SLIDE-AUDIO VS SLIDE-BOOKLET MEDIA FOR TEACHING SOLDERING TECHNIQUES

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INTRODUCTION

Present day educational and training technology has not been able to keep up with innovations in technology and growing industrial needs. The problems of training and retraining have been increasing with the increasing needs of people, and increasing new skills required to produce new and varied products. A statistical over view in 1962 for the emerging needs of job training in America reveals:

1. In the next decade and a half the labor force will increase by 34%. This is a greater increase than in any other 15 year period in U.S. history.
2. With a total labor force increase of 34%, the number of white collar jobs will increase by 57% and the number of blue collar workers by 25%. In the blue collar worker group, the largest relative growth will occur in the skilled worker category: from 3 to 11.5 millions (Margulies and Eigen, 1962).
3. There will be a total requirement of 650,000 scientists and two million engineers in 1975. This will require a very rapid rise in the supporting technicians, such as engineering aides, electronic specialists and other skilled labor.
4. In the craftsman's group, 2.5 million additional individuals will be needed because of the total national growth and 5.5 millions for replacements for a total of 8.0 million to be trained.
5. In the sales worker group, a two million increase over the four million individuals employed in 1957 will take place.
6. The number of clerical personnel will increase from 7.2 million to 13.7 million despite advances in automation.

There will also be a decrease in the number of male workers between the 25 and 44 age groups. This intensifies the total training problem since this age bracket supplies a large portion of the foremen, highly skilled workers, middle management personnel and technicians. The workers outside of the bracket will have to be trained and retrained for a greater proportion of these important jobs.

Commenting on Federal depressed areas bill in a statement to the House Committee on Labor and Education, HEW Secretary Ribicoff said:

> . . . technological change, innovation, automation and industrial mobility displace many people wanting to work and who are physically and mentally able to work and who cannot work because they lack the knowledge and skills which they need. Moreover, it appears that these changes . . . will increase at a much more rapid rate than they have in the past. . . . We must shift towards more training for technicians, distribution sales, personal and community services, and other areas required by our national man-power needs. . . .
>
> Of the five million unemployed, about one third are under age 22 and half of these haven't held a job since leaving the high school. Most are unskilled.
>
> The older workers constitute a special need for training and retraining. . . .

This increased need for training and instructing workers has brought new interest into the learning process, and out of this rigorous search for new training and instruction technology has emerged the concept of "programmed learning" and "programmed instruction" methods with its vast potentialities, too promising to be ignored.

Two training trends in training needs seem to call for the examination of programmed instruction—defined as "any form of pre-prepared presequenced instruction directed towards an educational or training objective."

The first trend is that towards higher and more complex human skills, and this leads to the second trend in which we will find a rising proportion of training assignments involving a single individual or at most a very limited number (Lysaught, 1962).

Experience over the last few years shows that time spent in exploring industrial applications of programmed learning was well spent. The programmed learning was found to be more effective, efficient and economical than conventional training techniques. Initial efforts have unearthed a good volume of theoretical knowledge, but the actual number of developed learning programs are small; most of those which were available were essentially for non-industrial subjects. Keluche (1963) points out that studies show 80% of the industrial skills can be programmed. Lysaught (1962) states that there are few industrial training programs compared to the rapidly growing demands of industry for skilled labor and the industrial skills that can be programmed.

O'Donnell (1964) suggested that these training programs should be written in a way that the learner could respond correctly 95 percent of the time; he says being right is the prime necessity that keeps the trainee proceeding through the program. He also states that programs will have to be simple and easy to understand since in any industrial situation workers vary widely in age, aptitude, formal education, and prior experience.

Training programs in order to be effective should also make use of the best medium of presentation or combination of media. Dickey and Konz (1967) investigated the constraints on various media used in communicating manufacturing assembly instructions and stressed the importance of the communication medium:

> . . . the decisions as to which communication medium to use is probably more important than the decision as to whether one or two hands are used or whether the distance moved is eight or eighteen inches.

Hence research for simple, inexpensive, and efficient media which offer versatility, standardization, and economy is as equally important as developing effective programs.

There has been a rather active research program concerning communication of work methods under the guidance of Konz at Kansas State University. From approximately 15 separate experiments it was established that instructional pictures were the best medium for short simple programs. The previous investigations in university laboratories also demonstrated that audio supplementation of words added little to good visual presentation for short simple training programs. But supplementation of words to pictures may be desirable for larger complex industrial training programs. The question left unanswered was "Should the supplemental words be spoken or printed?" The purpose of this research project, then, was to experimentally evaluate two media for teaching "Soldering Techniques" to industrial employees, and also to gather information to support the hypothesis that the slide-booklet medium with printed supplementation of words is better, less expensive and simpler than the slide-audio medium with spoken supplementation.

REVIEW OF LITERATURE

History of Programmed Instruction

Programmed instruction has tenuous links with the ancient Greeks (Socratic method), the Russian physiologist, Pavlov, and the American psychologist, Edward L. Thorndike. Pavlov studied the reflex in dogs; Thorndike's "Law of Effects" on humans states that the connection between a situation and a behavior is strengthened only if some success of satisfaction follows the response.

In 1926, Sydney L. Pressey, an Ohio State University psychologist, made public his pioneering studies on the first recognized teaching machine. His machine was designed to incorporate the known principles of the learning process into a mechanical device which would do some of a teacher's routine work and give the teacher added time to concentrate upon the more creative aspects of his work. This machine could be used for testing the student by means of multiple-choice questions. Pressey's program, essentially a linear program, passed through the material in a single unbroken sequence of steps. The multiple-choice program was developed by Pressey using the principle of "Response, Recognition, and Selection." In this type of program, a selection had to be made by the subject by recognizing the correct answer among several given answers.

In 1954, B. F. Skinner, a Harvard psychologist, proposed a method of programming which employed the principle of "Response, Recall, and Construction." The program consisted of short steps, which were considered essential for correct recall of response or answer. Then the subject composed or constructed his own answer by filling-in-the-blank with the missing word in the question frame.

Terminology Used in Programmed Instruction

Programmed Instruction: Any form of prepared, pre-sequenced instruction directed towards a specific educational or training objective.

Frame: A single instructional item, including information material, question, and answer. Frames are, generally speaking, the constituent elements in programming.

Stimulus: The small amount of information given to the trainee.

Response: The answer or performance given by the trainee.

Linear Program: In this type of program, the student passes through the same fixed sequence of frames. The sequence is determined by the program writer.

Branching Program: Each trainee or student determines his sequence of frames by his responses to the multiple-choice questions contained in the frames. This type of program usually has parallel tracks onto which the student can move for supplementary teaching.

Cues or Prompts: Aids that are incorporated in some frames to help the learner to respond correctly, e.g., prompting of initial letters of the missing word.

Reinforcement: To tell a student that his answer is correct is reinforcement. The immediate information to the student of the correctness or incorrectness of his answer was stated by Lysaught and Williams (1963, p. 18) as an advantage of programmed instruction since reinforcement or extinction, as the case may be, is more effective when feed-back of the correctness of the response is more rapid.

Reinforcement was defined by Deterline (1962, p. 27) as the "occurrence of a consequence which strengthens the behavior that produced that consequence, that is, the occurrence of an event which increases the probability that the same response will occur again in the presence of the same stimuli." He described extinction as the "weakening of a response" caused by the lack of reinforcement for a response. Extinction weakens the relationship between stimulus and response.

Characteristics of Programmed Instruction

1. Small steps: The material to be learned is presented in optimally sized increments. By this, Cook and Mechner (1962, p. 14) explained, the increment of difficulty between any two steps should be narrow for mastery to be possible and the sequence should be arranged to enable mastery of each step by the learner without referring back to the earlier material or looking ahead to further instructions.
2. Active participation: The student or trainee is made to interact with the program. With each small step a response is required of the student. In some programs the student cannot continue until he has made the correct response.
3. Immediate knowledge of results: As soon as the student has made a response, immediate information of the correctness or incorrectness of his response is given. If he is incorrect, he is told that he was wrong. On the other hand he is rewarded when he is told that he was correct. This is reinforcement. Reinforcement increases the probability of making the same response.
4. Self pacing: Since each student has his own copy of the program, his

rate of progress is determined by the speed at which he works through the program. A subject is not forced to wait for those slower than himself, nor is he left standing by those more apt.

5. Errors are the fault of the program. This may be the most important characteristic. If the student can't respond correctly, then the program should be rewritten. There are no stupid students--just poor programmers.

Media of Presentation

Programs can be presented through different media. Common among these are audio-visual equipment, teaching machines, printed devices, and pseudo-programmed instruction systems. Considerable research has been done to determine efficiencies of these different media in industry. The description of these various media and studies made on them are summarized herewith.

I. Audio-visual equipment:

Since most of the audio-visual aids are response or stimulus devices, the programmed principle was applied in the development of audio-visual systems which could aid in training. Audio-visual systems make use of the two most important learning senses, sight and sound, thus bridging the communication gap. The audio-visual equipment thus makes the best use of inherent human perception qualities.

The flexibility in display and presentation with audio-visual equipment has led to many applications of this equipment in industry such as new employee orientation, employee training, office systems and procedures, preparation for operation, manufacturing, inspection, testing and check out, instrument calibration, operating procedures, maintenance and troubleshooting.

The varied applications and the encouraging results in the past with audio-visual equipment have led to the designing of new audio-visual systems with various trade names such as Production Guidance System of LaBelle Industries, Audio-Visual Equipment of Northrop Corp., the Graflex Audiographic System of General Precision Corp., and the Videosonic System of Hughes. Considerable research was done in the past to use the audio-visual equipment as a teaching aid in industry and at the university. The findings are summarized below.

Way back in 1936, Williams realized the importance of pictures in teaching industrial subjects. He found that ordinary work instructions required lengthy, often tiresome, description of the jobs that were to be learned. He found it advantageous to use still photographs of the more important elements with concise instruction below the photographs instead of a lot of words. Roshal (1961) compared the efficiency of presenting information through slides and motion pictures for a knot tying task and found motion picture presentation to be better.

Erlick and Hunt (1957) cited as an advantage of audio-instruction that while visual information generally required either shifting of the operator's head orientation or locating the equipment in an already crowded work-place, auditory information can be presented by equipment located in a less critical work area. Goldman and Eisenberg (1963) also found the audio medium to be superior to the visual medium for an on-the-job learning of selecting, bending and positioning of electrical resistors on a terminal board.

Cardozo and Leopold (1963) found that visual instruction resulted in fewer errors than auditory instructions for subjects transcribing letters and numbers.

Studies made in the application of programmed instruction through an audio-visual medium for assembly tasks (Konz, Dickey, McCutchan, and Daniels, 1966) showed a significant decrease in assembly time for workers using 35 mm color slides projected in a Hughes Videosonic unit for their work instructions when compared with conventional typed running lists.

Temsen (1961) reported a study at Hughes Aircraft using audio-visual system (also known as Videosonic Training System) of instruction. The results were very encouraging. Training time was decreased by three weeks, individual productivity was increased up to about 33%, and rejects were cut by at least 60%. The system incorporated both 35 mm slides and step-by-step recorded commentaries.

Middleton and Konz (1965) used slides plus audio commentary to instruct food service employees in two methods of breading foods. The authors believed that audio-visual instructions could help solve the problem of employee training.

Hershfield (1967) believes that audio-visual systems can drastically change personnel training techniques, enabling quicker provisions of skilled help to the industry.

II. Teaching machines:

A teaching machine is a mechanical, electrical, or electronic device that controls the presentation of the program, keeps a record of the student's answers, and provides an immediate feed-back by displaying correct answers.

Stolurow (1961) described the nine characteristic functions of a teaching machine.

1. Presentation function:

The teaching machine may make use of the appropriate communication channels: visual, auditory, tactual, or a combination of media which are best suited to the subject matter information to be taught or learned. The display unit has two inputs and one output. One is the program input, which precedes response, the other is the knowledge of results input, which follows response. The output from the display is received and interpreted by the employee.

The form of the learner's response depends upon the training purpose involved. If the learner is to recognize something, then a type of response unit is needed. The trainee may choose and press a response button among a set of alternative buttons. On the other hand, the trainee may construct his answer from given components like slides, explanations and prompts. The trainee could also compose his answer by using a typewriter keyboard (Rath, Anderson, Brainerd, 1959), a set of sliders (House et al., 1957), or a pencil (Skinner, 1958) or perform some other act.

2. Pacing:

A teaching machine allows for variability in information presentation rate. As the trainees proceed at their own pace, the fast trainee learns faster without being bored and the slow trainee learns without being embarrassed or being left behind.

3. Comparator:

The comparator requirement is implemented by a comparator unit. This unit either automatically analyzes the response by comparing it with the appropriate correct response stored in the machine, or it allows the trainee to make this comparison himself.

4. Knowledge of results or feedback:

A teaching machine communicates to the trainee the correctness or incorrectness of his response.

5. Collator-recorder:

This is the requirement to measure and record the training process. This is done either by a collator or a recorder unit, which collects data about the number of errors, the type of error, and the time intervals required for response.

6. Selector function:

This requirement arises only whenever there are alternatives in the program. The selector unit selects the next frame.

7. Library:

This helps to store the information to be used, as needed by the trainee. The important features of the library are its capacity, access time, and form of medium of storage.

8. Programming function:

A teaching machine programs and arranges frames in sequence, according to a set of rules. The sequence can be entirely pre-determined as in a linear program, or by the learner responses as in the branching programs.

9. Computer:

The computer is a prime requirement for a versatile teaching machine system. It allows for a more complete adaptation of the teaching machine to the trainee.

Types of Machines

At present there are over 100 new teaching machines under development and in use. Stolurow (1961) classified these teaching machines into three types based on the notion of adaptability as the differentiating concept: (1) Minimally Adaptive Machines, (2) Partially Adaptive Machines, (3) Adaptive Machines.

1. Minimally Adaptive Machines:

A simple example of a minimally adaptive teaching machine is a deck of flash-cards with stimulus or cue material on one side and associated response material on the other. A few other examples are the memory drum of McGeoch and Irian (1952), and Bessnard et al.'s (1955) subject matter trainer.

2. Partially Adaptive Machines:

Most of these machines are made up of hardware or printed material. They are built to measure recognition and require a multiple-choice response. The chemo-card is a very simple device which is representative of this category. The student makes his choice with a damp stylus. The paper is so treated that the mark turns into one color if his choice is correct and another color if incorrect.

In contrast to the previous citation, there is another type of device which is in the textbook form, which is commonly used for presenting programs. The programmed textbook of Stolurow and Bergum (1958), and Homme and Glaser (1959) is composed of an information page and an immediately following answer page. The information-question page contained the information, explanation of concepts to be taught, question, and enough space for the learner to record his response. The punch-board device of Pressey, tab-system of Damrin and Saupe (1954), Skinner's Disc machine (1958), and Autotutor built by Western-Design are some of the examples under this category.

3. Adaptive Teaching Machines:

This teaching machine allows for changes in the teaching method without requiring the building of a new machine. The design characteristics of the machine are determined by the computer, the typewriter input, the program, and a visual output. The program adjusts to the trainee's capability by presenting a problem of particular level of difficulty dependent on the errors the student has made. The International Business Machines (general-purpose) digital computer used by Rath, Anderson and Brainerd (1958), and the teaching machines designed by Pask (1957-59) are examples of this category.

III. Pseudo-programmed instruction media:

These media are good only for specific applications and often require specific engineering in the mechanical and psychological senses. Many pseudo-programmed instruction systems such as the key-board trainer, production line trainer and troubleshooting trainer have been developed to teach various key-board skills, industrial production, and for instructional purposes in troubleshooting information.

1. Key-board trainer:

This device was developed for training in manual key-board skills (IBM key-punching). This consisted of three units: a key-board, a display unit, and the control unit. The key-board is identical to the one used on the job. The display unit consisted of rows of lights that indicated the letters or numbers to be key-punched by the trainee. Under these rows is a diagram of the key-board, which is lighted to show the key to be punched in response to the signal in the display unit. As the trainee gradually learns the key-board lights are gradually dimmed, until they finally do not light at all.

This machine is not completely student paced.

2. Production-line trainer:

The objective of this system is to produce work of high quality under controlled conditions. This type of system consists of a small audio-visual unit that presents pictures in the form of projected 35 mm slides with a concomitant audio message presented through the earphones. The machine informs visually and aurally of the production procedure to be carried out. The usual confirmation of correct response or reinforcement is absent. Devices of this type have been manufactured by Hughes Aircraft, the Applied Communication System division of Litton Industries, Graflex, and LaBelle, just to name a few.

3. Troubleshooting trainer:

A type of system used for instructional purpose is known as the "trainer-tester." The trainer-tester technique provides practice in troubleshooting without requiring expensive and possibly unreliable equipment. The "trainer-tester" consists of a printed sheet that may have a paragraph stating the trouble for which repair would be necessary, a list of possible remedies and, next to each possible remedy, an aluminized tissue that has been pressed on top of the paper. The trainee can erase the tissue opposite to any of the possible remedies; when he does, the information is revealed as to whether or not the instrument would operate properly with the particular remedy chosen. The trainer-tester can be used for electronic troubleshooting, engine maintenance and repair and problems of logistic management.

IV. Relative advantages and disadvantages of different modes of program presentation:

Programs can be presented either in a textbook form or through a teaching machine. Several studies were made comparing these two devices. Goldstein and Gotkin (1962) and Eigen et al. (1962) reported no significant difference, except for a saving in time by the trainees with the programmed texts. Goldberg et al. (1964), and Holt and Hammock (1962) studies indicated no such distinct advantage with programmed textbook. Eigen and Komoski (1960), and Roe et al. (1960) found the textbooks as effective as simple teaching machines.

An effort made by Foltz (1962) to bring out the differences between teaching machine and the textbook revealed versatility and infinite patience (machine) as the two advantages of the teaching machine.

Goldstein and Gotkin (1962) and Green (1962) reported that advantages of the textbooks as, convenience of carrying it around, could be read at any time at any place, its compactness, and its flexibility to changes in program.

Lysaught (1962) and Foltz (1962) summarized the disadvantages of programmed textbook as:

It is non-durable, consumes a large volume of paper, needs more storage space, does not keep the learner in a rigid sequence of presentation, and costs are greater since additional materials are needed to provide feed-back to the student.

Continuous progress is being made in the design of teaching machines. The findings, which showed no significant difference between programmed texts and teaching machines now, may not hold true in the future. Goldstein and Gotkin (1962) predicted that machines may prove better than the textbook.

A final choice among the books, machines and other audio-visual media thus depends on the subject matter, economics, personal preferences and administrative convenience.

V. Application of programmed instruction in industry:

Programmed instruction was virtually not in existence in 1960 (Shoemaker and Holt, 1965), but, in 1963, a survey disclosed that some 40 companies of a sample of 273, selected from 500 of the largest corporations of the U.S.A., were producing their own programs. Of these surveyed companies, 43 percent had used or intend to use programmed instruction while the rest (57 percent) had no plans for its use. Finn (1962) lists 132 companies which were producers of programs, writers of programs, manufacturers of hardware, consultants or a combination of these functions.

In the late 1950's and early 1960's various research studies were made on programmed instruction as a training tool in industry. Some typical programs were developed for training technical staff, commercial staff, clerical and secretarial staff, sales and customer service staff, and for teaching manual skills, basic skills and semi-skills to industrial workers. Some of the important companies which initiated these research studies are Dupont, International Business Machines, Bell Telephone Co., Eastman Kodak Co., The American Petroleum Institute Refining Division, General Precision, Western Electric Corporation and many others. In general all these studies sought to compare the program and lecture method of instruction in terms of amount of factual information learned, savings in training time, amount retained, and trainee attitude to the new technique. These findings are in short:

(a) There was a savings in the time needed to learn information. Savings in time of 25 to 30% were reported for the programmed instruction group.

(b) There was no significant difference in the retention of factual information.

(c) Trainees' reaction tended to be favorable. Some trainees disliked the constant page turning and felt that programmed instruction should be interspersed with other training techniques and that discussion periods with an instructor should be provided.

(d) Programmed instruction permitted personalized instruction and freed the training process from time and scheduling problems.

Hughes (1962) commenting on the gratifying results obtained applied programmed instruction in industrial, military and academic training situations said: "In almost every case where it has been used, programmed instruction leads to either a reduction in training time or an increase in the knowledge or skill acquired by students or both."

Cost of Industrial Programs

Programs are costly to produce, in terms of the time taken to determine the content and to write them in appropriate form. Lysaught (1962) feels this cost and investment of time is reasonable when measured against learning effectiveness. In terms of time it may take up to 18 months before a company satisfactorily completes an extensive program. The costs of producing the programs decreases in significance in proportion to the number of users; thus if the subject matter is to be taught to only a limited number of trainees, or if it is likely to be superseded, the cost may not be justified.

If a programmer's total compensation, including fringe benefits average $3.50 per hour, the direct cost of industrial programming will be about 90 cents to $1.20 per frame.

A typical industrial program would run from 2,500-5,000 frames (the equivalent of a 50-100 page, conventionally written manual). The direct cost of writing the program would range from $2,500 to $3,000 for the shorter programs, and from $4,500 to $6,000 for the larger programs. Allowing for 75% overhead, development costs would total $3,950 to $5,250 for 2500 frames and $7,900 to $10,500 for 5000 frames. Testing and rewriting would increase this value by 25-50% (Ross, 1962).

On balance programs produced by a company for its own use might cost $5.00 to $7.50 per frame, whereas those prepared by outside companies or sources may run up to $10 or more per frame.

Savings in Training Cost Due to Programmed Instruction

It is difficult to isolate costs and savings in the industrial training situation. The most common assumption is that programmed instruction somehow will reduce the overhead expenses. Several companies have reported savings in training costs due to Programmed Instruction.

DuPont estimated that reduced instructors and employee training time resulted in a savings of $30 to $50 per employee per course. It has also estimated that it would approximately cost $2000 per course hour to write a program. One plant reported a savings of $35,000 during a six month period covering the use of 586 courses or on the average a savings of $43 per course per student.

The Western Electric Corporation in Kansas City has so far produced programs in the fields of soldering and bonding techniques, and various assembly operations. It has been reported that there was a substantial savings in dollars.

In summary, the question "which is the most effective medium for teaching industrial skills?" does not seem to have been examined through extensive experimentation. The purpose of this research project was then to test the efficiencies of two types of media for teaching soldering techniques. The media compared were: slide-audio and slide-booklet.

METHOD

Task

The task used was the soldering of connections. The employee viewed a "soldering techniques" program which covered the basic information about soldering techniques including:

1. Definition of soldering.
2. Required tools for soldering connections.
3. Temperature conditions in soldering.
4. Precautions to be observed during soldering connections.
5. Various steps in soldering connections.
6. Requirements and appearance of a good soldered connection.
7. Various soldering defects and their appearances.

Apparatus

1. Soldering tools and accessories.
2. Humac teaching machine.
3. 35 mm slide projector.

4. Slide-booklet format.
5. "Soldering Techniques" program.
6. Decimal minute stop-watch.
7. Data sheets.
8. Written-test questionnaire.
9. Opinionnaires.
10. Methods agreement test data sheet.
11. Quality discrimination data sheets.
12. Data questionnaire.

EXPERIMENTAL DESIGN

The media compared were:

A. Slide-audio (Humac teaching machine).

This machine consists of three principle units.

1. Visual portion: The visual portion consists of a 35 mm slide, rear projection unit of Sawyer Rotoshaw type with a Sawyer slide projector. The circular slide magazine is capable of handling 100 slides.
2. Audio-portion: A magnetic play back unit for audio-explanations of the slides and testing. The magnetic tape runs with a speed of 3 3/4 inches per second.
3. Control unit: A five-choice response control unit. The control unit has a built-in printed wiring board logic system that is capable of handling a linear type of programmed instruction tape of up to one hour in length. This control unit also synchronizes audio and visual units.

The basic operation of the machine is that one or several frames of information are presented. Then, after a key point, a slide with a multiple-choice question comes on the screen. The trainee then has to press one of the five buttons on the control panel to answer the question. If the answer was incorrect, the "answer now" light blinks until the employee presses the correct button. If the answer was correct, the tape starts again, and goes on to the next frame.

B. Slide-booklet.

In this medium, the employee views the same slides as used in slide-audio, and reads in a separate booklet the written explanations of the slides. Testing is done by means of a booklet given to the employee. After a key point of information the employee answers the questions by composing the answer and by filling-in-the blank with the appropriate missing word, making use of the prompts before the blanks. The correct answers were given on the top left-hand corner of the next page.

Development of the Slide-booklet Program. The slide-booklet format (see Appendix X), was developed from an original multiple-choice program of the "Soldering Techniques" currently used at the Western Electric Plant, Lee's Summit, Missouri. The program covered the basic information necessary to learn the techniques of soldering and enable the employee to perform the skill.

In the original program the material was programmed into 73 detailed steps with multiple-choice questions after key points of information presented through 35 mm slides together with audio-explanations.

The slide-booklet format was developed using the same information slides, but instead of multiple-choice questions and audio-explanation, fill-in-the-blank statements in a booklet were given to the employee. Prompts were incorporated before the blanks to help the employee learn and remember material better.

Four main variables were involved in this experiment.

Variable	Slide-audio	Slide-booklet
1. Mode of presentation	audio-supplementation of pictures	printed supplementation of pictures
2. Type of response	multiple-choice	constructed
3. Type of answering	push-button system	manual-writing
4. Prompting	no prompting of the answers	prompts of the answers incorporated

The seven criteria used were:

1. Scores obtained for the same 25 question test given as a pre-test, post-test and 2-week retention test, given before the training, immediately after the training, and two weeks after the training respectively.
2. Length of time to complete the tests.
3. Scores obtained on soldering performance test. In this test the employee was required to solder ten connections. Her soldering skill was evaluated by means of a methods agreement list developed on all correct operational procedures of the task. Scores were calculated as agreements with these methods.
4. Time to solder ten connections.
5. Scores obtained on the quality discrimination test. In this test the employee was tested on her ability to point out good and bad connections. She viewed a set of ten slides showing soldered connections. She had to discriminate the good and bad connections and record her answer on the answer sheet. The number of correct answers she gave was

her score on the test. She was also timed on this test.

6. Time required to inspect ten connections.
7. Opinionnaire Survey. The opinionnaire was a fourteen item questionnaire in which they were asked their opinions of the training program used.
8. Cost of program presentation equipment.

Subjects. Sixteen women employees from the carbon-mount, switch-board lamp, and mount assembling lines of the Western Electric Plant, Lee's Summit, Missouri, were volunteered as subjects. The employees were all right handed, had no previous soldering experience, and the average age was approximately twenty-five years with a range from 19 to 36 years. The average number of school years completed was 12.4 with a range from 12 to 14.5 years. The average number of years of experience at the Western Electric Plant was 1.77 years with a range from .08 to 4 years.

EXPERIMENTAL PROCEDURE

The research was performed in an industrial setting by actual production operators, at the Audio-visual laboratory of the Western Electric Plant, Lee's Summit, Missouri, and under controlled experimental conditions.

The controlled conditions designed into the experiment, and the experimental procedure followed were:

1. The employees were told that this was an experiment for a student at Kansas State University.
2. The experimental sessions were uninterrupted by lunch or overnight breaks.
3. Each employee was given a "Data Questionnaire" (Appendix I) to obtain

information about age, length of experience at Western Electric, job classification held, and educational attainment to determine whether these variables had any effect on the results.

4. The pre-test was given (Appendix II). The time to answer the test was recorded to the closest second.
5. A formal set of introductory instructions were read from a typed paper prior to the program presentations and the performance test. This was necessary to enable the investigator to repeat the same words to each trainee.
6. The same information was given under both the media.
7. In order to balance the learning effect, eight trainees did the task using the slide-audio medium, and eight trainees did with the slide-booklet medium. The trainees were assigned to the medium in the sequence given in Table 1.
8. Each trainee was allowed to spend as long as she wished on each frame, but was not allowed to go back.
9. The trainee was given a five minute break after the completion of the program. The employee was not allowed to view the program during the rest period.
10. The trainee then took the performance test (Appendix VI). Time taken to solder ten connections was recorded to the closest second, from the moment she said that she was ready until the completion of the last connection.
11. The trainee was then given the quality discrimination test (Appendix VII). Time to inspect ten connections was recorded.
12. After a five minute break, the post-test was given. The time to answer

the test was recorded to the closest second.

13. Finally, each trainee was given the appropriate opinionnaires, depending upon the medium used, to find out her feelings towards the instructional medium.

14. Fourteen days after the first experimental session, the retention test was given.

15. The program and tests were given by a member of the audio-visual laboratory of Western Electric in a room of their laboratory.

RESULTS

The scores and length of times are given in Table 2. From the results it is evident that the slide-booklet group scored slightly higher than the slide-audio group on all the tests, except for the quality discrimination test where scores were equal. But this difference in scores was found to be non-significant with the Mann-Whitney 'U' test at the 5% level (see Table 4).

The data on the times to answer the tests indicate that the slide-audio group answered all the tests in a shorter time than the slide-booklet group. However, this difference in times also was not statistically significant.

Unfortunately the times to view the program for the slide-audio trainees were not recorded. However, with this medium the trainees took an estimated 45 minutes to view the program. With the slide-booklet medium the average time of five trainees to view the program was 55.9 minutes with the times ranging from 40-85 minutes.

The employees' age, educational attainment and length of experience in electronics were analyzed for possible correlations with each of the above criteria except for the cost of training equipment and opinionnaire survey.

The Spearman Rank Correlation Coefficients are shown in Tables 5 and 6.

Only one of the 30 tests with scores in Table 5 showed significance. For slide-booklet trainees, a significant negative correlation occurred between experience and scores obtained on the quality discrimination test—that is, experienced operators did worse on the quality discrimination test than the inexperienced operators. This negative relationship was also found to occur with the slide-audio trainees; however, for this case the relationship was not statistically significant. It is hard to explain this statistical phenomenon. It is also in contradiction with what one can normally expect.

In Table 6, where times were tested versus personal characteristics, for the slide-audio trainees an unexpected significant positive correlation occurred between experience and times to answer the post-test, which meant that the experienced operators took a longer time to answer the post-test than the inexperienced operators. On the other hand, the expected negative relationship occurred for the slide-booklet group—that is, the experienced operators answered the post-test in a shorter time than the inexperienced operators; however, this was non-significant.

Interrelation of the Criteria

Performance on the different tests for both slide-audio and slide-booklet groups were analyzed for possible correlations using the Spearman Rank Correlation Coefficient Test (Table 7).

Analysis of scores

For the slide-booklet group, a significant positive relationship existed between the post-test scores and 2-week retention test scores—a high grade on the post-test meant a high grade on the 2-week retention test. This expected relationship occurred with the slide-audio medium but the relationship was not statistically significant.

<u>Analysis of times</u>

For the slide-booklet group, a significant positive relationship occurred between the pre-test times and performance test times, so the longer the time a trainee took to answer the pre-test, the longer was also the time needed to do the performance test. On the other hand this expected relationship did not occur for the slide-audio group. Instead a non-significant negative relationship was found, so the shorter the time a trainee took to answer the post-test, the longer was the time required to do the performance test. The difference between the correlation coefficients was statistically significant which meant that the medium affected the relationship of the times to answer the pre-test and performance tests.

For the slide-booklet group, post-test times were found to be negatively correlated with the performance test times--the longer the time a trainee required to answer the post-test, the shorter was the time required to do the performance test. For the slide-audio group, an unexpected non-significant positive relationship was found between the times of these two tests. There was a significant difference between the correlation coefficients of these test times, indicating that the presentation media significantly affected the relationship between the post-test time and the performance test time.

The performance test times were significantly related to another time for the third time when the slide-audio group had a significant negative correlation between performance test times and quality discrimination test times. The longer a trainee took to inspect the soldered connections the shorter was the time to do the soldering job. The slide-booklet group showed a non-significant negative relationship. The difference in correlation coefficients between these test times for the slide-booklet and slide-audio media was statistically significant, which meant that the media significantly affected the relationship between test times and quality discrimination test times.

A significant negative relationship was found between quality discrimination test times and 2-week retention times for both slide-audio and slide-booklet groups—the longer a trainee took to answer the retention test, the shorter was time required to inspect the soldered connections. The medium seems to have had no significant effect on the relationship between the two times.

Analysis of correlation between scores and times within tests

The results of this analysis are shown in Table 8.

For the slide-booklet group, an unexpected significant positive correlation, instead of a negative correlation, was observed between the times and scores. This meant that the higher the score on the 2-week retention test, the longer was also the time needed to answer this test. The expected negative correlation was found for the slide-booklet group, but this was not significant. The difference between the correlation coefficients was not statistically significant, so the media seem to have had no significant effect on the relationship between the 2-week retention test times and scores.

A significant negative correlation between the performance test scores and times indicated that a trainee with the slide-booklet medium who was able to perform the skill better was able to perform it in a shorter time. This expected relationship was not found for the slide-audio group. The difference in the correlation coefficients was found to be statistically significant, which indicates that the relation of the scores and times of performance test were significantly affected by the presentation media.

It is felt that the unexpected correlations might be due to some sort of differential learning effect of media on different intelligence levels of trainees. An alternative explanation might be that some of the trainees who were already familiar with one of the media might have benefited more than those who have not used it earlier. However, these explanations are just hypothetical. So, investigations have to be made to find out whether the intelligence level is related to effectiveness of the medium. If related, in what way? If related, can any recommendations be made based on the effective combination of medium and intelligence level of trainee?

Except for the above cited significant relationships, the rest of the criteria showed no significant correlations.

Opinionnaire Survey

Results of the opinionnaire concerning the mechanics and usage of the slide-audio and slide-booklet media are given in Tables 9 and 10.

The opinions of the trainees, in general, were favorable to the presentation medium they used. To the question "Do you think this type of teaching can solve training problems in electronics?" the slide-booklet trainees voted 7 yes and 1 no while the slide-audio voted 4 yes, 3 no and 1 no opinion. With both techniques the trainees felt that either a fellow operator or a foreman should be available for questions while they used the program. With both techniques the trainees felt that the program was too long (it took 45 to 90 minutes).

DISCUSSION

Slide-Audio

In this presentation both audio and visual channels were used for transmitting the information. The trainee simultaneously viewed the slides and also listened to the audio explanation. The divided attention because of the two channel input may have had a different effect on different trainees. Another problem with the slide-audio was that the tape speed seemed to have acted as a pacing device. Since only one tape speed was used the slow trainee was not able to keep pace with the tape and lost track of the audio explanations. This was evident from the shorter times taken by these trainees than the slide-booklet trainee to view the program, and also from their comments. As suggested by Konz (1967), this problem of pacing could be overcome by using several tape speeds from which the trainee can select one best suited to him. Trainees using the slide-audio were required to have a good memory to recollect the correct answer since no prompts were provided in this presentation.

Skinner (1958) stated that, in the multiple-choice program, the incorrect multiple-choice answers on an item may compete with the correct response. Since a multiple-choice program was used in this presentation, this might have resulted in the incorrect choice of answers.

Slide-Booklet

In the slide-booklet presentation the information and testing was done through the trainee's visual channel. Since only one channel was used, this, in turn, improved the concentration and retaining capacity of the trainee. Other advantages of this medium were the additional practice of writing an answer and incorporated prompts. Krumboltz and Weissman (1961) and Cummings and Goldstein (1962) stated that the additional practice of writing an answer contributed to the retention of material. These factors probably account for the slightly higher scores obtained by the slide-booklet group over the slide-audio group.

General

Table 3 showed an absence of high level of scores observed for both groups in the different tests. This could be due to various factors, or a combination of factors, such as a less effective program, medium of presentation, intelligence, or the loss of interest due to boredom. The results in Table 4 indicate that the observed difference in test scores and testing times occurred by chance and are not due to a significant difference in media. Thus it seems that the knowledge comes from the instructional picture (slide) of the task and not from the use of either audio or printed supplementation. The media are equally effective whether testing time, test scores, or preferences are used as the criterion, so the choice can be made on the basis of costs.

The slide-booklet medium was found to be less expensive and more simple than the slide-audio medium, because the booklet replaced the relatively expensive and sophisticated electronic response and control unit and tape-recording unit used in the Humac teaching machine.

The equipment cost of the synchronized slide-audio medium (Humac teaching machine) with the five button response panel is approximately $2000 while the equipment cost of an ordinary slide-projector required in the slide-booklet medium was $75 to $125. If, for example, 4 programs are presented per day, the machine used for 250 days per year, and the machine lasts 2 years, then $2000 over 2000 uses becomes $1 per presentation for the slide-audio medium and $125 over 2000 uses becomes $.06 for the slide projector.

A set of slides is necessary for both media. Assume that the cost of preparing an audio tape is equivalent to the cost of preparing a ditto master for the booklet approach. The tape can be used over and over but a 25 page ditto program at .4 cent per page costs about $.10 per presentation. The ditto is not only a permanent aid which the employee can keep but could be used as a refresher. Considering the training time to be 45 minutes for slide-audio and 55 minutes for slide-booklet media, at an average wage rate of $2 per hour, the training time costs are $1.50 and $1.83 respectively. The total cost per presentation per trainee including the wages paid for the training period are $2.50 for the slide-audio medium, and $1.83 for the slide-booklet medium. Thus the cost per presentation is relatively low for both media for teaching the soldering skill. Since the benefits seem equal for this application the slide-booklet medium has the highest benefit/cost ratio or, in current terminology, is most cost effective.

SUMMARY

Shortage of training personnel, the increasing problems of training and retraining due to the increasing needs of people, the increasing new skills required to produce the new and varied products, and the growing need for skilled labor have emphasized the need for more efficient training techniques and equipment. The success of programmed techniques for industrial workers has led to investigations for a simple, inexpensive and efficient medium of training program presentations, which would offer versatility, standardization and economy. Previous research at Kansas State University had established the effectiveness of pictorial instruction for communicating work skills and procedures. Supplementing the pictures with words seemed desirable, but the question was, "Should the words be spoken or printed?". Therefore a slide-booklet containing 35 mm slides and written explanations in a booklet was developed from an original 73 frame slide-audio program of "Soldering Techniques," and a comparison was made between these two media.

Sixteen female employees from the Western Electric Plant, Lee's Summit, Missouri, were taught "Soldering Techniques." Half used the slide-audio medium and half used the slide-booklet medium. Testing times and scores were used as criteria.

From an effectiveness point of view there seems little to choose between the two media. Both seem to be equally effective. Preferences were not dramatically in favor of either alternative. Presentation costs of the slide-audio medium were higher than for the slide-booklet medium.

CONCLUSIONS AND RECOMMENDATIONS

Data in this research showed that the slide-booklet medium is a simple, less expensive and equally effective medium for program presentation when compared to the slide-audio medium for training industrial workers whether scores or preferences are used as the measure of effectiveness. The purpose of the experiment was to gather evidence to support the hypothesis that the slide-booklet medium was inexpensive and better than the slide-audio medium. The data collected does not completely justify this hypothesis. Based on the test scores, cost of training equipment, and attitudes of the trainees toward the slide-booklet medium, a recommendation for the use of slides supplemented with booklets as a training aid for industrial employees seems warranted.

REFERENCES

Abbott, R. 1962. Semi-skilled workers take their cue from A-V training machines. Prod. Eng. (August 20), 74.

Alder, H. L., and E. B. Roessler. 1960. Introduction to Probability and Statistics. San Francisco: Freeman and Company.

Altmaier, D. W. 1965. How DuPont developed programmed instruction. Hydrocarbon Processing. 44:309.

Bessnard, G. G., L. J. Briggs, G. A. Mursch, and E. S. Walker. 1955. Development of the subject matter trainer. AFPTRC Technical Memorandum, ASPRL-TM-55-7 (March).

Cardozo, B., and F. Leopold. 1963. Human Code Transmission. Ergonomics (April), 131-141.

Cathey, J. P. 1963. Programming: new fail-proof way to train. Iron Age, Philadelphia, Pennsylvania.

Christian, R. 1962. Programmed learning: where it works, where it won't, what it costs. Factory (March), 108.

Cook, D. J., and F. Mechner. 1962. Fundamentals of programmed instruction. In: Applied Programmed Instruction. (S. Margulies and L. D. Eigen, eds.), pp. 3-4. New York: Wiley and Sons.

Cress, R. J. 1966. The problem of boredom in programmed instruction. Prog. Instr. 5:1.

Cummings, A., and L. S. Goldstein. 1962. The effect of overt and covert responding on two kinds of learning tasks. Tech. Report 620919. New York: Center for Prog. Instr.

Damrin, Dora E., and J. L. Saupe. 1954. Proficiency of Q-24 radar mechanics: IV. An analysis of checking responses in troubleshooting on tab-test problems. Lackland Air Force Base, Tex.: Air Force Personnel and Training Research Center, AFPTRC, TR-54-53 (Nov.).

Deterline, W. A. 1962. An Introduction to Programmed Instruction, pp. 27, 39. Englewood Cliffs, New Jersey: Prentice-Hall.

Dickey, G., and S. Konz. 1967. Presentation and Dissemination of Training Information. Proceedings of 18th Annual Institute of Industrial Engineers, Toronto, Canada.

Eigen, L. D., and P. K. Komoski. 1960. Research Summary No. 1. Automated teaching project. New York: Collegiate School, 7 pp. (mimeo.).

Eigen, L. D., R. T. Filep, L. S. Goldstein, and B. W. Angalet. 1962. A comparison of three modes of presenting a programmed instruction sequence. J. Educational Research. 55:453.

Eigen, L. D., and S. Margulies. 1964. The request for overt responses as a function of response relevance and information level. In: Trends in Programmed Instruction. (G. D. Ofiesh and W. C. Meierhenry, eds.), p. 253. National Education Association and National Society for Programmed Instruction, U.S.A.

Erlick and Hunt. 1957. Evaluating audio warning displays for weapon systems. WADC Report.

Filep, R. T., L. G. Gotkin, L. S. Goldstein, and B. W. Angalet. 1960. Knowledge of results as a factor in achievement in programmed instruction. An interim report on a replication of the Denver study. New York: Center for Programmed Instruction.

Finn, J. D., and L. E. Campion. 1962. Teaching Machines and Programmed Learning A Survey of the Industry. Washington, D.C.: U.S. Department of Health, Education, and Welfare, OE-34019, Bulletin.

Foltz, C. I. 1961. The World of Teaching Machine, p. 48. Washington, D.C.: Electronic Teaching Laboratories.

Foltz, C. I. 1962. Aids to teaching: a survey of the current status of teaching machines. In: Applied Programmed Instruction. (S. Margulies and L. D. Eigen, eds.), pp. 230, 235, 236. New York: Wiley and Sons, Inc.

Gilbert, T. F. 1960. On the relevance of laboratory investigation of learning to self-instructional programming. In: Teaching Machines and Programmed Learning. (A. A. Lumsdaine and R. Glaser, eds.), p. 478. National Education Association, U.S.A.

Goldberg, M. H., R. I. Dawson, and R. S. Barrett. 1964. Comparison of programmed and conventional instruction methods. J. of Appl. Psych. 48:110.

Goldman, J., and H. Eisenberg. 1963. On the job learning. Electronic Production. (Nov.-Dec.), pp. 18-21.

Goldstein, L. S. 1964. Research in programmed instruction: an overview. In: Trends in Programmed Instruction. (G. D. Ofiesh and W. C. Meierhenry, eds.), p. 273. National Education Association and National Society for Programmed Instruction, U.S.A.

Goldstein, L. S., and L. G. Gotkin. 1962. A review of research: teaching machines versus programmed textbooks as presentation modes. J. of Prog. Instr. 1:29.

Green, E. 1962. The Learning Process and Programmed Instruction, pp. 115, 133, 134, 135, 199. New York: Holt, Rinehart, and Winston, Inc.

Harker, W. A. 1961. Audio-visual learning--its more than hear say! Electronic Industries (August), 103-105.

Hershfield, W. 1967. Video-sonic instructional techniques for training personnel. Personnel J. 46:109.

Holt, H. O., and J. Hammock. 1962. Books as teaching machines: some data. In: Applied Programmed Instruction. (S. Margulies and L. D. Eigen, eds.), p. 55. New York: Wiley and Sons.

Homme, L. E., and R. Glaser. 1959. Relationships between the programmed textbook and teaching machines. In: Automatic Teaching: The State of the Art. (E. Galenter, ed.), pp. 103-107. New York: Wiley and Sons.

House, B. J., D. Zeaman, R. Orlando, and W. Fisher. 1957. Learning and transfer in mental defectives. Progress Report No. 1. University of Connecticut: Department of Psychology (October).

Hughes, J. L. 1962a. Effect of changes in programmed text format and reduction of classroom time on the achievement and attitude of industrial trainees. J. Prog. Instr. 1:43.

Hughes, J. L. 1962b. Programmed Instruction for Schools and Industry, p. 50. Chicago: Science Research Associates, Inc., Publishers.

Hughes, J. L., and W. J. McNamara. 1961. A comparative study of programmed and conventional instruction in industry. J. Appl. Psych. 45:225.

Konz, S. A., G. L. Dickey, C. McCutchan, and R. Daniels. 1966. Manufacturing assembly instructions. Journal of Industrial Engineering, Vol. XVII, No. 5.

Konz, S. A., and G. L. Dickey. 1967. Manufacturing assembly instructions: Part II. Combinations and forms of media. J. Ind. Eng. 18:63.

Konz, S. A., G. L. Dickey, C. McCutchan, and B. Koe. 1967. Manufacturing assembly instructions: Part III. Abstraction, complexity, and information theory. Journal of Industrial Engineering, Vol. XVIII, No. 11.

Krumboltz, J. D., and R. G. Weisman. 1962. The effect of intermittent confirmation in programmed instruction. Journ. Educ. Psychol. 53(6): 250-253.

Krumboltz, J. D., and R. G. Weisman. 1962. The effect of overt vs covert responding to programmed instruction of immediate and delayed retention. Journ. Educ. Psychology. 53(2):89-92.

Lumsdaine, A. A. 1961. The analysis of student response as a factor in instruction. In: Student Response in Programmed Instruction. (A. A. Lumsdaine, ed.), p. 4. Washington, D.C.: National Academy of Science--National Research Council.

Lysaught, J. P. 1962. Programmed learning and teaching machines in industrial training. In: Applied Programmed Instruction. (S. Margulies and L. D. Eigen, eds.), pp. 30, 31, 42, 43. New York: Wiley and Sons.

Lysaught, J. P., and C. M. Williams. 1963. A Guide to Programmed Instruction, p. 18. New York: Wiley and Sons.

Maccoby, N., and F. Sheffield. 1961. Combining practice with demonstration in teaching complex sequences: summary and interpretation. In: Student Response in Programmed Instruction. (A. A. Lumsdaine, ed.), p. 82. Washington, D.C.: National Academy of Science--National Research Council.

Margulies, S., and L. D. Eigen. 1962. Applied Programmed Instruction. New York and London: John Wiley and Sons, Inc.

Markle, S. M., L. D. Eigen, and P. K. Komoski. 1961. A Programmed Primer on Programming. Published by the Center of Programmed Instruction. (Volumes I and II).

Middleton, R., and S. Konz. 1965. Slides plus recorded commentary instruct food service workers. Hospitals. 39:91.

Middleton, R., and S. Konz. 1966. Developing work instruction programs for food service employees. Unpublished report. Manhattan, Kansas: Kansas State University.

O'Donnell, L. H. 1963. Training of plant operators and maintenance personnel. In: Programmed Learning: A Critical Evaluation. (J. L. Hughes, ed.), p. 115. Chicago, Illinois: Educational Methods Inc.

O'Donnell, L. H. 1964. Programmed instruction at DuPont. Administrative Management. 25:43.

Ofiesh, G. D. 1965. Programmed Instruction. A Guide for Management, pp. 191, 223, 224, 290, 337, 343, 374. American Management Association, Vail-Ballow Press, Inc., U.S.A.

Pask, G. 1957. Automatic teaching techniques. British Communications and Electronics (April), 4(4):210-211.

Pask, G. 1957. A teaching machine for radar training. Automation Progress. 2:214-217.

Pask, G. 1957. Report on symposium papers at conference on automata held in Tedingham, England. Automation Progress. 4(2).

Pask, G. 1958. Teaching machines. Proceedings of Second Conference of International Association of Cybernetics, p. 1-19.

Pask, G. 1958. Teaching machines. Namur, Belgium: Solatron Electronics Group, Ltd. (September).

Pask, G. 1958. Electronic keyboard teaching machines. Education and Commerce. 24:16-26.

Pask, G. 1958. Organic control and cybernetic method. Cybernetica. 1(3).

Pask, G. 1959. The teaching machine. The Overseas Engineer (February), 231-232.

Pask, G. 1959. The teaching machine as a control mechanism. The Society of Instrument Technology (December).

Pask, G. 1959. The self organizing teacher. Automated Teaching Bulletin, 13-18.

Rath, G., N. S. Anderson, and R. C. Brainerd. 1959. The IBM Research Center teaching machine project. In: Automatic Teaching: The State of the Art. (E. Galanter, ed.), pp. 117-130, Ch. XI. New York: John Wiley and Sons.

Roe, A., M. Massey, G. Weltman, and D. Leeds. 1962. Automated teaching methods using linear programs. Los Angeles: UCLA Department of Engineering, 1960, 57 pp. (offset). Same data also in A. Roe Automated teaching methods using linear programs. Journal Applied Psychol. 40: 198-201.

Roshal, S. M. 1961. Film-mediated learning with varying presentation of the task: viewing angle, portrayal of demonstration, motion, and student participation. In: Student Response in Programmed Instruction. (A. A. Lumsdaine, ed.), pp. 155-175. Washington, D.C.: National Academy of Science—National Research Council.

Ross, W. L., Jr. 1962. The industrial market for programmed instruction. In: Applied Programmed Instruction. (S. Margulies and L. D. Eigen, eds.), pp. 189-197. New York: Wiley and Sons, Inc.

Schrader, A. W. 1964. Comparing programming methodologies in aspects of frame construction. Occasional Paper II. Ann Arbor: Center for Programmed Learning for Business, University of Michigan.

Schramm, W. 1962. Programmed Instruction, p. 1. The Fund for Advancement of Education, U.S.A.

Shoemaker, H. A., and H. O. Holt. 1965. The use of programmed instruction in industry. In: Teaching Machines and Programmed Learning, II. (R. Glaser, ed.), pp. 685, 687, 731. National Education Association, U.S.A.

Siegel, S. 1956. Non-parametric Statistics, pp. 75-83, 202-213, 254, 284. New York: McGraw-Hill.

Skinner, B. F. 1954. The science of learning and the art of teaching. Harvard Educ. Rev. 24:86.

Skinner, B. F. 1958. Teaching machines. Science. 128:969.

Smith, W. I., and J. W. Moore. 1962. Size of step and cueing. In: Programmed Learning. (W. I. Smith and J. W. Moore, eds.), p. 206. New York: D. Van Nostrand.

Stolurow, L. 1961. Teaching by Machine. U.S. Dept. of Health, Education, and Welfare. Cooperative Research Monograph no. 6, pp. 76, 93. Washington, D.C.: U.S. Government Printing Office.

Stolurow, L. M., and B. Bergum. 1958. Learning diagnostic information: effects of direction of association and of prose vs paired-associate presentation. In: Air Force Human Engineering, Personnel, and Training Research. (G. Finch and F. Cameron, eds.), pp. 69-84. Washington, D.C.: National Academy of Science—National Research Council.

Taber, J., R. Glaser, and H. Schaeffer. 1965. Learning and Programmed Instruction, pp. 23-24, 126. Reading, Massachusetts: Addison-Wesley Publishing Co.

Temsen, J. 1961. Video-sonic system instructions raise quality standard. Industrial Quality Control (July), 18:15-20.

Williams, A. 1936. Teach it with pictures. Factory and Management (Dec.), 94(12):58-59.

TABLE 1

SEQUENCING OF SUBJECTS

Subject	Medium assigned
1	Slide-audio
2	Slide-booklet
3	Slide-booklet
4	Slide-audio
5	Slide-audio
6	Slide-booklet
7	Slide-booklet
8	Slide-audio
9	Slide-audio
10	Slide-booklet
11	Slide-booklet
12	Slide-audio
13	Slide-audio
14	Slide-booklet
15	Slide-booklet
16	Slide-audio

TABLE 2

CHARACTERISTICS OF SUBJECTS

Subject	Slide-audio subjects			Subject	Slide-booklet subjects		
	Age	Educational attainment	Experience in electronics		Age	Educational attainment	Experience in electronics
	Years				Years		
1	21	14.5	0.75	2	30	12	3.5
4	23	12	3.00	3	25	12	Unknown
5	25	12	1.00	6	23	12.5	2.0
8	19	12	0.25	7	19	12	0.25
9	21	12	3.00	10	25	12	4.00
12	31	12	0.33	11	23	12	3.00
13	27	12	3.00	14	36	12	4.00
16	25	14	0.24	15	19	13	0.08
Average	24	12.6	1.4	Average	25	12.2	2.1

TABLE 3

SCORES AND TIMES FOR SLIDE-AUDIO AND SLIDE-BOOKLET TRAINEES

Subject no.	Test time, minutes			Test scores			Performance test		Quality discrimination test	
	Pre-test	Post-test	Retention test	Pre-test	Post-test	Retention test	Time, minutes	Scores	Time, minutes	Scores
Slide-audio subjects										
1	7.83	6.50	5.33	24	54	52	2.33	78	6.80	80
4	8.45	11.70	8.50	32	53	70	1.67	45	6.42	90
5	7.00	11.17	8.25	27	73	72	2.57	23	7.57	70
8	7.82	---	13.67	7	83	74	6.87	36	8.83	70
9	6.72	20.50	19.25	2	80	78	2.57	63	---	90
12	---	6.67	8.72	16	84	69	0.67	52	5.75	70
13	3.80	9.42	10.05	8	70	59	2.13	45	5.52	60
16	5.82	21.17	---	12	54	43	4.50	34	7.53	40
Average	6.78	11.02	10.54	16	69	65	2.93	47	6.83	71
Slide-booklet subjects										
2	9.50	10.48	---	24	54	---	3.0	50	6.75	60
3	4.00	10.33	9.25	8	57	59	3.58	26	9.33	60
6	13.20	12.25	9.30	27	78	71	3.12	77	8.95	80
7	15.73	12.70	13.33	44	70	55	2.33	87	7.25	80
10	15.67	9.50	13.70	47	99	91	2.75	65	6.90	70
11	9.20	23.73	8.85	20	76	60	2.25	60	12.25	80
14	7.93	12.35	18.03	24	44	44	3.20	39	6.20	60
15	5.75	6.90	8.20	28	95	82	3.75	20	7.95	80
Average	10.12	12.28	11.52	27	72	66	3.00	53	8.20	71

TABLE 4

MANN-WHITNEY U-TEST FOR SCORES AND TEST TIMES
BETWEEN THE TWO MEDIA

	Criterion	Probability that difference between slide-audio and slide-booklet media occurred by chance
1.	Pre-test scores	.27
2.	Pre-test times	.10
3.	Post-test scores	.40
4.	Post-test times	.19
5.	2-week retention test scores	.29
6.	2-week retention test times	.14
7.	Methods agreement test scores	.32
8.	Methods agreement test times	.16
9.	Quality discrimination test scores	.44
10.	Quality discrimination test times	.10

None of the above results were significant at 5% level and one-tailed test.

TABLE 5

SPEARMAN RANK CORRELATION COEFFICIENTS BETWEEN SCORES AND AGE, EDUCATIONAL ATTAINMENT AND EXPERIENCE

Personal characteristics	Slide-audio					Slide-booklet				
	Pre-test	Post-test	Retention test	Methods agreement	Quality discrimination	Pre-test	Post-test	Retention test	Methods agreement	Quality discrimination
Age	.21	-.10	-.45	-.08	-.25	-.36	-.02	-.41	-.25	-.43
Educational attainment	.16	-.50	.51	-.12	-.17	.28	.30	-.18	-.10	.56
Experience	.60	-.41	.33	-.22	-.59	.63	-.25	-.21	-.08	-.82*

*$p < .05$

TABLE 6

SPEARMAN RANK CORRELATION COEFFICIENTS BETWEEN TEST TIMES AND AGE, EDUCATIONAL ATTAINMENT AND EXPERIENCE

Personal characteristics	Slide-audio					Slide-booklet				
	Pre-test	Post-test	Retention test	Methods agreement	Quality discrimination	Pre-test	Post-test	Retention test	Methods agreement	Quality discrimination
Age	-.60	-.16	-.63	-.58	-.65	-.26	-.19	-.60	-.12	-.23
Educational attainment	.10	.29	-.47	.20	.25	.03	-.22	-.40	.22	-.01
Experience	.07	.79*	.14	-.49	.18	.08	-.06	-.31	-.12	-.60

*$p < .05$

TABLE 7

SPEARMAN RANK CORRELATION COEFFICIENTS FOR SCORES AND TEST TIMES FOR DIFFERENT TESTS

Comparison	Scores			Length of test times		
	Slide-audio (ρ_1)	Slide-booklet (ρ_2)	Significance of $\rho_1 - \rho_2$	Slide-audio (ρ_1)	Slide-booklet (ρ_2)	Significance of $\rho_1 - \rho_2$
1. Pre-test vs Performance test	.11	.47	.33	−.21	.71*	.05*
vs Quality discrimination test	.16	.42	.45	.09	−.26	.35
vs Post-test	.52	.61	.64	−.20	−.07	.39
vs 2-week retention test	−.28	.47	.18	−.49	.36	.17
2. Post-test vs Performance test	.05	.48	.30	.57	−.67*	.01*
vs Quality discrimination test	.40	.63	.35	.37	.14	.38
vs 2-week retention test	.52	.64*	.38	.54	.20	.34
3. Performance test vs Quality discrimination test	.59	.40	.37	.86*	−.10	.04*
vs 2-week retention test	−.18	.07	.37	.22	−.21	.33
4. Quality discrimination test vs 2-week retention test	.57	.48	.39	−.85*	−.78*	.39

*$p < .05$

TABLE 8

SPEARMAN RANK CORRELATION BETWEEN TEST TIMES TO ANSWER THE TESTS AND THE SCORES ON THESE TESTS WITHIN TESTS

	Comparison	Slide-audio (ρ_1)	Slide-booklet (ρ_2)	Significance of $\rho_1 - \rho_2$
1.	Pre-test times vs Pre-test scores	.54	.60	.39
2.	Post-test times vs Post-test scores	-.17	-.14	.39
3.	2-week retention times vs 2-week retention test scores	.64*	-.36	.11
4.	Performance test times vs Performance test scores	.40	-.76*	.03*
5.	Quality discrimination test times vs Quality discrimination test scores	.04	.59	.25

*$p < .05$

TABLE 9

SUMMARY OF RESPONSES TO OPINIONNAIRE CONCERNING THE SLIDE-AUDIO MEDIUM

Question	Response yes	no	no opinion
1. Do you think that teaching with a teaching machine can help solve the training problems in electronics?	4	3	1
2. By which method do you like to be trained?			
A. 1. Foreman	1		
2. Slide-audio	1		
3. Both	6		
B. 1. Your fellow operator	2		
2. Slide-audio	0		
3. Both	6		
C. 1. Trained in groups	1		
2. Trained alone	3		
3. Both	4		
3. Method you like best			
1. Foreman, fellow operator	4		
2. Slide-audio	0		
3. Slide-booklet	2		
4. Class-room training	2		
4. Would you prefer learning by (a) slides alone (b) slides with tape-recorded explanations	8	0	0
5. Would you prefer learning by picture slides with the written explanations and fill-in-the blanks questions to the method you have used?	3	5	0
6. Did you like the push-button system of answering?	5	3	0
7. Did you find the teaching machine			
1. Very interesting	1		
2. Interesting	6		
3. No opinion	0		
4. Not interesting	1		
5. Boring	0		

TABLE 9 (continued)

Question		Response	
	yes	no	no opinion
8. Were the tape-recorded explanations distracting your attention when viewing the slides?	1	6	1
9. Have you had any trouble hearing the tape-recorded voice while viewing the program?	0	8	0
10. The pitch of the tape-recorded voice: was it clear enough to hear?			
1. Low	0		
2. High	0		
3. Just right	8		
11. Did you find the tape-recorded explanations too lengthy to recollect while answering the questions?	1	7	0
12. Did you find the time-interval between slides sufficient enough to learn and answer correctly? (pacing)	4	3	1
13. Would you be willing to learn by viewing the slides with the explanatory sheets, and then answering the questions by a fill-in-the blank type of questions			
1. At home	0		
2. At work place	4		
3. Both	3		
14. Do you think the program is too long to be learned at one stretch (sitting)?			
1. Yes	7		
2. No	1		
3. No opinion	0		
4. Just right	0		

TABLE 10

SUMMARY OF RESPONSES TO OPINIONNAIRE CONCERNING THE SLIDE-BOOKLET MEDIUM

Question		Response	
	yes	no	no opinion
1. Do you think this kind of teaching can help solve the training problems in electronics?	7	1	0
2. Will you be willing to learn by viewing the slides on a slide-sorter with written explanations at			
1. Home	0		
2. Work	5		
3. Both	3		
3. By which method do you like to be trained?			
A. 1. Foreman	2		
2. Slide-booklet	2		
3. Both	4		
B. 1. Fellow operator	2		
2. Slide-booklet	2		
3. Both	4		
4. Method you like best?			
1. Foreman	2		
2. Slide-audio	1		
3. Slide-booklet	4		
4. Class-room training	1		
5. While viewing the slide-booklet, would you like to be left			
1. Alone	3		
2. With foreman	2		
3. With fellow operator	3		
6. Would you prefer learning by (a) slides alone?	0	0	0
(b) slides with written explanations?	8	0	0
7. Would you prefer learning by picture-slides with tape-recorded explanations and multiple-choice questions to the method you have used?	6	1	1

TABLE 10 (continued)

	Question	Response		
		yes	no	no opinion
8.	Did you like the idea of learning by picture slides with written explanations and answering the questions by filling-in-the blanks with missing word?	5	2	1
9.	Did you find the fill-in-the blank type of questions			
	1. Very interesting	2		
	2. Interesting	4		
	3. No opinion	0		
	4. Not interesting	1		
	5. Boring	1		
10.	Do you think that prompting of the initial letters of the missing words or answer, in the fill-in-the blank type of questions helped you to learn better?	8	0	0
11.	Would you prefer learning without prompting?	3	5	0
12.	Was the prompting of the initial letters of the words before the blanks confusing?	1	7	0
13.	Did you find the written explanations			
	1. Too lengthy	2		
	2. Too short	0		
	3. Just right	6		
14.	Do you think the program is too long to be learned at one stretch (sitting)?	7	1	0

APPENDICES

APPENDIX I

DATA QUESTIONNAIRE

EMPLOYEE NO:

NAME:

DATE (SESSION 1) __________

DATE (SESSION 2) __________

DATE (SESSION 3) __________

Age ______________

Educational attainment ______________________

Length of experience in electronic industry __________________

Job classification held:

APPENDIX II

WRITTEN TEST

Employee No:

Date:

Trial: Pre-Test
IMM Post Test
2-wk Retention Test

TOTAL SCORE:

SCORE QUESTION

1. To join a wire to a terminal by the soldering process, we need _________ and _________.

2. The Soldering Iron consists of three parts. These are
   1. _________
   2. _________
   3. _________

3. When not in use the Soldering Iron should always be placed in its _________.

4. The Soldering Iron _________ (must be/must not be) tinned before soldering.

5. The excess solder on the tip of the Iron should be removed by ___________________.

6. In order to have a good soldered connection:
   (a) the tip must make a contact with both the _________ and _________ of the wire and terminal.
   (b) The solder should be placed in the area between Soldering Iron _________ and the _________ of the wire and terminal.

7. As the solder starts to flow, you slide the solder wire to the _________ side of the terminal.

SCORE QUESTION

8. During the soldering process the solder flows ________ the source of heat.

9. The solder-filled area between the wire and the terminal is called a ________.

10. The three requirements of a good soldered connection are:
    a. Solder flowed ________ ______ the terminal and wire.
    b. The shape of the wire is ________ through the solder.
    c. Good solder ________.

11. A good soldered connection is ________, ________ and ________ in appearance.

12. TRUE OR FALSE
    Before placing the Soldering Iron in its holder the tip should be tinned and the excess solder should not be removed.

13. TRUE OR FALSE
    The fillet of a good connection will have a bolt-type of appearance.

14. TRUE OR FALSE
    A "bad solder joint" is a very serious defect because the equipment may fail electrically at any time.

15. If the iron is defective and does not get hot enough or if you don't hold the iron on the connection long enough you will get ________ ________ defect.

16. A connection with the insulation wrapped around a portion of the terminal should be ________ and ________.

SCORE QUESTION

17. A disturbed connection is a defect caused by moving the _________ or _________ before the solder cooled.

18. If the insulation is not brought up to the terminal a defect called _________ _________ will occur.

19. An insufficient solder defect is due to _________ (enough/ not enough) solder.

20. TRUE OR FALSE
    You should notify your supervisor if the solder does not adhere to the wire or terminal.

21. TRUE OR FALSE
    The hole in the terminal should be filled in only when it is practical to do so.

22. A burnt component should be _________ (replaced/repaired).

23. Burnt insulation on a wire or sleeving should be repaired because it may cause an _______ _________.

24. Too much solder on the tip may fall off and cause a _________ _________.

25. If the proper technique is not used when removing the iron from the connection, _________ _________ will occur.

APPENDIX III

INSTRUCTIONS FOR SLIDE-BOOKLET TRAINEES

This program has picture slides, explanations, and fill-in-the-blank type questions. Please look at the picture slides, read the explanations in the slides and also the explanation in this book. Answer the questions in this by filling-in-the blanks with the appropriate missing word, <u>making use of the prompting of initial letters given before the blank</u>. After you have finished writing your answer, <u>check your answer with the correct answer on the top left-hand corner of the next page</u>. It is not difficult to answer the questions because the answers are found in the picture slides or in the explanations given in this book.

You can read through the book only <u>once</u>. So read carefully and take your own time for each page. As soon as you have finished, tell me, you can then do the soldering job. After doing the soldering you will be given a simple and short written test and an opinionnaire.

APPENDIX IV

INSTRUCTIONS FOR SLIDE-AUDIO TRAINEES

This program has picture slides, tape recorded explanations and multiple-choice type questions. Please look at the picture slides, read the explanations in the slides and also listen to the explanations played on the tape recorder. During this program the machine will stop when a question is asked. When the "Answer now" light comes on you should push one of the five buttons that corresponds to the correct answer. It is not difficult to answer the questions because the answers are found in the picture slides or in the explanations heard through your earphone attachments.

You can view and hear the program only once so listen and view carefully. As soon as you have finished, tell me, you then can do the soldering job. After doing the soldering you will be given a simple and short written test and an opinionnaire.

APPENDIX V

ORAL INSTRUCTIONS FOR PERFORMANCE TEST

Now that you have viewed the program, you will now solder ten connections. Follow the method and take necessary steps and precautions you have heard, read, and seen in the program. Work quickly but accurately. You may correct errors that you notice before soldering the next connection in sequence. Your work will be timed and checked for errors. But, mind you, this is not a test, it is just to gather information whether the medium you used is really effective or not. If you have any procedural doubts please ask me, I will help you.

APPENDIX VI

PERFORMANCE TEST -- CHECK LIST

CONNECTION NUMBER

1 2 3 4 5 6 7 8 9 10

I. GRIP

______ 1. Picked up the soldering iron and held it in the right hand with the fingers wrapped around the middle portion of the handle.

______ 2. Thumb is straight out and is touching the flange.

II. PREPARATION STEPS

______ 3. Soldering tip is tinned before soldering.

______ 4. The tip is completely covered with solder.

______ 5. Excess solder on the tip is removed by wiping it on a wet sponge.

III. SOLDERING CONNECTIONS

______ 6. The soldering iron tip and solder are placed to the terminal simultaneously.

CONNECTION NUMBER

1 2 3 4 5 6 7 8 9 10

________ 7. Solder is placed in the area between the soldering iron tin and the connection of the wire and terminal.

________ 8. Slid the solder to the opposite side of the soldering iron tip when solder starts to flow.

________ 9. Remove the solder.

________ 10. Place the soldering iron back in its holder.

IV. REQUIREMENTS OF A GOOD SOLDERED CONNECTION

________ 11. The solder has flowed completely around the terminal and wire.

________ 12. The shape or contour of the line is visible through the solder.

________ 13. A good solder fillet.

V. APPEARANCE OF THE SOLDERED CONNECTION

________ 14. Clean.

________ 15. Shiny.

________ 16. Smooth.

________ TOTAL SCORE

APPENDIX VII

Employee:

Date & Session:

QUALITY DISCRIMINATION TEST

Read and view carefully the requirements and appearance of a good soldered connection shown in slides A and B. Then determine whether the connections shown in each of the following slides are good or bad. Write your answers opposite to each slide number. If it is a bad connection, write the defects present in the connection.

Slide No:	Good or Bad	Reasons for being a bad connection.
(1)	________	________________
(2)	________	________________
(3)	________	________________
(4)	________	________________
(5)	________	________________
(6)	________	________________
(7)	________	________________
(8)	________	________________
(9)	________	________________
(10)	________	________________

APPENDIX VIII

Employee No:

Date:

Media of Instruction:

OPINIONNAIRE
FOR
SLIDE-AUDIO EMPLOYEES

Thank you very much for helping me with my research project at Kansas State University. You have been very co-operative and helpful. I am now conducting a survey of your opinions towards the "Media of Instruction." Please read and answer questions carefully and honestly.

ANSWERS WILL BE KEPT CONFIDENTIAL

Please answer the questions by placing a circle around the word or number that best describes your feeling. Only one answer to a question please.

1. By which method do you like to be trained?

    1. Foreman.

    2. Slides and tape-recorded explanations and multiple choice questions.

    3. Foreman and slides and tape-recorded explanations and multiple choice questions.

2. By which method do you like to be trained?

    1. Your fellow operator.

    2. Slides and tape-recorded explanations and multiple choice questions.

    3. Your fellow operator and slides and tape-recorded explanations and multiple choice questions.

3. By which method do you like to be trained?

    1. Trained in groups.
    2. Trained alone.
    3. Both.

4. Circle the one method you like best.

    1. foreman,
    2. slides and tape-recorded explanations and multiple choice questions,
    3. slides and written explanations and fill-in-the blank type of questions,
    4. another operator,
    5. class-room training.

5. While viewing the program, would you like to be

    1. alone,
    2. with the foreman,
    3. with another known fellow operator.

6. Would you prefer learning by (a) slides alone, or (b) slides with tape-recorded explanations?

    1. Slides alone.
    2. Slides with tape recorded explanations.
    3. No opinion.

7. Would you prefer learning by (a) picture slides with the tape-recorded explanations or (b) slides without tape recorded explanations?

    1. Slides with tape recorded explanations.
    2. Slides without tape recorded explanations.
    3. No opinion.

8. Would you prefer learning by pictures slides with the written explanations and the fill-in-the blank questions to the method you have used?

    1. yes

    2. no

    3. no opinion

9. Were the tape-recorded explanations distracting your attention when viewing the slides?

    1. yes

    2. no

    3. no opinion

10. Have you had any trouble hearing the tape-recorded voice while viewing the program?

    1. yes

    2. no

    3. no opinion

11. The pitch of the tape-recorded voice: was it clear enough to hear?

    1. too low

    2. too high

    3. just right

12. Did you like the idea of push-button system of answering?

    1. yes

    2. no

    3. no opinion

13. Did you find the teaching machine:

    1. very interesting

    2. interesting

    3. indifferent, or no opinion

    4. not interesting

    5. boring

14. Did you have any trouble finding out <u>when</u> and <u>which</u> button to push, when a question was asked?

    1. yes

    2. no

    3. no opinion

15. Did you find the tape-recorded explanations <u>too</u> lengthy to recollect while answering the questions?

    1. yes

    2. no

    3. no opinion

16. Did you find the time interval between slides sufficient enough to learn and answer correctly?

    1. yes

    2. no

    3. no opinion

17. Would you be willing to learn by viewing the slides with explanatory sheets, and then answering the questions by a fill-in-the blank type of questions

    1. at home

    2. at work place

    3. both

18. Do you think that teaching with teaching machines can help solve the training problems in electronics?

    1. yes
    2. no

19. Do you think the program is too long to be learned at one stretch (sitting)?

    1. yes
    2. no
    3. no opinion
    4. just right

20. List any four good points (reasons) which you think, make this method of training the best.

    1.
    2.
    3.
    4.

21. List any four drawbacks in this method of teaching.

    1.
    2.
    3.
    4.

Thank you very much for your valuable opinions.

Surender Reddy

APPENDIX IX

Employee No:

Date:

Media of Instruction:

OPINIONNAIRE
FOR
SLIDE-BOOKLET EMPLOYEES

Thank you very much for helping me with my research project at Kansas State University. You have been very co-operative and helpful. I am now conducting a survey of your opinions towards the "Media of Instruction." Please read and answer questions carefully and honestly.

ANSWERS WILL BE KEPT CONFIDENTIAL

Please answer the questions by placing a circle around the word or number that best describes your feeling. Only one answer to a question please.

1. By which method do you like to be trained?

    1. Foreman.

    2. Slides and written explanations. Fill-in-the blank type of questions.

    3. Both methods 1 and 2.

2. By which method do you like to be trained?

    1. Your fellow operator.

    2. Slides and written explanations. Fill-in-the blank type of questions.

    3. Both methods 1 and 2.

3. By which method do you like to be trained?

   1. Trained in groups.

   2. Trained alone.

   3. Both.

4. Circle the one method you like best.

   1. foreman, fellow operator

   2. slides and tape-recorded explanations and multiple choice questions

   3. slides and written explanations and fill-in-the blank type of questions

   4. classroom training.

5. While viewing the program, would you like to be

   1. alone

   2. with the foreman

   3. with another known fellow operator

6. Would you prefer a learning by (a) slides alone (without written explanations) or (b) slides with written explanations?

   1. slides alone

   2. slides with written explanation

   3. no opinion

7. Would you prefer learning by (a) picture slides with the tape-recorded explanations or (b) picture slides without tape-recorded explanations.

   1. slides with taped explanations

   2. slides without taped explanations

   3. no opinion

8. Would you prefer learning by picture slides with tape-recorded explanations and multiple choice questions to the method you have used?

   1. yes
   2. no
   3. no opinion

9. Did you like the idea of learning by picture slides with written explanations and answering the questions by filling in the blanks with the missing word?

   1. yes
   2. no
   3. no opinion

10. Did you find the fill-in-the blank type of questions

    1. very interesting?
    2. interesting?
    3. indifferent? or no opinion
    4. not interesting?
    5. boring?

11. Were the written explanations

    1. too easy?
    2. easy to understand?
    3. hard to understand?
    4. complicated and confusing?

12. Do you think that prompting of the initial letters of the missing words or answer in the fill-in-the blank type of questions, helped you to learn better?

    1. yes
    2. no
    3. no opinion

13. Would you prefer learning without prompting?

    1. yes
    2. no
    3. no opinion

14. Was the prompting of the initial letters of the words before the blanks confusing?

    1. yes
    2. no
    3. no opinion

15. Did you find the written explanations

    1. too lengthy
    2. too short
    3. just right

16. Will you be willing to learn by viewing the slides on a slide sorter and written explanations at

    1. home
    2. work
    3. both

17. Do you think this kind of teaching can help solve the training problems in electronics?

    1. yes

    2. no

18. Do you think the program is too long to be learned at one stretch (sitting)?

    1. yes

    2. no

    3. no opinion

    4. just right

19. List any four good points (reasons) which you think make this "media of instruction" the best.

    1.

    2.

    3.

    4.

20. List any four drawbacks in this media of instruction.

    1.

    2.

    3.

    4.

Thank you very much for your valuable opinions.

Surender Reddy

APPENDIX X

SLIDE-BOOKLET FORMAT FOR
SOLDERING TECHNIQUES

JOB #78509-100

SLIDE 1

Soldering Techniques, a basic skill self-learning program. This program will cover the information necessary for you to learn the techniques of soldering and enable you to perform this skill.

SLIDE 2

First, let us define what we mean by a soldered connection. A soldered connection is the joining together of a wire and a metal terminal to form a "good" electrical connection.

SLIDE 3

In order to join two metals together by the soldering process, we need two things. One is a source of heat and the second is a bonding material called solder.

Soldering Techniques
Job #78509-1111

SLIDE 4

In order to join a wire to a terminal we need two things:

1. a source of h__________.

2. a bonding material called so__________.

SLIDE 5

The source of heat used is the soldering iron, which has a heating element. This soldering iron provides approximately one thousand degrees of heat to be used in the soldering process.

SLIDE 6

The solder used for electronic work is a small wire-like material which comes rolled on a spool. Solder is a special mixture of metals designed to melt at fairly low temperatures.

SLIDE 7

The soldering iron is composed of three main parts. They are: the <u>tip</u>, which actually does the heating of the connections; the <u>shank</u>, which houses the heating element, and the <u>handle</u> which provides a means of holding the soldering iron during the soldering operation.

Soldering Techniques
Job #78509-100

1. Heat	Answers to
2. Solder	Slide 4

SLIDE 8

<u>Warning</u>: The tip and shank of the soldering iron are extremely hot. Do not touch them with your bare hand. Do not lay the iron down so that you might brush up against it. This soldering iron is completely safe if you use it right. There is no reason to be afraid of it if you handle it properly.

SLIDE 9

The Soldering Iron consists of three different parts. These are:

1. The tapered point of the Soldering Iron which does the heating of the connection is the t_________.
2. Sh_________ is the middle part which holds the heating element.
3. H_________ is that with which we hold the Soldering Iron. The _________ and _________ are hot when the Soldering Iron is plugged in. BE CAREFUL.

Soldering Techniques
Job #78509-100

1. tip	Answers to
2. shank	Slide 9
3. handle	
tip and shank	

SLIDE 10

A special holder has been designed for your soldering iron. The soldering iron shall be placed in the holder any time it is not in use.

SLIDE 11

When not using the soldering iron, it should be placed in the soldering iron ho_________.

SLIDE 12

The correct grip of the soldering iron is shown here. The soldering iron is picked up and held in the right hand. The fingers should be wrapped around the middle portion of the handle. The thumb should be straight out and almost touch the flange. The handle should feel comfortable to you. If it doesn't, try moving your hand forward and backward on the handle until it is comfortable.

APPENDIX XI

SLIDE-AUDIO FORMAT FOR SOLDERING TECHNIQUES

JOB #78509-100

SLIDE 1

Soldering Techniques, a basic skill self-learning program. This program will cover the information necessary for you to learn the techniques of soldering and enable you to perform this skill.

SLIDE 2

First, let us define what we mean by a soldered connection. A soldered connection is, the joining together of a wire and a metal terminal to form a "good" electrical connection.

Soldering Techniques
Job #78509-100

SLIDE 3

In order to join two metals together by the soldering process, we need two things. One is a source of heat and the second is a bonding material called solder.

SLIDE 4

Okay, here is our first question on this information. Immediately after I stop talking the machine will stop. Choose one of the five answers and press the corresponding button.

Correct, to solder a connection we need heat and solder.

Soldering Techniques
Job #78509-100

SLIDE 5

The source of heat used is the soldering iron, which has a heating element. This soldering iron provides approximately one thousand degrees of heat to be used in the soldering process.

SLIDE 6

The solder used for electronic work is a small wire-like material which comes rolled on a spool. Solder is a special mixture of metals designed to melt at fairly low temperatures.

Soldering Techniques
Job #78509-100

SLIDE 7

The soldering iron is composed of three main parts. They are: the tip, which actually does the heating of the connections; the shank, which houses the heating element, and the handle which provides a means of holding the soldering iron during the soldering operation.

SLIDE 8

Warning! The tip and shank of the soldering iron are extremely hot. Do not touch them with your bare hand. Do not lay the iron down so that you might brush up against it. This soldering iron is completely safe if you use it right. There is no reason to be afraid of it if you handle it properly.

SLIDE-AUDIO VS SLIDE-BOOKLET MEDIA FOR TEACHING SOLDERING TECHNIQUES

by

KANDULA SURENDER REDDY

M. Sc. (Tech.), Osmania University, India, 1965

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Industrial Engineering

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1968

An attempt was made to show that a slide-booklet medium of program presentation was better than a slide-audio medium for teaching "Soldering Techniques." Sixteen female operators from the Western Electric Plant, Lee's Summit, Missouri, were volunteered as subjects. Half used the slide-audio medium and half used the slide-booklet medium. Times to answer the tests, and the scores obtained on the written, performance and quality discrimination tests, cost of equipment, and an opinionnaire survey were used to evaluate the results.

Both media were equally effective. There was no significant ($p < .05$) difference between the two groups in scores or times for the different tests. Presentation costs for the slide-audio medium were higher than for slide-booklet presentation.