTED EM AND TIMESED EM.

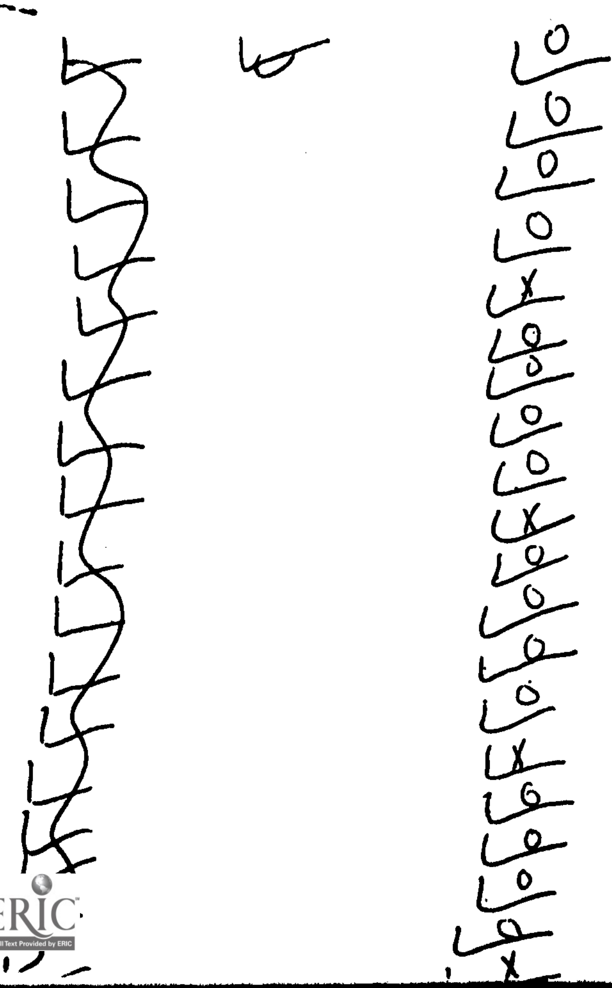
I: Count, counted what.

S: THE "X'S". OH NO. UM, UM, I DON'T KNOW. I JUST DID IT IN MY NEAD UM, I WOULD HAVE, ...OH I WOULD HAVE ADDED UP, SIXTY PASSENGERS AND TAKEN AWAY....,12, BECAUSE THERE'S OKAY THERE'S FOUR SEATS HERE THAT ARE EMPTY (Umhum) AND THAT, AND FOUR TIMES THREE IS TWELVE. AND SIXTY TAKE AWAY TWELVE IS FORTY EIGHT.

I: Oh okay good. That's fine.......All right.

PR5: A BUS HAS SEATS FOR 60 PASSENGERS. IF ONE OUT OF EVERY FIVE SEATS IS EMPTY, HOW MANY PASSENGERS ARE ON THE BUS?

PR5: Blank



PR 4. A post 25 feet long is pounded into the bottom of a river near its bank. Eight and a fourth feet of the post is below the bottom of the river and three and three-fourths feet is above the surface of the water. How deep is the river at that point?

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I: Next. .is problem number four. I'd like for you to read problem four silently and when you're finished reading it, turn the paper over......(Banging noise) I'm sure the person listening to the tapes (Student laughs a bit) is going to love that......

S: .....OKAY.

I: Okay, tell me the problem.

S: UM, THERE'S A 25, UM, POST THAT THEY POUNDED INTO THE WATER AND IT'S,...EIGHT AND A FOURTH UNDER THE GROUND AND,.....I THINK THREE AND, THREE FOURTHS UM, OUT OF THE WATER SO THEY WANNA KNOW, HOW DEEP THE WATER IS. HOW MANY FEET DEEP THE WATER IS.

I: Okay, good. Here's a blank piece of paper and I'd like for you to draw a picutre to solve the problem......(pause)

S: THIRTEEN. ??.

I: Okay, could you tell me what your picture shows and how you used that to solve the problem.

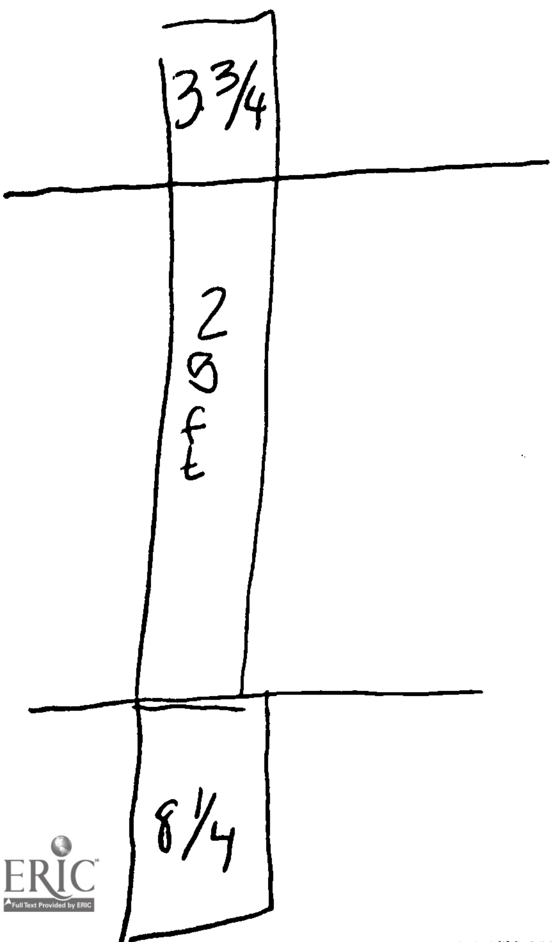
S: IT SHOWS THE 25 FOOT POLE AND THEN, THREE AND THREE FOURTHS STICKING OUT OF THE TOP AND THEN FOURTH, EIGHT AND A FOURTH IS HANGING OUT OF THE BOTTOM. AND I JUST...ADDED THE EIGHT AND THE THREE AND THE THREE FOURTHS AND THE ONE FOURTH. (Okay) AND I GOT 12. (Umhum) AND THEN 25 TAKE AWAY 12 IS 13.

I: Okay, good.........

3166

PR4: A POST 25 FEET LONG IS POUNDED INTO THE BOTTOM OF A RIVER NEAR ITS BANK. EIGHT AND A FOURTH FEET OF THE POST IS BELOW THE BOTTOM OF THE RIVER AND THREE AND THREE FOURTHS FEET IS ABOVE THE SURFACE OF THE WATER. HOW DEEP IS THE RIVER AT THAT POINT?

PR4: Blank



PR 11. Newspapers are delivered to a four-story apartment building with 40 apartments. If three out of every five apartments get a paper, how many papers are received each day?

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I: Next is problem 11. I'd like for you to read problem 11 silently and when you're finished reading it, turn the paper over..........

S: OKAY. UM, THERE'S A APARTMENT BUILDING WITH FORTY, APARTMENTS OR WHATEVER. AND THREE OUT OF EVERY FIVE GETS A NEWSPAPER. AND THEY WANNA KNOW, HOW MANY UM, NEWSPAPERS ARE DELIVERED THERE EACH DAY...

I: Okay ah, that's not exactly all the problem, why don't you t, read the problem again. When you're finished reading it turn the paper over..........

S: THERE'S A FOUR STORY BUILDING THAT HAS FORTY APARTMENTS. AND IF THREE OUT OF EVERY FIVE, GET A PAPER EACH MORNING THEY WANNA KNOW HOW MANY PAPERSARE DELIVERED THERE.

I: Okay, good. Here is a, blank piece of paper. And I'd like for you to draw a picture to solve the problem......And I'm going to,...Yeh I think I'm going to turn the tape over.....

S: OKAY............OHHH, I GOTTA DRAW A PICTURE.

I: (Laughs a bit) Don't forget the picture......(pause)

S: 32?

I: Okay let me give you a hint. Let me give you hint number one. See if you can use hint one to solve the problem......(pause)

S: 24, OH WAIT NO NO......

I: Why don't you write down what you're doing.

S: OH. I THOUGHT I WAS ONLY SUPPOSED TO DRAW A PICTURE.

I: You can use numbers but, we'd like you to use use picture, too.

S: OH. CAN I WRITE ON HERE?

I: Yeh.

S: OH. OKAY!

I: But I want you to use the picture, when you're solving the problem............That's the stuff I wanted you to write down (OH) XXXX What you're doing right there.

S: (Chuckle) OKAY..........(mumbles to self a bit).......

I: Okay now you're not using the picture anymore are you.

S: NO.

I: Okay why don't you go back to using the picture.

S: YEH, THIS IS JUST FOUR DOTS.

I: Well you can add to it. You can make the picture bigger or, you know, or just, that's just to get you started.

S: OH, OKAY........

I: I have other hints too if you get stuck.

S: OKAY. I"LL HAVE ANOTHER HINT CUZ I (All right) DON'T KNOW WHAT PICTURE TO DRAW.

I: All right, why don't I give you hint number two A.

S: OH OKAY.

I: See if you can use hint two to solve the problem..................Well excuse me, I ??.

S: THERE'S FIVE...

I: That's right. I've given you the wrong set of hints but that's, those are, XXXWMXK that'll work too.

S: OKAY.........(mumbles to self)...OKAY..............CAN I DRAW ON THIS?

I: Sure......

S: JUST CROSS OFF THIS. THAT'S EASIEST FOR ME.

I: ????(Both talk at same time hard to hear what interviewer said) what I should have given you in the first place.

S: YEH, IT'S, I AH......OKAY....THREE HERE (talking to self).........(To self:) SIXTEEN.... ...(Counts to self) 24.

I: Okay, good. CAn you ah, tell me what your picture there shows and how you used hint two to solve the problem.

S: OKAY IT SHOWS, THAT, TEN APARTMENTS ON EACH FLOOR AND THEN, SINCE THERE'S TEN...OKAY AND THEN YOU TAKE THREE OUT OF EVERY FIVE SO I TOOK THREE OUT OF EVERY FIVE, I CROSSED THREE OUT OF EVERY FIVE. AND THEN, THERE'S SIXTEEN HERE AND IT'S, THEN FOURTY YOU TAKE AWAY SIXTEEN. OR NO THAT"S NOT RIGHT....WELL THEN I JUST, OKAY I COUNTED, ALL THE ONES THAT I CROSSED OUT (Umhum) AND THERE WAS.........THERE WAS 24.

I: Okay, good. Good. I'm sorry I gave you the wrong set of hints.

S: OH THAT"S OKAY.

I: I get confused with all the dots. Okay now, you're progressing so quickly, you only have one problem left and so I think what I'll do is I'll give it to you right now. May run over a bit but, I don't think that, what do you have at ten o'clock.

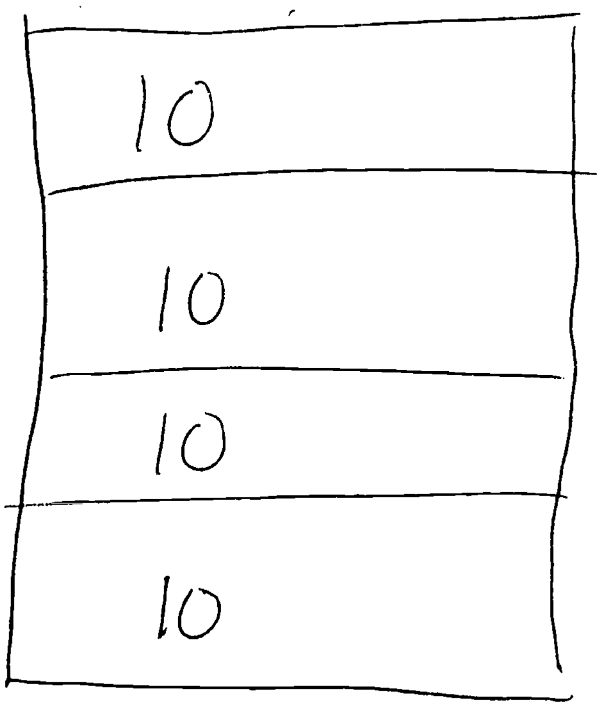
S: UM...I HAVE SCIENCE. NO I HAVE SOCIAL STUDIES.

I: Would it be all right if you, were a few minutes late?

S: I DON'T KNOW, YEH, MAYBE.

PR11: NEWSPAPERS ARE DELIVERED TO A FOUR-STORY BUILDING WHICH HAS 40 APARTMENTS. IF THREE OUT OF EVERY FIVE APARTMENTS GET A PAPER, HOW MANY PAPERS ARE DELIVERED TO THE BUILDING EACH DAY?

PRH: Blank



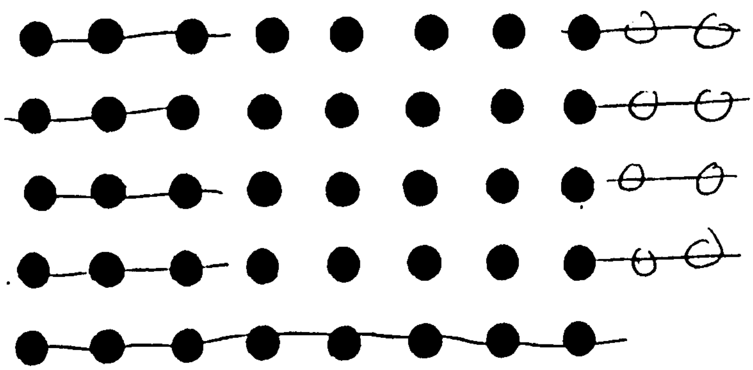
#3166

PR11: H1.

40

$10 = \frac{6}{10}$ 4.

PR11: H2a.



PR 1. A rubber ball bounces back up half the height it falls. If the ball is dropped from a height of 100 feet, how far will it have travelled altogether up and down when it hits the ground for the fourth time?

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I: Okay this is the last problem. Don't don't rush (OKAY) it or anything. We can get you a pass or....Read problem one silently first.........

S: OH OKAY.

I: Okay tell me the problem.

S: OKAY THERE'S, THEY, THEY SAY THAT THIS BALL BOUNCES HALF, EA, HALF IT'S HEIGHT THAT, THE WAY IT DR, THE WAY IT'S DROPPED. UM, HALF ITS, HALF THE HEIGHT THAT IT IS DROPPED. AND SO IF THEY DROPPED IT FROM A HUNDRED FOOT BUILDING, AND, THEY WANNA KNOW WHAT, HOW HIGH IT'S GOING TO BE BOUNCING ON THE FOURTH TIME.

I: Okay that's not exactly correct. So what I'd like you to do is read that problem over. And when you're finished reading it, turn the paper over......

S: OH I KNOW. OKAY THE BALL BOUNCES, UM, OKAY THE BALL BOUNCES, ~~HMXXHKXXXXTHK~~ HALF, THE HEIGHT OF WHAT IT"S DROPPED. AND SO, THEY, THEY'RE DROPPING IT FROM A HUNDRED FOOT BUILDING. AND SO WHEN, THE, THEY WANNA KNOW, HOW HOW MUCH ALL TOGETHER IT IS BOUNCED. WHAT'S THE HEIGHT OF WHAT , IT IS BOUNCED. AFTER THE FOUR BOUNCES.

I: Okay, that's not,

S: ??

I: That's not exactly correct but we're going to go on.

S: OKAY.

I: You can look at the problem so you'll have it to work with. Here is a blank piece of paper and I'd like for you to draw a picture, to solve the problem (OKAY).......

S: (mumbles to self)........(long pause) A HUNDRED AND A HALF (chuckle).

I: Okay let me giveyou a hint. Let me give you hint two. See if you can use hint 2 to solve the problem.....And remember you can add to it or **whatever** do whatever you want to it.

S: OKAY.....(Laughing a bit) NINETY SEVEN AND A HALF?

I: Okay, let me give you hint three. See if you can use hint three to solve the problem.

S: (pause) A HUNDRED? ~~XX~~.

I: Okay could you tell me how you used hint three to get that answer?

S: OKAY UM...WELL IT BOUNCED A HUNDRED FEET SO IT'D GO FIFTY AND THEN, IT WOULD BOUNCE DOWN AGAIN AND IT'D BE 25 AND THEN IT"D BOUNCE AGAIN AND IT'D BE, 12 AND A HALF. AND IT BOUNCED DOWN AGAIN AND IT WOULD BE THREE. AND THEN YOU JUST ADD EM ALL UP. THAT COMES OUT TO A HUNDRED AND A HALF. SO THAT'S WRONG.

I: Okay.

S: BUT I DON"T KNOW HOW I GOT, WELL THE HUNDRED...UM._.......WELL, IT'D BE A HUNDRED, I GUESS.

I: Okay. Yeh I just wanted to make sure you were done.

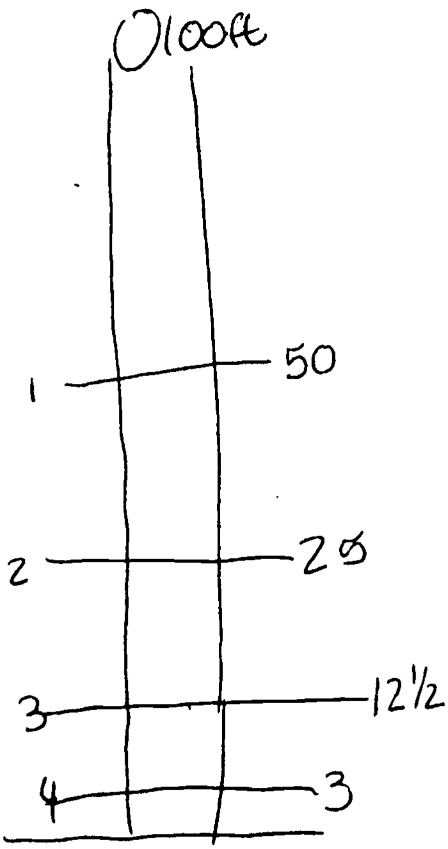
S: YEH.

I: Okay. Ah, we did the whole shabang, in that, period of time so I'm not going to to come back tomorrow. (Tape cut)

#3166

PR1: A RUBBER BALL BOUNCES BACK UP HALF THE HEIGHT IT FALLS. IF THE BALL IS DROPPED FROM A HEIGHT OF 100 FEET, HOW FAR WILL IT HAVE TRAVELED, ALTOGETHER, UP AND DOWN, WHEN IT HITS THE GROUND FOR THE FOURTH TIME?

·PR1: Blank

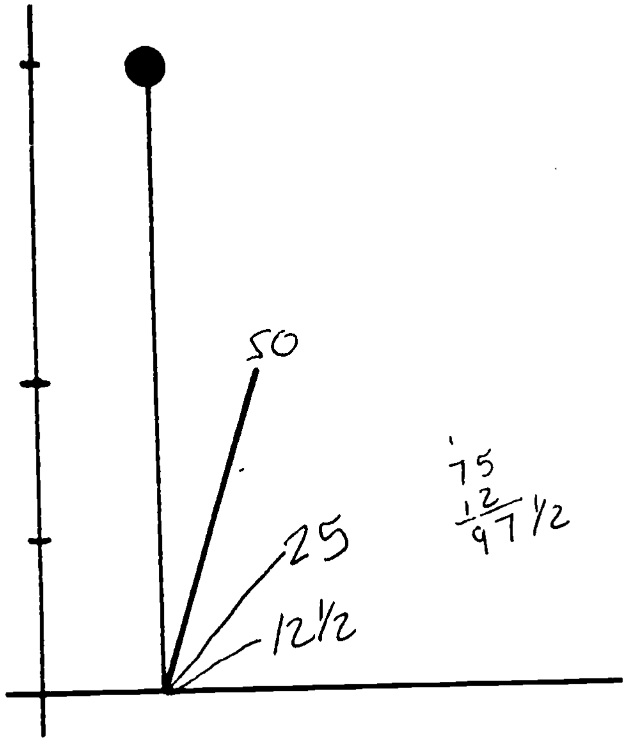


50
25

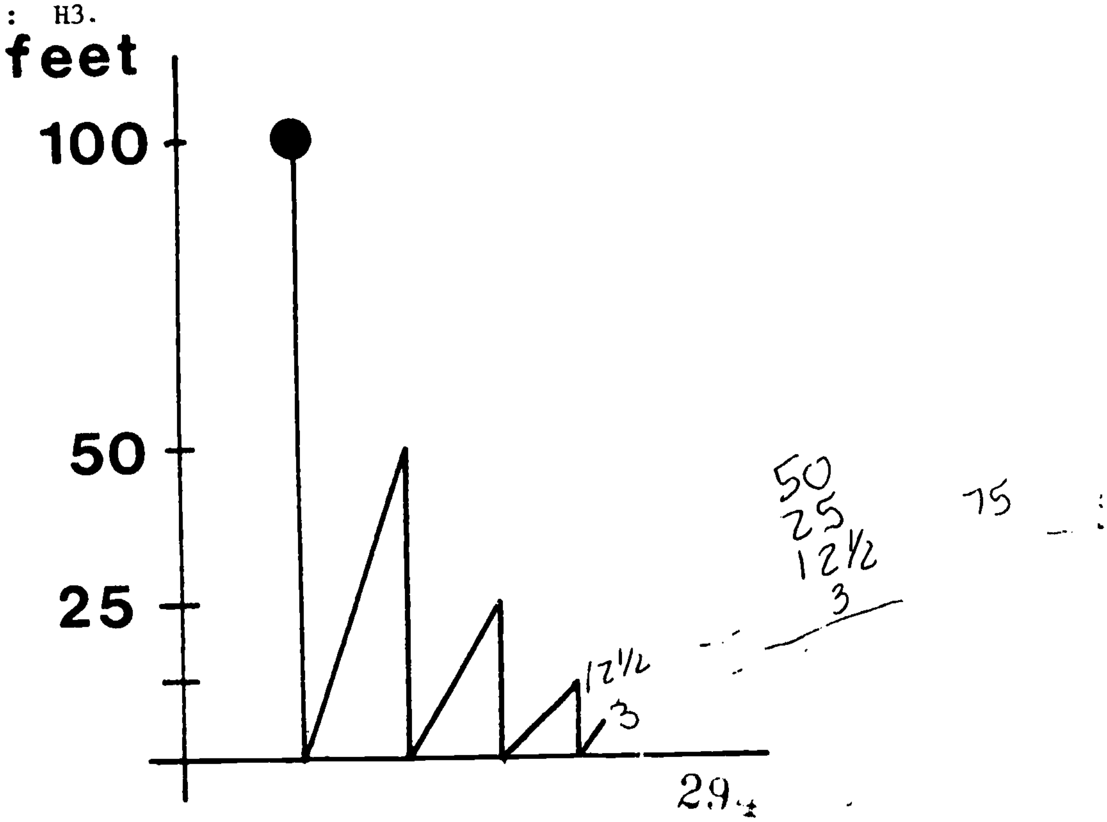
75
12
3
100½

29

PR!: H2.



PR!: H3.



Appendix I

Problem Specific Information

Year I

PR 1

Non-Numerical Data	Numerical Data
1) flagpole, 1st	9
2) shadow, 1st	36
3) flagpole, 2nd	
4) shadow, 2nd	24

Transformed question: How long is 2nd flagpole
Relation: Connection between flagpoles and shadows demonstrate, roughly the quantitative relationship between the parts.
Relation with Metric: some metric shown

PR2

Non-Numerical Data	Numerical Data
1) 'drove' thru 3 cities and back	323
2) 'distance' between 2 cities	114
3) 'distance' between 2 other cities	77

Relation: Lines connecting cities; placement of cities reflect given distances between them.
Relation with Metric: some metric shown

PR3

Non-Numerical data	Numerical Data
1) found part of cake	1/2
2) one person ate some	1/2
3) different person ate some	
4) of remainder	1/3

Relation: chord and two other pieces on one side
Relation with Metric: cake cut in half with 1/2 cut in half and one piece cut in 3rds; shading

PR4

Non-Numerical Data	Numerical Data
1) a post	12
2) some of post below bottom	2 1/2
3) some of post above watter	1/2

Transformed Question: How much post is in the water?
Relation: longest part in middle and smallest on top
Relation with Metric: Reasonably accurate ratios; some metric shown

Year I

PR 5

Non-Numerical Data	Numerical Data
1) bus with seats	36
2) some seats empty	1:4

Transformed Question: How many seats are filled?
Relation: 1:4 ratio represented
Relation with Metric: 36 seats with 1/4th marked

Year II

PR1

Non-Numerical Data	Numerical Data
1) staircase	
2) climbed up steps	5
3) climbed down steps	3
4) climbed up steps	6
5) was at top	

Transformed Question: How far is the baby from where it started? How far is the top from the bottom?
Relation: motions connected and opposite; up motions longer than down motion

PR3 See Year I PR3

PR4 See Year I PR4

PR5

Non-Numerical Data	Numerical Data
1) bus with seats	48
2) some seats empty	1:6

Transformed Question: How many seats are filled?
Relation: 1:6 ratio represented
Relation with Metric: 48 seats with 1/6th marked

PR7

Non-Numerical Data	Numerical Data
1) wire fence (multiple strands)	3
2) around field	
3) long	200
4) wide	100

Transformed Question: How far is it around the field three times?
Relation: rectangle (not square) with multiple strands
Relation with Metric: 2:1 ratio in rectangle, 3 strands

Year II

PR9

	Non-Numerical Data	Numerical Data
	1) pizza	5
	2) one person at some	1/3
	3) remainder divided equally	4

Relation: pizza with one large piece and four smaller pieces

Relation with Metric: pizza divided into 3rds and 2/3 divided in 4 equal parts.

PR11

	Non-Numerical Data	Numerical Data
	started at home	
	walked east	6
	walked south	2
	walked west	2
	walked north	2
	all blocks the same length	

Relation: correct ratio of lengths; right angles; single path

Relation with Metric: blocks marked off

Year III

PR1

	Non-Numerical Data	Numerical Data
	ball bounces	
	part of way dropped	1/2
	ball dropped	100
	bounces several times	4

Relation: path connected, down motions longer than up motions

Relation with Metric: up motions 1/2 of previous down motion; some metric shown

PR3 See Year I PR3

PR4

	Non-Numerical Data	Numerical Data
	a post	25
	some of the post below water bottom	8 1/4
	some of the post above water	3 3/4

Transformed: How much of the post is in the water?
How high is the water?

Relation: longest part in middle and smallest on top

Relation with Metric: Reasonably accurate ratio, some metric shown

Year 1

PR5

	Non-Numerical Data	Numerical Data
	bus with seats	60
	some seats empty	1:5

Transformed: How many seats are filled?
How many are left?
Relation: 1:5 ratio represented
Relation with Metric: 60 eats with 1/5 marked

PR7

	Non-Numerical Data	Numerical Data
	started cake and laundry together	35 minutes
	cake baked and was done	6:00
	laundry done	1 hour & 15 minutes

Relation: time flow appropriate direction
Relation with Metric: time flow appropriate magnitude, marking for time

PR9

	Non-Numerical Data	Numerical Data
	pizza	4
	one person ate some	1/3
	remainder divided equally	3

Relation: pizza with one large piece and three smaller pieces
Relation with Metric: pizza divided into 3rds and 2/3 divided into 6 equal parts

PR11

	Non-Numerical Data	Numerical Data
	apartment building with apartments	40
	some get paper	3:5

Transformed Question: How many apartments get papers?
Relation: 3:5 ratio represented
Relation with Metric: 40 apartments with 3/5 marked

PR12

	Non-Numerical Data	Numerical Data
	square cut from each corner	3
	rectangular cardboard	12
	fold up to make box	18

Relation: rectangle (not square), square in each corner, appropriate fold marks
Relation with Metric: appropriate ratio of lengths, some metric shown

APPENDIX B

Technical Report and Instrumentation
of Confidence Component

Table of Contents

Confidence Interview

Photographs and Cards

Year III

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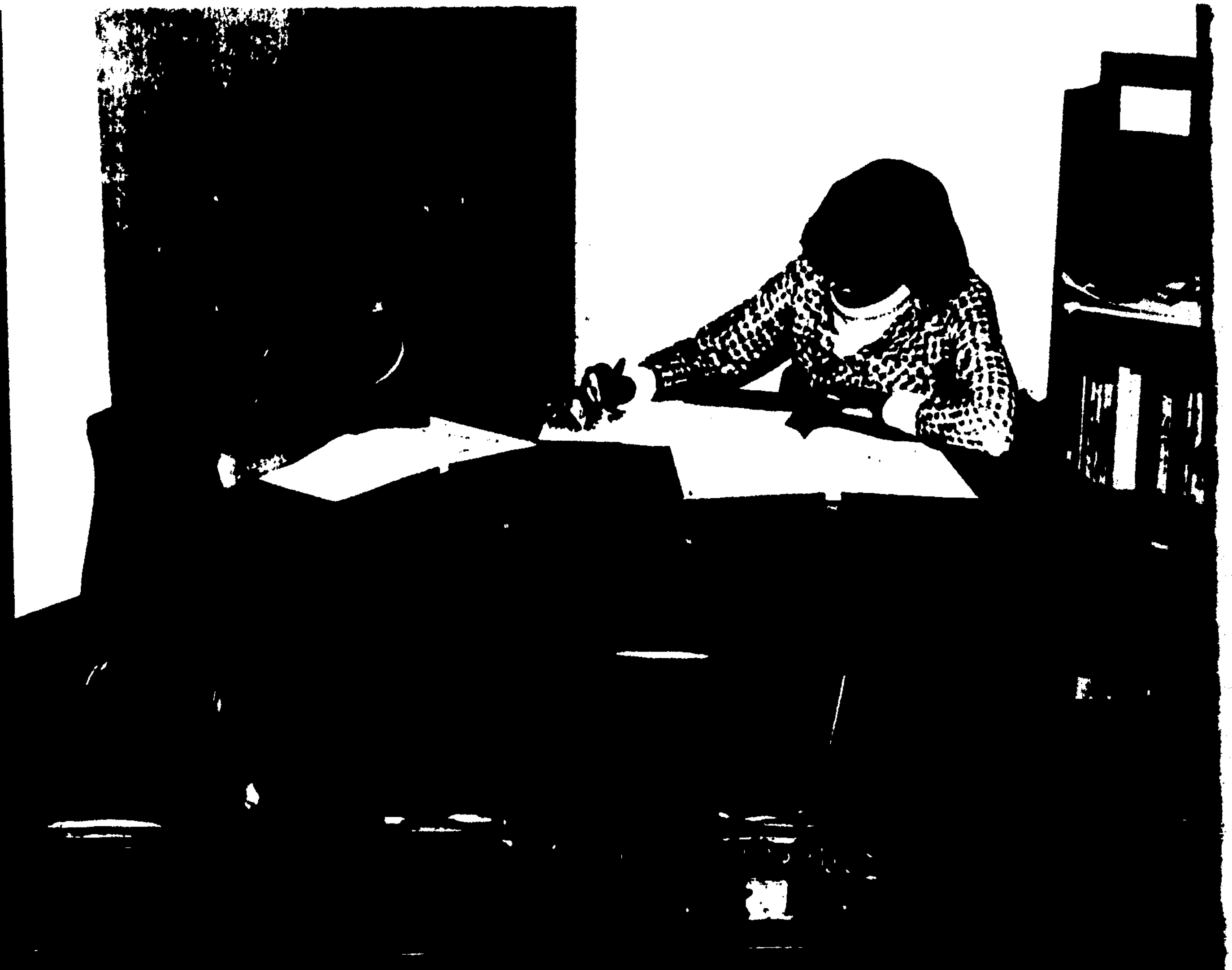

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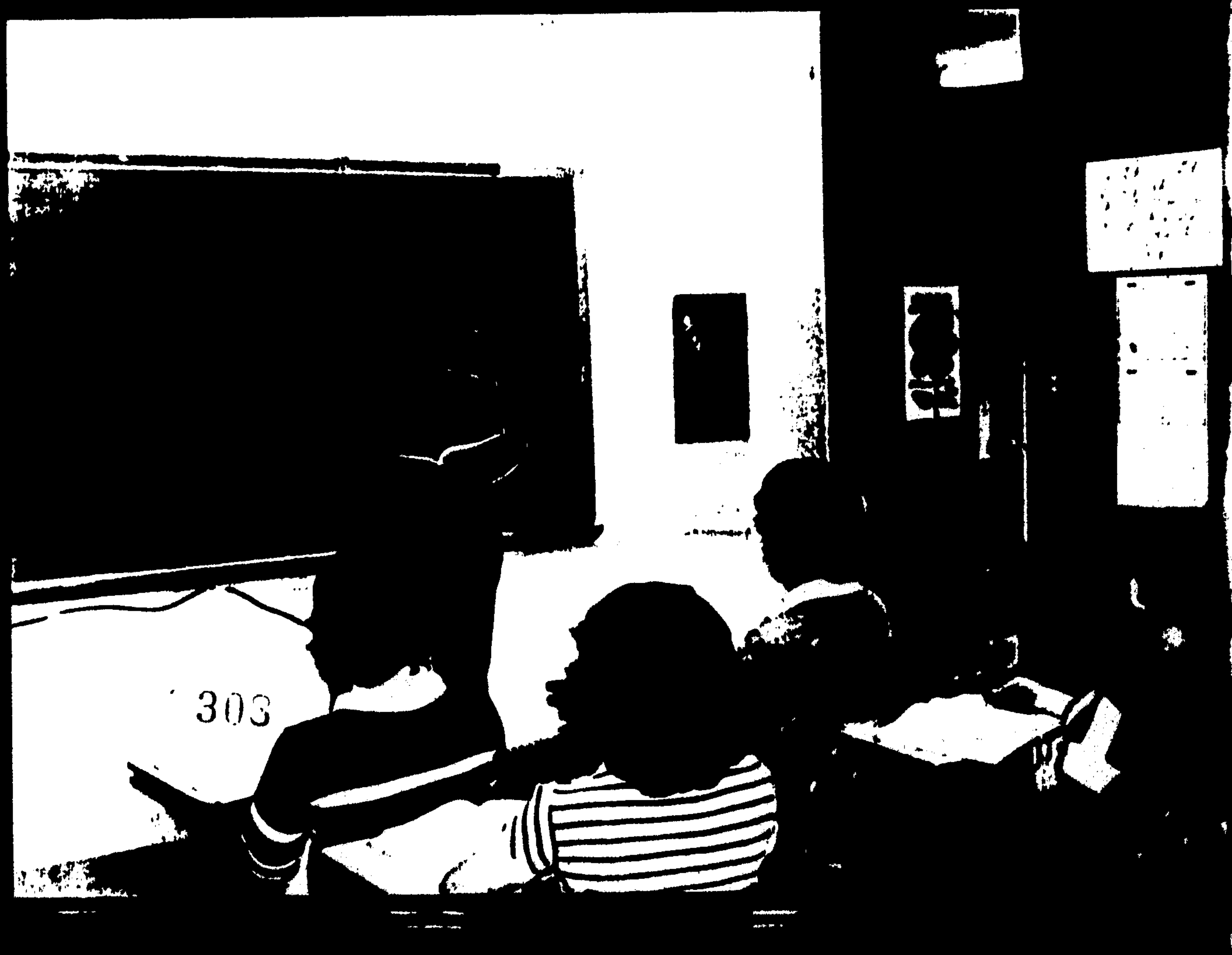

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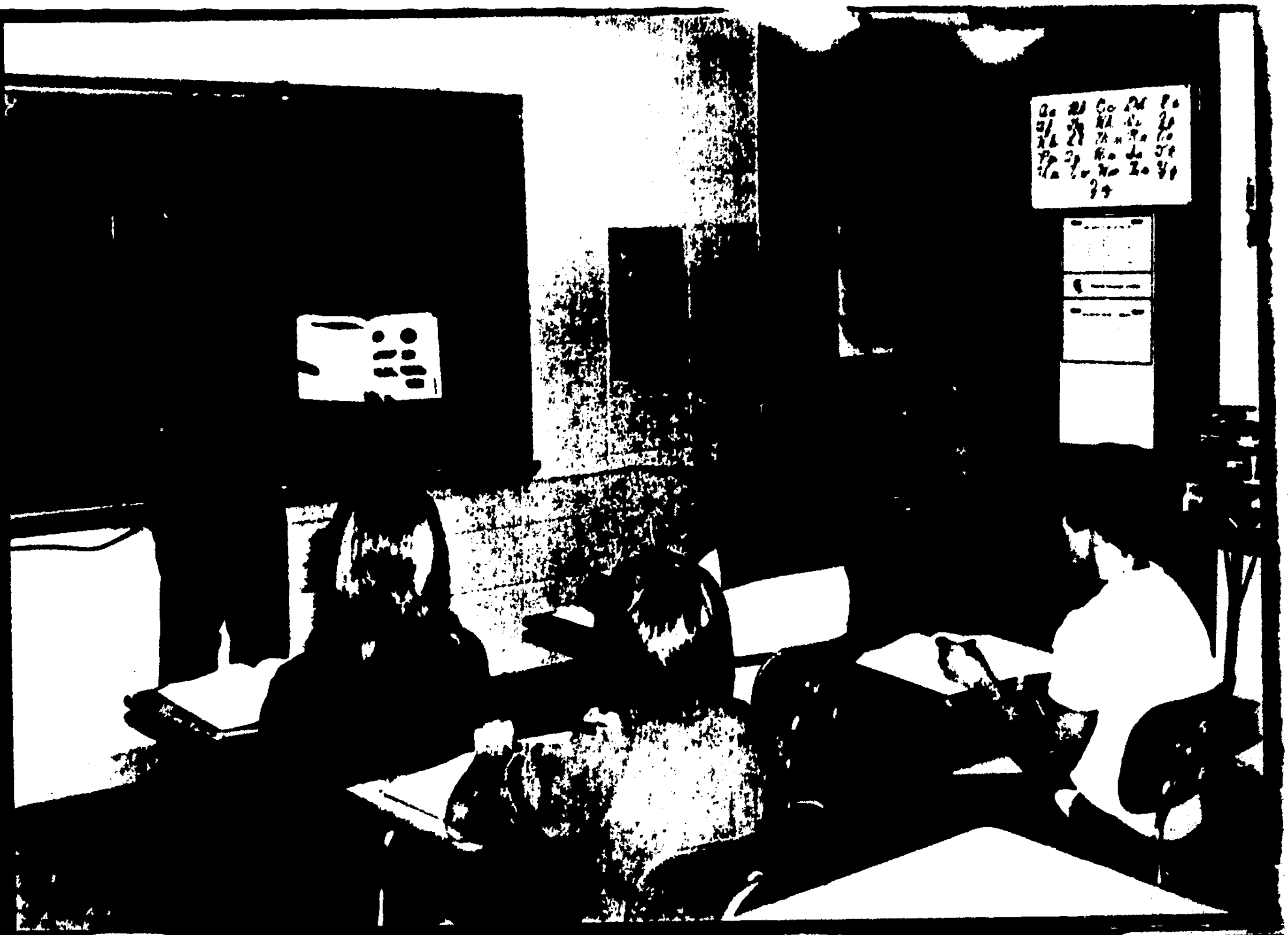


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10

CONFIDENCE INTERVIEW CARDS

YEAR III

1981

INTRODUCTION (Note that script is in upper case; directions are mainly in lower case.) (i)

(Ask student's name. Check if she/he is the one expected.)

I AM ________________________________. WE'RE DOING A STUDY ABOUT STUDENTS YOUR AGE LEARNING MATH. YOU MAY REMEMBER THAT YOU HELPED US OUT BEFORE, AND WE'D LIKE YOUR HELP AGAIN. WE FEEL THAT WHAT 8TH GRADERS HAVE TO SAY ABOUT LEARNING MATH IS VERY IMPORTANT, SO WE HOPE YOU WON'T MIND ANSWERING SOME QUESTIONS FOR US.

I'M GOING TO SHOW YOU SOME PICTURES TAKEN IN 8TH GRADE CLASSROOMS AND ASK YOU TO USE YOUR <u>IMAGINATION</u> AND TELL SOME STORIES ABOUT THE <u>PEOPLE</u> IN THEM.

THERE AREN'T ANY RIGHT OR WRONG ANSWERS TO THE QUESTIONS I'LL BE ASKING. I'M INTERESTED IN WHATEVER YOU SAY. WHATEVER YOU SAY IS STRICTLY CONFIDENTIAL. NO ONE ELSE WILL KNOW WHAT YOU SAY ... NOT YOUR TEACHERS, YOUR FAMILY OR THE OTHER STUDENTS.

ANY QUESTIONS SO FAR?

INTRODUCTION (continued) (ii)

I'M GOING TO BE ASKING YOU ABOUT SITUATIONS WHERE STUDENTS ARE WORKING ON TWO DIFFERENT KINDS OF MATH PROBLEMS. WE'RE GOING TO BE TALKING ABOUT <u>PLAIN ARITHMETIC PROBLEMS</u> AND <u>STORY PROBLEMS</u>.

(Show arithmetic problems.)

THIS IS WHAT WE MEAN BY A <u>PLAIN ARITHMETIC PROBLEM</u>.

(Show story problems.)

THIS IS WHAT WE MEAN BY A STORY PROBLEM. IS THIS CLEAR?

TELL ME ABOUT WHAT THIS BOY THINKS AND FEELS ABOUT MATH.

WHY DO YOU SUPPOSE THAT IS?

(This is a warm-up technique. Encourage student to talk. Content is not as important.)

INTRODUCTION

PLAIN ARITHMETIC PROBLEMS

$$\begin{array}{r} 3\frac{1}{2} \\ +4\frac{1}{4} \\ \hline \end{array}$$

$$\begin{array}{r} 38 \\ \times\ .4 \\ \hline \end{array}$$

STORY PROBLEMS

PAT MOWED 1/2 OF THE LAWN BEFORE LUNCH AND 2/5 IN THE AFTERNOON. HOW MUCH DOES PAT HAVE LEFT TO MOW?

THE RAINBOW TELEVISION COMPANY HAS ITS PORTABLE COLOR TELEVISION SETS ON SALE AT 25 PERCENT OFF THE REGULAR PRICE. WHAT IS THE SAVING ON A SET THAT REGULARLY SELLS FOR $390?

FEMALE
1

HERE'S PICTURE 1

TELL ME ABOUT WHAT THIS GIRL THINKS AND FEELS ABOUT MATH.

WHY DO YOU SUPPOSE THAT IS?

(This is a warm-up technique. Encourage student to talk, Content is not as important.)

BOTH
2A

HERE'S PICTURE 2

THESE TWO PEOPLE HAVE GOTTEN DIFFERENT ANSWERS TO A PLAIN ARITHMETIC PROBLEM LIKE THIS ONE. (Show problem 2A and read it.)

1. WHO WOULD PROBABLY HAVE THE RIGHT ANSWER?
2. WHY DID HE/SHE GET THE RIGHT ANSWER? (Attribution-success)
3. WHY DID SHE/HE GET THE ANSWER WRONG? (Point to the student who got it wrong) (Attribution-failure)
4. HOW DOES THE ONE WHO GOT IT WRONG FEEL ABOUT HIM/HERSELF?
5. HOW WILL THIS ONE (Point to the student who got it wrong) FEEL ABOUT THE ONE WHO GOT IT RIGHT?
6. HOW DOES THE ONE WHO GOT IT RIGHT FEEL ABOUT HER/HIMSELF?
7. HOW WILL THIS ONE (Point to student who got it right) FEEL ABOUT THE ONE WHO GOT IT WRONG?

(Use same photo for next card)

PROBLEM FOR 2A

FIND THE ANSWER:

$27 \div 1/3$

PROBLEM FOR 2B

A CATERPILLAR STARTED CRAWLING UP A TREE. IT CRAWLED UP $3\frac{1}{4}$ FEET, FELL BACK $2\frac{1}{2}$ FEET, AND THEN CRAWLED UP $6\frac{1}{4}$ FEET. HOW FAR FROM THE GROUND WAS IT AT THAT POINT?

SAME PICTURE 2

BOTH
2B

WHAT IF IT WERE A STORY PROBLEM LIKE THIS THEY HAD ANSWERED DIFFERENTLY? (Show problem 2B and read it.)

1. WHO WOULD PROBABLY HAVE THE <u>RIGHT</u> ANSWER?

2. WHY DID SHE/HE GET THE RIGHT ANSWER? (Attribution-success)

3. WHY DID SHE/HE GET THE ANSWER WRONG (Point to student who got it wrong) (Attribution-failure)

4. HOW WILL THE ONE WHO GOT IT WRONG FEEL ABOUT HIM/HERSELF?

5. HOW WILL THIS ONE (Point to student who got it wrong) FEEL ABOUT THE ONE WHO GOT IT RIGHT?

6. HOW WILL THE ONE WHO GOT IT RIGHT FEEL ABOUT HER/HIMSELF?

7. HOW WILL THIS ONE (Point to student who got it right) FEEL ABOUT THE ONE WHO GOT IT WRONG?

HERE'S PICTURE 3

BOTH
3

HERE ARE TWO GIRLS AND TWO BOYS LOOKING OVER A MATH TEST. ONE DID POORLY, TWO DID PRETTY WELL, AND ONE DID <u>VERY</u> WELL.

1. WHICH ONE DID <u>VERY</u> WELL?

2. (Point to student who did best) HOW DOES THE ONE WHO <u>DID WELL</u> FEEL ABOUT HER/HIM-SELF?

3. HOW DO THE OTHERS FEEL ABOUT THE ONE WHO DID WELL?

4. <u>WHY</u> DO THE OTHERS THINK THAT SHE/HE DID WELL? (Attribution-success)

5. WHO DID MOST POORLY?

6. HOW DOES THE ONE WHO DID MOST POORLY FEEL ABOUT HIM/HER-SELF?

7. HOW DO THE OTHERS FEEL ABOUT THE ONE WHO DID POOREST?

8. <u>WHY</u> DO THE OTHERS THINK THAT SHE/HE DID MOST POORLY? (Attribution-failure)

HERE'S PICTURE 4

BOTH
4A

THESE TWO GIRLS AND TWO BOYS ARE WORKING ON MATH.
(Point at girl on left in overalls.)

1. HOW MIGHT THE OTHERS EXPECT THIS GIRL TO DO ON THEIR MATH LESSON?

2. WHY DO THEY THINK SHE WOULD DO WELL/BADLY? (Attribution: success/failure

3. WILL THEY EXPECT HER TO DO BETTER/HAVE MORE TROUBLE ON PLAIN ARITHMETIC PROBLEMS OR ON STORY PROBLEMS? (Show problem card)

4. WHY DO THEY THINK THAT? (Attribution: success/failure)

(Use same photo for next card)

SAME PICTURE 4

BOTH
4B

(Point at girl on right, in striped shirt.)
THIS GIRL IS HAVING A LOT OF *TROUBLE/DOING WELL WITH HER MATH LESSON.
*(Choose opposite success/failure of 4A)

1. WHY DO THEY THINK SHE IS HAVING TROUBLE/DOING WELL? (Attribution: success/failur

2. DO THEY THINK SHE'S HAVING MORE TROUBLE/DOING BETTER WITH THE PLAIN ARITHMETIC PROBLEMS OR STORY PROBLEMS? (Show problem card)

3. WHY WOULD THEY THINK THAT? (Attribution: success/failure)

(Use same photo for next card)

PROBLEM FOR 4

PLAIN ARITHMETIC PROBLEM

$3\frac{1}{2}$
$+4\frac{1}{4}$

STORY PROBLEM

THE RAINBOW TELEVISION COMPANY HAS ITS PORTABLE COLOR TELEVISION SETS ON SALE AT 25 PERCENT OFF THE REGULAR PRICE. WHAT IS THE SAVING ON A SET THAT REGULARLY SELLS FOR $390?

SAME PICTURE 4

BOTH
4C

(Point at boy in white T-shirt)

1. HOW MIGHT THE OTHERS EXPECT THIS BOY TO DO ON THEIR MATH LESSON?
2. WHY DO THEY THINK HE WOULD DO WELL/BADLY? (Attribution: success/failure)
3. WILL THEY EXPECT HIM TO DO BETTER/HAVE MORE TROUBLE ON PLAIN ARITHMETIC PROBLEMS OR ON STORY PROBLEMS? (Show problem card.)
4. WHY WOULD THEY THINK THAT? (Attribution: success/failure)

(Use same photo for next card)

SAME PICTURE 4

BOTH
4D

(Point at boy, black football shirt.)

THIS BOY IS ALSO HAVING A LOT OF TROUBLE/IS DOING WELL WITH HIS LESSON.

1. WHY DO THEY THINK HE IS HAVING TROUBLE/DOING WELL? (Attribution: success/failure

2. DO THEY THINK HE'S HAVING MORE TROUBLE WITH/DOING BETTER IN THE PLAIN ARITHMETIC PROBLEMS OR STORY PROBLEMS? (Show problem card.)

3. WHY WOULD THEY THINK THAT? (Attribution: success/failure)

HERE'S PICTURE 5

5 MALE (Same sex as student)
TEACHER (Same sex as student's teacher)

THIS STUDENT HAS COME TO ASK HIS TEACHER FOR HELP ON HIS MATH LESSON.

1. DID HE COME FOR HELP ON A PLAIN ARITHMETIC OR ON A STORY PROBLEM?

2. HOW DOES THE STUDENT FEEL ABOUT ASKING THE TEACHER A QUESTION ABOUT MATH?

3. HOW DOES THE TEACHER FEEL ABOUT THE STUDENT ASKING A QUESTION ABOUT MATH?

HERE'S PICTURE 5

5 FEMALE (Same sex as student)

TEACHER (Same sex as student's teacher)

THIS STUDENT HAS COME TO ASK HER TEACHER FOR HELP ON HER MATH LESSON.

1. DID SHE COME FOR HELP ON A PLAIN ARITHMETIC OR ON A STORY PROBLEM?

2. HOW DOES THE STUDENT FEEL ABOUT ASKING THE TEACHER A QUESTION ABOUT MATH?

3. HOW DOES THE TEACHER FEEL ABOUT THE STUDENT ASKING A QUESTION ABOUT MATH?

HERE'S PICTURE 6

BOTH
6A

THIS IS A GIRL AND THIS IS A GIRL, AND THESE ARE TWO BOYS.

THE TEACHER HAS JUST ASKED THIS QUESTION (Show problem six and read it)

1. WHO WILL THE TEACHER CALL ON FOR THE RIGHT ANSWER?
2. WHY DOES THE TEACHER THINK SHE/HE WILL KNOW THE ANSWER? (Attribution-success)
3. WHY DOES THE STUDENT THINK SHE/HE GOT IT RIGHT? (Attribution-success)

   (Choose a student of the opposite sex on the same side)

4. DOES THE TEACHER THINK THIS STUDENT WILL KNOW THE ANSWER?
5. WHY DOES THE TEACHER THINK SO? (Attribution-success/failure)

(Use same photo next card)

1. WHO DOES THE TEACHER THINK WILL GET THE PROBLEM WRONG?
2. WHY DOES THE TEACHER THINK SO? (Attribution-failure)
3. WHY DOES THE STUDENT THINK SHE/HE GOT IT WRONG? (Attribution-failure)

(Choose a student of the opposite sex on the same side.)

4. HOW ABOUT THIS STUDENT. DOES THE TEACHER THINK SHE/HE WILL BE ABLE TO SOLVE THIS PROBLEM?
5. WHY DOES THE TEACHER THINK SO? (Attribution-success/failure)

PROBLEM FOR 6

WHAT IS THE ANSWER?

$\boxed{.91\overline{).3457}}$

HERE'S PICTURE 7

BOTH
7A

THIS IS A GIRL AND THIS IS A GIRL, AND THESE ARE TWO BOYS.

THE TEACHER HAS JUST ASKED THIS QUESTION.
(Show problem seven and read it.)

1. WHO WILL THE TEACHER CALL ON FOR THE RIGHT ANSWER?

2. WHY DOES THE TEACHER THINK SHE/HE WILL KNOW THE ANSWER? (Attribution-success)

3. WHY DOES THE STUDENT THINK SHE/HE GOT IT RIGHT? (Attribution-success)

(Choose a student of the opposite sex on the same side)

4. DOES THE TEACHER THINK THIS STUDENT WILL KNOW THE ANSWER?

5. WHY DOES THE TEACHER THINK SO? (Attribution-success/failure)

(Use same photo next card)

SAME PICTURE 7

BOTH
7B

1. WHO DOES THE TEACHER THINK WILL GET THE PROBLEM WRONG?

2. WHY DOES THE TEACHER THINK SO? (Attribution-failure)

3. WHY DOES THE STUDENT THINK SHE/HE GOT IT WRONG? (Attribution-failure)

(Choose a student of the opposite sex on the same side)

4. HOW ABOUT THIS STUDENT. DOES THE TEACHER THINK SHE/HE WILL BE ABLE TO SOLVE THIS PROBLEM?

5. WHY DOES THE TEACHER THINK SO? (Attribution-success/failure)

PROBLEM FOR 7

LAST YEAR A DELUXE 10-SPEED BICYCLE COST $129.50. THIS YEAR THE PRICE IS $142.45. WHAT PERCENT DID THE PRICE INCREASE IN ONE YEAR?

HERE'S PICTURE 8

BOTH
8A

THE TEACHER HAS ASKED A PROBLEM ABOUT THE VOLUME OF WEDGES.

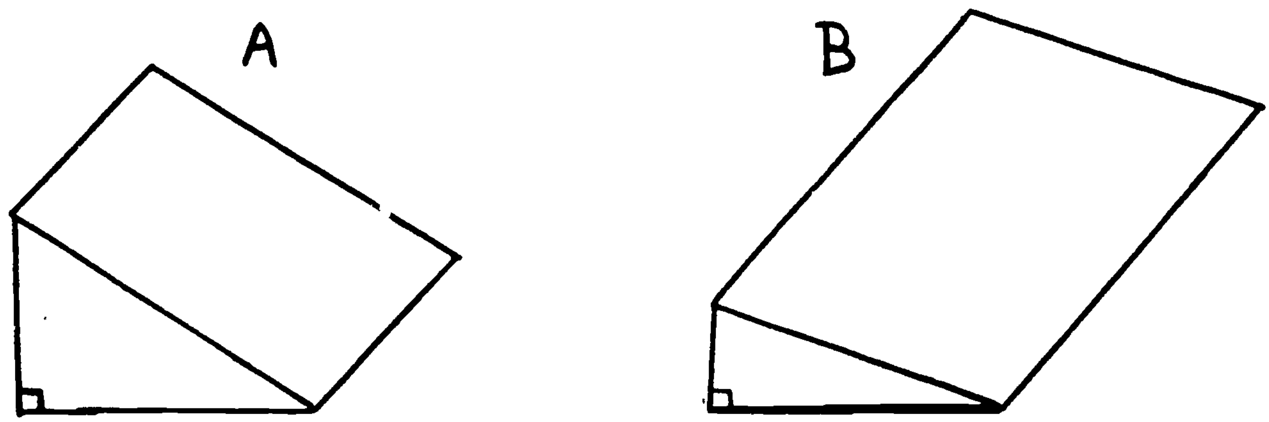
(Show problem 8 and read it.)

1. WHO AMONG THESE FOUR DOES THE TEACHER THINK WILL KNOW HOW TO DO THE PROBLEM?
2. WHY DOES THE TEACHER THINK THAT THE STUDENT CAN DO IT? (Attribution-success)
3. WHY WOULD THE STUDENT THINK HE/SHE COULD DO IT? (Attribution-success)
4. WHO AMONG THESE FOUR DOES THE TEACHER THINK WILL NOT KNOW HOW TO DO THE PROBLEM?
5. WHY DOES THE TEACHER THINK THAT? (Attribution-failure)
6. WHY DOES THE STUDENT THINK SHE/HE COULDN'T DO IT? (Attribution-failure)

(Use same photo next card)

PROBLEM FOR 8

WEDGE A IS TWICE AS HIGH AND JUST AS WIDE AS B. WEDGE B IS TWICE AS LONG AS A SO THAT A AND B HAVE THE SAME VOLUME. IS THE AREA OF THE BOTTOM OF WEDGE A THE SAME AS THE AREA OF THE BOTTOM OF WEDGE B?



SAME PICTURE 8

BOTH
8B

(Pick a student of the opposite sex from answer to ques. 1, 8A)

NOW LET'S TALK ABOUT THIS STUDENT.

1. HOW WOULD THE TEACHER THINK SHE OR HE WOULD DO ON THIS PROBLEM?

2. WHY DOES THE TEACHER THINK THAT THE STUDENT WOULD DO WELL/NOT WELL? (Attribution-success/failure)

3. WHY WOULD THE STUDENT THINK SHE/HE WAS ABLE TO DO WELL/NOT WELL? (Attribution-success/failure)

HERE'S PICTURE 9

MALE
9A

THIS BOY IS VERY CONFIDENT THAT HE CAN DO HIS MATH.

1. WHAT MIGHT HAVE HAPPENED TO HIM BEFORE THAT HE FEELS LIKE THAT?

2. WHICH ONE OF THESE 2 KINDS OF PROBLEMS IS HE MOST CONFIDENT THAT HE CAN DO? (Show introduction problems: arithmetic vs. story problem)

3. WHY?

(Use same photo next card.)

HERE'S PICTURE 9

FEMALE
9A

THIS GIRL IS VERY CONFIDENT THAT SHE CAN DO HER MATH.

1. WHAT MIGHT HAVE HAPPENED TO HER BEFORE THAT SHE FEELS LIKE THAT?

2. WHICH ONE OF THESE 2 KINDS OF PROBLEMS IS SHE MOST CONFIDENT THAT SHE CAN DO? (Show introduction problems: arithmetic vs. story problem)

3. WHY?

(Use same photo next card.)

SAME PICTURE 9

FEMALE
9B

LET'S CHANGE OUR POINT OF VIEW AND IMAGINE THAT THIS GIRL IS THE OPPOSITE OF WHAT YOU TALKED ABOUT BEFORE. THIS GIRL IS NOT AT ALL CONFIDENT...ACTUALLY VERY WORRIED ABOUT DOING HER MATH.

1. WHAT MIGHT HAVE HAPPENED TO HER BEFORE THAT SHE FEELS LIKE THAT?

2. WHICH ONE OF THE TWO KINDS OF PROBLEMS, PLAIN ARITHMETIC OR STORY PROBLEMS, IS SHE LESS WORRIED ABOUT?

3. WHY?

SAME PICTURE 9

MALE
9B

LET'S CHANGE OUR POINT OF VIEW AND IMAGINE THAT THIS BOY IS THE OPPOSITE OF WHAT YOU TALKED ABOUT BEFORE. THIS BOY IS NOT AT ALL CONFIDENT...ACTUALLY VERY WORRIED ABOUT DOING HIS MATH.

1. WHAT MIGHT HAVE HAPPENED TO HIM BEFORE THAT HE FEELS LIKE THAT?

2. WHICH ONE OF THE TWO KINDS OF PROBLEMS, PLAIN ARITHMETIC OR STORY PROBLEMS, IS HE LESS WORRIED ABOUT?

3. WHY?

HERE'S PICTURE 10

MALE
10

THIS BOY IS THE BEST STUDENT IN HIS MATH CLASS.

1. HOW DOES HE FEEL ABOUT BEING THE BEST STUDENT?

2. HOW DO THE OTHERS IN HIS CLASS FEEL ABOUT HIS BEING THE BEST STUDENT?

3. WHAT DO YOU THINK HIS LIFE WILL BE LIKE?

4. (If a short term response is given in 3) WHAT DO YOU THINK HE'LL BE DOING 10 YEARS FROM NOW?

   (If a long term response is given in 3) WHAT DO YOU THINK HE'LL BE DOING NEXT MONTH?

HERE'S PICTURE 10

FEMALE
10

THIS GIRL IS THE BEST STUDENT IN HER MATH CLASS.

1. HOW DOES SHE FEEL ABOUT BEING THE BEST STUDENT?

2. HOW DO THE OTHERS IN HER CLASS FEEL ABOUT HER BEING THE BEST STUDENT?.

3. WHAT DO YOU THINK HER LIFE WILL BE LIKE?

4. (If a short term response is given in 3) WHAT DO YOU THINK SHE'LL BE DOING 10 YEARS FROM NOW?

   (If a long term response is given in 3) WHAT DO YOU THINK SHE'LL BE DOING NEXT MONTH?

SUMMARY QUESTIONS (no picture)

BOTH
Summary

O.K. NOW I WANT TO ASK YOU ABOUT WHAT YOU BELIEVE ABOUT SOME OF THE KINDS OF THINGS WE'VE BEEN TALKING ABOUT.

1. DO YOU THINK THAT TEACHERS TEND TO CALL ON BOYS MORE OR ON GIRLS MORE IN MATH CLASS?

2. WHY DO YOU THINK THIS IS?

3. SOME PEOPLE SAY THAT GIRLS ARE BETTER IN MATH THAN BOYS...AND SOME SAY THE OPPOSITE, THAT BOYS ARE BETTER THAN GIRLS. WHAT DO YOU THINK?

4. SOME PEOPLE SAY GIRLS DO BETTER AT STORY PROBLEMS THAN DO BOYS. WHAT DO YOU THINK?

5. MOST PEOPLE HAVE TROUBLE AT SOME POINT OR ANOTHER WHEN THEY ARE STUDYING MATH. DO YOU EVER HAVE TROUBLE WITH MATH?

(Summary continued next card)

SUMMARY QUESTIONS CONTINUED

BOTH
Summary

6. (If yes) WHAT DO YOU DO WHEN YOU HAVE TROUBLE?

(If no) SUPPOSE A FRIEND OF YOURS WAS HAVING TROUBLE WITH MATH. WHAT WOULD YOU SUGGEST THAT YOUR FRIEND DO?

7. SOME PEOPLE ARE VERY SCARED ABOUT DOING MATH. WHY DO YOU THINK GIRLS ARE SOMETIMES NOT SO CONFIDENT? WHY DO YOU THINK BOYS ARE SOMETIMES NOT SO CONFIDENT?

8. HAVE YOU EVER HAD A MALE MATH TEACHER? (If yes) DO YOU THINK THAT THEY TREAT GIRLS DIFFERENTLY THAN THEY TREAT BOYS? HOW?

9. WE HAVE FOUND THAT MANY STUDENTS EXPECT GIRLS TO DO BETTER IN MATH THAN BOYS. HOWEVER, MEN SEEM TO WORK IN CAREERS THAT USE MATH MORE OFTEN THAN WOMEN DO. FOR EXAMPLE, THERE ARE A LOT MORE MALE ENGINEERS THAN THERE ARE FEMALE ENGINEERS. WHY DO YOU SUPPOSE THAT GIRLS ARE EXPECTED TO DO BETTER IN MATH, YET BOYS USE MATH MORE IN THEIR CAREERS?

CONCLUSION

Thank you ______________________________ for your cooperation.

ATTRIBUTION EXAMPLE CARD

Environment
- was lucky
- got help
- teacher explained it
- was absent

Task
- easy problem
- new problem
- not used to doing this kind of problem

Effort
- paying attention
- listening
- daydreaming
- studying
- tried really hard

Ability
- is smart
- is naturally good at math
- catches on easily
- forgets how to do it

Unacceptable
- got a good grade
- does well in school

1. Did she/he do well because she/he was SMART, because she/he WORKED HARD, because it was EASY, because she/he GOT HELP or for some other reason?

2. Did he/she get the answer right because he/she was LUCKY, because he/she was PAYING ATTENTION, because he/she had DONE THIS PROBLEM BEFORE, because he/she CATCHES ON EASILY or for some other reason?

CONFIDENCE INTERVIEW MANUAL

by

Mary C. Schatz
Elizabeth Fennema

February 1981

Developed under a grant from the National Science Foundation

Table of Contents

I. DESCRIPTION OF THE CONFIDENCE INSTRUMENT YEAR III

The Confidence Instrument consists of pictures, script cards, and problem cards. The pictures depict 8th graders in typical mathematics classroom situations. Some scenes shown are: students in a class with a teacher, students working together, students asking the teacher for help, and students working alone. The pictures are numbered and ordered. Along with each picture is a corresponding set of questions that the interviewer asks the student. Most of these questions fall under the broad categories of expectation of, feelings about and attribution of success and/or failure in mathematics. The problem cards show examples of types of mathematics problems. Each problem card corresponds to a particular picture. The types of problems shown are plain arithmetic problems, story problems, and spatial problems.

Here is a sample picture with its corresponding question card.

HERE'S PICTURE 3

BOTH
3

HERE ARE TWO GIRLS AND TWO BOYS LOOKING OVER A MATH TEST. ONE DID POORLY, TWO DID PRETTY WELL, AND ONE DID VERY WELL.

1. WHICH ONE DID VERY WELL?
2. (Point to student who did best) HOW DOES THE ONE WHO DID WELL FEEL ABOUT HER/HIM-SELF?
3. HOW DO THE OTHERS FEEL ABOUT THE ONE WHO DID WELL?
4. WHY DO THE OTHERS THINK THAT SHE/HE DID WELL? (Attribution-success)
5. WHO DID MOST POORLY?
6. HOW DOES THE ONE WHO DID MOST POORLY FEEL ABOUT HIM/HER-SELF?
7. HOW DO THE OTHERS FEEL ABOUT THE ONE WHO DID POOREST?
8. WHY DO THE OTHERS THINK THAT SHE/HE DID MOST POORLY? (Attribution-failure)

II. PROCEDURE FOR THE INTERVIEWER TO FOLLOW

1. Privacy. The confidence interview must be conducted in a private setting. The interviewer must not allow any person (other than the student to be interviewed) to be present in the room. If someone does enter the room, stop the interview. Ask that person to leave the room, and do not continue the interview until that person has left the room.

2. Equipment. Each confidence interview is to be audio-recorded. The interviewer must be certain that the recording equipment is in working order. Put only one interview on a cassette tape. Label that tape clearly with: student #, sex of student, date, school, and your initials.

3. Conducting the Interview. Begin the interview by setting the student at ease. Some "small talk" (about the weather or some school event, for example) might help to "break the ice." Assure the student that whatever he/she says is strictly confidential (see Intro card). The interviewers should present the pictures and ask the questions in order. (However, if a picture or question is inadvertently skipped, the interviewer can go back to it.) As you present a picture to the student, be sure to say "Here's picture #____," for clarity in the transcription. Keep the picture in the student's view while you ask the corresponding questions. If there is a problem card also, then present that at the appropriate time. Either read the problem to the student, or allow the student to read the problem. Allow time for the problem to "sink in" but do not have the student solve, or attempt to solve the problem. After all the questions are asked about a particular picture, remove that picture from view and go on to the next picture and set of questions.

Some pictures depict a student working alone, and some depict scenes involving a teacher. In these cases, you will notice that there are multiple photos. The interviewer should match the sex of the student pictured to the sex of the student being interviewed, and should match the sex of the teacher shown to the sex of the student's mathematics teacher.

After all the pictures and questions have been gone through, thank the student for his/her cooperation. Put your cards and pictures back in order, then wait for your next interview.

III. QUESTIONNING TECHNIQUE

1. Introduction

It is very important to establish a good rapport with the student you are interviewing. The atmosphere should be warm and relaxed. Encourage the student to talk by being supportive and non-judgmental. It is important that we find out about the student's thoughts and feelings, not the interviewer's. Encourage the student to use his/her imagination, and follow-up on interesting comments that the student might make. (Interesting comments would include comments about confidence and stereotyping, for example).

While it is important to encourage the student to talk, it is crucial that all of the questions that correspond to each picture get asked and answered. So, while you may follow a student's line of thinking for a moment, it is imperative to return to the questions of the interview. We will now go through the various types of questions you will be asking. Examples of actual interviews will be given to illustrate how to ask the various questions, and how to elicit adequate responses to those questions.

2. Expectation Questions

Two types of expectation questions are asked. These are: Who will succeed? and Will this particular person succeed? Parallel questions are asked about failure.

As a response to the first type of question, we expect the student to choose one of the pictured students. There are two steps for the interviewer to follow here. First, be sure that the student makes a choice. Answers such as "both of them," "all of them," "none of them" are unacceptable. Second, be sure to clarify for the tape recorder which student in the picture has been chosen. This is especially important if the student points to his/her choice.

Here are some examples of these two points.

Example 1: Interviewer gently forces student to choose, and clarifies who was chosen.

I: Here's our second picture. These two people have gotten different answers to a plain arithmetic problem like this one. Find the answer to three hundred and eighty six divided by twenty five. And they've got different answers. Tell a story about what they're saying to one another.

S: UM, WELL, IT WOULD DEPEND ON, LIKE ONE IS SAYING TO THE OTHER THAT THEY'RE TRYING TO EXPLAIN WHY THEIR ANSWER IS RIGHT. AND THAT... THAT THEY'RE JUST TRYING TO...TRYING TO TELL THE OTHER ONE WHY THEY THINK THEIRS IS RIGHT.

I: Okay. Who do you think would probably have the right answer?

S: I DON'T KNOW.

I: Take a guess.

S: WELL, I DON'T KNOW WHAT THEIR ABILITIES ARE SO HOW'RE YOU SUPPOSED...

I: Oh, I know that you wouldn't know for sure, but just, if you had to pick one, which one would you pick as having gotten the answer right?

S: MMM, THAT ONE?

I: Okay, you picked the girl. And now, why did you pick her?

Example 2: Interviewer is a bit too abrupt in getting student to choose.

I: Okay, here's picture number 2. These two people, the girl with the plaid jacket and the boy with the red hair, have gotten different answers to this plain arithmetic problem. 25 divided into 386. Okay? Tell a story about what they're saying to one another.

S. WELL, THEY'RE PROBABLY WORKING THROUGH THE PROBLEM, TRYING TO FIGURE OUT WHAT'S WRONG WITH IT. AH...YEH, PROBABLY TRYING TO FIGURE OUT WHAT'S WRONG WITH IT AND MAYBE BRINGING UP DIFFERENT VIEWS, LIKE A DISCUSSION ON THE PROBLEM.

I: Okay, fine. Who do you think would probably have the right answer?

S: I CAN'T TELL.

I: Oh, make a choice.

S: IT COULD BE ANYBODY.

I: Make a choice.

S. UM...HER.

I. Okay, why did you pick her?

Example 3: Student gives a general response. Interviewer gets student to be more specific.

I: Next we're going to picture number 6. And, these two girls and these two boys are in this class and the teacher has just asked this question. 300, what's 362 times 48. Okay? And who will the teacher call on for the right answer?

S: THE PERSON WHO FINISHES THE EQUATION FIRST.

I: Alright, which one in this case do you think that'll be? Or remember, we want somebody that she's calling on for the right answer.

S: THE BOY IN THE RED SWEATSUIT.

I: Okay. Why does the teacher think he will know the answer?

To the second type of expectation question, the interviewer must again be sure the student makes a clear choice. The question is some variation of: How will this particular student do? Do not accept vague answers such as "sorta okay" or "half and half." Instead, push for answers where success or failure is clear cut. Here are some interviews which illustrate this point.

Example 4: Interviewer gets student to clarify a response.

I: What about the boy in the blue t-shirt? How might the others expect him to do on their math lesson?

S: PROBABLY ABOUT AVERAGE.

I: Okay, and...what, um...in your opinion, what is average? Is that pretty good or is that a bad...

S: WELL, IT'S IN BETWEEN GOOD AND BAD.

I: ....Okay, um...well, suppose, um, they weren't giving out average grades this day and they were just giving out, you know, good grades or bad grades. How would he do then?

S: PROBABLY GET...UM...PROBABLY DOWN TO A BAD GRADE.

I: He'd get a bad grade. Okay, and why would they think that he wouldn't do very well on this lesson?

I: Let's look at the boy in the blue t-shirt over here. How might the others expect this boy to do on their math lesson?

S: JUST SATISFACTORY.

I: Just satisfactory? Does that mean he's doing well or badly?

S: IN BETWEEN.

I: In between? Let's say we've gotta say either well or badly...

S: WELL.

I: Well? (OKAY) Okay, so he's going to do well. Now, do they have any reasons for thinking that he's going to do well?

Example 5: Interviewer gets student to make a decision.

I: Okay. Now, will they expect her to do better...on plain arithmetic problems or on story problems?

S: WELL, SHE'D PROBABLY DO ABOUT THE SAME ON THEM. SHE LOOKS LIKE SHE COULD DO BOTH KINDS REALLY GOOD.

I: Okay, even though she can do both kinds really good, which would she ...you know, suppose she was a little bit better at one than the other. Which would she be better at?

S: AT MAYBE STORY PROBLEMS.

Example 6: Student answers the question by breaking the situation into two parts. Interviewer gets student to respond to original question.

I: Now let's look at this boy in the blue t-shirt. How might the others expect this boy to do on the math lesson?

S: WELL, HE LOOKS SORT OF INTO IT, BUT IT LOOKS LIKE HE'S...YOU KNOW, HE'S SCRATCHING HIS HEAD, HE'S "OH, WHAT DO I DO NOW?" UM, LET ME SEE UM, HE MIGHT NOT DO REALLY GOOD...IF HE'D BE DOING THIS PROBLEM, LIKE THE PLAIN ARITHMETIC, HE MIGHT NOT DO REALLY GOOD BECAUSE HE'S THINKING ABOUT IT A LOT, SEE, CHECKING HIS ANSWER. BUT IF HE WAS LIKE READING THE STORY PROBLEM AND...HE MIGHT DO GOOD.

I: Okay, overall, let's just think overall. Say there's a mixture of problems. Overall, how's he going to do?

S: WELL, TO ME HE DOESN'T LOOK LIKE...HE'S SORT OF INTO IT, BUT, HE JUST DOESN'T UNDERSTAND WHAT..HE'S TRYING REALLY HARD, BUT HE DOESN'T UNDERSTAND WHAT'S GOING ON.

I: So overall, he's going to do well or not do well...

S: WELL, NOT REAL WELL, BUT NOT TOO BAD.

I: Okay, but not...say less than average or more than average?

S: LESS THAN AVERAGE.

I: A little less than average. Okay. Um...and which type of problem did you say that they thought that he would do better at?

Example 7: Student gives an acceptable response, but in a subsequent question seems to change that response. Interviewer goes back to original question and clarifies the response.

I: This boy in the t-shirt here. How might the others expect this boy to do on their math lesson?

S: PRETTY GOOD.

I: Why do they think that?

S: BECAUSE...BECAUSE HE LOOKS LIKE HE'S...WELL HE LOOKS KIND OF LIKE HE'S STUMBLED OR SOMETHING, LIKE HE DOESN'T GET A PART, MAYBE...

I: So, is he going...is he going to do well or is he not going to do well?

S: WELL, I DON'T THINK HE'LL DO WELL ON THAT ONE. BECAUSE HE LOOKS LIKE HE'S...DOESN'T GET IT OR SOMETHING.

I: And why would they think he's not going to get it?

Example 8: Interviewer does not force student to make a choice. The result is missing data, not only for this question, but also for subsequent questions.

I: Okay. Uh, does the student think she can do the problem?

S: SHE'S NOT SURE.

I: She's not sure?

S: YEAH, SHE'S NOT SURE WHETHER OR NOT SHE'LL BE ABLE TO GET IT RIGHT.

I: Okay, why does she think so?

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3. Feelings Questions

Examples of feelings questions are: How does the student who got the highest score feel about him/herself? How does the one who got it wrong feel about the one who got it right? There are two important points for the interviewer to be aware of. First, it is important that the student answers with a feelings response. Expressing emotions such as happiness, sadness, embarassment, pride are acceptable responses. Secondly, it is important that the student respond about the particular student in the picture that is the focus of the question. For example, the question "How does the one who got it wrong feel about the one who got it right?" is sometimes confused by the student and instead the question answered is "How does the one who got it wrong feel about him/herself?"

Here are some transcripts showing feelings questions, and interview techniques for getting appropriate responses.

Example 9: Student gives clear feelings as responses.

I: Now, here's picture three. Here are two girls and two boys looking over a math test. One did poorly, two did pretty well, and one did very well. Which one did very well?

S: UM...THE RED HEAD. THE GIRL THERE.

I: Alright, and what are the others thinking about the one who did well?

S: UM...UH, THEY ADMIRE HER.

I: Okay, why do they think that she did well?

S: WELL, THEY THINK SHE...SHE'S A LOT SMARTER THAN THEY ARE.

I: Okay. Who did most poorly?

S: UM. HERE, THIS BOY HERE.

I: Okay, in the white shirt there. Now, how do the others feel about the one who did the poorest?

S: WELL...THEY THINK HE'S THE DUMBEST AND...THEY PUT HIM DOWN.

I: Okay, how does the one who did very well, the one with the red hair there, how does she feel about herself?

S: SHE'S PROUD...AND...YEAH, SHE'S PROUD OF HERSELF.

Example 10: Interviewer attempts to get a feelings response, but begins to lead the student.

I: Okay, how does the one who did really well feel about herself?

S: THAT UM, WELL...THAT, THAT SHE'S A GOOD STUDENT AND, AND,

I: Okay. She knows she's a good student and how does that make her feel about herself?

S: WELL, MAYBE SHE KNOWS SHE'S GOOD AT IT, THE STUFF, BUT MAYBE SHE WANTS TO BE A LITTLE BIT LESS SMART OR SOMETHING SO SHE CAN HANG AROUND WITH THE REST OF THE KIDS.

I: She can't hang around with them now?

S: WELL SHE, SHE CAN BUT THEY ALWAYS THINK SHE'S JUST A BRAIN OR SOME-THINK AND THEN...

I: So...she feels a little ??? about being so smart?

S: SORT OF, ASHAMED OR SOMETHING ABOUT, SHE MUST BE SMART, BUT YOU KNOW, EVERYBODY ELSE JUST THINKS SHE DOESN'T LIKE TO HAVE FUN OR SOMETHING.

I: So she feels that being smart makes her somehow different?

S: YEH.

I: And she feels that the other kids are going to react the same way? And that kind of excludes her?

S: UH HUM.

Example 11: Student does not give a feelings response. Interviewer does not try to get an answer. (Answer given is actually an attribution--more about these in the next section.)

I: Alright, how do the others feel about him?

S: MAYBE HE DIDN'T STUDY THE TEST AT ALL.

I: Okay, alright, le'ts look at that. Let's go back to the boy that did the best. How does he feel about himself?

S: I GOT LUCKY.

I: And how do the others feel about the one who did the poorest?

S: UM, THEY PROBABLY THINK THAT HE'S NOT VERY SMART AND THAT, AND THAT HE NEEDS EXTRA HELP OR SOMETHING LIKE THAT.

Example 12: Student answers the wrong question. Interviewer does not follow up on it.

I: Okay, good. Okay, how will the boy feel about the girl this time?

S: UM...PROBABLY KIND OF FRUSTRATED THAT HE'S NOT GETTING IT ANYMORE.

I: Okay, how about the boy, how does he feel about the girl?

S: HE MIGHT FEEL STUPID FOR GETTING AN EASY PROBLEM WRONG.

I: Okay, um, how about the boy now who got it wrong. How might he feel about the girl who got it right?

S: WELL, HE'D FEEL EMBARASSED.

Example 13: Student answers the wrong question. Interviewer follows up by asking the question again.

I: Okay. How is...the girl who got it wrong going to feel about the boy who got it right?

S: PROBABLY, OH, I THINK IF I TRIED I COULD HAVE DONE IT BETTER, OR SOMETHING LIKE THAT. IF I UNDERSTOOD IT BETTER I COULD HAVE DONE IT.

I: Okay, that's kind of how she's going to feel about herself. How's she going to feel about him?

S: PROB, WELL, IT'S HARD TO SAY. UM...PRETTY, KIND OF JEALOUSY.

I: Okay, how about him. He got it right. How is he going to feel about the girl who got it wrong?

S: WELL.. ??? ON THE OTHER. UM, HE'D FEEL KIND LIKE IF SHE TRIED, SHE MIGHT HAVE BEEN ABLE TO DO IT IF SOMEBODY WOULD HAVE HELPED HER UNDERATAND IT SHE COULD HAVE DONE IT.

I: Okay.

I: Okay, alright. How will the girl this time, because she got it wrong, feel about the boy who got it right?

S: WELL, SHE'LL PROBABLY FEEL THAT...THE BOY DID BEFORE, LIKE SHE FEELS LIKE "WELL, I CAN DO MATH PROBLEMS, IT'S JUST THAT I CAN'T READ THE MATH PROBLEMS AS WELL, YOU KNOW, I SHOULD--I'M KIND OF DUMB TO DO THAT."

I: Alright, how will she feel about him do you think?

S: WELL, PROBABLY THINK THAT, YOU KNOW, "HE'S NOT AS GOOD IN THE MATH PROBLEMS, BUT HE'S PRETTY GOOD AT READING IT AND HE ENJOYS IT."

I: Okay. How will the boy this time, because he got it right, feel about the girl that got it wrong?

S: HE'LL PROBABLY FEEL A LITTLE PROUD BECAUSE, YOU KNOW, ON THE OTHER PROBLEM, HE DIDN'T GET IT RIGHT, BUT NOW HE'S SHOWING HER THAT HE CAN DO IT.

I: Good, he'll feel proud of himself. How will he feel about the girl do you think?

S: WELL, HE'LL FEEL LIKE "I TOLD YOU, LIKE I CAN...LIKE..." HE SAID, MAYBE HE CAN THINK "NOW I TOLD YOU I CAN DO THIS, I COULDN'T DO THE OTHER THING, BUT I CAN STILL DO SOMETHING ELSE."

I: Okay.

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4. Attribution Questions

A large portion of the questions on the confidence interview fall into this category. The basic question asked is: Why was student successful? (or unsuccessful?) We are asking the student about the causes of success/failure. There are essentially four categories an appropriate response can fall into. If the given response does not fall into one of these categories, the interviewer must rephrase the question until an acceptable response is given.

The four categories of responses can be illustrated using a model from Weiner:

	Internal	External
Stable	Ability	Task
Unstable	Effort	Environment

Ability refers to how smart or capable a person is.

Effort is the amount of work or time one is willing to expend to achieve a goal.

Task refers to the ease or difficulty of the problem or activity itself.

Environment refers to factors in the surroundings that might affect performance.

Here are some examples of these categories, based on interview data from previous years:

Environment

got help at home
teacher explained it clearly
was lucky

Task

easy problem
have done this type of problem before
complicated problem

Effort

pays attention
works really hard
is always prepared
asks for help
completes all the assignments

Ability

is smart
catches on easily
is naturally good at math

When a response is given that does not fit into one of these categories, then the interviewer should suggest one possibility from each category. The order in which the categories are enumerated, as well as the examples from each category, should be varied. The "Attribution Card" included in the instrument should be a help to you in doing this. Note: <u>If you are in doubt as to whether or not an attribution response has been given, continue questioning the student until you get one</u>. Here are some examples of attribution questions and responses from previous interviews:

<u>Example 14:</u> Interviewers persisting until they get an attribution.

I: Okay, why do the rest of these think he's not going to do so well?

S: WELL, HE LOOKS LIKE HE'S HAVING TROUBLE.

I: Okay, why...why do they think he's having trouble with it? Why does he look that way?

S: WELL HE'S GOT..HE'S GOT HIS HAND UP THERE...

I: Do they have any reasons why he may be having trouble with the math? Can you think of any? They know this kid pretty well. They might have, they must have some kind of reason why they'd think he isn't doing well...just use your imagination again...pretend they're really good friends, and...

S: WELL...UM, HE DOESN'T STUDY AS MUCH...AND DOESN'T REALLY TRY VERY HARD.

- -

I: Good. Now why does the student think he got the problem right?

S: UMM, BECAUSE HE CHECKED IT OVER.

I: Okay, and when he checked it over, what made him feel kind of sure that he got it right or...

S: WELL, IT CAME OUT RIGHT AND...LIKE HE DIVIDED, OR HE SWITCHED THE NUMBERS ??? HE KNOWS WHAT'S HAPPENING.

I: And, what made him able to ... why was he able to do the problem right. Is it because he gets lots of help, or is lucky, or because it was an easy problem, or because he works hard or because he's smart...

S: HE WORKS HARD.

I: Okay, and why did he get the right answer?

S: WELL, UM, HE IS BETTER AT MATH.

I: Okay and why is it that he's better at math. Is it because he's smart, or because he works hard, or it's easy, or he gets help, or he's lucky or some other reason?

S: HE WORKS HARD IN MATH AND PARTICIPATES IN CLASS.

I: Why was she able to get the right answer?

S: UM, SHE JUST KNEW IT. I MEAN, SHE JUST WORKED IT OUT RIGHT NOW ??? LIKE MAYBE HE DIVIDED WRONG OR SOMETHING.

I: Why was she able to just work it out? Is it because she's smart or because she studies a lot or because it was an easy problem or because she got help or was lucky or some other kind of reason?

S: UM...JUST BECAUSE, UM...

I: Well, um, what would be one reason that caused her to get it right? You said that she knew how to do it, but...what made her able to know how to do it?

S: WELL, SHE'S LISTENED TO THE TEACHER, MAYBE WHEN SHE'S--WHEN THE TEACHER GAVE IT TO THEM.

<u>Example 15:</u> Interviewers not successful at giving an attribution response.

I: Alright, and why would they think that he's doing well?

S: WELL, YOU KNOW, HE DOESN'T START GETTING MAD AND EVERYTHING ABOUT WHAT HE'S DOING, YOU KNOW, OR GETTING IN A RUSH. HE COULD DO REAL WELL.

I: Alright, any...can you take it a step further than that? Why else might they think he's doing well?

S: WELL, IF HE DOES GOOD IN EVERYTHING ELSE...THEY'D PROBABLY EXPECT HIM TO DO REAL WELL.

I: Alright, let's think just about math and not think about other subjects. Why else might they think that he's doing well?

S: WELL, IF HE GETS, YOU KNOW, REAL GOOD HIGH SCORES IN EVERY...OTHER MATH ASSIGNMENTS THAT THEY GET. YOU KNOW, IF HE DOES REAL WELL ON THOSE, THEY MIGHT EXPECT HIM TO DO REAL WELL ON EVERYTHING.

I: Okay, that's possible. Could it also be because he gets a lot of help from his teacher, or because the assignment's real easy, or because he pays attention a lot, or because he really knows how to do it or...any...

S: YEH, IT COULD BE ALL OF THOSE.

I: Okay, any specifically of those? Or anything else like that?

S: NO.

I: Okay, why does the student think he got it right?

S: UMM...I DON'T KNOW..HE'S GOT A ONE TRACK MIND.

I: Uhh...is he...what do you mean?

S: I MEAN...YOU KNOW, HE JUST...USUALLY THINKS HE'S RIGHT.

I: Why does he think he's, usually that he's right, is it because he's smart or because...uh, he's lucky or because he worked hard or because ...uh, he got help or that the problem was easy or what?

S: HE'S PROUD.

I: Huh?

S: HE'S PROUD.

I: Why do you suppose he's proud?

S: I DON'T KNOW.

Example 16: Interviewer attempts to "pull out" an attribution, but ends up leading the student.

I: Here's picture 6. These two are girls and these two are boys. The teacher has just asked this problem. About multiplying 362 by 48. Who will the teacher call on for the right answer?

S: UM, THIS ONE.

I: The girl with the multi-colored sweater? (UMHUM) Why do the students think that that's, why does, excuse me, the teacher think that that student will know the answer?

S: UMM, CAUSE SHE, CAUSE SHE LOOKS LIKE SHE, LIKE, LIKES MATH CAUSE SHE LOOKS LIKE SHE'S READY TO ANSWER THE QUESTION.

I: Why is she ready to answer?

S: UM, CAUSE IT'S EASY FOR HER.

I: What makes it easy for her?

S: UM,

I: Is she naturally smart or are her parents both math teachers and work a lot with her, she spent a lot of time working with the teacher,

S: UM, HER BROTHER'S IN COLLEGE OR SOMETHING, AND AH,

I: And he helps her?

S: YEH.

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5. General Reminders

a. Don't let the student change the setting. If a success situation is being discussed, make sure the student doesn't get mixed up and start discussing failure. Or, if a student has chosen to talk about one student in the picture, make sure he/she doesn't get confused and start talking about another student. Situations like this only cause the data to be lost. Here is an example:

Example 17: Student changes the situation. Interviewer notices and gets it back on track.

I: Okay, here's picture six. These two girls and these two boys are in a math class. The teacher has just asked this question. What is the answer to three hundred and sixty two times forty eight? Who will the teacher call on for the right answer?

S: THE BOY IN THE BACK WITH THE BLUE SWEATER ON, OR SHIRT...???

I: Um, point to the one again?

S: HIM.

I: Um, yeah, that's a girl. Or I think...so now who would the teacher call on?

S: THE PERSON IN THE BACK...

I: On the right there. Okay, on the right in the back. Now why does the teacher think that she will know the answer?

S: WELL, SHE DOESN'T THINK THAT SHE WILL KNOW THE ANSWERS, BUT SHE DOESN'T VOLUNTEER SO SHE ASKS HER TO VOLUNTEER THIS TIME (that's called "drafted").

I: Okay, teachers, they do that a lot. In this particular situation, the teacher wanted to be sure she got the right answer to the problem, so she wanted to call on someone who she felt certain would have the right answer.

S: OH...

I: So, who would she call on then if she were looking for someone who she was certain would have the right answer. Would she call on the same person, or...

S: WELL, SHE'D CALL ON THE GIRL ACROSS FROM HER.

I: Okay, so she'd call on the girl on the left then, to get the right answer. Now why does the teacher think that the girl on the left will know the answer?

I: Here's picture six. These two are girls and the two in the front are boys. The teacher has just asked this plain arithmetic problem, about multiplying 162 by 48. Who will the teacher call on for the right answer?

S: HER.

I: The girl with the dark blue sweater (UMHUM). Why does the teacher think she'll know the answer?

S: WELL, SHE DOESN'T, SHE THINKS SHE'S ABOUT TO TURN HER HEAD TO...

I: Well, but I want, I want the one the teacher's going to call on for the <u>right</u> answer. She knows the kid's going to....

S: THE GIRL ACROSS FROM HER.

I: Ah, the girl in the multi-colored sweater. Okay, why does the teacher think that she's going to be right?

I: Here's picture six. These two are girls and these two are guys. The teacher has just asked this question. What is the answer to three hundred and sixty two times forty eight? Who will the teacher call on for the right answer?

S: I THINK THE BOY WITH THE...UH STRIPED SHIRT ON. THE BIG STRIPES.

I: Okay, So he's on the right then. Why does the teacher think that he will know the answer?

S: WELL...HE MIGHT NOT, BUT HE'LL...SHE MIGHT HAVE CALLED ON HIM TO SEE IF HE'S...IF HE COULD KNOW IT. IF HE GETS HOW TO DO IT.

I: Mmhmm. In this particular case, the teacher really wanted to call on someone she was very sure would have the right answer. Okay?

S: I THINK THE GIRL ON THE LEFT WOULD KNOW IT.

I: Here's picture number two. That was good imagination. That's the idea, to get into the people, you know, into their heads. See what they're thinking. Those two kids, seventh graders, are working on this math problem: three hundred eighty six divided by twenty five. Now, they both have gotten different answers, okay? Tell a story of what they might be saying to one another.

S: SHE SAYS...IS THAT A SHE? (yes, girl and boy) SHE SAYS, "LET ME COPY OFF YOUR PAPER" HE SAYS, "OKAY."

I: Okay, which one got it right? Of the two?

S: THEY BOTH GOT IT WRONG.

I: Okay. Um, they both got it wrong, huh? Now, they reworked it, okay? And one of them gets it right, and one of them gets it wrong. Which one has it right?

S: THE ONE WHO THE OTHER ONE COPIES OFF.

I: Okay, and which one's that?

S: WHOEVER'S SMARTER.

I: Alright, well, who do you think. You can almost close your eyes.

S: I DON'T KNOW.

I: Which one probably has it right?

S: THE ONE WHO UNDERSTANDS IT BETTER.

I: Okay, that's true, that's a good reason. Let's pretend that one of them does have it right, and you can almost close your eyes and pick out one or the other. Who's got it?

S: SHE DOES.

<u>Example 18:</u> Student changes the situation. Interviewer doesn't notice. This results in missing data.

I: Okay, here is picture six. And...this is a girl and this is a girl and this is a boy and that's a boy. Uh, the teacher has just asked this question: three hundred and sixty two times forty eight. Who will the teacher call on for the right answer?

S: UHH...HIM.

I: The guy in the red jacket?

S: UH-HUH.

I: Okay, why does the teacher think he will know the right answer?

S: UMM...MAYBE SHE DOESN'T, HE'S BEEN MESSING AROUND AND HE JUST WANTS...

I: Hmmm?

S: MAYBE SHE DOESN'T THINK HE'LL GET THE RIGHT ANSWER AND...SHE JUST WANTS TO SEE IF HE WILL.

I: Okay, like a puzzle, huh? (AHAH) And why would he be able to do it, why would he think he could do it? Or???

S: HE DOESN'T THINK HE CAN, HE DOESN'T REALLY KNOW.

I: Okay. He doesn't think that he can. Okay, he's not sure. And why is he not sure that he can do it?

S: WELL, MATH IS USUALLY NOT HIS BEST SUBJECT.

I: Okay, is he not too smart or he doesn't try hard or doesn't get help or does he feel unlucky? (Pause)

S: HE TRIES.

I: He tries.

S: AND HE'S FAIRLY SMART.

I: Okay, I wonder why he feels that way?

S: I DON'T KNOW.

---

b. Some of the questions are repeated throughout the interview. Students may begin to give the response "the same reason I gave before." This response is unacceptable. Each picture and corresponding set of questions should be able to stand alone. If the student gives this response, encourage him/her to restate his/her previous response. For example:

Example 19: Interviewer gets student to repeat a previous response.

I: Alright, how about the girl. She got it right and he got it wrong. How will she feel about him?

S: UM...PROBABLY THE SAME WAY AS BEFORE.

I: I forgot what you said before.

S: UM, THAT...THAT, UH, SHE THINKS HE'S KIND OF DUMB LIKE.

I: Okay.

Example 20: Interviewer unsuccessful at getting student to repeat response.

I: Okay, how about the boy this time. How would he feel about the girl because she got it right and he got it wrong?

S: SAME WAY?

I: I can't remember what you said before.

S: OKAY, UH, HE WOULD FEEL KIND--HE'D JUST FEEL THE SAME WAY YOU KNOW, ABOUT HER THAT HE FELT BEFORE.

I: Oh, okay. Okay, and how will the girl feel about the boy, since she got it right and he got it wrong?

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c. In some instances, questions and/or responses will focus on a teacher or other individual who is not pictured. When this occurs, do not use masculine or feminine pronouns to describe this person.

Example 21: Interviewer uses both good and bad technique. Refers to the teacher as "the teacher," but also uses "she."

I: Okay, here's picture six. The two in back, the one with the red shirt and the one with the blue shirt are girls, and the two in front are boys, one with a red shirt and one with a stripe...a red stripe on his sweater. The teacher...has just asked this question: What is three hundred and sixty two multiplied by forty eight. Who will the teacher call on for the right answer?

S: .....

I: Okay, imagine a teacher standing up front, looking out at these four people. Which one will she call on for the right answer?

S: THE GIRL IN THE DARK BLUE.

I: Okay, why does she think that the girl in the dark blue will know the answer?

S: BECAUSE SHE DOES BETTER ON HER MATH THAN THE OTHERS.

I: Why does she do better? Why does the teacher think she does better?

IV. SUMMARY

Procedure. The interview should be private and audio-recorded. Label tape with student #, sex of student, date, school, and your initials. Ask all the questions. Match sex of student and student's teacher on appropriate pictures.

Questioning Technique

1. Intro - be warm, friendly
2. Expectation Questions
   - A. Who will succeed?
     - i. force students to choose one student (gently)
     - ii. clarify their choice for the tape recorder
   - B. How will this one do?
     - i. force (gently) students to commit themselves to success or failure
3. Feelings Questions
   - A. Make sure response is a feeling
   - B. Make sure it is a feeling directed at the person being discussed
4. Attribution Questions
   - A. Make sure it is an attribution - see examples. If not, give suggestions.
5. General Reminders
   - A. Don't let student change the setting
   - B. Don't let student respond "same as before"
   - C. Don't refer to a non-pictured individual as she or he

Confidence Coder's Manual Year III

Introduction

The basic aim in coding the confidence interview is to get the data from the unstructured form of the interview into a structured, and ordered, form so that the data can be analyzed using the computer. The end product of the coding will be a series of numbers representing the students' responses to the interview questions. To get from the transcript of the interview to the numbers on the coding sheet for the computer, we will be using the coding scheme. The coding scheme outlines the confidence interview by picture and question, and indicates a numerical value for each likely student response.

Types of Questions

Most of the questions asked fall into one of three categories: expectations, feelings, and attributions. (See the Confidence Interview Training Manual for a more detailed description.) Expectation questions ask either "who will succeed/fail?" or "How will this student do?" and responses are coded boy or girl, or success or failure, respectively. Feelings questions ask "How will this student feel about success/failure?" and the responses are coded as positive, negative, or neutral. The attribution questions ask, "Why did this student succeed/fail?" and the responses are coded as environment, task, effort, ability, or prior success/failure. Examples will be given of all of the above mentioned response categories.

Not all questions fit into the above three categories. Questions asked in picture 1, picture 10 and the summary are not repeated throughout the interview and are therefore not lumped into any categories. Some of the response categories are self-explanatory. For those that are not, examples will be given.

Often, in the course of the interview, students make remarks that are not necessarily in direct response to a question, or they elaborate on a response. Since these remarks may occur at any point is the interview it is hard to build a place for them into the coding scheme. Instead, any interesting or stereotypic comments made will be recorded on separate forms. Examples of these will also follow.

Attribution Examples

1. Environment - external, unstable

got help, needed help
was lucky
teacher explained it
was absent
cheated (if stated as got help from)
finds it difficult to concentrate because its noisy

2. Task - external, stable

easy, hard
new problem, not used to doing this kind of problem
done this already
understands it, understands the problem
liked those kind of problems
it takes more thinking
needs help on that problem
good at this type of problem
will do better at story problems since she is a good reader

3. Effort - internal, unstable

paying attention, listening, daydreaming, alert
studying, trying hard
was prepared (brought books, papers, etc.)
didn't want to do it
wasn't interested
cheated (if stated as if premeditated cheating)
asks for help
made a careless mistake
did all the assignments
thought about it a lot
thinks more about it
took her time, checked it over

4. Ability - internal, stable

knows what she's doing
is smart, has above average intelligence
catches on easily
doesn't know how to do it
forgets/remembers how to do it
does well in math

Ability (continued)

is good at math
understands math
can put it all together
needs a lot of help and isn't really that independent in math
is naturally good at math

5. Prior success/failure (use other categories first)

did good on all worksheets/assignments
got good grades in math before
did well in math in earlier grades

0. No attribution/ambiguous or general attribution

gets good grades
does well in school
liked mathematics
was confused

Expectation Examples

1. Failure

below the middle of the class
below the class average
can't do it at all
any comment indicating less than successful performance

2. Success

okay
average
very successful
can do it when interested
could do it after a while
would take them longer, but they could do it

Feelings Examples

0. Negative - lowered esteem

scared
embarassed
thinks he is dumb
is jealous
feels sorry for her
depressed

1. Neutral - no change in feeling, or lack of feeling

wants to help him
is thankful she got help from him
it doesn't make any difference

2. Positive - raised esteem

is happy for her
doesn't mind helping her, but thinks she could do it on her own
thinks he is smart
thinks she is a brain
respects her
proud

PICTURE ONE

COMMENT CATEGORIES EXAMPLES

Confidence

Positive

feels good about it
seems confident

Negative

looks like he isn't sure of himself

Effectance Motivation

Positive

enjoys it
it's fun
likes it
is into it
excited about it

Negative

doesn't like it
it's tedious
it's boring

Usefulness

Positive

it's important
good for getting a job
wants to be a _____, so needs math

Negative

it is a waste of time
won't need it for their career
isn't going to take any more math

Examples for Picture 10, Questions 3 & 4

Academic/Career

Negative -

Neutral -

still going to school
will be doing regular classwork
still be doing the same kind of work

Positive -

he'll be a math professor
will get a job involving math
accountant, working with computers
she'll be getting involved in extra math classes
he'll still be at the head of his class

Social/General

Negative -

will have a boring life
won't have a very fun life
her friends are jealous

Neutral -

her social life will be the same

Positive -

she'll have a pretty good life
she'll have lots of friends

Coder Schatz

CONFIDENCE CODING

Examples of Stereotyping Comments

ID#	Picture	Comment
4063	2A	He might...sort of be a little mad because maybe she was a girl and girls usually aren't really supposed to...I don't know, boys, they're supposed to be smarter or something.
3006	2B	sometimes boys think girls are inferior
4199	6A	Are there any reasons the teacher might think she knows the right answer? Because she's a girl..it's nature's way for the girl to be smarter
4199	7B	Why does the teacher think that he's going to get it wrong? Cause he's a boy...it's nature's way that the girls be smarter
1092	Summary	The boys kind of like know the answer, well the girls probably do too, but the girls are just probably shy to say it cause they might get something wrong..then they think the boys will laugh at them..the boys will think they're dumb or something ...the boys wouldn't care if the girls thought they were dumb...
1184	Summary	Boys are usually busy doing something--like being outside playing football or baseball or whatever and girls, they don't do that much..they would have more time to study
3202	Summary	---girls would rather have good grades...they just study, they work harder..all the boys work on other things besides.
4106	Summary	girls study more...boys just run off and do sports and such ...boys can't let anyone see them ask the teacher--it would ruin their image..cause they're you know, too tough.
1160	2A	Who do you think would probably have the right answer? Probably her...it seems like usually do better in math.
4172	2A	Why did you pick her as having the right answer? Because girls at this age, they develop faster mentally, and um, they grow a little faster...They're usually larger than boys around this time...
4199	2A	Why did you pick her? Well, it's just...sort of like nature's way for the girl to be smarter.
4129	2B	How about the girl. What's she feel about the guy? Girls are superior to boys.
4172	2B	Girls always seem to get better grades in things....most girls...well some girls go out for a lot of sports and things, but I don't think that a lot of girls do, and so maybe they have more time...to study...the father of the family or the boys might want to watch sports, the girls might not be interested in that...they would have nothing to do.

Coder Schatz

CONFIDENCE CODING

Examples of Interesting Comments

ID#	Picture	Comment
4037	7B	confidence comments
4218	7B	Does she think she can do it? Probably...because maybe she has a lot of confidence in herself
1013	8A	Why does the teacher think that he can't do it? He's a jock and jocks are pretty stupid...she hates jocks too and she thinks that he's pretty stupid. She's a very hateful teacher...being a simpleton is kind of in among the jocks.
1031	8A	Why would the student think he'd be able to do it? Because he's confident. He has confidence in himself. And knows like, you know, if he tries hard that he can do it.
3139	8A	Why doesn't she understand do you think? Well she doesn't have confidence in herself on how's she's doing it.
3166	8A	Why can the boy do it? Because he knows how and he's got a lot of faith in himself and he knows that he knows how.
4227	8A	Why does the teacher think that student can do it? Maybe she's pretty confident.
3121	8B	Why does the student herself feel...she'll do well? Maybe she's got self-confidence and she just figures she can figure it out.
1013	9B	Why does he have this mental block towards math? Sixteen tons fell on his head.
1048	2A	Who do you think would probably have the right answer? The boy would. He seems more confident.
4199	4A	Why do they think she's going to do pretty good? Because she is thin. Because when you're fat, you're thinking about losing weight....If she doesn't have to think about losing weight, she'll listen to the teacher more.
4199	4B	Why do the other kids think she's having trouble doing her math lesson? Maybe she smokes...The way I see it a lot of the cute girls smoke and a lot of the ugly ones don't. Smoking affects her brain so she can't think well.
1013	5	The boy is saying "I'm having some trouble here with this, with these problems. Seems to be I just can't get anything right lately." The teacher asks him why he thinks that he's not getting anything right. He says "cause I think math is a real bummer" "Why do you think math is a bummer?" He says "because it is" She gets angry with him and kicks him out, throws his math book at him, he gets a concussion and dies a week later."
2012	6A	Why does the student think that she would get the answer right? cause she...she knows the answer. She's confident that it's the right answer.
3114	6A	Does the boy think that he can do this problem? No. I don't think he's very confident in himself.
3202	6A	Why does he think he can do it? Maybe he checked it, or maybe he's just confident in himself.

Coding Procedure Notes

1. Read the transcript carefully. Students sometimes change their responses so it is very important to not just skim the interview.

2. If a student gives a contradictory or confusing response, code the last response. This is usually the response when the interviewer pushes the student to clarify the response.

3. In the case of attributions, an allowance has been made for two attributions. Code the first two that the student mentions, with the exception of the prior success/failure category. Prior success/failure is coded only if any other attributions given have been coded.
   Don't code [illegible] same attributions

4. Missing data is coded as 9. Missing data includes

   i) responses that are not given, or questions that are not asked;
   ii) responses or questions that are confused and not clarified.

      e.g. I: Why did she get it right?
      S: She got it wrong because she didn't study.

5. Use pencil when filling out the coding form. Write legibly, completely erasing any changes. Each interview will get coded on three lines, so skip a line between each. This will put one interview in a block of five lines.

6. Remember to write out interesting or stereotypic comments on the forms provided. These will be typed, so write so that they can be easily read.

7. If there are any questions, or hard to code responses, see Mary.

BIODATA

Col#	Item	Code
1	school	1 = Cherokee 2 = Gompers 3 = Jefferson 4 = Orchard Ridge
2 -- 4	subject ID#	
5	grade	6 = 6th grade 7 = 7th grade 8 = 8th grade
6	sex	0 = female 1 = male
7	studies in	*1 = T/P & Confidence 2 = MT only *3 = T/P, Conf, MT *4 = Conf, MT 5 = T/P only *6 = Conf only 7 = T/P, MT
8	confidence group	1 = high 2 = low
9	MT category	0 = not relevant 1 = Hi Sp/Lo V 2 = Lo Sp/Hi V
10	study of which data is a part	2 = conf
11	interviewer	1 = Fennema, E. 2 = Griffith, G. 3 = Libby, J. 4 = Lund, D. 5 = Parcel, N. 6 = Schatz, M. 7 = Tartre, L.
12	coder	1 = Parcel, N. 2 = Schatz, M.
14	card #	1 = card #1 2 = card #2 3 = card #3

Confidence Coding
Version 1, Year III
Schatz 5/20/81

PICTURE ONE - Student Alone

Col#		
1-16, 1-17 and 1-18, 1-19	Confidence	10 = negative 11 = neutral 12 = positive
	Effectance Motivation	20 = negative 21 = neutral 22 = positive
	Usefulness	30 = negative 31 = neutral 32 = positive
	Stereotyping	40 = in favor of girls 41 = in favor of boys 42 = neutral
	Environment	51 = mother 52 = father 53 = parents/family 54 = teacher positive 55 = teacher negative
	Task	61 = easy 62 = hard

PICTURE 2A & 2B - Two Students, Different Answers

Col #		Question #		
2A	2B			
1-22	1-34	1	success expectation-sex	0 = female 1 = male
1-23	1-35		failure expectation-sex	0 = female 1 = male
1-24	1-36	2	Success attribution - 1	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior success
1-25	1-37	2	Success attribution - 2	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior success
1-26	1-38	3	Failure attribution - 1	0 = no attribution 1 = environment 2 = task 3 = task 4 = ability 5 = prior failure
1-27	1-39	3	Failure attribution - 2	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior failure
1-28	1-40	4	Feelings (wrong about self)	0 = negative 1 = neutral 2 = positive
1-29	1-41	5	Feelings (wrong about right)	0 = negative 1 = neutral 2 = positive
1-30	1-42	6	Feelings (right about self)	0 = negative 1 = neutral 2 = positive
1-31	1-43	7	Feelings (right about wrong)	0 = negative 1 = neutral 2 = positive

PICTURE 3 - Four Students, Math Test

Col#	Question #		
1-46	1	Success expectation-sex	0 = female 1 = male
1-47	2	Success feelings-self	0 = negative 1 = neutral 2 = positive
1-48	3	Success feelings-by peers	0 = negative 1 = neutral 2 = positive
1-49	4	Success attribution-by peers-1	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior success
1-50	4	Success attribution-by peers-2	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior success
1-51	5	Failure expectation-sex	0 = female 1 = male
1-52	6	Failure feelings-self	0 = negative 1 = neutral 2 = positive
1-53	7	Failure feelings-by peers	0 = negative 1 = neutral 2 = positive
1-54	8	Failure attribution-1	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior failure
1-55	8	Failure attribution-2	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior failure

PICTURE 4A, 4B, 4C, 4D - Four Students, Math Lesson

Col #					
4A	4B	4C	4D		
1-58	1-66	1-74	2-16	Expectation of female/male by peers on math lesson	1 = failure 2 = success
1-59	1-67	1-75	2-17	Attribution of success/failure on math lesson-1	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior success/failure
1-60	1-68	1-76	2-18	Attribution of success/failure on math lesson-2	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior success/failure
1-61	1-69	1-77	2-19	Expectation of female/male by peers on arithmetic/story	1 = better at arithmetic/ more trouble with story 2 = better at story/more trouble with arithmetic
1-62	1-70	1-78	2-20	Attribution of success/failure on arithmetic/story problem-1	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior success/failure
1-63	1-71	1-79	2-21	Attribution of success/failure on arithmetic/story problem-2	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior success/failure

PICTURE 5 - Student Coming for Help

Col #	Question #		
2-24	1	type of help sought	1 = plain arithmetic 2 = story problem
2-25	2	Feelings by student about asking teacher for help	0 = negative 1 = neutral 2 = positive
2-26	3	Feelings by teacher about student asking for help	0 = negative 1 = neutral 2 = positive

PICTURES 6A, 7A - Four Students and Teacher

Col # 6A	Col # 7A	Question #		
2-29	2-51	1	Teacher expectation of success	0 = female 1 = male
2-30	2-52	2	Success attribution-by teacher-1	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior success
2-31	2-53	2	Success attribution-by teacher-2	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior success
2-32	2-54	3	Success attribution-by student-1	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior success
2-33	2-55	3	Success attribution-by student-2	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior success
2-34	2-56	4	Sex of next student (opposite of 2-29, 2-51)	0 = female 1 = male
2-35	2-57	4	Teacher success/failure expectation	1 = failure 2 = success
2-36	2-58	5	Teacher attribution of success/failure-1	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior success/failure
2-37	2-59	5	Teacher attribution of success/failure-2	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior success/failure

PICTURE 6B, 7B - Four Students and Teacher

Col # 6B	Col # 7B	Question #		
2-40	2-62	1	Teacher expectation of failure	0 = female 1 = male
2-41	2-63	2	Failure attribution-by teacher-1	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior failure
2-42	2-64	2	Failure attribution-by teacher-2	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior failure
2-43	2-65	3	Failure attribution-by-~~teacher~~ student-1	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior failure
2-44	2-66	3	Failure attribution-by student-2	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior failure
2-45	2-67		Sex of next student (opposite of 2-40, 2-62)	0 = female 1 = male
2-46	2-68	4	Teacher/success/failure expectation	1 = failure 2 = success
2-47	2-69	5	Teacher attribution of success/failure-1	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior success/failure
2-48	2-70	5	Teacher attribution of success/failure-2	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior success/failure

PICTURE 8A - Four Students and Teacher

Col #	Question #		
3-16	1	Teacher expectation of success	0 = female 1 = male
3-17	2	Success attribution-by teacher-1	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior success
3-18	2	Success attribution-by teacher-2	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior success
3-19	3	Success attribution-by student-1	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior success
3-20	3	Success attribution-by student-2	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior success
3-21	4	Teacher expectation of failure	0 = female 1 = male
3-22	5	Failure attribution-by teacher-1	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior failure
3-23	5	Failure attribution-by teacher-2	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior failure

Col #	Question #		
3-24	6	Failure attribution-by student-1	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior failure
3-25	6	Failure attribution-by student-2	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior failure

PICTURE 8B - Four Students and Teacher

3-28		Sex of next student (opposite of 3-16)	0 = female 1 = male
3-29	1	Teacher expectation of success/failure	1 = failure 2 = success
3-30	2	Success/failure attribution-by teacher-1	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior success/failure
3-31	2	Success/failure attribution-by teacher-2	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior success/failure
3-32	3	Success/failure attribution-by student-1	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior success/failure
3-33	3	Success/failure attribution-by student-2	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior success/failure

PICTURE 9A - Confident Student

Col #	Question #		
3-36	1	Influences on Confidence-1	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior success
3-37	1	Influences on Confidence-2	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior success
3-38	2	More confident on...	1 = arithmetic 2 = problems (story)
3-39	3	Attribution of Confidence on arithmetic/story problems-1	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior success
3-40	3	Attribution of Confidence on arithmetic/story problems-2	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior success

PICTURE 9B - Worried Stuc nt

3-43	1	Influences on anxiety-1	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior failure
3-44	1	Influences on anxiety-2	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior failure

Col #	Question #		
3-45	2	Less worried about...	1 = arithmetic 2 = story problems
3-46	3	Attribution of anxiety on arithmetic/story problems-1	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior failure
3-47	3	Attribution of anxiety on arithmetic/story problems-2	0 = no attribution 1 = environment 2 = task 3 = effort 4 = ability 5 = prior failure

PICTURE 10 - Successful Student

3-50	1	Success feelings-self	0 = negative 1 = neutral 2 = positive
3-51	2	Success feelings-peers	0 = negative 1 = neutral 2 = positive
3-52	3 & 4	Long term-academic/career	0 = negative 1 = neutral 2 = positive
3-53		Long term--social/general	0 = negative 1 = neutral 2 = positive
3-54		Short term-academic	0 = negative 1 = neutral 2 = positive
3-55		Short term--social/general	0 = negative 1 = neutral 2 = positive

SUMMARY

Col#	Question #		
3-58	1	teachers call on...	0 = girls more 1 = boys more 2 = same
3-59	2	why	1 = discipline 2 = volunteer (raised hands) 3 = helping 4 = expectation of correct answer/smarter 0 = none of these
3-60	3	better at math	0 = girls better 1 = boys better 2 = same
3-61	4	better at story	0 = girls better 1 = boys better 2 = same
3-62	5	trouble with math	1 = have some trouble 2 = never have trouble
3-63	6	remedy for difficulty	1 = help from peer 2 = help from teacher 3 = help from parent 4 = study more 0 = none of these
3-64	7	girls not confident because..	1 = afraid/embarassed to seek help 2 = lack of ability 3 = don't like math 4 = prior failure 0 = none of these
3-65		boys not confident because..	1 = afraid/embarassed to seek help 2 = lack of ability 3 = don't like math 4 = prior failure 0 = none of these
3-66	8	male math teachers treat	0 = girls better 1 = boys better 2 = same

Col#	Question #		
3-67	9	why more males than females in math-related careers	1 = girls don't like math 2 = girls quit taking math 3 = men get hired more 4 = women don't want or need careers 5 = stereotyping 0 = other

PICTURE 1 Student Alone

Student # 1184 Sex M Interviewed: Date 4/20/81 By DL

Transcribed: Date 5/13/81 By mvdb Page 1 of ____

I. Allright As I told you I'm Debbie Lund and We're doing a study about students your age learning math. Ah you may remember you helped us out before and we'd like your help again. We feel that what eighth graders have to say about learnig math is very important so we hope you won't might answering some of the questions we're going to be asking you. Um, I'm going to be showing you some pictures I have ten pictures here. They were taken in eighth grade class rooms and all I'm going to be doing is asking you some quesitons where you'll want to use your imagination Ah just try to think back to past math classes you've been in and students... who've been in the classes with you and teachers you've had. Ok? And just, using that and your imagination um, provide some answers for the questions I have, Now the your answers aren't right or wrong, there arent any right or wrong answers to the questions I'm going to ask is what I mean. And so, just whatever you have to say is fine. Ok? (OK) Um and,whatever you ~~have/to~~/say is strictly confidentialnobody else will hear what you said, none of your firends or teachers or parents, or anybody. Ok? All right, Um I'm going to be asking you about situations where students are working on two different kinds of problems, math problems Um, plain arithmetic problems and story problems, ah these are just a couple examples of each. Obviously, there are millions of examples you can get, Ok? any questions about the difference of the two?

S. WHAT DO YOU MEAN?

I. Well, meaning that plain arithmetic is basically just the numbers are set down for you Story problems are, they've got the words ~~that~~ you've got to read them, set it up. Ok? How you worked both of them? (YEAH) I'm sure you've worked both of them, both kinds Ok. Cuz we'll be talking aobut um, I might mention plain arithmetic problems and this is just to explian what I'm talking about. OK?
All right here's picture nubmer one. No it's not! Here's picture number one. Um all I want you to do is tell me what this guy thinks and feels aobut math now, remember you're just using your imagination, OK?

S. WELL,.....I HE LOOKS LIKE OF HE"S UNDERSTANDING WHAT HE"S DOING AND HE KNOWS ABOUT MATH AND..HE..HE UM, HE CAN UNDERSTAND WHAT THE STU... WHAT THE WHAT HE"S DOING.

I. Ok, Do you think he likes it?

S. YEAH, IF HE CAN DO IT.

I.Ok.

PICTURE 2A Two Students Plain Arithmetic

Student # 1184 Sex M Interviewed: Date 4/30/81 By dl

Transcribed: Date 5/13/81 By mvdb Page 1 of

I Here's picture number two. I got it right that time. Ok this guy and girl are working on a plain arithmetic problem and have gotten different answers. All right? Here's this is just to give an idea of the kind of problem that they're working, OK? Twenty seven divided by one third. All right, they've worked it out and have gotten different answers. Who would probably have the right answer to this problem now again you're using your imagination so..... just whatever you might think

S. WELL IT LOOKS LIKE THE BOY,HAS THE RIGHT, ~~HAS~~ THE RIGHT ANSWER LOOKS LIKE HE"S SHOWING H WHAT HE GOT.

I. Ok um, why did he get the right answer? What caused him to get the right answer?

S. WELL HE LOOKS MORE SURE OF HIMSELF, SHE LOOKS KIND OF , UM LIKE I DONT REALLY KNOW

I. Ok do you think he got the right answer becuase uhn oh he's done this sort of problem before, or he completes all of his assignments? or he's naturally good at math? or he's gotten help from the teacher, or any other sort of reason like that?

S. CUZ HE"S DONE IT BEFORE.

I. Ok Um, why did the girl get the right answer, what caused her, er I'm sorry, why did she get the wrong answer? What caused her to get the wrong answer?

S. MAYBE SHE, I SHE PROBABLY NEVER DID IT BEFORE

~~I. OK UM, HOW DOES SHE FEEL ABOUT HERSELF SINCE SHE~~

I. Ok Um, how does she feel about herself since she got it wrong? What sort of feeling Does she have about herself?

S. WELL,....UM LOOKS LIKE SHE, I DON"T KNOW SHE DOESN"T REALLY CARE BUT SHE JUST MADE A MISTAKE AND SHE KNOWS SHE"S WRONG.

I. Ok Um, how does she feel about the guy? Now she got the wrong answer and he go the right answer.

S. SHE PROBABLY THINKS OF HIM AS A AS A PREETY SMART AND THAT IN HERE CLASS OR WHATEVER.

I. Ok Um, how does the guy feel about himself since he's gotten the right answer?

S. PROBABLY FEELS GOOD. HE KNOWS WHAT HE"S DOING.

I. Ok, How does he feel about the girl? He got the right answer and she got the wrong answe what sort of feelings does he have toward ehr.

S.

S. UM, HE PROBABLY DOESN"T REALLY CARE, HE JUST THINKS THAT MAYBE SHE NEVER DID IT BEFORE.

I. Ok Now,

PICTURE 2B   Two Students   Story Problem

Student # 1184 Sex M Interviewed: Date 4/30/81 By DL

Transcribed: Date 5/13/81 By mvdb Page 1 of ____

I. What if they were working on a story problem? Like this one and they got different answers. Catepiller starts climbing up a tree, crawled up three and a quarter feet, fell back two and a half feet, and then crawls up six and a quarter feet, how far from the ground was it at that point? Ok so there's their problem, they've wroked it out and they've gotten differnt answers. again, Um, for the story problem who would probably have the ight answer of these two students? Again using your imaginations

S. PROBABLY THE BOY

I. Ok Um, Why did he get the right answer? What caused him to get the right answer on this problem?

S. WELL HE LOOKS LIKE THINKS A LOT, AND SOTRY PROBLEMS YOU USUALLY HAVE TO THINK ABOUT IT, UM THE GIRL"S JUST I DON"T KNOW, SHE DOESN"T LOOK LIKE SHE"D GET IT RIGHT.

I. Ok Um,

S she looks confused.

i. All right, Do you think that ahm she got the answer wrong becuase oh... maybe she's been absent or she forgets how to do it, or it ah complicated problem, Or she's been daydreaming Or any other sort of reason like that?

S. IT"S PROBABLY TOO COMPLICATED FOR HER.

I. Ok Um, how does she feel about herself, again she's gotten this problem wrong, How does that make her feel about herself?

S. AH, SHE PROBABLY FEELS LIKE SHE"S NOT TOO SMART. SHE SHOULD MAYBER STUDY MORE

I. Ok, how does she feel about the guy since he got it right?

S. SHE PROBABLY LOOKS UP TO HIM LIKES HE"S PRETTY GOOD IN MATH, SHE PROBABLY COULD GET A GOOD GRADE ???????

~~I. Ok. WHAT"S THE GUY FEEL ABOUT HIMSELF, SINCE HE GOT THE RIGHT ANSWER?~~
How does the guy feel about himself since he got the right answer to story problem.

S. REAL SMART

I. Ok. Um, how, and how does he feel about the girl? What sort of feelings does he have toward her since she got the wrong answer and he got the right answer.

.S WELL, HE PROBABLY REALLY, HE PROBABLY DOESN"T CARE THAT MUCH ...BUT, HE JSUT DOESN"T THINK SHE"S TOO SMART

I. Ok all right....

PICTURE 3 Two Girls/Two Boys Math Test

Student #1184 Sex M Interviewed: Date 4/30/81 By DL

Transcribed: Date /14/81 By mvdb Page 1 of

I. Ok here's picture nubmer three. Now, grab a pencil it will be easier to point, Ok that's a girl right there in the striped, red striped shirt, that's a girl in the white, these two are guys Ok? Sometimes it's hard to tell on these pictures. So I'll point them out to you. Um these four students are looking over a math test, that they've just gotten back, One of the students did poorly, two did pretty well and one did very well, um Which one of these four students did very well? Again you're using your imagination.

S. PROBABLY THIS.. THE GIRL IN THE.. RED AND WHITE SWEATER.

I. Ok. Um, how does she feel about herself? Since she did very well?

S. PROBABLY FEELS GOOD.

I. Ok how do the others feel about her since she did so well?

S. PROBABLY,... MAYBE THEY, THEY LOOK UP TO HER LIKE SHE"S SMART, OR FEEL, FEEL GOOD THAT THEY, THAT THEY KNOW SOMEONE THAT KNOWS HOW TO DO THEIR MATH OR SOMETHING(?)

I. Ok um, why did the others think that she did so well, If they had to give a reason, Um, what would they say?

S. SHE LOOKS LIKE SHE CARES OR STUDIES...

I. Ok who did most poorly out of these four students?

S. PROBABLY THIS GUY IN THE BLUE SHIRT.

I. Ok um, how does he feel about himself? Since he did so poorly?

S. HE PROBABLY DOESN"T CARE...

I. Ok Um, how do the others feel? about tah that guy since he did the worst of the four?

S. PROBABLY THINK HE"S STUPID OR SOMETHING

I. Ok Um, why do the others think that he did most poorly? ah..

S. I GUESS HE DOESN"T CARE, HE DOESN"T REALLY TRY HARD ENOUGH OR ANYTHING

I. Ok. Good! End of picture three

PICTURE 4A Two Girls/Two Boys Girl on left in overalls

Student # 1184 Sex M Interviewed: Date 4/30/81 By DL

Transcribed: Date 5/14/81 By mvUb Page 1 of

I. Here's picture four. That's a girl pretty obvious there, and that's a girl, these two are guys. Ok, these four students are working on a math lesson, Um How might the others expect this girl in the blue bibs to do? On this particular math lesson?

S. PRETTY GOOD

I. Ok. Um, why do they think she would do well? pretty good, or well, what sort of reason would they give for her doing so well?

S. I DON"T KNOW MAYBE SHE...SHE LISTENS IN CLASS,TRIES HARD, TRIES HARD ENOUGH,

I. Ok um, will they expect her to do better on plain arithmetic problems such as this type or a story problems such as those? Which one would they expect her to do better on?

S. STORY PROBLEM

I. Ok why do they think she'll do better on story problems?

S. SHE LOOKS LIKE SHE CNA THINK ABOUT THINGS AND STORY PROBLEMS YOU HAVE TO THINK WHAT YOUR DOING INSTEAD OF JUST LOOKING AT IT PROPERLY WRITING IT UP.

I. Ok

PICTURE 4B Two Girls/Two Boys Girl on right in striped shirt

Student # 1184 Sex M Interviewed: Date 4/30/81 By DL

Transcribed: Date 5/14/81 By mvdb Page 1 of ___

I. Let's think about this other girl.Let's say she having a lot of trouble with the same math lesson. Why do the others think she's having trouble. ??????think of a reason what would they say?

S. AH SHE PROBABLY DOESN"T DO HER HOMEWORK OR DOESN"T LISTEN IN CLASS

I. Ok um, do they think she's having more trouble with the story problems or the plain arithmetic problems?

S. STORY PROBLEMS

I. Ok why do they think she going to have, that she's having more trouble with the story problems?

S. BECUASE YOU HAVE, SHE DOESN"T, SHE DOESN"T PROBABLY UNDERSTAND HOW TO DO THAT WITH THE PLAIN ARITHMETIC, PLAIN ARITHMETIC PROBLEMS YOU JUST LOOK AT IT AND WRITE IT OUT. BUT THIS YOU HAVE TO THINK OF HOW TO SET IT UP.
HOW TO DO IT, AND SHE"S NOT SO SMART SO SHE WOULDN"T KNOW HOW TO DO IT.

I. Ok.

PICTURE 4C   Two Girls/Two Boys   Boy in white T-shirt

Student # 1184 Sex M Interviewed: Date 4/30/81 By DL

Transcribed: Date 5/14/81 By mvdb Page 1 of ____

I. Let's think about the guy in the white T-shirt. Um, how might the others expect him to do on this math lesson?

S. POORLY, NOT SO GOOD

I. Ok, Um why do you think he'll do poorly? If they had to give a reason what might they say?

S. ....PROBABLY DOESN"T LISTEN, IN CLASS TO THE TEACHER,

I. Ok Um, will they expect him to have more trouble on plainarithmetic problems or story problems?

S. STORY PROBLEMS

I. Ok and why would they think he's going to have more trouble with the story problems?

S. WELL THE SAME REASON CUZ, THE GIRL, THE OTHER GIRL... THAT YOU HAVE TO THINK ABOUT THE STORY PROBLEMS, AND IT"S A LITTLE BIT HARDER THAN THE PLAIN ARITHMETIC.

I. Ok good

PICTURE 4D   Two Girls/Two Boys   Boy in black football shirt

Student #1184   Sex M   Interviewed: Date 4/30/81   By DL

Transcribed: Date 5/14/81   By mvdb   Page 1 of

I. And let's think about the last guy in the picture.With the foot ball jersey on. Um, let's say he's doing well, on this lesson, Why do the others think he's doing so well?

S. WELL HE LOOKS SMART BUT SAY THAT AGAIN

I. Why do the others think that he's doing so well on this lesson? Why is he able to do so well? If they had to give a reason, what would they say?

S. HE PROBABLY STUDIES AT HOME.

I. Ok um, do they think he'll do better on plain arithmetic problems or the story problems?

S. PLAIN ARITHMETIC

I. Ok why do they think he'll do better on plain arithmetic?

S. BECUASE IT"S A LITTLE BIT EASIER

I. Ok

PICTURE 5 Student and Teacher

Student # 1184 Sex M Interviewed: Date 4/30/81 By DL

Transcribed: Date 5/14/81 By mvdb Page 1 of

I This is picture number five. Um, this student has come to ask his teacher for help on his math lesson. Did he come for help on a plain arithmetic problem or a story problem?

S. STORY PROBLEM

I. Ok How does the student feel about asking the teacher a question about math? How does that make the student feel?

S. HOW HE MIGHT FEEL? HE"D FEEL EMBARRASSED AND(?) HE SHOULD KNOW MORE. CUZ IF ITS AN EASY PROBLEM HE MIGHT FEEL KIND OF DUMB ASKING THE QUESTION ABOUT IT.

I. Ok how does the teacher feel about the student asking the question aobut math?

S.QAH HE PROBABLY THINKS THAT.. HE"S INTERESTED AT LEAST TO FIND OUT WHAT IT"S ABOUT BUT HE WOULD A BB DOWN ABOUT HIM

I. Ok So do you think the teacher feels ahm... really happy that the guy came up, or not so happy?

S IT"S PROBABLY GOOD THAT HE, HE"S PROBABLY GLAD THAT HE CAME UP TO ASK HIM....

PICTURE 6A   Two Girls/Two Boys/Teacher   Plain Arithmetic (Right)

Student # 1184   Sex M   Interviewed: Date 4/30/81   By DL

Transcribed: Date 5/14/81   By vmdb   Page 1 of ____

I. Here's picture number six. Ah its a girl, and that's a girl, these two are guys. Ok. Um, They're in math class and the teacher has just asked this question: Point three four five seven divided by point nine one. Ok, Who will the teacher call on for the right answer to that division problem? Which of those four students.

S. wELL THE GUY IN THE BACK.

I. Ok on the left side.All right um, Why does the teacher think that he'll know the answer?

S. WELL HE MIGHT NOT THINK HE KNOWS THE ANSWER BUT, SOMETIMES TEACEHR"S WILL CALL ON SOMEONE JUST TO SEE IF HE KNOWS HOW, HOW HE"S DOING HE MAYBE TOO EMBARRASSING, THAT WAY HE"D GET TO STUDY MORE. HE"D LEARN HOW TO,HE"D REMEMBER TO STUDY MORE SO HE"D DO BETTER

I. Ok, teachers do that quite often, but let's say this time teacher's really looking for somebody, really expecting that person to have the right answer, which ever student... So which student would that be? The teacher's really expecting a right answer, ?? this particular time.

S. THE GIRL IN THE FRONT.

I. Ok.Um, why does the teacher think that she'll know the answer?

S. WELL SHE LOOKS CONFIDENT, OR SHE

I. I'm sorry what did you say?

S. SHE LOOKS CONFIDENT IN HERSELF AND LIKE... SHE PROBABLY STUDIES AT HOME SHE HE PROBABLY KNOWS THAT SHE"S GOOD IN MATH,

I. Ok why does the student think that she got the right answer to this division problem?
(WHAT) Wh why does that girl think that she got the right answer? Let's say she's she rea;;y has the feeling inside that she got the right answer, Why is that? What causes...

S. BECUZ,... AH, SH SHE MAY HAVE A LOT OF EXPRRIENCE WITH THOSE KINDS OF PROBLEMS OR SHE DOES THOSE A LOT,..

I. Ok um, now lets think about the guy right behind her then. The guy with the jersy on.. Um does the teacher think that He'll know the answer? (NO) to this problem? Ok Um, Why, does doesn't the teacher think he'll know the answer?

S. WELL, HE LOOKS, AH.... SAY THAT AGAIN?

I. Why doesn't the teacher expect the right answer from him?

S. HE"S PROBABLY A GUY THAT DOESN"T REALLY PAY MUCH ATTENTION TO HIM OR CLOWNS AROUND IN CLASS, SOMETHING LIKE THAT.

I. Ok

PICTURE 6B   Two Girls/Two Boys/Teacher   Plain Arithmetic (Wrong)

Student # 1184 Sex M Interviewed: Date 4/30/81 By dl

Transcribed: Date 5/14/81 By mvdb Page 1 of ___

I. Now of the two students we haven't talked about yet, who does the teacher think will get the problem wrong of those two students?

S. THE GIRL IN THE BACK

I. Ok,Why does the teacher think that she'll get the problem wrong?

S. SHE LOOKS CONFUSED.

I. Ok

S. SHE DOESN"T PROBABLY UNDERSTAND ?????

I. All right, So she looks confused, and she doesn't understand it, um, so... why does the teacher why beside that would the teacher think she... um know the answer becuase um... maybe becuase she forgets how to do the problem? or becuase she's been absent? or becaase ah, she hasn't been studying? or

S. SHE PROBABLY NEVER HAD IT BEFORE OR SHE HASN"T STUDIED, STUDIED THIS QUESTION

I. All right and why does the girl think that she got the wrong answer, she just has this fee that she got the wrong answer, Why does she....

S. BECUASE SHENEVER DID IT BEFORE.

I.Ok and how 'bout the guy right in front of her then, um,...does the teacher think he'll be able to solve this problem?

S. YEAH

I. Ok, Why does the teacher think that he'll be able to?

.S THE..... CUZ HE"S A GOOD STUDENT, AND PROBABLY PAYS ATTENTION TAH AND HE DOESN"T MESS AROUND IN CLASS ??????

I. Ok all right.

PICTURE 7A   Two Girls/Two Boys/Teacher   Story (Right)

Student # 1184   Sex M   Interviewed: Date 4/30/81   By DL

Transcribed: Date 5/14/81   By mvdb   Page 1 of

I. Here's picture number seven. Um, that's a girl, in the turquoise sweater and that's a girl the striped shirt, Um. these four students are in math class, and the teacher has just asked this question, this story problem: Last year a dèluxe tem speed bucycle cost a hundred and twenty nine dollars and fifty cents. This year the price is a hundred and forty two dollars and forty five cents. What percent did the price increase in one year? Ok Now who will the teacher call on for the right answer? Again the teacher is going to call on someone he expects to have the right answer. Which student would that be?

S. PROBABLY THE.... THIS GIRL IN THE SECOND ROW

I. Ok with the striped (YEAH) Ok Um, why does the teacher think that she'll know the answer?.......just using your imagination.

S. AHM, CUZ HE GETS GOOD GRADES? SHE PAYS ATTENTION TOO

I. Ok why does this, the that girl think that she got the right answer? Again, she's got that feeling inside that she's got the right answer.

S. SHE DID IT BEFORE, SHE SHE"S GOOD IN STORY PROBLEMS...

I. Ok um, does the teacher think the guy right in front of her will know the answer to this problem?

S. NO

I. Ok why doesn't the teacher think that he'll know the answer?....Why doesn't he expect the right answer from that guy?

S. BECUUSE... HE PROBALBY DOESN"T TRY..TRY TO STUDY, TRY TO PAY ATTENTION TO...

I. Ok, um,.

PICTURE 7B Two Girls/Two Boys/Teacher Story (Wrong)

Student # 1184 Sex M Interviewed: Date 4/30/81 By DL

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I. Now, let's think about the other two students on the other side. Who of those two studen who does the teacher think will get the problem wrong?

S. THE GIRL IN FRONT WITH THE BLUE SWEATER.

I. Ok. Um, why does the teacher think that she'll get the problem wrong? ...What might the teacher say if you asked?

S. ....

I. Just use your imagination there, it's a little hard sometimes but just....

S. UM, BECUZ, SHE"S PROB, UM, MAYBE SHE NEVER DID IT BEFORE, SHE"S NOT USED PERCENTS. (ok) STORY PROBLEMS

I. All right. Um and why does the girl think she got the wrong answer to this problem? What makes her think that?

S. SHE MIG, SHE MIGHT HAVE PROBABLY NEVER DID IT BEFORE.

I. Ok fine. And how 'bout the guy right behind her then, does the teacher think that he'll be able to solve this problem?

S. YEAH!

I. Ok, Um, why does the teacher think that he'll be ab le to do?

S. BECUZ HE LOOKS LIKE HE"S FOLLOWING ALONG IN HIS BOOK, AND HE PAYS ATTENTION TO AHM, AND HE UNDERSTANDS WHAT HE"S TALKING ABOUT.

I. Ok good.

PICTURE 8A Two Girls/Two Boys/Teacher Spatial (1st student)

Student # 1184 Sex M Interviewed: Date 4/30/81 By DL

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I. Here's picture number eight. Un that's a girl and that's a girl in the white Ok? Again they're in math class and the teacher has asked a problem about the volume of wedges:Wedge A is twice as high and just as wide as B. Wedge B is twice as long as A, so that A and B have the same volume. Is the area of bottom of wedge A the same as the area of Wedge B? Ok, there's the question and the teacher is going to call on someone. Who among these four students does the teacher think will know how to do the problem? Which one of these four students?

S. THE GIRL IN THE WHITE SWEATER, SHIRT WHATEVER.

I. Ok. Um, why does the teacher think that she can do this p this story problem?

S. SHE LOOKS LIKE SHE"S FOLLOWING ALONG,,SHE UNDERSTANDS WHAT HE"S TALKING ABOUT AND SHE PROBABLY PAYS ATTENTION AND STUDIES.

I. Ok. Um, why does the girl think that she can do this problem? What makes her feel that way?

S. BECUASE ITS AN EASY PROBLEM. AND SHE DID IT BEFORE

I. Ok. Now who among these four does these four will not know how to do the problem?

S. ....THE BOY IN THE BLUE SWEAT SHIRT.

I. Ok, um, why does the teacher think that he won't be able to do the problem? What might the teacher say?

S. UM,,,PROBABLY DOESN"T STUDY HIS WORK AT HOME. AND...MAYBE HE NEVER DID A PROBLEM LIKE THIS BEFORE.

I. Ok why does that guy think that he can't do this problem? That student?

S. MAYBE HE THINKS...MAYBE HE DOESN"T REALLY CARE ABOUT IT... HE THINKS ITS A DUMB PROBLEM. WHY SHOULD HE DO IT, OR UM... HE DOESN"T REALLY CARE THAT MUCH

I. Ok so how does that affect his work then?

S. WELL IF YOU DON"T STUDY, YOU"RE NOT GOING TO GET IT RIGHT.

I. Ok ~~now, lets talk about ahm... the other guy in the striped shirt.~~

PICTURE 8B Two Girls/Two Boys/Teacher Spatial (~~2nd~~ 3rd student)

Student # 1184 Sex M Interviewed: Date 4/30/81 By DL

Transcribed: Date 5/14/81 By mvöb Page 1 of

I. Now, lets talk about uhm... the other guy in the striped shirt. How would the teacher think that eh would do on this story problem?

S. PROBABLY GET IT RIGHT.

I. Ok again why would the teacher think that he'll do well, get it right?

S. BECUZ,.. BECUZ HE DID IT BEFORE.

I. Ok. um, why would the student think that he can, ah do a good job on this problem?

S. WELL IF HE DID IT BEFORE ??? AND ITS AN EASY PROBLEM. AND HE CAN UM,.. IT SHOULD BE REALLY EASY FOR HIM TO DO IT THEN.

I. Ok.

PICTURE 9A Confident Student

Student # 1184 Sex M Interviewed: Date 4/30/81 By DL

Transcribed: Date 5/14/81 By mvdb Page 1 of

I. All right. Almost done. Here's picture number nine. Um this guy is very confident that he can do his math, what might have happened to him before that makes him feel taht way?

S. UM, HE PROBABLY GOT...WELL(?) HE PROBABLY DID GOOD ON TEST SCORES AND IF, AND IF HE KNOWS HE"S DOING GOOD, THEN IF HE KEEPS ON DOING GOOD, HE"LL GET GOOD GRADES. AND....UM, HIS TEACHER PROBABLY TOLD HIM HE WAS GOOD AND IF HE KEEPS IT UP THEN... HE"LL PROBABLY GET GOOD GRADES ON IT ...

I. Ok shich one of the two kinds of st of problems is he most sure about doind? the plain arithmetic or the story problems?

S. PLAIN ARITHMETIC

I. Ok why is he most sure about doing those?

S. CUZ THOSE ARE EASIER

I. Ok

PICTURE 9B Worried Student

Student # 1184 Sex M Interviewed: Date 4/30/81 By DL

Transcribed: Date 5/14/81 By mvdb Page 1 of

I. Now let's change our point of view to the exact opposite. Let's say ~~that~~ this guy is not at all confident about doing his math, actually he's very worried about doing it. What might have happened to him before that makes him feel like that?

S. HE PROBABLY GOT REAL BAD ON A, DID REAL BAD ON A TEST SCORE AND HIS TEACHER TOLD HIM THAT IF HE DOESN"T DO ANY BETTER, HE"S GOING TO BE LIKE THE FOOT OF THE CLASS OR SOMETHING, PUT BELOW IN A LOWER GRADE. OR AND HIS MA WANTS HIM TO STUDY MORE, OR SOMETHING LIKE THAT?

I. Ok um, which one of the two kinds of problems is he less worried about doing?

S. THE PLAIN ARITHMETIC

I. Ok why is he less worried about doing plain arithmetic?

S. CUZ IT"S A LOT EASIER.

I. Ok. All right

PICTURE 10 Successful Student

Student # 1184 Sex M Interviewed: Date 4/30/81 By DL

Transcribed: Date 5/14/81 By mvdb Page 1 of

I. Here's picture number ten. Um this guy's the best student in his math class. How does he feel about being the best student?

S. PROBABLY FEELS PROUD AND... THAT"S ALL

I. Ok how do the other in his class feel about his being the best student?

S WELL, THEY PROBABLY LOOK UP TO HIM LIKE HE"S REALLY GOOD. AND...THE KID(?) PROBABLY(?) DO(?) ALL(?) OF THEIR(?) ~~ASSIGN~~... DO ALL OF HIS ASSIGNMENTS RIGHT.

I. Ah, what do you think his life will be like?

S. HE"LL PROBABLY GET A GOOD JOB, ???FAST(?) CLLEGE OR SOMETHING LIKE THAT

I Ok, what do you think he'll be doing next month?

S. WHAT?

I. What do you think he'll be doing next month?

S. WELL, LIKE HOW OLD IS HE ABOUT? IS THIS IN COLLEGE?

I. I'd say he's you age.

S. OH,

I. Just, next month from this picture.

S. AH PROBABLY DOING MORE ACCELERATED WORK...

I. Ok.

SUMMARY

Student # 1184 Sex M Interviewed: Date 4/30/81 By DL

Transcribed: Date 5/14/81 By mvdb Page 1 of 3

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i. Those were all the pictures I wanted to ask you about. Now, I just have a few questions to ask you about what you believe about some of the kinds of things we've been talking about. Ok? Um, first of all, do you think that teachers tend to call on boys more or on girls more in math class?

S. MOSTLY ON BOYS

I. Why do you suppose .. they do that? Why do you think that is?

S. WELL, MOST CA, MOST BOYS IN THE CLASS USUALLY DON"T KNOW WHAT"S GOING ON, AND HE CALLS ON TAH AND HE CALLS ON BOYS TO EMBARRASS THEM. ???????

I. Wh why is it that guys don't don't know what's going on?

S. 'CUZ THEY"RE FOOLING AROUND, AND TALKING TO THEIR FRIENDS OR SOMETHING...

I. Ok, um some people say girls are better in math than boys and some say the opposite, that boys are better than girls. What do you think?

S. I THINK BOYS ARE BETTER THAN GIRLS.

I. Um... Why do you think that? Do you feel like...um (WELL) I was going to ask you another question but... wh why do you think that guys are better than girls?

S. WELL MOST GIRLS.. THEY ,???? IN OUR CLASS THEY USUALLY DON"T KNOW WHAT"S GOING ON AND THEY"RE.. THEY"RE BEHIND IN SOMETHING AND THEY ALWAYS HAVE TO ASK A BUCH OF QUESTIONS ABOUT THE SAME SUBJECT. THEY"RE USUALLY BEHIND.

I. Ok um,.... some people say girls do better at story problems than boys, um, what do you think about that?

S. .. UM, THEY PROBABLY...UN.... YEAH, I THINK MAYBE GIRLS WOULD DO BETTER ON STORY PROBLEMS BECUASE THEY... YOU KNOW LIKE MOST BOYS WILL JUST EASILY GET A PLAIN ARITHMETIC PROBLEM AND GIRLS THEY USUALLY HAVE TIME TO THINK ABOUT THOSE KIND OF QUESTIONS, THEY PROBABLY JUST, THEY PROBABLY WORK MORE ON THOSE QUESTIONS.

I. Ok most people have trouble at some point or another when they're studying math. Do you ever have trouble with math?

S. YES

I. What do you do when you ~~have~~ have a problem?

S. I JSUT ASK MY TEACHER, DISCUSS IT WITH HIM.

I. Ok. Um some people are very scared about doing math, why do you think girls are sometimes not so sure about doing their math? What makes them feel that way?

S. .... WHAT MAKES THEM SURE THEY"RE NOT SO GOOD AT MATH?

...n, what makes them <u>feel</u> um, un-confident about doing their math? They're not sure

I. (cont)about doing their math? ....Why is that?

S. WELL, MAYBE, ... LIKE WHEN THEY WERE YOUNGER THEY"VE PROBABLY HAD SOMEONE LIKE IF THEY"RE DOING THEIR MATH IN A LOWER GRADE, LIKE THIRD GRADE, AH LIKE A TEACHER CALLED ON HER... ON A GIRL AND SHE GOT IT WRONG AND EVERYONE LAUGHED AT HER, AND SHE PROBABLY WOULDN"T,..JUST SHE PROBABLY FEELS BAD ABOUT HERSELF. OR ??????? SELF

I. OK.

S. LIKE MAYBE THEY WERE TEASING ???????

I. Allr ight. Um, why do you think guys are sometimes not so confident about doing their math?

S. WELL, BECUZ......MOSTLY BECUZ THEY HAVEN"T DONE SOMETHING BEFORE. LIKE IN ALGEBRA THAT(?) I(?) HAVE(?) RIGHT(?) NOW(?), YOU GET SOMETHING NEW AND YOU DON"T KNOW HOW TO DO IT, AND YOU"RE NOT REALLY SURE YOU KNOW WHAT YOU"RE DOING....

I. Ok. Um lets, see, do you have a male math teacher now? (YEAH) Have you had other ones in the past too (UMHUM)? Um do you think that the they treat girls differently than they treat boys?

S. YES

I. How? do you think they treat them differently?

S. WELL I, OK THE THERE"S A BUNCH OF GIRLS, THEY ALWAYS UM...THEY"RE ALWAYS MAKING A LOT OF NOISE, AND THEY(?) GET, OK, LIKE YOU GOT A BUNCH OF YOUR FRIENDS... BOYFRIENDS ....I MEAN NOT LIKE THAT BUT JUST FRIENDS.. AND YOU WANT TO SIT BY THEM OR SOMETHING LIKE THAT, THEN HE"D PUT ONE OF YOU ON ONE SIDE OF THE ROOM AND ONE ON THE OTHER, BUT THE GIRLS, THEY WOULD ALL SIT TOGETHER (chuckle) AND ALWAYS MAKE A LOT OF NOISE BUT HE WOULDN"T CARE ABOUT THAT (laugh)

I. So you think he picks on the guys hun! Um we've found that many students expect girls to do better in math than boys. however, men seem to work in careers that use math more often. For instance, engineering, um... most of the time we find men if engineering, more men, a lot more men than women,ah, why do you suppose that girls are expected to do better in math and yet later one guys end up in the careers that use math?

S. ??? MAYBE LIKE WHEN YOU GET MARRIED, MOST SOME MEN WOULD WANT YOU TAH, WOULDN"T WANT YOU TO HAVE A JOB, AND BE OUT DOING THAT KIND OF THING. AND THEN A LADY WOULD UM, MAYBE WATCH WATCH HER KIDS AT HOME OR SOMETHING LIKE THAT? OR BE A HOUSEWIFE AND THEN... WITH PEOPLE WITH TWO JOBS TAHT WOULD LIKE AH. THE LADY HAS A JOB AND A MAN HAS A JOB THEY MIGHT ??? A WAY(?) BUT, MOST OF THE TIME... THE WIFE JUST STAYS AT HOME.

I. What do you think about that?

S. I THINK IF A LADY (go ahead I'm sorry) THE LADY SHOULD...PROBABLY GET IN IT... PROBABLY GET A JOB ANYWAYS IF SHE"S GOOD AT IT LIKE ENGINEERING.

I. Ok so you think... you think there are women who are capable of doing jobs like that?

S. YEAH

I. Ah do you think, men really mind, having you know a woman working in the same sort of job?

S. YEAH ~~BUT~~ THEY PROBABLY FEEL DUMB IF A LADY DOES BETTER THAN HE DOES.

I. alright That's all the questions I have to ask you Thanks for being so [illegible] [illegible] couldn't [illegible]

I. (cont)Ok. All right. That's all the questions I have to ask you. Thanks for being so cooperative. You've been really helpful, couldn't have done the study without students who were willing to answer, ou answer our questions. (OK) Thanks a lot Brian. Have a good day now.

Note: The student used the pronoun "he" when talking about "the teacher" before the interviewer ever gave gender. Ther interviewer used the general term "the teacher" which the kid translated into "he".

PICTURE 1 Student Alone

Student # 4226 Sex F Interviewed: Date 4/13/81 By GG

Transcribed: Date 5/26/81 By mvdb Page 1 of ___

I. And like last year I'm goig to read off cards so....????? Um, we're doing a study about students your age learning math. You may remember that you helped us out before and we'd like your help again. We feel that what eighth graders have to say aobut learing math is very important, so I hope you don't mind answering some questions for us. I'm going to show you some pictures taken in eighth grade classrooms and ask you to use your imagination and tell some stories about the people in them. There aren't any right or wrong ansers. to the questions I'll be asking, I'm interested in whatever you say, and whatever you say you know is strictly confidential, no one else will know what you say, not your teachers, not your family, any other student. Any questions so far? Ok.. And, I have a sample card.... I'll show you... Ok I'm going tobe asking you about situations where students are working on two different kinds of math problems, we're going to be talking about plain arithmetic problems and they're like adding three and a half and four and a half, and we'll also be talking about story problems, that's where you have reading like these: Pat mowed half the lawn before and two fifths in the afternoon. How much does pat have left to mow. So these are what we're going to call plain arithmetic kind of probłems these are story problems that clear? (OK UMHUM) Ok and need that card later... ok we'll start with picture number one. And I'd like you to tell me what this girl thinks and also what she feels about math..... And remember you can use your imagination you're the script writer.

S. WELL, IT LOOKS LIKE SHE LIKES MATH, IT DOESN"T, IF SHE DIDN"T LIKE IT IT ... WELL, (umhum)SHE SHE LOOKS LIKE SHE"S INTERESTED IN WHAT SHE"S DOING AND SHE LOO, AND SHE"S DOING IT, SHE"S NOT JUST SITTING THERE YOU KNOW, THINKING ABOUT IT. HOW HARD IT IS OR WHATEVER (CHUCKLE)

I. Ok, so she kind a likes doing math and she's interested Ok, um any other feelings she might be having?

S. .....UM.....

I. You already said she liked it, (YEAH) and she's interested so those are feelings. Um, what kind of work do you think she's doing?.. ?????hwat kind of problems?

S. UM...LIKE SENTENCES. WELL, IT LOOKS LIKE LONG ON THE PAPER (ok yeah) BUT (CHUCKLE)

I. But whatever you want to make it. Ok those are just the types of questions I'll be asking you. (OK) and remember you can just make up whatever you want.

PICTURE 2A Two Students Plain Arithmetic

Student # 4226 Sex F Interviewed: Date 4/13/81 By GG

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I. Let's go on to the next picture. Which is picture number two. And these two people here a boy and a girl, have gotten different answers to a plain arithmetic problem like this one, where they had to find the answer to twenty seven divided by a third. And who would probably have the right answer?

S. ..... (?????) .....WELLL IT LOOKS LIKE THE GIRL WOULD

I. Ok we'll say the girl's got the right answer. (OK) Um, and why did she get the right ans

S. WELL, SHE LOOKS LIKE SHE"S MORE SURE THAN THE THAN THE BOY DOES ABOUT HER ANSWER AND SO... (CHUCKLE)

I. Ok, um what reasons might she have for you know being more sure aobut it, and getting the right answer?

S. WELL LIKE SHE USSUALLY GETS THEM RIGHT PROBABLY (CHUCKLE)

I.And what reason for that, why did she usually get them right?

S. UM, I QUESS SHE"S SMART (CHUCKLE)

I. Ok, We'll say she's smart. (OK) She usually gets them right. See you can... you know you're the one who says..... Um, then, let's look at the boy. Why did he get it wrong? Why did he get it wrong?

S. (CHUCKLE) MAYBE HE DOESN"T LIKE MATH TOO MUCH, OR HE"S NOT VERY GOOD IN MATH, ~~OK/WHY/~~

I. Ok why might he not be good in math? Not like it?

S. WELL, (CHUCKLE) UM......(CHUCKLE) WAIT (you're doing fine) (CHUCKLE) OK UM...... I GUESS HE"S NOT VERY SMART IN MATH. (ok maybe he's) OR ANYTHING

I. Just not smart in math (OH OK) Ok that's a good reason. Um how does the one then who go it wrong how does he feel about himself? His feelings about himslef?

S. WELL (CHUCKLE) UM............(if you could just look inside, and you know see his emotions) (CHUCKLE) UM, WELL I DON"T THINK HE"D BE... I DON"T THINK HE"D BE THAT THAT HURT OR ANYTHING (Umhum) BECUASE HE"S PROBABLY, IF HE"S NOT VERY GOOD IN MATH AND STUFF HE"S PROBABLY NOT USED TO , HE"S PROBABLY USED TO NOT ALWAYS GETTING THE RIGHT ANSWER.

I. Umhum, so how could you explain his feelings, you know so he's not that hurt, how could you explain how he does feel then....

S. WELL

I. I know it's hard, feelings are hard to discribe.

S. YEAH, OH......UM.....

I You know,could you, just discruibe maybe have as sad, or you know frustrated, or really not frustrated at all?

S. UM NOT, JSUT THE SAME AS HE USUALLY IS, HE JUST KNOWS HE GOT IT WRONG.

I. How does he usually feel tehn?

S. UM(CHUCKLE)

i. I have to pin you down (chuckle)

S. UM....WELL, JSUT AS HAPPY AS USUAL I MEAN

I. Ok, so he's just his usual happy self. Ok, So it really wasn't a big deal or (RIGHT) it was a big? it wasn't a big

S. NO IT WASN"T A BIG DEAL

I. Ok, um, lets look at the one who got it right then, how does she feel about, oops, ... yeah how about the one who got it right how did she feel... nnaaunnn.... now let's think first how he feels, the one who got it wrong, how does he feel about her then? What are his feelings toward her who got it right?

S. THAT SHE"S SMART (CHUCKLE)

I.Ok He might feel that she's smart.

S. YEAH

I. Ok, Um, how about the one who got it right? How does she feel about herself?

S. GOOD, SHE FEELS GOOD THAT SHE GOT IT RIGHT AND EVERYTHING ...

I. Ok how might she feel about him , who got it wrong?

S. WELL (CHUCKLE) UM..................WELL, SHE PROBABLY DOESN"T, I MEAN SHE" DOESN"T, I MEAN SHE JUST, (CHUCKLE) THERE"S NOTHING BAD ABOUT HIM OR ANYTHING THERE"S JUST, IT WOULD BE THE SAME.

I. Ok. and how does she usually feel, are, you know are is she happy or sad about him? (HAPPY) Or friends or not friends or... ?????????

S. WELL THEY LOOK LIKE THEY"D BE PRETTY GOOD FRIENDS (so) SO SHE"S JUST HAPPY

I She's happy for(?) him(?) (YEAH) ok. Uhm let's go onto picture..... Oh no let's not lets change the problem

PICTURE 2B Two Students Story Problem

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I. Instead of working on that other problem, let's say they're working on the story here, a catepiller started carwaling up a tree, it crawled up three and a quarters feet and fell back two and half feet, and then crawled up six and a quarter feet how far from the ground was it at that point. Ok now they're working on this problem and who would probably have the right answer?

S. ....UM,.......UM THTT PROBABLY HE WOULD

I. Ok, we'll say that he's got the right answer. Um, and why did he get the right answer?

S? WELL IT"S A EASIER PROBLEM

I. Ok, we'll say it's an easier problem. Um, why did she get a wrong answer then? Why didn't she get it right?

S. WELL, SHE PROBABLY WORKED IT OUT WRONG.

I. And why'd she doo that?

S UM, MAY, I DON"T THINK SHE"S VERY GOOD AT THE STORY PROBLEMS, SHE CAN DO BETTER AT JUST REGUALR ONES.

I. Ok, um, why isn't she so good at story problems?

S. ....UM (CHUCKLE).......

I ???? Like um maybe you know for her they're harder (UMHUM) or maybe she never got any help on them or maybe she's really unlucky with that kind or maybe you know she just .... isn't smart when it comes tah (YEAH) ????problems, which type?

S. SHE PROBABLY NOT, VERY SMAART WHEN IT COMES TO STORY PROBLEMS.

I. Ok.Let's talk about feelings again. Um, We'll talk about her. How does the one who got it wrong then, feel about herself?

S. UPSET

I. Ok she might be upset. (UMHUM) Um, how about the one who gottit right? Actually it was the .....Let's think of how she might feel towards him who got it right.

S. WELL NO DIFFERENT, JUST HAPPY AS USUALLY (CHUCKLE)

I. Happy as usual (YEAH) ??????him, Ok, how about the one who got it right now, how does he feel about himself?

S. HE FEELS GOOD.

I He feels good, (UMHUM) Ok um how might he feel towards her who got it wrong?

S. NOTHING DIFFERENT... THE SAME AS HE USUALLY DOES, HAPPY

I. Ok happy with her Ok.

PICTURE 3 Two Girls/Two Boys Math Test

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I. Let's go on to picture number three. .... And here we have a boy and a girl and boy and a girl. And these two girls and two boys are looking over a math ~~test~~ one of them did poorly, two did pretty well, and one did very well, Ok? Which one did very well?

S. ....PROBABLY HIM

I. Ok the boy in the red plaid(UMHUM) Ok and how does the one who did well then feel about himself?

S. GOOD,

I He's feels pretty good about himself (UMHUM) How about the others, how do they feel about him?

S. WELL, HE LOOKS LIKE HE"S USUALLY SMART SO THEY DON"T FEEL ANY DIFFERENT. I MEAN HE"S USUALLY SMART AND THEY"RE USED TO THAT (CHUCKLE)

I. Ok so how might you discribe their feelings?

S. WELL THEY"RE HAPPY TOWAR, THEY"RE HAPPY THAT HE GOT A...

I. They're happy that he got it right? (UMHUM) Ok, um how about, why do the others think that he did well, you know what are thereasons,that they think he did well?

S. CUZ HE USUALLY GETS GOOD GRADES.

I. Ok, and why is that? Why do they think he usually gets good grades?

S. OH HE"S SMART (CHUCKLE)

I. Ok, I guess ~~that~~ you said that before,,, smart.... Um, ok out of the other three who did most poorly?

S. ....UM, THAT ONE, (ok that boy) THAT GUY

I. in the blue, ok the boy in the blue plaid, and how does the one who did most poorly feel about himslef?

S. WELL NOT SO GOOD.

I. Ok he might not feel so good,about???????? (RIGHT) How aobut the tohers how do they feel about him.....???????????

S. ....WELL THEY DON"T....THEY DON"T FEEL ANY DIFFERENT.(CHUCKLE)

I Ok and how do they feel then if they don't feel any different?

S. HAPPY

I. They feel happy,Ok, Um now why do the others think that he did the most poorly?

WELL HE USUALLY DOESN"T GET GOOD GRADES (CHUCKLE)

I. Why doesn't he?

S. I GUESS HE"S NOT SO SMART (CHUCKLE)

I. Ok, he's not so smart. Let's go on to picture number four.

PICTURE 4A Two Girls/Two Boys Girl on left in overalls

Student #4226 Sex F Interviewed: Date 4/13/81 By Gg

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I. You're doing a fine job here., .. Got some more kids for you, Here's a boy and a girl a b a boy and a girl and these two girls and two boys are working on math, and let's look at the girl in the overalls here. How might the tohers expect this girl to do on their math lesson?

S. .....UM............PRETTY GOOD.

I. Ok, they'll expect her to do pretty good, and why do they think that she's going to do pretty good?

S. UM,....WELL SHE USUALLY DOES PRETTY GOOD (CHUCKLE)

I. Ok of course I'm going to ask you why does she usually do pretty good?

S. WELL, I GUESS SHE"S PRETTY GOOD, SHE"S SMART IN MATH.

I. Ok she's smart in math. Um, will they expect her to do better on, palin arithmetic prbblems, like this kind here, adding three and a half and four and a quarter or do they expect to do better on story pooblem like this one; the rainbow televison .. I can't read it upside down, um- has it's portable color television sets on sale at twenty five percent off the regular price, what is the savings on a set that regularly sells for three ninety? So which type do they expect her to do better on?

S. ......PROBABLY THE PLAIN ARITHMETIC PROBELM

I. Ok and why is that?

S. ....WELL THEY"RE, IF SHE"S GOOD IN MATH, THEY"RE MORE MATH,(CHUCKLE) I MEAN IT"S HARD TO EXPLAIN... (CHUCKLE) BUT UM.... THEY"RE EASIER YOU KNOW FOR, FOR HER

I. Ok for her they're easier, because there's more math. (chuckle) Ok I htink I know what you mean.

PICTURE 4B Two Girls/Two Boys Girl on right in striped shirt

Student # 4226 Sex F Interviewed: Date 4/13/81 By GG

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I. Let's look at the other girl in the striped shirt sitting over here. And let's say this girl's having a lot of troyble with her math lesson. And why do they think that she's having trouble?

S. WELL, SHE PROBABLY DOESN"T UNDERSTAND MATH VERY WELL

i. Ok and why is that?

S. UM.... WELL MATH ISN"T ONE OF HER BETTER SUBJECTS, SHE"S NOT VERY SMART IN MATH.

I. Ok she's not very samrt in math. Um, do they think then that she's having trouble with the plain arithmetic types or the story problems?

S. PROBABLY THE STORY PROBLEM (CHUCKLE)

I Ok so she;s having more troubel with those, and why is that?

s. UM, WELL THEY"RE HARDER TO DO ND THEY"RE HARDER TO FIGURE OUT AND EVERYTHING.

I. Okso they are harder to figure out. Ok

PICTURE 4C Two Girls/Two Boys Boy in white T-shirt

Student # 4226 Sex F Interviewed: Date 4/13/81 By GG

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I. Ok let's look at the boy in the white T-shirt. How might the others expect this boy to do on their math lesson?

S. .....PRETTY WELL

I. Ok they'll expect him to do pretty well, (UMHUM) and why do they think he's going to do pretty well? (CHUCKLE) (UM) heard that question before (YEAH!) (chuckle)

S. CUZ HE USUALLY DOES WELL (CHUCKLE)

I. And of course again I'm going to ask.....

S. OK BECUASE HE"S SMART IN MATH.

I. Ok he's smart in math he usually does well. Ok, um, so they expect him to do better on plain arithmetic problems or on story problems?

S. ???? STORY PROBLEMS.

I. Ok and why do they expect to do better on story problems?

S. BECAUSE THEY"RE PROBABLY EASIER FOR HIM.

I. Ok for him they're easier. Ok !.

PICTURE 4D Two Girls/Two Boys Boy in black football shirt

Student # 4226 Sex F Interviewed: Date 4/13/81 By GG

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I. Let's look at the last guy here, in the black here. And let's say that this boy is having a lot of trouble with his math lesson. And why do they think that he's having trouble?

S. (CHUCKLE) UM, ??? HE USUSALLY DOESN"T DO VERY, HE"S NOT VERY SMART.

I. He's not very smart (both laugh) ok you almost ????? (I KNOW) but you knew I'd get you Do they think then that he's having more trouble in the plain arithemtic problems or on the story problems

S. PLAIN ARITHMETIC PROBLEM

I. Ok and why?

S. UM... CUZ IT"S MORE MATH. (CHUCKLE)

I. Ok so, can you kind of explain thatagain?

S. UM... HE PROB, HE DOESN"T DO VERY WELL IN MATH (umhum) AND.....UM(CHUCKLE) AND IT"S EASIER FOR HIM TO DO THE STORY PROBLEM AND FIGURE IT OUT, YOU KNOW WITH ALL (umhum) THE WORDS AND STUFF, AND SET IT, THEN HAVE IT SET UP LIKE THAT

I. Ok, so for him that's more math, and, i don't know how to say it,...but the story problems are easier so... ok what'd you say the plain arithmetic are set up and he can do those. (RIGHT WELL) he <u>can'</u>tdo those ???????math (umhum)????? they're harder for him.

S. UMHN YEAH

I. Um, maybe I should pin you down some more, why those are harder for him, can you ... describe that maybe a little more, why they're harder for him?.....

S. UM.... (i know it's hard, ??? say) UM, WELL THE STORY PROBLEMS LIKE MORE SET UP FOR HIM, ERR , NOT SET UP BUT... (umh<u>um</u>) THE UM, THE WORDS GIVE HIM AN I A BETTER IDEA AND STUFF

I. Ok, ok and so when there's wordsthat gives him a better idea. Ok, let's leave that. Um, let's go onto picture number five.

PICTURE 5 Student and Teacher

Student # 4226 Sex F Interviewed: Date 4/13/81 By GC

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I. and this student has come into to ask the teacher for help on her math lesson did she come for help on a plain arithmetic or a story problem?

S. STORY PROBLEM

I. Okand, how doe sthe student feell about asking the teacher a question about math?

S. GOOD

I. Ok, so she feels good. And how's the teahcer feel about the student coming in and asking a question about math?

S. HE:S GLAD THAT SHE CAN ASK HIM

I. Ok, so he feels glad that she could come in.

S YEAH

I. Ok, that's all for that picture.

PICTURE 6A   Two Girls/Two Boys/Teacher   Plain Arithmetic (Right)

Student # 4226   Sex F   Interviewed: Date 4/13/81   By GG

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I. Here's picture number six. And we have some more kids. A girl and a boy, a girl and a boy. And.. the teacher has just asked this question here. What is the aanswer to point nine one into point three four five seven. Now who would the teacher call on for the right answer, teacehr wants the right answer? ... Ok the boy in the front, in the white, mainly white shirt. (YEAH) Ok, and why does the teacher think taht he will know the answer?

S. WELL HE LOOKS SURE OF HIMSELF AND THE OTHERS JUST (CHUCKLE) THEY LOOK QUESTION

I. Ok they do... Um, Why does the teacher think he's sure of himself?

S. CUZ HE USUALLY GETS THE RIGHT ANSWERS, OH ARE YOU GOING TO ASK ME (unhun) THAT EXPRESSION(?)

I. Why does he usually (OK) get the right answer?

S. (CHUCKLE) UM, HE DOES GOOD IN MATH.

I. Ok why does he do good in math?

S. OH, (CHUCKLE) CUZ A HE"S PRETTY SMART

I. Ok, maybe he's pretty smart. Um, How about the student why does he think he's got it right?

S UM, CUZ HE USUALLY GETS "EM RIGHT

I. Ok and...

S. OH! UM...(CHUCKLE)

I. Why does he u think that he usually gets them right?

S. OH, CUZ HE"S SMART

I. Ok so he thinks he's smart too. (CHUCKLE) Um, let's look at the girl in the plaid sitting behind him. Does the teacher think this student will know the answer?

S NO

I. Ok she doesn't know the answer. And why does the teacher think so?

S CUZ SHE LOOKS QUESTIONED.. SHE DOESN"T LOOK LIKE SHE KNOWS THE RIGHT....

I. Ok why does the teacher think she's questioned, I mean you know like why does the teacher think she has that questioning look on her face?

S. UM..... CUZ SHE"S NOT VERY SMART IN MATH (CHUCKLE)

I. Ok, she's not very smart in math.

PICTURE 6B Two Girls/Two Boys/Teacher Plain Arithmetic (Wrong)

Student # 4226 Sex F Interviewed: Date 4/13/81 By GG

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I. Ok let's look at the kids on the other side of the room. And who does the teacher think will get the problem wrong of these two kids?

S. THE ONE ON THE BACK

I. The guy in the back in the drake T-shirt, and why does the teacher think so?

S. WELL HE... HE"S NOT VERY SMART (CHUCKLE)

I. Ok how about the studnet why does the student think he's got it wrong?

S. SAME, HE"S NOT VERY SMART, AND HE USUALLY DOESN"T GET IT.

I. Ok, Let's look at the girl in front of him in the stripes. Does the teacher think she' will be able to solve this problem?

S. NO

I. no, Ok (CHUCKLE) And why does the teacher think that?

S. SHE SHE DOESN"T LOOK LIKE SHE WOULD KNOW IT EITHER. SHE JUST ...(CHUCKLE) UM

I. (chuckle) I agree (UM) Why though

S. UM... SHE MIGHT NOT BE VERY SMART

I. Ok, she might not be very smart.

PICTURE 7A   Two Girls/Two Boys/Teacher   Story (Right)

Student # 4226   Sex F   Interviewed: Date 4/13/81   By GG

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I. Ok, let's look at picture number seven. And this a girl, a boy a girl and a boy. And the teacher has just asked this question: U. Last year a deluxe ten speed bicycle cost one twenty nine fifty. This year the price is one forty two forty five. What percent did the price increase in one year? Again the teacher wants the right answer. So who will the teacher call on for the right answer?

S. THERE RIGHT THERE

I. The girl in the pink and blue stripe? (UMHUM) Ok, in the back there,I quess we better describe 'em better (UMHUM) Ohm, and why does the teacher think that she will know the answer?

S. CUZ SHE"S SMART (CHUCKLE)

I. Ok, she's smart (chuckle) How about the student? Why does she think she's got:it right?

S. BECUZ SHE"S SMART (CHUCKLE)

I. ?????????? Um let's look at the boy in front of her in the red rhite white and blue Does the teacher think that this studetn will know the anser?

S. UMHUM

I. Ok, so why does the teacher think he's going to know?

S. CUZ HE"S SMART IN MATH (CHUCKLE)

I. Cuz he's smart in math. (UMHUM) Ok.

PICTURE 7B Two Girls/Two Boys/Teacher Story (Wrong)

Student # 4226 Sex F Interviewed: Date 4/13/81 By GG

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I. Let's look at the other two kids on the oterh side of the room, and who does the teacher think will get the problem wrong of these two kids?

S. THE BOY IN THE BACK, IN THE BLUE

I. The boy in the back in the blue, and why does the teacher think so?

S. UM....CUZ HE"S NOT VERY SMART.

I. Ok, he's not very smart. How about the studnet why does he think he's got it wrong?

S. CUZ HE"S NOT VERY SMART EITHER (CHUCKLE) (ok) HE DOESN"T TRY VERY HARD

I. Ok he doesn't try very hard. Ok, Let's look at the girl in front of him, the blonde Howabout this student, does theteacher think she will be able to solve this problem?

S. ....UM... UMHUM

I. Ok the teacher thinks she going to be able to, and why does the teacher thin so?

S. CUZ SHE"S SMART AND SHE TRIES HARD

I. Ok she's smart and she tries hard (umhum) Ok.

PICTURE 8A   Two Girls/Two Boys/Teacher   Spatial (1st student)

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I. Let's go onto picture nubmer eight. The classroom, Boy and a girl, boy and a girl, And the teacher has just asked a problem about the volume of wedges. This one here. Wedge A is twice as high and just as wide as wedge B. Wdge B is twice as long as A, so that A and B have the same volume. Is the area of the bottom of wedge A the same as the area of the bottom of Wedge B?
Who among these four does the teacher think will know how to do the problem?

S.

S. ....UM, THE ONE WITH THE BLACK HAIR IN FRONT (ok) THE BOY

I. Ok the boy in black hair and black and white shirt. And why does the teacher think that this student can do it?

S. UM, CUZ HE"S GOOD AT WORKING OUT THOSE.. HE"S GOOD AT GEOMETRY AND WORKING OUT THOSE... SHAPES AND PROBLEMS STUFF

I Ok so he's ????? himself (VOLUME) ???? that kind of problem. Um, why is he good at kind of problem?

S. CUZ HE"S SMART (CHUCKLE)

I. Ok, he's smar t and he just makes.???????

S. YEAH, WELL HE TRIES HARD...

I. Ok he tries ahrd too. Ok how about the student why does he think he can do it?

S.CUZ HE TRIES HARD

I. Ok he knows he tries hard. Ok Who among these four then, does the teacher think will not know how to do the problem?

S. ...THE FIRL BEHIND HIM

I. Ok the girl in the white, (UMHUM) and why does the teacher tink that?

S. BECUASE SHE USUALLY DOESN"T GET IT...WELL (CHUCKLE)

I. Why doesn't she usually get it?

S UM, CUZ SHE"S NOT VERY SMART

I. Ok, she's not very smart. How about the student, why does she think she can't do it?

S. CUZ SHE"S NOT VERY SMART (CHUCKLE)

I. Um,.......

PICTURE 8B Two Girls/Two Boys/Teacher Spatial (2nd student)

Student # 4226 Sex F Interviewed: Date 4/13/81 By GC

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I. Um, let's look at the girl over here in the red and talk aobut her. How would the teacher think that she would do on this problem?

S........UM, GOOD

I. Ok the teacher ????? think she'sgoing to do good (UMHUM) Why does the teacher think that she's going to do good?

S. CUZ SHE"S SMART.

I. Ok How about the student then why does she think she's going to ???? to get it right?

S. UM.....WELL SHE"S SMART (CHUCKLE)

I. Ok ???????she thinks that (UMHUM) Ok.

PICTURE 9A Confident Student

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I. On to picture nine. And this girl is very confident, that she can do her math. ??? What might have happened to her before that she feels like that?

S. WELL SHE USUALLY GETS IT RIGHT, SHE GETS HER PROB, THE PROBLEMS RIGHT A LOT

I Ok, so she usually does get them right. Um, which one of our two kinds of problems.... the plain arithmetic or the sotry problems um, is she most confident that she can do?

S. THE PLAIN ARITHEMTIC

I. Ok why, why is that?

S. CUZ THEY"RE EASIER (CHUCKLE)

I. Ok cuz they're easier. (UMHUM)

PICTURE 9B Worried Student

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I.

I. Ok, let's change our point of view now, and imagine that this girl is the opposite of what you juust talked about, ~~Let's~~ We're going to say she's not very confident actually, she's you konw really worrried about doing math. (UMHUM) And what might have happened to her before that she feels like that?

S. WELL SHE DIDN"T GET VERY ... SHE DIDINT GET VERY GOOD ANSWERS BEFORE

I. She didn't get very good answers before (UMHUM) Um which one of these two kinds of problems, the plain arithmetic or story problems is whe less worried about? Less worried

S THE PLAIN ARITHMETIC

I. Ok and why is that?

S CUZ THEY"RE EASIER

I. Ok, that's a pretty good reason. Ok

PICTURE 10 Successful Student

Student # 4226 Sex F Interviewed: Date 4/13/81 By GG

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I. Let's go onto our last picture here. Picture number ten. And this girl is the best student in her math class. And how does she feel about being the best student?

S. GOOD

I. Ok, she feels pretty good. (UMHUM) And how do the otehrs in her calss feel about her being the best student?

S. THEY FEEL HAPPY FOR HER

I. Ok and what do you think her life wlll be like? (CHUCKLE)

S. UM,...WELL SHE PROBABLY HAS A LOT OF FRIENDS (umhum) UM, SHE"S PROBABLY HAPPY, (CHUCKLE) (ok) UM,...

I. What do you think sheill be doing ten years from now?

S. UM... (CHUCKLE).........PROBABLY WORK IN A OFFICE.

I. Ok she might be woiking in an office. What might she be doing?

S. LIFE INSURANCE AND STUFF

I. Ok likfe an Insurance office? (YEAH) (UMHUM) What types of thimgs woudd she be doing in an insurance office?

S. ?????? MAEN LIKE WHAT POSITION LIKE?

I. Yeah, what position, what's her work going to be like, ??? what doesx she do every day?

S. WELL, SHE PROBABLY BE LIKE AN EXECUTIVE ANS STUFF (umhum) SHE"S SMART THEN(?) SHE GET UP THERE (CHUCKLE)

I. Ok, what might she do every day? ??????????????

S. UM...WELL (CHUCKLE)

I. Just whatever they do?

S YEAH WHATEVER, I DONT KNOW

I. Ok let's think aobut next month, what's she going to be doing next month?

S. UM.....SHE"LL PROBABLY BE WITH HER FIRENDS

I. Ok what are they doing?

S UM... WELL RIDING HER BIKE AND STUFF AND BEING IN A LOT OF SPORTS AND STUFF

I. Oh that sounds nice (both laugh) That's a good thing to do in may. That's the end of the pictures but...

SUMMARY

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I. Now I want to ask you some questions what you believe about some of the kinds of things that we've been tlaking about. Ok? Do you think that teachers tend to eall on boys more or on girls more in math class?

S. ... PROBABLY GIRLS MORE (ok)ON THINGS(?) LIKE THAT YEAH

I. Ah, why do you think this is?

S I DON"T KNOW (CHUCKLE) UM...... WELL, HE MIGHT THINK THAT THE GIRLS KNOW MORE PROBLEMS OR SOMETHING YEAH

I. Ok, um, some people say that girls are better in math than boys and some say the opposite that boys are better tehn girls. What do you think?

S. I THINK THEY"RE THE SAME. I DON"T KNOW, I DONT" HAVE ANY ??????

I.You think they're the same? (YEAH) Ok, some people say girls do better at story problems than do boys, What do you think?

S. UM.....I thiNK GIRLS WOULD DO BETTER. (on the story problems?) YEAH

I. Ok um, Most people have trouble at some point or another when they are studying math. Do you ever have trouble with math?

S. UMHUM, SOMETIMES YEAH

I. What do you do, when you have trouble?

S. UM, WELL I ASK FOR HELP

I. Ok who do you usually ask for helP?

S TEACHER

I. Teacher usually? (UNHUN) Ok some people are very scared about doing math, and why do you think that girls are sometimes not so confident?

S. UM.....WELL,...UM (CHUCKLE) IT"S HARD, UM... ...

I. You can think of ..you know, friends you might know or yourself you know when you'renot so confident?

S WELL FROM LIKE IF THEY DON"T DO VERY GOOD LIKE IN ONE PART OF MATH, THEY MIGHT NOT THINK TH DO VERY GOOD AT THE OTHER PART.

I. Ok, Theymight lose their confidence (YEAH) a little bit. How about boys? Why do you think that boys are sometimes not so confident?

S. ....WELL THEY MIGHT NOT TRY SA HARD, SOME OF THEM MIGHT NOT TRY AS HARD

I. Ok, why might that be?

I. You know if they cant ??????????

S. ???? THEY MIGHT NOT REALLY CARE (CHUCKLE)

I. Ok, um have you ever had a male math teacher?

S. UMHUM

I. Ok do you think that they treat girls differently than they treat boys?

S UMHUM

I. How, you know if you could explain it?

S. CUZ THEY DON"T YELL AT GIRLS AS MUCH (they don't?) UNHUN, THEY TALK TO GIRLS MORE.

I. They yell at boys more?

S. (CHUCKLE) YEAH

I. Why do you think that is?

S. I DON"T KNOW UM, WELL.... UM

I. ???????????????????

S. YEAH WHAT I WAS SAYING AND STUFF

I. Ok, We have found that many studnts expect girls to do better in math, than boys however men seem to wrok in careers that use math more than woment do. Fore example there are a lot more male engingeers than female engineers. Why do you suppose that girls are expected to do better in math and yet boys use math more in their careers?

S. I DON"T KNOW (CHUCKLE).......UM, (CHUCKLE) ..... WELL (CHUCKLE)

I! You could just think about the part, you know why you think that maybe you know men use math more in their careers tahn women do/

S WELL, THER"S MORE JOBS FOR MEN, THEN MOST OF THE JOBS, YOU KNOW USE MATH.

I. Ok the ones like, what kind?

S. UM ..WELL(CHUCKLE)

I. I know here they meation engineers.

S YEAH, UM

I. Why do you think more men go into those kinds of jobs, than women do?

S. WELL (CHUCKLE)....... I WELL,.....I GUES SOME MEN WOULD LIKE TAH RATHER BE ENGINEERS THAN THAN UM SIT IN A OFFICE AND STUFF (umhum) AND DRESS UP AND THINGS (CHUCKLE)

I. Um, yeah, but you think that women would do that more than the men?

S. YEAH

I. Ok. That's the end of my quesitons. Do you have any questions for me that I can try to answer? (NO) Ok this is the last year of this study and um it's going to be writing

I. (con't) and printed in some national journals ????????? So if you are interested if next fall you come back here to vidit, you know one of the banqqets you could probably the articles again (OK I'll do that) We really appreciate you help over the years. ??? been importsnt

S. (CHUCKLE) OH OK.