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THE PRODUCTION AND VALIDATION OF EDUCATIONAL SYSTEMS PACKAGES FOR OCCUPATIONAL TRAINING OF DEPRESSED AREA STUDENTS, FINAL REPORT.

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*MATHEMATICS INSTRUCTION, *INSTRUCTIONAL MATERIALS, *TEACHING TECHNIQUES, *INSTRUCTIONAL IMPROVEMENT, TENTH GRADE, VOCATIONAL EDUCATION, TUTORING, SANTA BARBARA, CALIFORNIA

INDIVIDUAL TUTORIAL SESSIONS WERE CONDUCTED WITH 42 10TH-GRADE STUDENTS IN A LARGE INNER-CITY HIGH SCHOOL, WITH THE PURPOSE OF REVISING A UNIT OF GENERAL MATHEMATICS FROM A STANDARD TEXT. THE HYPOTHESIS TESTED WAS THAT MATERIAL SO REVISED WOULD YIELD MORE LEARNING FOR STUDENTS OF THIS POPULATION THAN MATERIALS REVISED UNDER STANDARD CURRICULUM WORKSHOP CONDITIONS. THE EXPERIMENTAL GROUP (50 STUDENTS) STUDIED TUTORIALLY REVISED MATERIALS, AND THE CONTROL GROUP (50 STUDENTS) STUDIED TEACHER-PREPARED MATERIALS BASED ON THE SAME UNIT. STUDENTS IN THE EXPERIMENTAL GROUP SCORED SIGNIFICANTLY HIGHER ON CRITERION TESTS ADMINISTERED IMMEDIATELY UPON COMPLETION OF THE MATERIAL. THE HYPOTHESIS APPEARED TO HAVE BEEN SUPPORTED BY THIS STUDY. RECOMMENDATIONS WERE MADE FOR A MAJOR RESEARCH PROJECT AIMED AT THE PRODUCTION AND VALIDATION OF FIVE SEMESTER UNITS OF INSTRUCTION IN SUBJECT AREAS BASIC TO PROGRAMS OF VOCATIONAL EDUCATION. (GD)

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U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
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Division of Adult and Vocational Research

Vocational Education Act of 1963
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PROJECT SUMMARY- ERD-439-65 5-0192
Contract No. OE-6-85-041

TITLE: The Development and Evaluation of Educational Systems Packages for the Occupational Training of Depressed Area Students in Five Basic Subject Areas

PRINCIPAL INVESTIGATOR: Don D. Bushnell

INSTITUTION: Brooks, Foundation, Santa Barbara, California

FEDERAL FUNDS REQUESTED: $38,990

DURATION: Beginning, September 1, 1965 Ending, February 28, 1966

Objectives: A twenty-four month program of research and testing is proposed for the experimental testing of the following hypothesis:

> Classroom instruction with instructional materials which have been modified during tutorial sessions will result in significantly better learning than study with (1) workshop produced versions of the instructional materials, and (2) first-order revision of the educational packages. This first-order revision will be based on upon the post-facto analysis of responses to study questions, criterion test measures, and subjective feedback from the instructors - but not upon iterative tutoring sessions.

Complete units of instruction in basic arithmetic, reading, writing, speech, and manipulative skills, will be developed and tested in a new Center for Vocational Education Materials Development located in the Simon Gratz Vocational High School in North Central Philadelphia, an area of high population density and predominantly negro population. In addition to the main experimental hypothesis, two fundamental questions will be answered by the proposed research: (1) are the three techniques for developing and testing instructional materials described in the research of equal value for courses embodying verbal, quantitative, or manipulative skills, and (2) are there learning plateaus where further developmental testing exceeds the corresponding gain in student performance?

Uses of a data bank maintained on magnetic tape and stored in a digital computer will be explored for instructor training purposes as a by-product of the research program.

Procedures: Preliminary to the initiation of the main research program, a pilot study program is proposed to test the viability of procedures outlined for the major period of research. A test of the hypothesis that tutorial revision procedures for the improvement of instructional materials are more conducive to learning than workshop produced materials is described. During the major experimental period, it is proposed that three groups composed of one hundred depressed area students each, will study the basic instructional materials, prepared and modified under the three experimental conditions, for a period of four months. The data gathered from these study periods will serve as baseline data for subsequent alterations of instructional materials. Data on both students and instructors will be extracted from tutorial sessions which will extend over a seven-month period. This data, it is proposed, will be used for instructional materials development as well as for instructor training.

In the final experimental phase, analysis of co-variance and independent T tests will be completed for three groups of one hundred students, instructed under standard classroom conditions, studying with (1) the original workshop-produced materials, (2) the modified material from the first-order revision, and (3) the tutorially revised version of the instructional material. The experimental hypothesis will be tested by comparison of final criterion test data. Answers to the basic questions raised concerning variable cost ratios and the appropriateness of different procedures to the fundamental skill areas will be sought.

# FINAL REPORT

Pilot Phase

## THE PRODUCTION AND VALIDATION OF EDUCATIONAL SYSTEMS PACKAGES FOR OCCUPATIONAL TRAINING OF DEPRESSED AREA STUDENTS, FINAL REPORT.

The Brooks Foundation

2020 Alameda Padre Serra

Santa Barbara, California

Principal Investigator: Don D. Bushnell

March 30, 1966

Project # ERD - 439-65

Contract # OE 6-85-041

## ABSTRACT

Individual tutorial sessions were conducted with forty-two 10th grade students in a large inner-city high school, with the purpose of revising a unit of general mathematics from a standard text, and testing the hypothesis that material so revised would yield more learning for students of this population than materials revised under standard curriculum workshop conditions. After each tutorial session, text material was revised on the basis of several student variables: reading difficulties, verbalized conceptual difficulties, answers to diagnostic questions, and responses to tutors' questions. After twenty-three such revisions, when it was demonstrated that typical students were able to learn the material, two groups of fifty students each, matched on IQ, arithmetic and reading achievement scores, were presented with the unit. The Experimental group studied tutorially revised materials, and the Control group studied teacher-prepared materials based upon the same unit. Students in the Experimental group scored significantly higher ($p < .025$) on criterion tests administered immediately on completion of the material. The hypothesis that tutorial revision of instructional material will produce a more effective teaching tool than will workshop (teacher) revision is supported.

From the recorded observations of student learning problems during tutorial sessions, an index was prepared of the types of problems encountered, the specific instructional materials causing the problem, and the strategies used to resolve it. This index was coded for later inclusion in a computerized data file to be used in the training of teachers by simulating actual educational interactions.

Recommendations were made, on the basis of the experience gained in this feasibility study, for a major research project aimed at the production and validation of five semester units of instruction in subject areas basic to programs of vocational education.

## INTRODUCTION

The research program here reported was designed to test two methods of revising curriculum materials in order to tailor them to the learning needs of a special target population of students. The study was anticipatory of a larger research program, designated Phase II, which will have the purpose of comparing and recommending three procedures for the validation of textbooks for deprived, inner-city students and for preparing multi-media packages of self instructional materials in five subject areas basic to success in vocational education courses. The hypothesis under test in the pilot study being reported contends that instructional material revised in iteratively cycled individual tutorial sessions with students from an urban deprived population would yield more learning than would material revised in a typical curriculum workshop situation involving modifications based upon the teachers subjective experience but not upon direct interaction with the individual student. By placing the student into the feedback loop of material evaluation and modification in the tutorials, it was assumed that more powerful instructional resources could be developed through face to face interaction between the teacher-author and the student.

Another aim of the pilot study was to investigate the feasibility of establishing a data bank of student responses to the instructional material. Additional data sought during the pilot phase were: measures on various aptitude and achievement tests; criterion test responses; and observer notes on program content and interactions between students and material. A procedure for observing, coding and classifying this data was to be standardized during the study and recommendations developed for coding procedures to be followed during the main research program or Phase II.

From the experience of those teachers directly involved with the tutorial sessions, a technique for the training of teachers for these deprived students has been recommended. In Phase II, a computer-based simulation technique will be evolved whereby actual teaching interactions will be simulated and teacher trainees will be

required to react as though in the actual setting. This will provide an economical and convenient method to expose teacher trainees to the particular learning difficulties associated with this student population.

Concurrent to the pilot research, curriculum workshops have met to develop instructional units in five different areas. These units will be employed in the main research project and represent a product similar to that developed by text publishers or curriculum development institutes.

This pilot study and the main research effort comprise an experimental evaluation of different models which might be adopted by any local school district for tailoring curriculum materials to educate special student populations. The majority of commercial texts are aimed at a wide representative sample of students and may be entirely inadequate to the learning needs of select populations; vis, the urban disadvantaged. Through the development of a standard methodology for evaluating, modifying and preparing individualized study programs for inner city student, the educational needs of this population of disadvantaged children might someday be met.

## METHOD

### Design:

The design of this study consists of comparisons of learning test scores between groups of students studying tutorially revised material and a group studying workshop (teacher only) prepared materials. The students receiving the workshop material compose the Control group. There were three experimental groups which studied the tutorially revised material: the Laboratory, Audio, and Classroom groups. The Laboratory group were administered their educational material in a tutorial center in their high school. The Classroom group received the material in their own classroom. The Audio group was run in the tutorial center and received the same material but the method of its presentation was varied: it was recorded on

audio tapes and they simultaneously listened to and read it. All materials were presented in a self-instructional format. It was hypothesized that the groups studying the tutorially revised materials would have significantly higher learning scores than the group studying the workshop prepared materials, at an alpha level of .05.

The study was conducted in Simon Gratz High School, Philadelphia, Pennsylvania. All subjects were tenth graders currently enrolled in a course in general mathematics. No one from the "modified" program for low I.Q. students was included, as an arbitrary cut off at a measured I.Q. of 80 was made. Fifty subjects each were included in the Laboratory and Control Groups. They were chosen at random from classes meeting at five different periods a day and were then matched on I.Q., and arithmetic and reading achievement test scores. One member of each pair was then randomly assigned to the experimental group; the other to the control group. Nineteen subjects were included in the Audio group; these students too were chosen at random from classes meeting at five successive periods a day. In the Classroom group, twenty-five students were run. All subjects in this group received the material at the same time, the group was chosen specifically because the teacher was willing to give up her class for the time needed to run the experiment. Attendance records became an additional criteria of selection. No student who had missed more than 30 days in his previous year at school was considered for either group. This further narrowed the field of choice.

## Tutorial Revisions

Tutorial sessions were conducted to revise the basic text materials. Individual sessions were initiated using a unit on "The Measures of Central Tendency" from the tenth grade General Mathematics, Book One, by Brown, Simon and Snader. Instruction was in the Simon Gratz tutorial center and usually lasted a full period (forty-five minutes) per child.

Tutorial subjects were volunteers, as representative as possible of the experimental and control groups. Tutorial sessions were held, for the most part, six periods each day. The first three periods were devoted to tutoring one of the revisions; the intervening time was given over to developing a new revision for the afternoon students; and the last three periods of the day to tutoring the resulting revision. Because each new revision required re-typing, and also grew in length, it soon became apparent that only three students a day could be comfortably handled with the available staff. In all forty-two students were cycled through the tutorial procedure. This required two months time and engendered twenty-three revisions of the original mat rial. The final revision required approximately four days for a student to complete.

In the first tutorial sessions the students were required to read the text material aloud and were encouraged to talk about any conceptual difficulties encountered. Because of the reluctance of the students to verbalize any learning difficulties, diagnostic questions were built into the text at the end of every instructional paragraph. Text exercises were used and student errors analyzed. The tutor spontaneously questioned the student whenever it was evident there was a difficulty and attempted various teaching techniques to communicate the material. After each group of tutees had been through their daily sessions, the researchers worked out the next revision on the basis of the behavior that had been observed and the strategies that had appeared to be particularly effective. Essentially, this procedure was maintained through to the twentieth revision. From the twentieth revision on, the material was administered in a self-instructional, rather than a tutorial, format as this was the method to be employed in the actual experimental situation.

## Coding Procedures

During the tutorial sessions, an observer took notes on all the difficulties the students encountered with the material. The

notes were written on a copy of the particular revision involved so that the specific material engendering each problem could be identified easily. The notes were transcribed into a list of "Student Problems" and the list was categorized in terms of the kinds of problems involved. Also, a tabulation was made of every problem every student encountered during every session. During the tutorial sessions, tape recordings were made of the proceedings to be used where needed to validate the notes of the observer. Appendix A gives examples of the observations of one student taking the fifteenth revision. In Appendix B, several general instructional concepts are listed and typical learning problems they generated are identified.

The notes on each student can be coded according to types of problems encountered and these data then used as input to a computer. Once put on magnetic tape, the student problems will be tallied and breakdowns made according to individual students, number of particular revision, and certain student variables (reading level, arithmetic achievement score, I.Q., etc.). Analyses of these data will provide information on typical learning difficulties of individual students and on the teaching efficacy of each serial revision of the instructional material. This data bank can also prove of value in the training of teachers by simulating actual educational interactions.

## Text Revisions

Changes in the original text and in the subsequent revisions were made on the basis of several student variables. These were: reading difficulties the students encountered; conceptual difficulties verbalized by the students; answers to diagnostic questions, both correct and incorrect; and responses to tutor's questions. Revisions of the material were designed to facilitate student learning by anticipating the types of difficulties likely to be encountered and providing instruction to forestall them. The

decision to stop revising the text material was made when it appeared that typical students in this population were able to learn all the material contained in the unit: when they could respond correctly to all the diagnostic questions in the text without any prompting from the tutor.

Several general instructional variables were manipulated in the successive revisions in an attempt to write a revision that communicated effectively. These variables included general format of presentation of material; order of presentation of material; vocabulary level; amount of material presented in each frame; step size, i.e., amount of conceptual progress between frames; speed of fading of each concept; and amount of repetition. These variables were always considered in relation to the specific material being taught. See Appendix B for a comparison between some of the revisions, and Appendix D for the final revision.

## Workshop Production of Material for Instruction of Control Group

An experienced mathematics teacher from Simon Gratz prepared the unit to be taught to the control group. This material is based on the same unit, from the same textbook, as that which was revised in the tutorial sessions. The teacher first taught the unit in one of her classes and then reworked the text material into a complete self-instructional unit. At her discretion, text material was augmented, and improved. This technique represents the rational approach ordinarily used by textbook authors and teacher institutes devoted to writing instructional material. See Appendix E for the completed text prepared by the workshop committee.

## Criterion Testing

Before the tutorial revisions and the workshop revisions were initiated, a criterion test was developed by the tutor and the workshop teacher. The test measured the behaviors to be taught in the unit. After all revisions were completed, the revised material was administered to groups of subjects who studied it and then took

the criterion test. The workshop produced material was used by the Control group. The three experimental groups studied the tutorially revised material. Both instructional units were administered to 50 Laboratory and 50 Control subjects in the laboratory setting of the Simon Gratz tutorial center. Approximately twenty subjects were run at a time; all of them received the materials in a self-instructional format. The administration of the materials occupied approximately six school days or until the last student had completed the unit and the criterion test. Each student worked at his own pace, spending one class period (forty-five minutes) per day in the tutorial center.

Two other experimental groups were also run using the tutorially revised material. One group, the Audio group, was run in an attempt to compensate for the verbal difficulties of this population of students; they simultaneously received the printed material and listened to an audio tape recording of the material. A total of nineteen students were in this group: they studied four at a time, each having his own tape recorder and ear phones. Stops were programmed onto the tapes at those points where the students were supposed to do actual work.

The other experimental group received the tutorially revised material in the printed format in their classroom. The students did not study the material or take the test in the laboratory setting of the tutorial center. This group was designated the Classroom group and consisted of twenty-five subjects.

Appropriate t tests were made between the differences in learning scores of all four groups: The Laboratory, the Control, the Audio, and the Classroom groups.

## Other Workshop Sessions

During the course of this study, five other workshop sessions were conducted to prepare material in five curriculum areas. This material is to be used in the second phase of the study and includes units in Composition Writing, Speech, Reading, General Mathematics,

and Manipulative Skills. Each workshop group consisted of an experienced teacher in the area, a consultant, and assistants who were college seniors or graduate students in education specializing in the subject matter of that specific unit. Each of the five groups analyzed and prepared an instructional unit and wrote the concomitant exams, completing the steps listed below:

1. an explicit statement of the test to be used and the material to be covered in that text,
2. a definition of the behaviors taught in the unit,
3. a pre-test to evaluate whether the student had the skills -necessary to take the unit,
4. within-unit diagnostic quizzes to determine the students' comprehension of the material and therefore their readiness to go on to the next step of instruction,
5. a criterion test to determine the level of learning after the student had completed the unit,
6. a retention test,
7. actual revision of the text material through additions of necessary material, revision of vocabulary that might be beyond the student's grasp, deletion of extraneous material, etc.

Appendix C gives samples of this material.

Participants in the workshop sessions received two weeks of instruction in programming, i.e., defining instructional goals, preparing alternative instructional sequences, establishing test validation procedures, etc. Dr. James Evans, Vice President of Teaching Materials Corporation, and Mrs. S. K. Dunn of the Office of Economic Opportunity both served as alternate instructors. Each workshop team then proceeded independently on a twice weekly schedule to prepare their instructional units. However, frequent interaction among the different teams became the rule during the planning sessions. Consultants Temple and Pennsylvania Universities were also shared among the various teams.

Several students of the Simon Gratz high school population were involved in a preliminary validation of the units on math and on manipulative skills. In general, however, teachers participating in the workshop sessions refrained from using or testing their materials during the workshop development [illegible].

## RESULTS

### Descriptive Data

Certain aptitude and achievement test scores were available on the subjects used in this study. For all subjects an I.Q. measured on the Philadelphia Verbal Intelligence Scale was available: all subjects also had a score on an Arithmetic Fundamentals test; and data were available for most subjects on a Reading Fundamentals test. The information on the last measure is in the form of two scores, one for Reading and one for Usage. These data are presented in Table 1. Both the Arithmetic and Reading tests were administered in the eighth grade; by halving the scores a grade level score is obtained. Table 2 presents these grade levels.

TABLE 1: Aptitude and Achievement Test Means by Group

| | TEST | | | |
|---|---|---|---|---|
| | Phila. | Arithmetic | Reading Funds. | |
| GROUP | I.Q. | Funds. | Reading | Usage |
| Control Group (N=50) | 88.14 | 12.94 | 14.89 | 14.16 |
| Laboratory-experimental Group (N=50) | 88.26 | 13.10 | 14.17 | 13.95 |
| Audio-experimental Group (N=19) | 88.42 | 13.00 | 14.32 | 14.31 |
| Classroom-experimental Group (N=25) | 92.54 | 12.96 | 13.89 | 13.69 |

TABLE 2: Achievement Test Grade Level Means by Group

| GROUP | TEST | |
|---|---|---|
| | Arithmetic Fundamentals | Reading Fundamentals |
| Control | 6.47 | 7.46 |
| Laboratory | 6.55 | 7.05 |
| Audio | 6.50 | 7.16 |
| Classroom | 6.48 | 6.95 |

For the students to have been achieving at grade level, all the Arithmetic and Reading test score means should have been 16.00. The tabled means represent from 1/2 to 1-1/2 years lag in achievement.

In 1964 the Philadelphia Research Division of the Board of Education conducted an achievement testing program. From this the eighth grade Arithmetic Fundamentals mean grade level for the lowest performing school school in the district was 6.3. The lowest performing school mean grade level for the eighth grade Reading Fundamentals was 7.1. The students in the samples used in this study have achievement scores on the average that are on a par with those from the lowest achieving schools in the district. These students are on the bottom when compared with their whole school district.

The I.Q. scores are equally depressed, representing an average of 10 to 21 plus points below the average score of 100. According to their test scores, these students must be classified educationally handicapped.

The corresponding data for the students used in the tutorial sessions to develop the experimental revisions are presented in Table 3.

TABLE 3: Aptitude and Achievement Test Means for Tutorial Subjects

| | | TEST | | |
|---|---|---|---|---|
| | | Phila. I.Q. | Arithmetic Funds. | Reading Funds. |
| Tutorial Subjects | (N=42) | 90.00 | 13.35 | 14.75 |

## Criterion Tests

The three experimental groups and the Control group were given the same criterion test in order to measure learning performance. The means for these groups are presented in Table 4.

TABLE 4: Group Means on Criterion Test

| G R O U P | MEAN CRITERION TEST PERFORMANCE | N |
|---|---|---|
| Laboratory | 66.23 | 50 |
| Audio | 68.26 | 19 |
| Classroom | 69.92 | 25 |
| Control | 59.04 | 50 |

Between these groups, t tests were run on the mean performances to ascertain any significant differences. Independent t's were run on all comparisons except for that between the Laboratory and Control groups as the subjects in these groups had been matched. A correlated t test was run on this comparison. The data are summarized in Table 5.

TABLE 5: The t Values for Comparisons Between Mean Criterion Test Performances

| | t value | df | p |
|---|---|---|---|
| 1. Laboratory and Control | 2.32 | 49 | .025, one tailed |
| 2. Laboratory and Audio | .51 | 67 | n.s. |
| 3. Laboratory and Classroom | .762 | 73 | n.s. |
| 4. Audio and Control | 2.19 | 67 | .025, one tailed |
| 5. Classroom and Control | 2.74 | 73 | .005, one tailed |
| 6. Audio and Classroom | .15 | 42 | n.s. |

A t test was also run on the criterion test scores of those subjects with I.Q.'s of 95 plus between the Laboratory and Control groups. The resulting t was 2.29 with 24 d.f., and was significant at the .05 level, one tailed.

## Criterion Test Components

Figure 1 presents a frequency diagram of the criterion test scores of the Control and Laboratory groups. Although the ranges of scores for these two groups are almost identical, the Control group scores extend down twenty points below the Laboratory group scores. And, the scores from the Laboratory subjects extend upward twenty points above those of the Control group.

To make a finer analysis of criterion test scores, the content of the criterion tests was analyzed. This content analysis should lead to statements concerning which items on the test contributed to the overall significant difference. The criterion test was broken down into three major components. These components consist of items on the three topics taught in the unit. the Frequency Table, the Mode, and the Median. The Frequency Table items represent 32.5 points on the criterion test, the items on the Mode make up another 32.5 points, and the items on the Median account for 34.5 points.

In an attempt to account for the significant difference between the criterion test performances of the Control and the Laboratory experimental groups, test scores were broken down into measures of the three components. Table 6 presents scores based on the percent of errors on all items related to each conceptual component. These scores are presented for both the Control and the Laboratory groups.

TABLE 6. Percent of errors on the criterion test items measuring the concepts of the Median, the Mode, and the Frequency Table for the Control and the Laboratory groups.

| ITEMS | GROUP | |
|---|---|---|
| | Laboratory | Control |
| Median | 46.96% | 56.00% |
| Mode | 25.22% | 27.65% |
| Frequency Table | 19.20% | 25.94% |

On each category of test items, the Control group has a higher percent of errors than the Laboratory group. For both the Control and Laboratory groups, the items on the Frequency Table yielded the least percent of errors while the items on the Median led to the highest error scores.

A further breakdown was made on these data by dividing the subjects in both groups on the basis of I.Q. This division was made at I.Q. 90. Table 7 presents these data. The scores are mean correct performances by group on the items related to the three conceptual categories of the criterion test.

TABLE 7: Mean correct responses on criterion test items measuring the concepts of the Median, the Mode, and the Frequency Table by I.Q. for the Control and Laboratory groups.

| | GROUP | | |
|---|---|---|---|
| | Laboratory | Control | |
| I.Q. 90-109 | | | |
| Median | 16.17 | 13.24 | P .05 |
| Frequency Table | 30.71 | 27.06 | .05 |
| Mode | 19.50 | 18.47 | n.s. |
| I.Q. 80-90 | | | |
| Median | 11.66 | 9.76 | n.s. |
| Frequency Table | 26.97 | 25.15 | n.s. |
| Mode | 16.19 | 15.50 | n.s. |

Between the Laboratory and Control groups t tests were run to test the mean difference on each criterion test component by I.Q. group. The only significant differences were for the higher I.Q. subjects (I.Q. 90 plus) on the items measuring the concepts of the Median and the Frequency Table. The rest of the comparisons yielded nonsignificant t's.

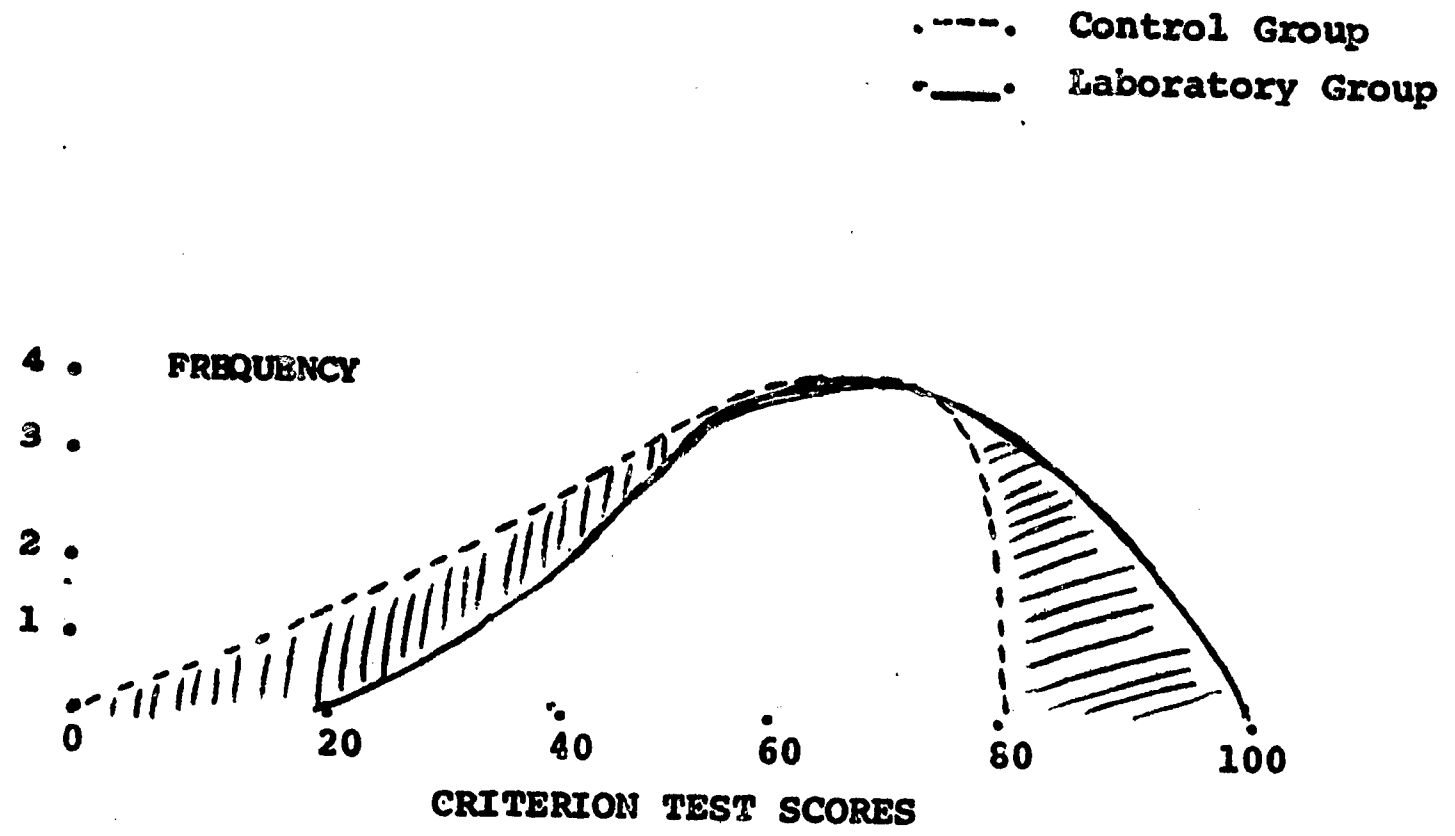



FIGURE 1: Frequency diagram of criterion test scores for the Control and Laboratory Groups.

## DISCUSSION

The significant differences between mean criterion test scores for the Control and Experimental groups support the hypothesis that tutorial revision of instructional material will produce a more effective teaching tool than will workshop revision. There were no significant differences between the mean criterion test performances of the three experimental groups. The method of presentation of the tutorially revised material -- printed format vs. audio format, laboratory setting vs. classroom -- did not affect criterion test performance. The material taught as effectively in all three experimental group situations.

Considering the level of the scores in the Control and Experimental groups, the workshop revision of the material used to instruct the Control group yielded scores no higher than 79.5. The tutorial revision, however, led to scores as high as 98.5. There was a similar difference on the lower end of the scale with the Control material yielding scores as low as 12.5, while the lowest score in the Laboratory group was 32.5. Not only was the workshop revised material a less effective instructional instrument when considering the mean scores, also it never led to scores which would ordinarily receive a good grade in a classroom. Only the tutorially revised material yielded scores that could be graded as either A, or B.

From the data on the components of the criterion test, it can be seen that the Median was the most difficult topic for either group. The Mode was the second most difficult topic, and the Frequency Table was the easiest. Whether these error scores represent a measure of the basic conceptual difficulty of the three topics, or whether they merely reflect the ease with which either of the materials taught the topics is a moot point.

When the Experimental and Control groups were broken into high I.Q. (90 plus) and low I.Q. (80-90) subjects, there was no clear pattern of relationship between IQ level and the relative effectiveness of the tutorially-revised versus the workshop-revised materials. While two significant differences between the two kinds of materials appeared in the high IQ group, all differences for both groups were in the same direction and of similar magnitude.

There is no basis for concluding any correlation between teaching effectiveness of materials and level of IQ. This result encourages the belief that the tutorial revision process produces study materials yielding test performances which are not correlated with IQ level and which may even tend to compensate for measured differences in IQ.

While not reflected in the test data, the subjective experiences of the tutorial staff and the teachers from Simon Gratz were of considerable value in the growth of both young and old staff members. Asked to comment upon the value of their experiences during the pilot project, the teachers and their student consultants expressed enthusiasm for the tutorial procedure of analyzing and revising text materials. The study gave them a critical awareness of the need to analyze student learning problems through face-to-face interaction and for subsequent tailoring of the learning experiences. The following are candid comments from the various staff members elucidating the advantages gained from participation in the study.

> from a teacher: "That which I formerly considered beneath my attention is now particularly stressed. I no longer leave out bits of information the student should have had. I make sure he gets it now, even if it has been part of the curriculum for the last six or eight years."
>
> from a teacher: "The unit which I worked on became entirely new to me as I dissected it and evaluated its parts. By this process, I feel I can understand the difficulties and problems the slower student might encounter when embarking upon an assignment."
>
> from a teacher: "I am far more critical now of the material taught, how it should be taught, and how much is absorbed by the student."
>
> from a student workshop consultant. "From merely working on revision and seeing the results of comprehensive revision, I feel that I can analyze a concept and present varied techniques on a basic level, consequently bringing about a fruitful relationship between student and teacher."

from a student workshop consultant: "After my experience in the compilation of a unit on manipulative skills, I began to realize how misunderstandings could develop because, in part, real communication is lacking."

The approach hypothesized as most productive of a meaningful learning experience for deprived area students was apparently a learning experience for staff as well.

## RECOMMENDATIONS FOR SUBSEQUENT RESEARCH

From the analysis of the concepts measured by the criterion test, it can be seen that the intergroup differences in student achievement are due to the unequal teaching effectiveness of the workshop and the tutorially revised material covering the topics of the Median and the Frequency Table. The fact that the material covering the Mode did not give rise to a significant difference (although it gave rise to an apparent difference in the same direction) is difficult to interpret without further observation; one possible explanation is that the tutorially revised material on the Mode should have been carried through additional iterations to come up to the quality of the other tutorial material. Tutorial revision was stopped as soon as the students could respond correctly to the diagnostic questions built into the text, whereas the ultimate comparison between materials was made on the basis of criterion test items, where a longer period of retention is a factor. If the tutorial sessions had been continued until a criterion of retention (rather than immediate comprehension) was reached, the tutorially-revised material would undoubtedly have been even more effective.

Recommendation 1. In future, statistical comparisons should be made of test performances between one revision and the next on a group of students not previously used for the research. The results should indicate the statistical reliability of observed changes and will result in a better basis for determining when a sufficiently effective text has been produced.

Recommendation 2. When tutoring the subjects whose behavior was used as a basis for revising the text material, it was

discovered that they were extremely reluctant to verbalize any learning difficulties they encountered. It was necessary to have the students read the material aloud in order to make their reading difficulties obvious, and to build diagnostic questions into the text to constantly check on their comprehension of the material. The one-to-one tutorial session is extremely foreign to the students and calls for a level of responsiveness that they have never experienced before. It is likely that in ordinary classroom situations, any spontaneous expression from the students, whether relevant to the learning situation or not, has been seriously discouraged. In subsequent studies, it is recommended that the tutorial sessions be conducted with two or three students at a time to reinforce and encourage each other. Another procedure to be tested, involves having the students individually tape record their reactions to the material. With some encouragement and privacy, the students may be able to critique the material and their insights can be analyzed and used in the next successive revision.

Recommendation 3. For the final tutorial revision, an answer booklet was prepared that gives correct responses to every question included in the material. It was observed during the actual experimental run of the tutorial material, that the students would quite often merely copy the answers onto their copy of the text. Although the immediate feedback resultant from having the answer booklet is deemed important, a better procedure would be to break the unit into sections and hand out the answers at the end of each section. This procedure would force the students to respond, and still provide them with feedback. The feedback would be delayed but probably not long enough to cause any significant difference between the techniques.

Recommendation 4. All tutorial sessions in all subject areas should be subjected to a standard procedural routine that includes observation, recording, classification, and indexing of the interactions among tutor, text, and student. But, in subsequent studies it is recommended that in each subject area, a classification system should be developed that is intrinsic to that area. Learning problems experienced by the student must be classified in categories directly related to the text material. For example, the system growing out of the mathematics text material will, of course, be quite different from that growing out of the English material, and so on.

Each category of learning problems arising from the textual material must have one or more referents in the literal record of the student's interaction with the material. A category entitled for example, "confusion of median with mode" should be keyed to actual occurrences of such confusion in the learning sessions. A complete system would be keyed to all such occurrences.

Recommendation 5. A quite different classification system should be developed out of the behavior of the student that can be specified without necessary reference to the textual material. Both "student expresses discouragement" and "student gives wrong answer" are categories that are common to all subject areas. This response classification system would tend to cut across the subject matter areas pretty generally and would add unique and indispensable information.

Like the text-problem classification system, the response or behavioral classification system would be keyed to actual occurrences in the literal record of the tutorial sessions.

The keying and cross-referencing of both systems together would result in a comprehensive index that would make all the information immediately accessible and all the interactions among

events in the system subject to analysis. A crucial step in building the general index would be the development of a code for each category that would allow direct input from the entire system, or data bank, to a computer. Only by electronic data processing can full and practical use be made of such an extensive bank of data as results from the procedures described.

Recommendation 6. The data bank should be used, when reasonably complete for any one subject area, for two distinct purposes: 1) general research, and 2) instruction of teachers. The second purpose could be accomplished by using the data bank as the basis for a simulated teaching situation, where typical problems of learners and successful handling of those problems by teachers would be displayed in a program responsive to the teaching behavior of the student teacher. Only an extensive and empirical data bank can support such a simulation approach.

## APPENDIX A: Sample Observations of Tutorial Session

Subject--B. McL.
Fifteenth Revision
2 & 3 November, 1965

| No. | Test Reference | Area of Difficulty | Student Behavior |
|---|---|---|---|
| 1. | paragraph A4 | finding a mode in a list | "I don't understand" |
| 2. | " | " " " | Gives verbal definition of mode rather than number. |
| 3. | paragraph B1 | finding a median in a list | has difficulty deciding which number is in the middle of the list. |
| 4. | paragraph C6 | counting number of circles in a line | hesitates over instructions. |
| 5. | paragraph D6 | definition of median and mode | reads material too fast without any comprehension |
| 6. | paragraph F1 | "1/2 of 4 is ____" | can't answer |
| 7. | paragraph H1 | inventing a median in an even numbered list | confused over procedure |
| 8. | paragraph L1 | demonstration of crossing out and tallying procedure in making a frequency table | confused over crossed out numbers in list of data. |
| 9. | paragraph L | filling in a frequency table according to directions | no need to read directions, can do it without them |
| 10. | paragraph M | " " " | " " " |
| 11. | teacher question following paragraph M6 | "what is the mode" | starts to find the median. |
| 12. | paragraph N3 | titling a frequency table | can't fill in title of middle column ("tally marks") |
| 13. | paragraph O | titling a frequency table | titles a "Table of Weights" as a "Table of Ages" |
| 14. | paragraph P | making a frequency table from supplied data | slow about titling; forgets "Table |

| No. | Test Reference | Area of Difficulty | Student Behavior |
|---|---|---|---|
| 15. | paragraph Q | frequency table of heights | unfamiliar with notation for inches (") and feet ('). |
| 16. | paragraph K1 | frequency table with instructions at side next to frequency column | stumbles reading. |
| 17. | paragraph R | "how many distances are there in the table", finding total to frequency column | responds with the number of categories of distances. |
| 18. | paragraph R6 | finding median in frequency table | identifies middle tally mark as median rather than middle item. |
| 19. | paragraph T | finding mode in table | wrong answer. |
| 20. | paragraph T1 | dividing total number of frequencies by 2 | divides wrong |
| 21 | paragraph U2 | dividing total number of frequencies by 2 and finding middle tally mark | no blanks for responses in text so confused. |
| 22. | paragraph U3 | finding median in frequency table | identifies middle tally mark as median rather than middle item. |
| 23. | paragraph V2 | " " " | " " |
| 24. | paragraph X | " " " | " " |
| 25. | paragraph Y2 | "If both middle tallys are on the same line the median must be the number on that line to the _____(left, right)" | confused over format. |

APPENDIX B· Original Text Presentation of the Topic "The Mode and Two Subsequent Examples from Revisions 13 and 23.

## I. Original Text Presentation

### Definition of Mode

"The MODE is the most frequently occurring number in a group of numbers. For example, the mode of 93, 92, 93, 90, and 75 is 93. To find the mode easily, arrange the statistical data (numbers) in a frequency table.

## II. Text for 13th Revision

### Definition of Mode

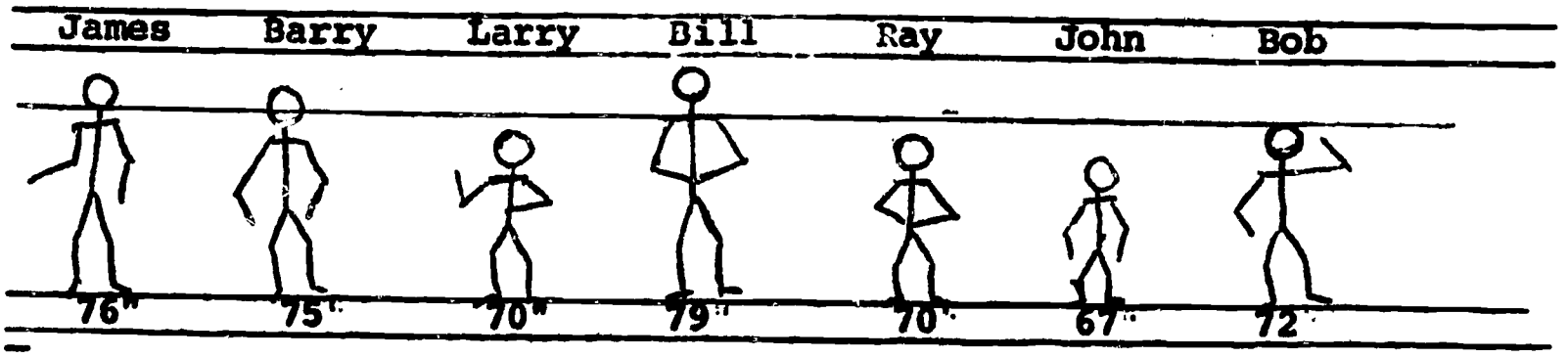
Here are some numbers:

3, 4, 4, 4, 6, 8, 9, 9, 11

The number 4 happens MOre times than any other score.
It is called the MODE.
Here are some words to help you remember: MOre = MODE
In the example above, the MODE is _____.

23rd Revision

Here are some stick men.

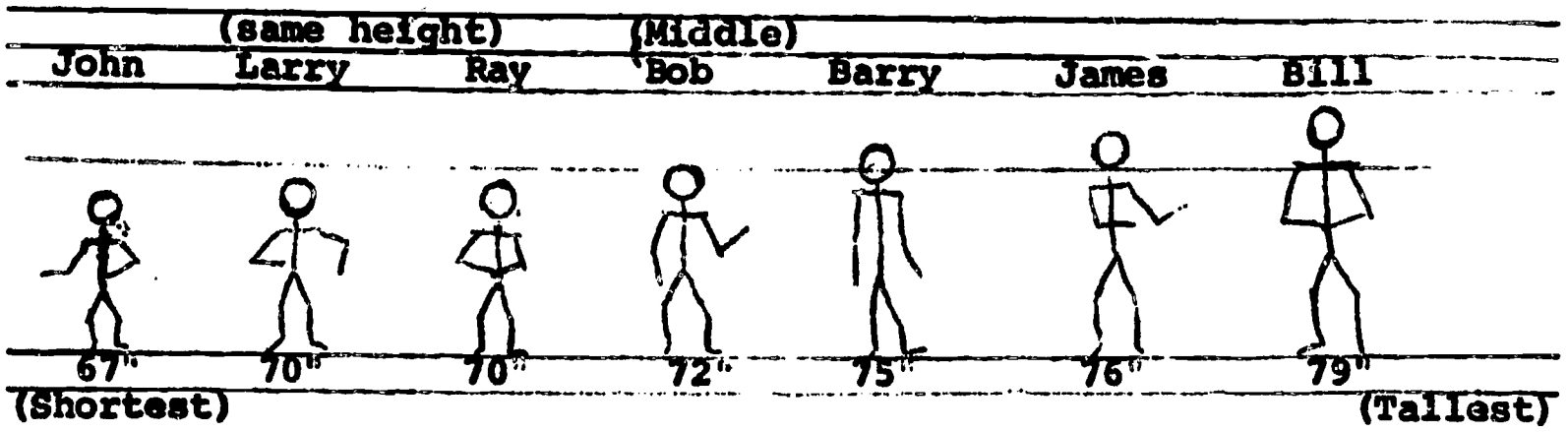



If we wanted to describe this group of men, what could we say about them? Not very much the way they look now, so let's line them up from shortest to tallest.

We find the smallest one: John (67 inches tall)
And the biggest one: Bill (79 inches tall)

Now we can say something about the group. They are all either taller than John or shorter than Bill.

What else could we say? If we put them all in order from smallest to tallest, we could say much more.




Here are some very simple things we can now use to describe our group of stick men:

1. There are seven of them.
2. They are all between the heights of 67 to 79 inches.
3. Larry and Ray are the same height. In Statistics we call their height (70 inches) the MODE. It is the most common or popular thing in a group.

## APPENDIX B-1: Outline of Text Treatment as Taken from the Examples shown

### I. Original Text

six exercises finding a mode in a frequency table

two thought problems relating to the definition of the mode

one question about the method of calculating the mode

i.e., nine exercises all together

### II. 13th Revision

two exercises finding mode in an ordered list

two exercises finding the mode in an unordered list

eleven exercises finding the mode in a frequency table

i.e., fifteen exercises all together

three re-definitions of mode

### III. 23rd Revision

five exercises finding mode in ordered list

eight exercises finding mode in unordered list

twelve exercises finding mode in frequency table

i.e., twenty-five exercises involving mode

six re-definitions of mode

# APPENDIX C

## GENERAL EDUCATIONAL OBJECTIVES

## OF THE FIVE BASIC SUBJECT AREAS

I. READING UNIT

To be able to read and understand trade publications, manuals, job sheets, want ads and newspapers.

To be able to expand vocabularies, especially by using contextual clues to learn the definition of new words.

To be able to locate personal and business listings in telephone directories.

To be able to find places in the city on a map and to determine the best routes for reaching these places.

To be able to extract essential information from catalogs, reference books, container labels and job specifications.

II. MATHEMATICS UNIT

Teach students addition, subtraction, multiplication and division of whole numbers with respect to the number line.

Teach students the meaning of a fraction, and how to perform the fundamental operation of fractions.

Teach students the meaning of mixed numbers and their relations to fractions.

To develop an understanding of arithmetical and mathematical principles and processes.

To extend and strengthen the student's vocabulary of arithmetical and mathematical terms.

III. SPEECH UNIT

To teach the students to articulate words clearly.

To teach students to speak in sentence form.

To teach students to differentiate between casual and formal spoken english.

To teach students to hold sequential conversations.

To teach students how to use a telephone effectively and how to behave at a job interview.

## IV. WRITING UNIT

To be able to revise paragraphs through the use of coded materials including:

Dictionary Skills
Grammar

To be able to identify and write topic and clincher sentences.

To be able to use connectives in writing.

To be able to write descriptive, narrative, and expository paragraphs.

To be able to complete job application forms, questionnaires and job reports in an acceptable manner.

## V. MANIPULATIVE SKILLS UNIT

To develop the basic skills and knowledge required for the use of measuring instruments.

To learn how to make effective drawings and to read blueprints.

To become familiar with techniques of assembling materials from printed and oral instructions.

To be able to identify and analyze basic types of machines.

To be able to construct models from written specifications and blueprints.

# MANIPULATIVE SKILLS

## JOB #2

START READING HERE.
READ EVERYTHING IN ORDER.
DO NOT SKIP ANYTHING.
DO THE THINGS ASKED OF YOU.
BE SURE YOU HAVE AN INFORMATION BOOKLET.

1. In front of you there should be:

   a. A measuring board
   b. A set of measuring blocks in a white box
   c. A set of red, white, and blue colored blocks with a letter followed by a dash and a number on each one of them. (B-1)

Look in your information booklet.

Find the pictures of each of the above and read the valuable information which should help you do this job.

GO ON TO THE NEXT PAGE

2. Answer the questions below in order to get ready for Job # 2.

Put your answers in the space below each question.

First check your red, white and blue colored blocks.

a. How many do you have?

ANSWER

b. Each colored block has a letter and a number on it: (like B-1)

What is the color of the side of the block which has this letter and number on it?

ANSWER

c. Now draw that mark which looks like a letter.

You can see it on every side of every block.

ANSWER

Next check your measuring blocks in the white box.

d. What is the color of the metal measuring blocks marked "1/16"?

ANSWER

e. How many of those metal measuring blocks marked "1/16" do you have?

ANSWER

GO ON TO THE NEXT PAGE

f. How many one-inch measuring blocks marked "1" do you have?

ANSWER

g. How many two-inch measuring blocks marked "2" do you have?

ANSWER

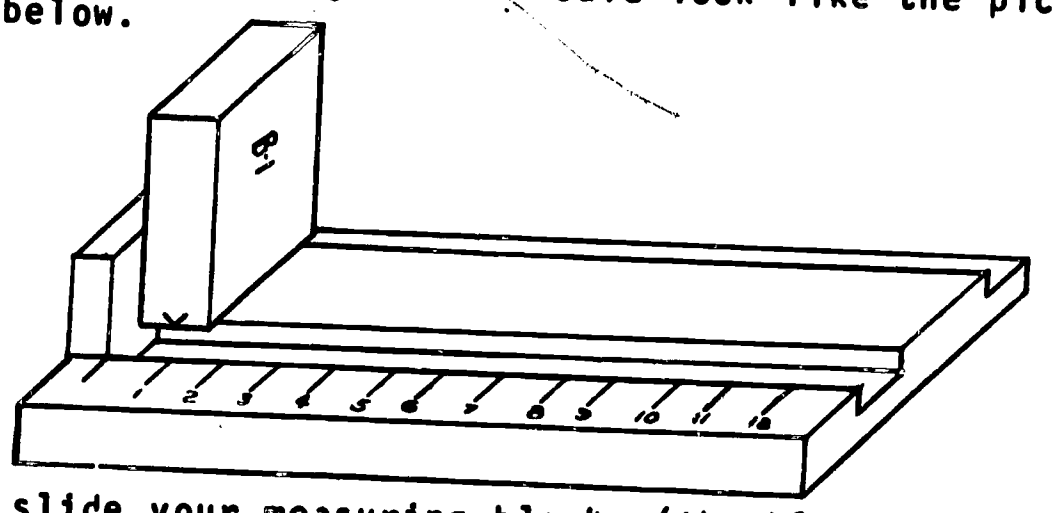
h. How many three-inch measuring blocks marked "3" do you have?

ANSWER

NOW YOU SHOULD BE READY TO DO JOB #2

3. Place colored block B-1 on your measuring board.
   Have red side facing you.
   The little arrow should be facing down. (V)
   Be sure that a little part of the colored block hangs over the slot.

   Now your measuring board should look like the picture below.




4. Now slide your measuring blocks (the blocks in the white box) into the slot.

USE ONLY THE MEASURING BLOCKS MARKED WITH A "3", "2", "1", AND "1/16".

GO ON TO THE NEXT PAGE

5. Keep sliding in the measuring blocks into the slot until the lenght of the measuring blocks is the same as the red side.

   Use your fingertips to feel if they are even.

6. Add up the whole numbers on the tops of the blocks.

   This is the number of whole inches.

7. Then count up the number of the gold colored metal pieces and put this number on top of the number 16. $\frac{\text{(number)}}{16}$

   This is the number of sixteenths.

8. Put both these numbers together.

   This is the length of the side in whole numbers and sixteenths.

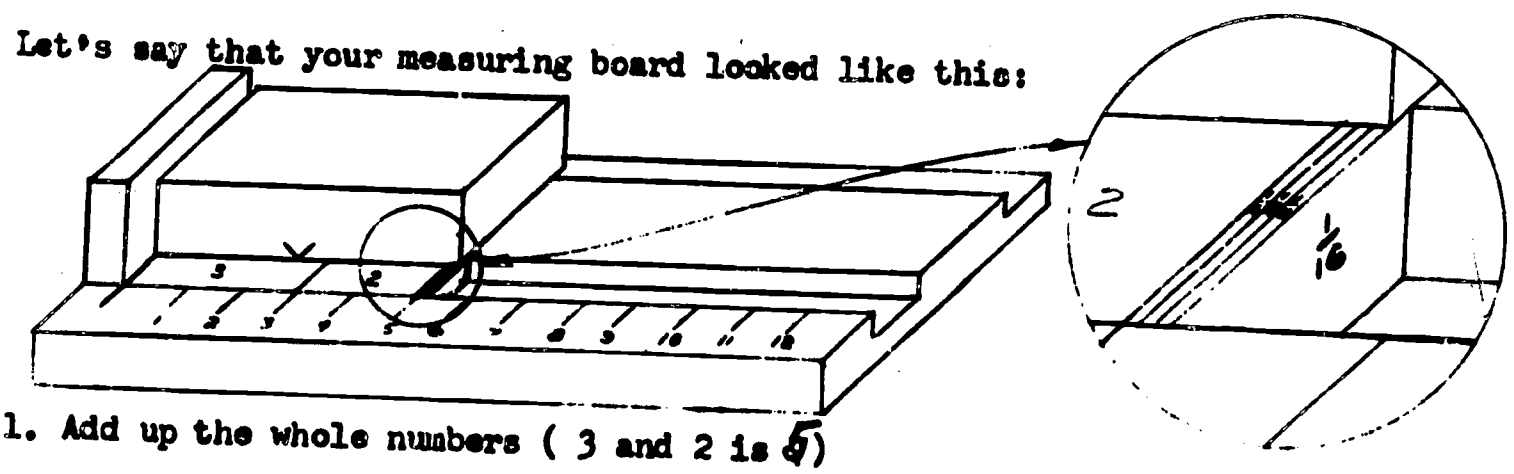
9. Put this number on the chart found on page #13.

   Put this in the right space on that chart.

IF THE ABOVE IS **NOT** CLEAR FOLLOW THE EXAMPLE GIVEN BELOW.
IF THE ABOVE IS CLEAR SKIP THE EXAMPLE AND GO DIRECTLY TO STEP # 10.

EXAMPLE

Let's say that your measuring board looked like this:




1. Add up the whole numbers ( 3 and 2 is 5)

2. Count the number of gold colored metal pieces ( which here is 3). Put this number over 16 ( which would be 3/16)

GO ON TO NEXT PAGE

3. Put these two number (7 and 5/16) together and you should have 7 5/16.

This is the end of the example.

10. Do the smae thing to the white and blue sides of block B - 1.

    Don't forget to use only the measuring blocks marked "1", "2", "3" and "1/16".

11. Put these answers on the chart found on page #13.

12. Now do the same thing to the red, white and blue sides of blocks B-2, B-3, B-4, B-5, B-6, B-7, and B-8.

13. Put these answers on the chart found on page #13.

14. When all the empty spaces on your chart have been filled in as best you can, do these things:

    a.) Replace all the measuring blocks back into the white box.

    b.) Be sure that all the measuring blocks are there. Tell your teacher if any are missing.

    c.) Collect and stack all the red, white and blue colored blocks.

YOU HAVE NOW COMPLETED JOB #2. TELL YOUR TEACHER YOU ARE FINISHED.

| BLOCK LETTER AND NUMBER | RED SIDE | WHITE SIDE | BLUE SIDE |
|---|---|---|---|
| B-1 | | | |
| B-2 | | | |
| B-3 | | | |
| B-4 | | | |
| B-5 | | | |
| B-6 | | | |
| B-7 | | | |
| B-8 | | | |

## APPENDIX D: Learning Difficulties Associated with the Operation of Making a Frequency Table and with the Concept of the Mode

**Operation:** Making a Frequency Table

**Learning Difficulties:**

1. Titling the table:
   - a. forgets column titles
   - b. forgets title to whole table
   - c. incorrectly titles columns and whole table
2. Filling in the item column:
   - a. doesn't table items of category in order of increasing magnitude
   - b. missed one item category
   - c. left out item column entirely
   - d. puts all items in column rather than item categories
3. Tally mark column
   - a. doesn't tally each item
   - b. tallies items randomly rather than counting them
   - c. not crossing out items as tallying
   - d. left out tally mark column entirely
   - e. tallies one category twice
   - f. puts tallies in wrong column
   - g. puts numbers in columns rather than tally marks
   - h. makes tallies correspond to items rather than to frequencies
   - i. crossing out item categories in table rather than list as tallying
   - j. crossing out items as filling in item column rather than in tally mark column
4. Frequency column
   - a. doesn't table frequencies instead numbers each line
   - b. left out frequency column
   - c. put frequencies in wrong column
   - d. added total of frequencies incorrectly

5. Data:
   a. doesn't put data in discrete categories for tabling
   b. sets up titles but doesn't fill in data
6. Format:
   a. sets table up vertically rather than horizontally

Concept: The Mode

Learning Difficulties:

1. Confuse Mode with the total of the frequencies.
2. Confuse Mode with the frequency that occurs most often.
3. Confuse Mode with the highest frequency.
4. Confuse Mode with the highest item category.
5. Confuse Mode with the median.