R E P O R T   R E S U M E S

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THE DEVELOPMENT AND TESTING OF A POLYSENSORY INSTRUCTIONAL SYSTEM FOR TEACHING KNOWLEDGES AND SKILLS ASSOCIATED WITH THE USE OF EXPANDABLE POLYSTYRENE PLASTICS. REPORT NO. 18.

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REPORT NUMBER BR-7-0031   PUB DATE   JUN 68
WASHINGTON STATE COORD. COUNCIL FOR OCCUP. EDUC.
GRANT   OEG-4-7-070031-1626
EDRS PRICE MF-$0.50 HC-$2.72   66P.

DESCRIPTORS- SINGLE CONCEPT FILMS, PROGRAMED TEXTS, *INSTRUCTIONAL TECHNOLOGY, *PLASTICS, HIGH SCHOOLS, *SKILL DEVELOPMENT, COMPARATIVE ANALYSIS, EDUCATIONAL EXPERIMENTS, *AUTOINSTRUCTIONAL AIDS, ABILITY GROUPING, STUDENT EXPERIENCE, SCHOOL SHOPS, *INDUSTRIAL ARTS, WASHINGTON,

THIRTY STUDENTS IN GRADES 6 THROUGH 12 CLASSIFIED INTO HIGH, AVERAGE, AND LOW ABILITY GROUPS, USED EXPANDABLE POLYSTYRENE PLASTICS AND EQUIPMENT TO CONSTRUCT A FOAMED RUBBER ICE BUCKET TO PROVIDE AN INDICATOR OF THE SUCCESS OF THE POLYSENSORY SELF-INSTRUCTIONAL SYSTEM DEVELOPED FOR THIS EXPERIMENT. A PRETEST DETERMINED EXISTING KNOWLEDGES AND PROFICIENCIES. SINGLE CONCEPT FILMS, PROGRAMED INSTRUCTION BOOKS, LABORATORY EXPERIENCES, AND A TEACHER'S GUIDE WERE DEVELOPED FOR EACH OF FOUR INSTRUCTIONAL UNITS. CAPABILITIES OF THE SYSTEM TO HELP PUPILS ACQUIRE DEFINED LEVELS OF KNOWLEDGE AND SKILLS WERE EVALUATED BY ANALYZING--(1) PERFORMANCE TEST SCORES, (2) KNOWLEDGE TEST SCORES, (3) NUMBERS OF TIMES FILMS WERE REVIEWED, (4) ERRORS MADE IN THE PROGRAMED BOOKS, (5) STUDENT WORK PROCEDURES, (6) QUALITY OF FINISHED POLYSTYRENE PRODUCT, AND (7) THE PERFORMANCE DIFFERENCES BETWEEN AND WITHIN THREE ABILITY LEVELS. RESULTS INDICATED--(1) LABORATORY PERFORMANCE SCORES EXCEEDED THOSE DEFINED AS ADEQUATE, (2) PERFORMANCE SCORE VARIATION AND TIME VARIATION WERE AS GREAT WITHIN ABILITY GROUPS AS BETWEEN THESE GROUPS, (3) HIGH ABILITY GROUPS VIEWED THE FILMS MOST OFTEN AND LOW ABILITY GROUPS LEAST OFTEN, AND (4) THE QUALITY OF PRODUCTS PRODUCED INDICATED THAT ALL STUDENTS PERFORMED IN EXCESS OF MINIMUM ACCEPTABLE CRITERIA. IT WAS CONCLUDED THAT SUCH POLYSENSORY SELF-INSTRUCTIONAL SYSTEMS CAN BE EFFECTIVELY USED TO TEACH ALL TYPES OF KNOWLEDGES AND SKILLS SUCH AS THOSE STUDIED. AN EXTENSIVE BIBLIOGRAPHY IS INCLUDED. (EM)

ED019512

FINAL REPORT
Project No. OE7-0031
Contract No. OEG-4-7-070031-1626
Report No. 18

The Development and Testing of a Polysensory Instructional System for Teaching Knowledges and Skills Associated With the Use of Expandable Polystyrene Plastics

June 1968

U. S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education
Bureau of Research

VT005549

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Contract No. OEG-4-7-070031-1626
Report No. 18

by

Dale LeRoy Nish

June 1968

The research reported herein was performed pursuant to a contract with the Office of Education, U. S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

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CONTENTS

Page

ACKNOWLEDGEMENTS v

LIST OF TABLES iv

SUMMARY 1

Chapter

I. INTRODUCTION 3

Background of the Study 3
The Nature of the Polysensory Instructional System . 4
Significance of the Study 6
Statement of the Problem 6
Definition of Terms 7

II. REVIEW OF RELATED DEVELOPMENTS AND RESEARCH 10

Studies Related to Motion Pictures 13
Studies Related to Programmed Instruction 15
Studies Related to Laboratory Work 16

III. RESEARCH DESIGN AND PROCEDURES 21

Design of the Study 21
The Polysensory Instructional System 22
General Conditions 22
Operational Objectives 23
Behavioral Objectives 23
Instructional Components 24
Evaluation Procedures 27
Administration and Use of the Polysensory Instructional System 29
Statistical Procedures 31
Population 31
Limitations 31

IV. FINDINGS 33

Performance Scores on Laboratory Work 35
Time Used for Laboratory Work 39
Frequency of Film Viewing 45
Student Errors in Programmed Instruction Books . . . 46
Student Evaluation of Work 47

Page

V. CONCLUSIONS 49

Results 50
Conclusions 50
Implications 51

BIBLIOGRAPHY 53

APPENDIX

A. JURY FOR EVALUATING INSTRUCTIONAL PROCEDURES AND APPROACHES USED IN THE SINGLE-CONCEPT FILMS AND PROGRAMMED INSTRUCTION BOOKS 58

JURY FOR EVALUATING CONTENT OF SINGLE-CONCEPT FILMS . 58

B. RAW DATA COLLECTED IN THE STUDY 59

LIST OF TABLES

Table		Page
1.	Performance Pretest Scores	33
2.	Knowledge Pretest Scores	34
3.	Performance Scores of Students Pre-expanding Raw Expandable Polystyrene Beads	35
4.	Performance Scores of Students Disassembling and Preparing the Mold	36
5.	Performance Scores of Students Molding the Pre-expanded Beads	37
6.	Performance Scores of Students Removing the Foamed Object from the Mold	38
7.	Total Performance Scores of Student Performance of Laboratory Work	39
8.	Time Used by Students Pre-expanding the Raw Polystyrene Beads	40
9.	Time Used by Students to Prepare and Assemble the Mold	41
10.	Time Used by Students to Mold the Pre-expanded Beads	42
11.	Time Used by Students to Remove the Foamed Object from the Mold	43
12.	Total Time Used to Perform the Laboratory Work	44
13.	Frequency of Film Viewing	45
14.	Total Student Errors in the Programmed Instruction Books	46
15.	Student Evaluation of the Foamed Object	47
16.	Raw Data Collected in the Study	59

ACKNOWLEDGEMENTS

The author wishes to acknowledge his debt to Dr. William A. Bakamis and Dr. Arnold M. Gallegos for advice and technical assistance. He also expresses his appreciation to Ernest G. Kramer, Washington State Director of Occupational Education, for encouraging development of improved occupational educational practices.

SUMMARY

The purpose of this study was to develop an experimental self-instructional system to provide evidence about the degrees to which, and the amounts of time in which, such a system enables pupils with varying abilities to acquire certain types of knowledges and skills. Answers were also sought to the following questions: (1) How much student time is needed to complete such an instructional system? (2) How much repetition is necessary to acquire defined levels of knowledge and skills? (3) What difficulties do students experience in use of the system?

The experiment involved use of expandable polystyrene plastics and equipment to construct a foamed rubber object (ice bucket). Thirty students enrolled in grades six through twelve were subjects of this study.

To study the effect of varying mental abilities on results, subjects were divided into three groups classified as high, average and low on the basis of scores on the Numerical and Verbal Sections of the Differential Aptitudes Test (Form L).

The polysensory self-instructional system developed for this experiment included four sub-systems each consisting of single-concept audio films, a programmed instruction book, laboratory experiences and a teacher's guide. Each sub-system was designed to enable pupils to acquire pre-defined levels of knowledge and skill.

All students were administered pretests to determine existing knowledges and proficiencies.

As a group, students received an orientation to the plastics industry. Students were then directed to proceed with the system on an individual basis.

Individualized self-instruction consisted of viewing single-concept films, completing programmed instruction books and performing the laboratory work. This sequence was repeated for each of the four instructional units of the system.

Capabilities of the system to help pupils acquire defined levels of knowledge and skills was evaluated by analyzing results of the following variables: performance test scores, knowledge

test scores, numbers of times films were viewed, errors made in the programmed instruction books, evaluation of students' work procedures and the quality of the foamed objects they produced. Performance between and within the three ability groups were compared.

Results show that:

Performance scores on laboratory work exceeded those defined as adequate.

Variation of performance scores within ability groups was as great as between groups.

Performance time varied as much within ability groups as between groups with the maximum time needed for performance being approximately two and one-half times the minimum time required.

Frequency of film viewing varied between ability groups, with the high ability groups viewing the films most often and the low ability groups viewing the films least often.

Evaluation of the foamed objects indicated that all students performed at a level exceeding minimum acceptable performance criteria.

The findings indicate that such polysensory self-instructional systems can be effectively used to teach types of knowledges and skills such as those associated with the use of expandable polystyrene plastics.

Chapter I

INTRODUCTION

Background of the Study

In recent years educational technology has been improved by the development of 16mm films, projection equipment and programmed materials.

After World War II, and especially during the 1950's and 1960's, systematic improvement of educational technology became a subject of national concern. Forces affecting that interest included sharp increases in enrollments, increased demand on inadequate teacher supply and educational facilities, the knowledge explosion, technological change, drop-outs, unemployment and a concern with national defense. At present a rising demand for individuals possessing advanced skills, and national efforts to surmount poverty have accentuated that interest. The increasing numbers of children, youth and adults seeking further education also increase the need to make instruction more efficient.

Major educational needs of youth and the nation can be served by development of more effective instructional systems. Evolving elements of educational technology provide concepts and techniques for such development.

Slaughter has noted that "the realization of the potential contribution of technology to education will depend. . .upon the research and development effort put behind the planning and production of systems of technology."[1]

> . . . educational technology . . . seems likely to grow in certain directions. One unmistakable direction will be the development of educational technology on a systems basis, with close and direct relevance to the purposes of education and objectives of instruction with a maximum contribution being made by each component of the technology to the end result obtained with the system.[2]

Numerous studies have demonstrated that sound films may be successfully employed to facilitate learning the performance of a perceptual-motor task.

Vandermeer[3] found that the use of demonstration films reduced training time and enabled pupils to acquire large amounts of factual information about engine lathe operation. He suggested that the use of films be further explored, that media other than films be tried, and that the media be adapted to individualized training. Studies by Roshal[4], Harby[5], and Vandermeer and Cogswell[6] further demonstrated the effectiveness of films in teaching psychomotor skills.

Single-concepts films appear to be exceptionally useful instructional media. These are short films, usually running from three to five minutes. Such a film presents only one, or a few, major concepts. The film forms a continuous loop which is housed in a special cartridge, thus permitting students to use it repeatedly without rewinding.

At present loop films are used by industry, schools and the armed forces. However, much research necessary to ascertain their effectiveness in teaching knowledges and skills is needed. Gerlach and Vergis[7] and Meierhenry[8], have indicated a need for experimental combinations of single-concept films and audio information. Single-concept films and audio commentary can serve as elements of polysensory system instructional systems.

Further, while technological innovation rapidly is becoming part of our society, the authors of this study assumed that educational research can beneficially experiment with the new combinations of old and new instructional procedures. For example, selected laboratory experiences along with films and programmed materials can serve as elements of systems enabling pupils to learn through combinations of kinesthetic, visual and auditory senses. This combination would employ several senses to promote learning.

The Nature of the Polysensory Instructional System

Polysensory systems are designed to utilize several senses in the learning process.

McPherson[9], notes three basic characteristics of a learning system. First, instruction be planned in terms of an educational ecology. Relationships of subject areas and learning tasks must be defined. Instructional methods and materials should utilize the best available knowledge about the means of giving each individual the kinds of experiences most likely to result in desired learnings. The purpose is to make all of education a systematic whole for learners. Various specialists can make essential contributions to systems development.

A second characteristic of a system is detailed analysis of (1) learning objectives specific to the subject field and to the learners, (2) the kinds of learning activities which must be carried on in order to gain these objectives, and (3) methods and media which will enable learners to engage in appropriate learning activities.

A third systems characteristic is that required learning resources must be arranged and utilized in ways that make it possible for learners to engage in activities designed to help pupils achieve each selected learning objective. This requires experimental development of learning system resources, appraisal of their use, and redesign of systems until they enable pupils to reach objectives.

McPherson suggests that systems require precise stipulation of objectives, resources, alternatives, and criteria. Proposed modes of organization then may be derived and structured. The selected mode should permit the allocation of various choices to be applied to a particular problem. It also may imply new techniques, equipment and facilities better suited to a specific objective.

A strength of the systems-concept lies in the analysis of alternate pathways through which the desired terminal objectives may be attained. The paths through which the objectives may be realized may range from the use of a combination of media for mass instruction, including components such as films or video tape, to selected media for individual instruction such as language laboratories, programmed learning and other individual response systems.

A system may require the integration of machines with teaching teams. Since the aim is greater productivity without sacrificing standards of quality, it also may involve the use of labor-saving devices such as computers for rapid data acquisition and analysis.

McPherson also suggests that to perform the analysis necessary for system development, several steps are involved. One must ask questions such as the following:

1. What is the system under study?
    a. What are the educational processes to be implemented?
    b. What are the characteristics of the learners?
2. What is the system supposed to do?
    a. What are the educational objectives of the system?
    b. What are the financial and environmental factors involved?
3. How is the system intended to perform its functions?
    a. What facilities are available?
    b. What are the possible media options?

c. What methods will best present the instructional materials?
d. With what materials is the educational system involved?
4. What individual functions are specific components intended to achieve?
5. How can performance be measured and evaluated?
6. What are the criteria for acceptable performance of the tasks?

Continual evaluation is necessary. By defining and stating objectives--the prerequisites of evaluation--and by a continual evaluation of the program and the materials being used, systems become tools for improvement of instruction.

Significance of the Study

Studies have been conducted which indicate that certain kinds of learning are facilitated when several senses are involved in the learning process. This study is intended to provide additional evidence about the potential of a polysenstory system to enlarge the performance capabilities of pupils possessing three levels of ability--low, average, high. Thus, the polysensory system developed for this study is designed to utilize several senses through the varied combination of educational media. Inherent in the polysensory system are several other roles which may have potential bearing on educational processes. Some of these roles may be:

1. To provide increased teacher time for individual instruction.
2. To more fully utilize various media for giving pupils access to information.
3. To provide for individual differences in rate of learning and assimilation of information.
4. To enlarge the self-instructional dimensions and means of facilitating continuous student progress.
5. To reinforce manipulative information be providing for student participation in laboratory or work experiences.

Statement of the Problem

The problem of this research was to answer the question: "To what degrees and in what amounts of time does a polysensory instructional system enable pupils with varying abilities to acquire knowledges and skills associated with use of expandable polystyrene plastics?" Further, answers were sought to the following questions as related to the use of expandable polystyrene plastics:

1. How much student time is needed to complete a polysensory system of instruction?
2. How much repetition is necessary for successful performance of the construction of the expandable polystyrene object?
3. In what respects do students experience difficulty in use of the system?

Definition of Terms

Polysensory Instructional System

The term polysensory instructional system signifies various combinations of instructional materials and processes with each component, making a maximum contribtuion to specified educational objectives. This concept emphasizes utilization of as many senses of the student as is feasible to maximize learning and to facilitate instruction.

Single-Concept Loop Films

Single-concept loop films are color and sound films. They are in a continuous loop enclosed in a plastic cartridge which allows students to view each film as often as they desire without rewinding the film. The films illustrate the basic knowledges and skills necessary for the production of an expandable polystyrene foamed object. The audio portion of the film reinforces what the student views in the film.

Programmed Instruction Books

Programmed instruction books are programmed teaching and self-testing devices. They are designed to help each student test and at the same time reinforce his own learning of the knowledges presented by the films. If a student should choose an incorrect answer to a test question, the book provides remedial information. For example, a remedial frame will (1) tell him why is was wrong; (2) give the correct answer; and (3) provide him another opportunity to answer the original question. If the student then should choose the correct answer, he is referred to the next question. If, however, he should choose a second incorrect answer, he is directed to view the film again.

Laboratory Experience (Project Work)

Laboratory experiences are those which provide the student with an opportunity to apply knowledge he has acquired from the films and programmed instruction book. Laboratory experiences were components of each of the four units. Upon satisfactory completion of each programmed instruction book, the student is directed to perform related laboratory work in a manner similar to processes shown in the films. Safe and proper use of equipment is required of the student at all times.

High Ability

Students whose total scores on the Numerical and Verbal sections of the Differential Aptitude Test (Form L) are from the 75 to 100 percentile are classed as high ability.

Average Ability

Students whose total scores on the Numerical and Verbal sections of the Differential Aptitude Test (Form L) are from 26 to 74 percentile are classed as average ability.

Low Ability

Students whose total scores on the Numerical and Verbal sections of the Differential Aptitude Test (Form L) are from the 0 to 25 percentile are classed as low ability.

Minimum Acceptable Performance

A score determined to be 75 per cent of the maximum possible score for the performance of laboratory work in an instructional unit is classed as minimum acceptable performance.

Footnote References--Chapter I

[1] Robert E. Slaughter, Technology in Education (Washington, D.C.: U.S. Government Printing Office, 1966), p. 5.

[2] Ibid., p.6

[3] A.W. Vandermeer, "The Economy of Time in Industrial Training: An Experimental Study of the Use of Sound Films in the Training of Engine Lathe Operators," Journal of Educational Psychology, XXXVI (February, 1945), 65-90.

[4] Sol M. Roschal, "Effects of Learner Representation in Film-Mediated-Perceptual-Motor Learning," Technical Report 269-7-5, Pennsylvania State College Special Devices Center, Port Washington, L.I., N.Y., 1949.

[5] S.F. Harby, "Evaluation of a Procedure for Using Daylight Projection of Film Loops in Teaching Skills," Human Engineering Report 269-7-25, Pennsylvania State College Special Devices Center, Port Washington, L.I., N.Y., 1944.

[6] A.W. Vandermeer and John Cogswell, "Instructional Effect of the Film: How to Operate the Army 16mm Sound Projector Set." Technical Report SDC 269-7-29, Pennsylvania State University Special Devices Center, Port Washington, L.I., N.Y., 1952.

[7] Vernon S. Gerlach and John M. Vergis, "Self-Instructional Motion Pictures," AV Communications Review, XIII (September-October, 1965), 196-204.

[8] Wesley C. Meierhenry (ed.), "Needed Research in the Introduction and Use of Audio Visual Materials: A Special Report, "AV Communication Review, X (November-December, 1962), 307-316.

[9] J.J. McPherson, "Let's Look at the Systems Concept of Educational Planning," Educational Media Branch, Office of Health, Education and Welfare, Washington, D.C. (n.d.), pp. 2-4.

Chapter II

REVIEW OF RELATED DEVELOPMENTS AND RESEARCH

Educational technology is as old as education itself. From its inception, some means or techniques of instruction and learning have been used, and in a broad sense these have constituted educational technology.

In the 1950's and 1960's educational technology took rapid strides forward. Signigicant advances and developments were evident. According to Slaughter, these developments included:

1. Open and closed-circuit educational television.
2. Video tape recordings and equipment.
3. Computerized instruction and student testing, evaluation and guidance systems.
4. Information storage, retrieval and distribution systems.
5. Programmed instruction.
6. Teaching machines.
7. 8-mm film, printing and projection equipment.
8. Microfilm and microfilm viewing equipment.
9. Language laboratories.
10. Systems approach to the development and utilization of educational technology.[1]

Slaughter further notes that:

> The realization of the potential contribution of technology to education will depend upon the perspective and successful development of systems of technology, in which each component in nature and function as part of the system makes a synergistic contribution to the total result obtained by the system.
>
> Educational technology . . . seems likely to grow in certain directions. One probable direction will be the development of educational technology on a systems basis, with a close and direct relevance to the purposes of education and objectives of instruction and with a

> maximum contribution being made by each component. . . to the end result obtained by the system.[2]

Educational technology, systems approach, polysensory instructional system: What are the essential characteristics of these terms?

Heinich states:

> The systems approach requires examination of a process as an entity with cognizance of the relationships involved in and among all components. It starts with specification of objectives, proceeds through the necessary operations, evaluates the end product in terms of these objectives, and modifies the system if found wanting.[3]

Carpenter suggests:

> A systems design for an educational enterprise would provide: a conceptual framework for planning, orderly consideration of functions and resources, including personnel and technical facilities . . . the kinds and amounts of resources needed, and a phased and ordered sequence of events leading to the accomplishment of specified and operationally defined achievements. A systems approach should provide a way of checking on the relation of performances of all components to factors of economy and should reveal any inadequacies of the several components, including the faults of timing and consequently of the entire system.[4]

A definition offered by Donald Stewart offers another version of a system. He states:

> A learning systems approach is a effort to organize and condense those necessary or desired experiences as concisely and systematically as possible so as to increase the probability that learning will occur in an efficient manner. A learning Systems Concept, when applied to educational or training courses offers an opportunity to develop or rebuild these courses to be significantly more effective and efficient in relation to the learning tasks and goals of the students.[5]

From these definitions and the significant advance of educational technology, it seems clear that systems have been with us a long time, and that they are here to stay.

Perhaps the earliest reference to the systems approach was by

James D. Finn.[6] In this editorial he compared public school practices to the systems concept of industry.

Later developments culminated in other authors specifying the actual steps in systems construction. Leslie J. Briggs suggests that the following steps be followed in the design of instruction:

1. Selecting and defining the objectives of instruction and stating them in terms of behavioral outcomes expected of the students.
2. Sequencing the objectives in such a way that component or prerequisite knowledge is acquired prior to more complex learning.
3. Identifying for each objective the type of learning represented.
4. Listing for each objective the sequence of instructional events which would provide the general conditions of learning required for the type of learning represented by the objectives.
5. Identifying for each instructional event the nature of the stimuli (such as intensity, duration, and requirement for motion).
6. Identifying tentatively the optimum medium for presenting each stimulus described in the preceding steps.
7. Reviewing sequences of objectives in an overall fashion in order to make media choices that would permit use of one medium of presentation for a reasonable length of time before changing to another medium during the instruction.
8. Writing specifications representing instructions to the specialist who will prepare material for each medium.[7]

Other writers such as Heinich,[8] Gagné,[9] Allen,[10] and Morrill[11] view the steps as listed above as useful. Many possible variations are recognized.

The media selected for use in a typical polysensory instructional system are chosen with the intent of involving the maximum number of senses in the learning process. According to Silvern, learning involves the visual, aural, tactual, olfactory, and gustatory senses. He suggests that approximately:

85% of learning is through the visual sense.
10% of learning is through the aural sense.
3% of learning is through the tactual sense.
1% of learning is through the olfactory sense.
1% of learning is through the gustatory sense.[12]

Much research has dealt with self-instructional programs. A variety of media has been utilized for experimental presentation of instructional materials. Some research has compared the effects of various media in teaching mechanical skills and has sought to identify specific training problems in industry and the armed services. Many of these studies were related to the operation of one piece of equipment. Demonstration devices were presented in which the student was expected to respond by performing the demonstrated task. In most, cases, task performance began immediately after the presentation of the instruction.

As this study was primarily concerned with the combination of aural, visual, and tactual senses, the media selected were those which were felt to be most adequate for presenting instructional materials to maximize learning via these senses. Accordingly, this review of literature has been organized in three sections: (1) motion picture film research; (2) programmed instruction research; and (3) participation of the learners in task performance.

Studies Related to Motion Pictures

Many studies have demonstrated that sound film may be successfully employed to facilitate the learning of a perceptual-motor skill.

Vandermeer[13] found that the use of demonstration films reduced training time and produced more factual information about lathe operation. He further suggested that other studies exploring the use of films be used in training operators of other types of machines, that media other than films be used, and that media be adapted to individualized training.

A study conducted by Harby, Murnin, and Hayes[14] concluded that learning from film-taught groups did occur to a significant extent. They also found that by using daylight projection of film loops, instructors with a minimum of training and experience could teach perceptual-motor skills with an effectiveness approaching that achieved by expert instructors using live demonstrations.

Beck and Lumsdaine[15] used an exploratory comparison of two methods of teaching the assembly and disassembly of a portable radar station. The methods consisted of (1) a film and (2) a competent instructor using a scale model. The results indicated that the film was at least as effective as a comparable lecture-demonstration by a highly competent instructor. This would seem to indicate that film would likely be much more effective than an average or poor instructor. Other observations were that the film group performed more as a team and required less additional on-the-job instruction.

Roshal found that "the learning of a perceptual-motor task (knot tying) through films, will be more effective as the film approaches a representation of the learner himself performing the act to be learned."[16] He also concluded that a film was more effective when it showed all of the movements in performing the task than when it showed static shots of successive stages of task performance.

Jaspen[17] conducted a study in which films were used to teach assembly of the breechblock of the 40 mm antiaircraft gun. The films showed common errors to be avoided as well as the nomenclature of the parts of the breechblock. He found that showing potential errors in addition to demonstrating the proper procedure was markedly superior to demonstrating proper procedure only. He also found that technical nomenclature may not aid learning. In another study, Jaspen[18] found that a slow rate of film development and requiring audience participation was an effective procedure.

Nelson and Moll[19] conducted a study dealing with the relative contributions to learning made by (1) auditory channel, (2) visual channel, and (3) visual and auditory combination in instructional films. They found that the auditory was least effective, and a combination of visual and auditory channels was much more effective than either one alone. The evidence supported the fact that even in films in which the narration apparently contained the greater part of the material to be learned, the visual element was almost as effective in communicating the material as was the narration.

Several studies approached the problem of optimum verbalization in instructional films. Jaspen systematically studied high (142) words per minute of film and very low (45) words per minute of film. He concluded that "the relationship between the level of effectiveness of the film and level of verbalization appeared to be curvilinear, with the apex of the curve at the medium level (97) words per minute of film."[20]

Zuckerman[21] also found that some verbal description assists the learner, but may be increased until it interferes with and actually reduces learning. He stated that directive statements using the imperative mood or second person active were the most effective as verbal description. Another conclusion of this study was that films with sound leading the picture (slightly preceding the visual representation it describes) were superior to films in which the commentary followed slightly behind the visual representation on the screen.

A study conducted by Neu[22] investigated the effectiveness of devices used to draw attention to particular points of content in a film. He found that where instruction is the principal aim, producers of training films should present the subject matter in a simple, straightforward way, and avoid the use of devices such as spotlighting, zooms, extreme magnification, and stop motion to gain the learner's attention.

Studies Related to Programmed Instruction

An examination of studies dealing with programmed instruction was made because of the use of programmed instruction in the poly-sensory instructional system. Many programs of various subject areas have been developed and are in use. These studies help to contribute to an understanding of programmed instruction as it is used in this system. Comparative in nature, they considered similarities and differences of programmed instruction and traditional methods of instruction.

According to Schram:

> There has been a considerable amount of research on programmed instruction--probably somewhere near 100 experiments. Indeed, no teaching medium has ever come into use in such an atmosphere of research.[23]

He goes on to say:

> This research leaves us in no doubt that programs do teach. A great deal of learning seems to take place, regardless of the kind of program or the kind of students. Even a bad program is a pretty good teacher. Programs have been used successfully at all levels of the educational system, at all levels of ability from slow learners to the very best students, and to teach a great variety of academic subject matter and verbal and manual skills.
>
> We can accept confidently, therefore, that programs do teach. But how they teach, and what combinations of characteristics make them teach better, is still much in doubt.[24]

Two basic patterns of programming are currently being used. According to Trow,[25] they are the "Skinnerian" or linear program and the "Crowder" or branching program. The essential elements of the linear program are: (1) an ordered sequence of stimulus items, (2) student recall and response in a specified way, (3) responses reinforced by immediate knowledge of results, (4) progress by small steps, (5) mostly correct responses, and (6) movement from what the student knows by a process of successively closer approximation toward what he is supposed to have learned from the program.

The Crowder, or branching theory, is characterized by (1) large masses of information; (2) provision of relatively few responses; (3) student response in a specified way; (4) stress on recognition of correct response; (5) response-determined route which may result in the following of any one of several branches; and (6) utilization of errors to provide for individual learning needs.

Some research indicates there might be an optimum size of step for different students, and that the solution might lie in branching--introducing remedial frames or review passages into a program for learners who need them--while permitting the others to omit the extra practice. This is one of the advantages claimed for Crowder programming, where it can be handled more easily than in Skinnerian programs.

Another essential difference in the two techniques is the programmer's purpose in eliciting the response from the student. The linear program requests the response because it is believed to be an essential part of the learning process. Once the response has been made, it has served its purpose. In the branching program, the response is elicited in order to see if the student has learned, because this information will be used to determine whether the next point is to be presented or whether additional material on the previous point is required.

Studies Related to Laboratory Work

A study by Maccoby and Sheffield[26] sought to determine the optimum relationship between the length and number of demonstration periods and practice opportunities utilizing demonstration films. They concluded that with lengthy sequential tasks, practice is particularly useful if it follows demonstration segments which constitute natural units of the task. They also observed that the optimum use of practice probably involves transition from smaller to larger segments of the task, with the aim being to maximize the initial practice, and to promote integration of the task as a whole.

During the investigation of the effectiveness of slides for teaching perceptual-motor skills, Lichtblau's most significant conclusion was that:

> When the sole aim of the slide set is to teach a specific perceptual-motor skill as applied in one situation, no explanations of why certain procedures

are to be followed should be included unless the explanations are absolutely essential to follow the rote procedure.[27]

Other variables--such as using the same tools as the student would be using, using attention-gaining devices such as arrows, placing only one thought in a frame, including a summary, and including a motivation section--failed to show a significant difference.

LeMaster[28] conducted a study in which the purpose was to determine the effect on pupil learning of specially prepared filmed demonstrations of selected teaching units in woodworking, when presented to the class before the manipulative skill was performed by the instructor. They concluded that film reinforcement to the manual class demonstration (1) enables pupils to learn more technical information, (2) enables pupils to understand and apply the manipulative skill processes more efficiently, and (3) reduces repeat demonstrations (both small group and individual) required of the instructor.

Footnote References--Chapter II

[1]Slaughter, p. 3.   [2]Ibid., p. 4.

[3]Robert Heinich, "Application of Systems Thinking to Instruction," The Systems Engineering of Education, II (Los Angeles: University of Southern California, 1965), pg. 4.

[4]C. R. Carpenter, "Approaches to Promising Areas of Research in the Field of Instructional Television," New Teaching Aids for the American Classroom (Stanford University: The Institute for for Communications Research, 1960).

[5]Donald K. Stewart, "A Learning Systems Concept as Applied to Courses in Education and Training." (Unpublished paper, Articualted Instructional Media Program, University of Wisconsin, Madison, 1964), p. 7.

[6]James D. Finn, "Audio-Visual Development and the Concept of Systems," Teaching Tools, III (Fall, 1956), p. 163.

[7]Leslie J. Briggs, "A Procedure for the Design of Multi-Media Instruction," AV Instruction, XII (March, 1967), 228.

[8]Heinich, p. 4.

[9]Robert M. Gagné (ed.), Psychological Principles in System Development. (New York: Holt, Rinehart and Winston, Inc., 1962), p. 4.

[10]W. H. Allen, "Media Stimulus and Types of Learning," AV Instruction, XII (January, 1967), 30.

[11]Charles S. Morrill, "Setting Programmed Instruction Objectives Using Systems Methodology," Trends in Programmed Instruction (Washington, D.C.: National Education Association, 1964), pp. 51-52.

[12]Leonard C. Silvern, Testbook in Methods of Instruction, 2d ed., (Los Angeles: Hughes Aircraft Company, 1962), p. 44.

[13]Vandermeer, pp. 65-90.

[14]S. F. Harby, J. A. Murnin and W. Hayes, "Daylight Projection of Film Loops as the Teaching Medium in Perceptual-Motor Skill Training," Technical Report 269-7-26, Pennsylvania State University Special Devices Center, Port Washington, L. I., N. Y., 1953.

[15] L. F. Beck and A. A. Lumsdaine, "The Comparison of Two Methods of Teaching the Assembly and Disassembly of a Portable Radar Station," Technical Report SPC 269-7-19. Instructional Film Research 1918-1950, Special Devices Center, Port Washington, L. I., N. Y., 1953.

[16] Roschal, p. 31.

[17] Nathan Jaspen, "Especially Designed Motion Pictures: I. Assembly of the 40 mm Breechblock. Technical Report SDC 269-7-19. Instructional Film Research 1918-1950. Special Devices Center, Port Washington, L. I., N. Y., 1951, pp. 8-9.

[18] Nathan Jaspen, "Effects of Training on Experimental Film Variables, Study II, Verbalization, Rate of Development, Nomenclature, Errors, How-It-Works, Repetition," Technical Report SDC 269-7-17, Instructional Film Research Program, Pennsylvania State College Special Devices Center, Port Washington, L.I., N. Y., 1952.

[19] H. E. Nelson and K. Moll, "Comparisons of the Audio and Video Elements of Instructional Films," Technical Report, SDC 269-7-18, Instructional Film Research Program, Pennsylvania State College, Special Devices Center, Port Washington, L. I., N. Y., 1950.

[20] Jaspen, 1952.

[21] J. V. Zuckerman, "Commentary Variations: Level of Verbalization, Personal Reference and Phase Relations in Instructional Films on Perceptual-Motor Tasks," Technical Report SDC 269-7-4, Instructional Film Research Program, Pennsylvania State College Special Devices Center, Port Washington, L. I., N. Y., 1949.

[22] D. Morgan Neu, "The Effect of Attention Gaining Devices on Film-Mediated Learning," Technical Report SDC 269-7-9, Instructional Film Research Program, Pennsylvania State College Special Devices Center, Port Washington, L. I., N. Y., 1950.

[23] Wilbur Schram, Programmed Instruction, Today and Tomorrow (New York: Fund for the Advancement of Education, Ford Foundation, 1962), pp. 11-12.

[24] Ibid., p. 4.

[25] William Clark Trow, Teacher and Technology, New Designs for Learning (New York: Appleton-Century-Crofts, 1963), pp. 96-102.

[26] Nathan Maccoby and Fred D. Sheffield, "Theory and Experimental Research on the Teaching of Complex Sequentian Procedures by Alternate Demonstration and Practice," Symposium on Air Force

Human Engineering, Personnel, and Training Research, Publication 516, National Academy of Sciences--National Research Council, Washington, D.C., 1958.

[27] Leonard R. Lichtblau, "Slides for Perceptual-Motor Skills: An Examination of Some of the Factors Which May Make Slides Effective in Teaching a Perceptual-Motor Skill in a Junior High School Industrial Arts Shop," (Unpublished doctoral dissertation, New York University, 1958).

[28] Lelan Kenneth LeMaster, "Filmed Demonstrations with Manual Class Demonstrations, v.s. Conventional Demonstration in Introductory Woodwork," (Unpublished doctoral dissertation, Pennsylvania State University, 1961).

Chapter III

RESEARCH DESIGN AND PROCEDURES

This experiment was designed to determine the feasibility of a polysensory instructional system for teaching knowledges and skills involved in the use of expandable polystyrene plastics. Emphasis was placed on evaluating results of utilizing several student senses in the learning process. The purpose of the study was not to determine if the polysensory instructional system was superior to other methods of instruction, but rather to determine the feasibility of the system for use as an alternate instructional method. Therefore, the study was not comparative in nature. Instead, minimum acceptable criteria were established by juries of experts and results of the study were evaluated in terms of those criteria. Comparison of the results with established criteria necessitated that instructional procedures and information presented by the media used in the system be the same for all students.

Each student worked in a laboratory setting with an instructor present at all times. The instructor was necessary to introduce the student to the system, to observe and record student performance, or to stop the student should performance become hazardous or detrimental to the equipment.

Design of the Study

This study was designed as follows:

1. A major instructional need was identified in the area of expandable polystyrene plastics.
2. A target population was selected.
3. Behavioral objectives were formulated.
4. Experimental instructional materials were developed. These consisted of: (a) a teacher's guide, (b) a student's guide, (c) single-concept sound loop films, (d) programmed instruction books, (e) laboratory experiences and equipment, (f) a comparison chart.
5. Evaluation instruments and procedures were developed. These consisted of: (a) a performance pretest, (b) a knowledge pretest, and (c) performance checklists.
6. The polysensory instructional system was tested.
7. The test results were analyzed and reported.

The Polysensory Instructional System

The system used in this study involved the use of the following components: (1) four programmed instruction books, (2) four single-concept audio loop films, (3) laboratory--shop--experiences in which students used materials and equipment to produce the plastic object as directed by the films and programmed books, and (4) a teacher's guide. All of those items are available from the Vocational Education ERIC Center, Ohio State University, Columbus, Ohio.

The system was designed to facilitate instruction by providing the necessary equipment, materials, and procedures for efficient and effective learning experiences for each student. The system was developed in the following manner:

1. The behavioral objectives were formulated and arranged in presumably logical sequence.
2. Types of learning involved in reaching each objective were identified.
3. Stimuli evoking each type of learning were identified.
4. The stimuli served as criteria for media options which would be useful in the polysensory instructional system.
5. Media for the polysensory instructional system then were chosen with regard to effectiveness of stimuli.

General Conditions

Due to the experimental nature of the system and the need for uniformity in the testing of the system, it was necessary to establish the general conditions under which the researcher and students were to function. These conditions were as follows:

1. Each student was given access to equipment and materials necessary to construct a foamed polystyrene object (in this case, an ice bucket).
2. Each student was responsible for selecting the equipment and materials necessary to complete the unit.
3. Each student worked individually except while two films were viewed. These films were shown to groups of students.
4. No student was allowed to proceed in an unsafe manner or in ways detrimental to the equipment.
5. Each student was required to perform in such a manner as to produce a foamed polystyrene object (ice bucket) of good quality.

The researcher was present at all times to observe and record student performance.

Operational Objective

The following operational objective was established to provide an indicator of the success of the polysensory instructional system: The student will acquire the capability to produce an expandable polystyrene foamed object (ice bucket). The objective served as a basis for determining criteria for evaluating the results of the total instruction presented in the four instructional units.

Behavioral Objectives

A list of skills, knowledges, and understandings necessary for using expandable polystyrene plastics was formulated. These skills, knowledges, and understandings then were stated in behavioral terms to specify the behavior of the learner upon completion of each instructional unit. The behavioral objectives also served as a basis for determining criteria for evaluating the success or failure of each unit. The objectives are:

1. Unit 1.--Pre-expansion of Expandable Polystyrene Beads.
   The student will acquire the capability to select the materials and equipment necessary for pre-expanding the raw expandable polystyrene beads.
   The students will be able to pre-expand raw expandable polystyrene beads.

2. Unit 2.--Preparation and Assembly of Mold.
   The student will acquire the capability to select the mold and necessary materials and equipment for preparing the mold.
   The student will be able to disassemble, prepare, and assemble the mold.

3. Unit 3.--Molding the Pre-expanded Polystyrene Beads.
   The student will acquire the capability to select the materials and equipment necessary for charging the mold.
   The student will be able to charge the mold.
   The student will be able to safely operate the autoclave.
   The student will be able to cool the mold and remove the mold from the autoclave.

4. Unit 4.--Removing the Foamed Piece.
   The student will acquire the capability to select the equipment necessary for removing the foamed piece from the mold.
   The student will be able to remove the foamed piece from the mold.

Instructional Components

To achieve the above objectives, the system used the following combinations of instructional materials and methods.

Tape-Filmstrip, "Talking Plastics"

A commercially produced filmstrip, "Talking Plastics," was used to give the students a consumer's viewpoint of the plastics industry and to provide them with a more common background regarding the kinds and uses of plastics. The filmstrip was 13 minutes in length and was accompanied by a tape commentary.

16 mm Film, "Born of Foam"

This commercially produced sound-color film, was shown to the students to provide them with a common knowledge of the industrial processes and applications of expandable polystyrene plastics. This film was 28 minutes in length.

Single-Concept Loop Films

Four single-concept loop films were produced. Each of the four films was designed to teach specific knowledges and procedures necessary to produce an expandable polystyrene foamed piece.

Each film formed a continuous loop and was enclosed in a plastic cartridge for use in the Fairchild Mark IV projector. The film loop cartridges used with the Mark IV projector made it possible for each student to view the films without rewinding, as often as he desired.

Concepts and processes presented in the films were evaluated by a jury consisting of three industrial chemists. Members of this jury are listed in Appendix A.

A script was written, revised, and recorded on the magnetic sound stripe on the film. Concepts presented in the films were reinforced by the audio commentary. Commentary was recorded in manners consistent with research regarding verbalization of films.

The films then were evaluated by a jury of educational experts for consistency with accepted criteria for instructional films. Jury members are listed in Appendix A. Films and content are as follows:

1. Film 1.--"Pre-expansion of Expandable Polystyrene Beads." The basic purpose of this film was to show the materials, equipment, and procedure for pre-expanding raw polystyrene beads since the raw polystyrene beads must be pre-expanded before they can be used to form the ice bucket.

2. Film 2.--"Preparation and Assembly of Mold." This film showed the materials, equipment, and procedure for preparing and assembling the ice bucket mold, a step necessary to prevent the foamed ice bucket from sticking in the mold.

3. Film 3.--"Molding the Pre-expanded Polystyrene Beads." Materials, equipment, and procedure for molding the pre-expanded beads into a foamed ice bucket were shown in this film. The molding process involved the use of the autoclave to provide the necessary heat and pressure for successfully molding the pre-expanded beads.

4. Film 4.--"Removing the Foamed Piece." This film showed the materials, equipment, and procedure for removing the foamed ice bucket with the use of air pressure. Use of air pressure for object removal is a common industrial practice in the manufacture of expandable polystyrene products.

Programmed Instruction Books

Four programmed instruction books were written--one to accompany each single-concept film. These books were developed according to currently acceptable standards for programmed instruction.

An evaluation of the content, organization, and format of the books was conducted by the same jury of educational experts which evaluated the single-concept films. Suggested revisions were made, and the revised books then were printed for use in the polysensory instructional system. These books were numbered and titled as follows:

1. Pre-expansion of Expandable Polystyrene Beads.
2. Preparation and Assembly of Mold.
3. Molding the Pre-expanded Polystyrene Beads.
4. Removing the Foamed Piece.

All four books were programmed learning and self-testing devices. They were designed specifically to help each student test his own learning of the knowledges presented in the films and at the same time to reinforce his learning. Should a student choose an incorrect answer to a test question, the book provided remedial information. For example, the remedial frame would (1) tell him why it was wrong, (2) give the correct answer, and (3) provide him another opportunity to answer the original question. Should the student choose the correct answer, the book referred him to the next question. But if he again were to choose an incorrect answer, he would be directed to review the appropriate film.

A summary of the information and procedures appeared on the last page of the programmed instruction book. After reviewing the summary of the information and procedures, the student had the option of (1) viewing the film again, (2) reviewing the programmed instruction book, or (3) proceeding to the next step. When the student was satisfied with his understanding of the information and procedures, he proceeded to the laboratory experience (project work) phase of the system.

Laboratory Experiences

The purpose of the laboratory experiences was to provide an opportunity for application of knowledges and capabilities the student had acquired from the films and programmed instruction books.

Laboratory experiences were planned for each of the four units. Upon completion of each programmed instruction book the student was directed to perform a phase of laboratory work in a manner similar to processes shown in the films.

Safe and proper use of equipment was required of the student at all times. These were illustrated by the films that were to be viewed by the student. It was the instructor's responsibility to make certain that these practices were followed.

Students neglecting to follow good safety practices or using the equipment in detrimental manners were stopped immediately by the instructor. The student then was told why he had been stopped and was asked to view the appropriate film again. After having reviewed the film the student continued with his work.

Teacher's Guide

A teacher's guide was designed primarily to help teachers become familiar with objectives and procedures involved with this system. It briefly outlines the use of plastics in industry, the purpose of the expandable polystyrene plastics unit, and the operation of the polysensory instructional system in plastics. Instructors were asked to study and follow the procedures as outlined.

Student's Guide

A student's guide was prepared to acquaint the student with the system. It outlined the purpose of the unit. Students were required to proceed according to the instructions outlined in a step-by-step order. The guide also provided a checklist for film student evaluation of the films and answer sheets for student response to items in the programmed instruction books.

Evaluation Procedures

Pretests

Two pretests were developed: a knowledge pretest and a performance pretest. Instructions were developed for administering and taking these tests.

The purpose of the knowledge pretest was to determine what the student knew about the equipment, materials, and procedures for the construction of an expandable polystyrene ice bucket. The 22 multiple choice questions appearing in the knowledge pretest are the same as those used in the programmed instruction books.

The performance pretest was designed to determine the capability of the student to select the necessary equipment and materials and his capability to perform the first two operations necessary for constructing the ice bucket. The first part required the student to discriminate between a number of materials and equipment placed before him on the table. He was to choose the necessary equipment and materials to prepare the raw polystyrene beads for construction of an ice bucket. If the student were to select the necessary equipment and materials, he then proceeded to the second part which required him to perform the operation of pre-expanding the raw polystyrene beads. Students who did not select the necessary equipment and materials omitted the second part of the test and proceeded to part three.

Part three consisted of selecting equipment and materials necessary for preparing the mold. Students selecting the correct equipment and materials proceeded to part four which required the student to disassemble, prepare and reassemble the mold for use in producing the ice bucket. A student failing to select the required equipment and materials was not asked to try part four of the performance pretest. Students were rated on the performance pretest by the use of a checklist which was administered and recorded by the researcher.

Evaluations were made by both the student and the instructor. In both cases, results were immediately available to the student.

These results determined whether the student proceeded to the next phase of work or repeated previous work to acquire knowledge he needed before continuing.

The instructor assured students that evaluation results would not be used to determine student grades, but would be used to help each student learn what he needed to do next to reach his objective.

Posttests

Two types of posttests, objective and performance, were built into the system. Objective tests for each unit were used to evaluate the student's knowledge of information obtained from viewing the films. These tests were incorporated into the programmed books. Student responses to questions were used to determine the succeeding steps for completing the programmed instruction books.

Performance tests for each instructional unit were used to evaluate the student's proficiency in performing tasks presented by the films. Performance of laboratory work was evaluated by the use of a performance checklist. A separate checklist was provided for each of the four instructional units. Each checklist was accompanied by instructions for its use and was administered by the instructor.

A jury of educational experts determined minimum acceptable performance scores for each of the four laboratory experiences. The jury decided that recorded scores would be those obtained by the student the first time he attempted the laboratory work. Later success would not alter the score.

The purpose of this study was to determine the amount of time necessary to complete the polysensory system. Consequently, no maximum time allowance was set for successful performance of the laboratory work.

Quality of the foamed object was evaluated by using a comparison chart. This chart showed photographs illustrating results of common mistakes. Causes and remedies were listed under each photograph or example. The student compared the product of his work with the illustrations shown on the chart and recorded his self-evaluation on the checklist.

Administration and Use of the Polysensory Instructional System

1. Pretests were administered to the class.
   The performance pretest was administered individually to each student. Materials and equipment needed for constructing the foamed piece were made accessible to the student at a work station.
   Knowledge pretests were administered to the students as a group. The test was a paper-and-pencil test consisting of 22 multiple-choice items and was administered according to the instructions accompanying the knowledge pretest.

2. The tape-filmstrip, "Talking Plastics," was shown to the group. Students were introduced to the tape-filmstrip by the instructor. No follow-up activities were conducted at the conclusion of the "Talking Plastics" presentation.

3. The 16 mm film, Born of Foam was presented immediately after the showing of the tape-filmstrip. No follow-up activities were planned for this film.

4. The necessary equipment and materials were assembled for presenting the expandable polystyrene process to the student. While facilities varied, every effort was made to ensure that all the equipment and materials were readily accessible to the student in close proximity to the work station. The following instructional equipment and materials were provided:

   a) Fairchild Mark IV Projector.
   b) Single-concept films:
      - Pre-expansion of Expandable Polystyrene Beads.
      - Preparation and Assembly of Mold.
      - Molding the Pre-expanded Polystyrene Beads.
      - Removing the Foamed Piece.
   c) Programmed instruction books:
      - Pre-expansion of Expandable Polystyrene Beads.
      - Preparation and Assembly of Mold.
      - Molding the Pre-expanded Polystyrene Beads.
      - Removing the Foamed Piece.

The materials, tools, and equipment listed below were provided for use in performing the laboratory experiences:

Raw Beads
Hot Plate
Pan
Airtight Container
Nut Driver
Screw Driver

- Screen
- Stirring Rod
- 3-Minute Timer
- Container of Water (at Least 3 Quarts)
- Paper Towels (1 Roll)
- Measuring Cup
- Ice Bucket Mold
- Wax
- Rags
- Air Nozzle (with Source of Compressed Air)
- The Ice Bucket Comparison Chart

5. The student was introduced to the system.
   Introduction of the student to the system began with the instructor showing the student where the equipment and materials were assembled. Students' questions regarding equipment and materials were answered.
   Use of the Fairchild Projector then was demonstrated to the student. If a student had learned previously how to use the projector, a brief review was used to verify his capability.
   Students were given the Student Guide and its use was explained by the instructor. As the student proceeded with work, the instructor was present at all times to answer questions or to provide help when the student no longer could proceed on his own; to make certain the student proceeded in a safe manner and one which was not detrimental to the equipment; and to record places in the system where the student was encountering difficulty.

6. The student's performance was evaluated.
   The performance checklists were contained in a 9 x 12 inch envelope marked Performance Checklists. Each envelope included the checklists needed to evaluate all four units of each student's work. The instructions which accompanied the checklists were followed by the instructor. Four evaluations of a student's performance were conducted. These evaluations were made while the student was completing each of the four units of laboratory work.
   Evaluations were made by the instructor with the use of a performance checklist. Complete instructions accompanied the checklist, and every effort was made to ensure instructions were followed. A separate evaluation was made of each of the following units of laboratory work.
   Unit 1--Pre-expansion of Expandable Polystyrene Beads--was checked during Step 3 in the student's guide.
   Unit 2--Preparation and Assembly of Mold--was checked during Step 6 in the student's guide.
   Unit 3--Molding the Pre-expanded Polystyrene Beads--was checked during Step 9 in the Student's guide.
   Unit 4--Removing the Foamed Piece--was checked during Step 12 in the student's guide.

7. The completed Student Guide and Performance Checklists were replaced in the 9 x 12 inch envelope marked Performance Checklists.
The envelope was sealed and the student's name written thereon. The sealed envelopes were filed until used for system evaluation.

8. After each student completed the system, equipment was cleaned and the work station was prepared for the next student.

Statistical Procedures

Numerical and Verbal sections of the Differential Aptitude Tests were administered to the population in this study. Results of these tests were used to place the students into three categories. High ability included those from the 75 to 100 percentile; average ability included those from 26 to 74 percentile; and low ability included those from 0 to 25 percentile.

Fifteen variables were studied to determine observable differences between the high, average, and low ability students.

Variables were recorded on frequency tables with the frequencies of occurrence being recorded in the appropriate spaces. These tables then were studied to determine observable differences within the three ability groups.

The variables were compared, when appropriate, with minimum acceptable criteria as determined by the jury of educational experts.

Population

Thirty students selected from two industrial arts classes constituted the population of this study. Fourteen students from the Anatone (Washington) School composed one class. Sixteen students from Pullman (Washington) High School composed the other class. Subjects ranged from the sixth through the twelfth grades. Five were seniors; ten, juniors; three, sophomores, eight, freshmen; two, eighth grade students; and two, sixth grade students.

Limitations

1. The procedure limited students to the two industrial arts classes and did not provide an equal number of students in the high, average, and low ability groups.

2. There was no way of controlling student learning outside of the instructional system between the time of pretesting and before student participation in the self-instructional part of the system; however, most of the information and procedures were not readily accessible to students outside the system.
3. Individual levels of motivation may have varied.
4. Student learning consisted primarily of knowledge and sequential operations or procedures.
5. Unequal numbers of students in the six grades were represented in the study.

Fifteen variables were studied to determine observable differences in the performance of high, average, and low ability students in response to their use of a polysensory instructional system designed to help them acquire knowledges and skills associated with use of expandable polystyrene plastics. The variables studied were students' knowledge pretest scores, performance pretest scores, performance scores on each of the four laboratory experiences, time needed to perform each of the four laboratory experiences, total performance scores for laboratory experiences, total time needed for laboratory experiences, number of times the films were viewed, mistakes made in use of the programmed instruction books, and evaluation of performance.

Chapter IV

FINDINGS

Student performance exceeded the expectations defined by minimum acceptable performance criteria established as the basis for testing the system. All students successfully completed the work required by the system. Amounts of time required for reaching the defined level of acceptable performance varied.

Observed scores on the performance pretest indicated that the students did not possess the capability to produce the foamed polystyrene object. During the administration of the pretest several students selected some correct items; however, the selection of incorrect items suggested that the students were unable to discriminate between those items which were necessary and those which were irrelevant. The majority of the students made no attempt to perform the necessary steps. They simply stated that they did not know how to utilize the equipment and materials to produce the object. Table I presents the student scores on the performance pretest by ability groups.

Table I

PERFORMANCE PRETEST SCORES

Score Intervals	Numbers of Pupils Scoring in Intervals		
	High Ability Group	Average Ability Group	Low Ability Group
0 - 2	5	16	9
3 - 5			
6 - 8			
9 - 11			
12			
Total Group Scores	5	16	9

Table 2 presents the student scores on the knowledge pretest. The knowledge pretest was a multiple-choice test of 22 questions by ability groups. Probability indicates that a student should have received a minimum score of 5.5 merely by guessing.

Observed scores indicate that the students did possess some knowledge of the expandable polystyrene plastics process; however, study of the responses indicated a slight knowledge of isolated pieces of equipment and its operation or slight knowledge of some materials and their uses.

Table 2

KNOWLEDGE PRETEST SCORES

Scores	Numbers of Pupils Scoring in Intervals		
	High Ability Group	Average Ability Group	Low Ability Group
2			1
3			
4			
5			2
6		1	
7		2	1
8		3	3
9	1	2	1
10	1	4	
11	2	2	
12	1		1
13		1	
14		1	
Total Group Scores	5	16	9

There was no indication that the correct responses were due to a prior knowledge of the expandable polystyrene process. This was supported further by student performance on the performance pretest.

The results of the knowledge pretest seem to indicate that there was little prior knowledge regarding the expandable polystyrene process.

Performance Scores on Laboratory Work

Table 3 presents the observed student scores on the performance of the laboratory work required to pre-expand the raw polystyrene beads.

Table 3

PERFORMANCE SCORES OF STUDENTS PRE-EXPANDING RAW EXPANDABLE POLYSTYRENE BEADS

Score intervals	Numbers of Pupils Scoring in Intervals		
	High Ability Group	Average Ability Group	Low Ability Group
27 - 32			1
33		1	1
34			1
35	1		
36	1		1
37	1	1	1
38		3	1
39	1	5	3
40	1	6	1
Total Group Scores	5	16	9

All students reached acceptable levels of performance. All but one exceeded acceptable levels.

A score of 30 was defined as minimum acceptable performance on this phase of laboratory work. Five students of high ability and sixteen students of average ability exceeded the minimum acceptable score.

Of the nine low ability students eight performed above the minimum level. One student originally scored only 27 because of incorrect choice of equipment but discovered his error, started over, and performed the laboratory work satisfactorily.

The performance scores do not indicate a major variation due to the ability of the students.

Table 4 presents the observed student scores on the performance of the laboratory work required to disassemble and prepare the mold.

Table 4

PERFORMANCE SCORES OF STUDENTS DISASSEMBLING AND PREPARING THE MOLD

Scores	Numbers of Pupils Scoring in Intervals		
	High Ability Group	Average Ability Group	Low Ability Group
24			1
25			2
26		1	2
27	1	3	
28	4	12	4
Total Group Scores	5	16	9

A score of 21 was defined as minimum acceptable performance. Scores of all subjects exceeded the minimum set for acceptable performance. The observed scores indicate a slight variation due to student ability. Although low ability students scored slightly less than the average or high groups, the difference was minimal.

Table 5 presents the observed student scores of the laboratory work required to mold the pre-expanded beads.

Table 5

PERFORMANCE SCORES OF STUDENTS MOLDING THE PRE-EXPANDED BEADS

Scores	Numbers of Pupils Scoring in Intervals		
	High Ability Group	Average Ability Group	Low Ability Group
38		3	
39		1	1
40			1
41	1		
42	2	2	1
43			2
44	1	2	1
45	1	8	3
Total Group Scores	5	16	9

A score of 34 was defined as minimum acceptable performance.

All 30 students were successful in exceeding the acceptable minimum performance score. The observed scores indicate little variation due to the ability of the students.

Table 6 presents the observed student scores of the laboratory work required to remove the foamed object (ice bucket) from the mold. The jury determined that a score of 9 would indicate minimum acceptable performance.

Table 6

PERFORMANCE SCORES OF STUDENTS REMOVING
THE FOAMED OBJECT FROM THE MOLD

Scores	Numbers of Pupils Scoring in Intervals		
	High Ability Group	Average Ability Group	Low Ability Group
10			
11			2
12	5	16	7
Total Group Scores	5	16	9

Table 7 presents the total performance scores of all the laboratory work done by students. Minimum acceptable performance was determined to be a total score of 100. All students exceeded this score. The average total score was 120. Three of the five high ability students exceeded the average total score. Two students did not.

Ten average ability students received scores above average for all students. The total scores of this group varied from a low of 115 to a high of 125. Four of these students made maximum scores.

Three low ability students made scores above the average for all students. Six received scores below the average. Scores varied from a low of 108 to a high of 125.

Table 7

TOTAL PERFORMANCE SCORES OF STUDENT PERFORMANCE OF LABORATORY WORK

Scores	Numbers of Pupils Scoring in Intervals		
	High Ability Group	Average Ability Group	Low Ability Group
108			1
114			1
115		1	1
116	1	1	1
117		1	2
118	1	1	
119		2	
120			
121	1	2	1
122	1		1
123	1	3	
124		1	1
125		4	
Total Group Scores	5	16	9

Time Used for Laboratory Work

Table 8 presents the amounts of time utilized by students for performance of the laboratory work required to pre-expand the raw polystyrene beads. Time used for performance varied as much within groups as between groups.

Table 8

TIME USED BY STUDENTS PRE-EXPANDING
THE RAW POLYSTYRENE BEADS

Time Intervals	Numbers of Pupils Using Time Intervals		
	High Ability Group	Average Ability Group	Low Ability Group
20 - 24	1	4	1
25 - 29	2	1	4
30 - 34		5	1
35 - 39	2	4	2
40 - 44		2	
65			1
Total Group Scores	5	16	9

The average time used for this phase of laboratory work was 30 minutes. The minimum was 20 minutes. Maximum time used was 65 minutes or approximately three times the minimum. The student who used 65 minutes made an incorrect choice of equipment and had to start over. Otherwise, the maximum time used would have been 40 minutes or twice the minimum.

Table 9 presents the amounts of time used to disassemble and prepare the mold. The average time used for this phase of laboratory work was approximately 20 minutes. The minimum time used was 15 minutes and the maximum was 35 minutes. One high ability student needed 35 minutes. Younger students needed more time than older ones.

Table 9

TIME USED BY STUDENTS TO PREPARE AND ASSEMBLE THE MOLD

Time Intervals	Number of Pupils Using Time Intervals		
	High Ability Group	Average Ability Group	Low Ability Group
15 - 19	4	8	3
20 - 24		5	5
25 - 29		2	1
30 - 34		1	
35 - 39	1		
Total Group Scores	5	16	9

Results indicate that time needed for performance varied as much within ability groups as between groups. The ability of the student does not seem to be a major cause of variation in the amount of time needed to perform the laboratory work.

Table 10 presents the amounts of time used to mold the pre-expanded beads.

Table 10

TIME USED BY STUDENTS TO MOLD THE PRE-EXPANDED BEADS

Time Intervals	Number of Pupils Using Time Intervals		
	High Ability Group	Average Ability Group	Low Ability Group
15		2	
20	1	4	4
25	4	4	
30		3	2
35		2	3
40			
45		1	
Total Group Scores	5	16	9

The average time needed to perform this phase of laboratory work was 25 minutes. The minimum was 15 minutes. The maximum was 45 minutes. Except for one student, time needed varied from 15 to 35 minutes or approximately two times the minimum.

Results indicate that the high ability group took slightly less time to complete the performance than did the average. The low ability group also used slightly more time than the average ability group. The differences, however, were minimal and indicate little difference in time required due to ability. Performance time varied nearly as much within groups as between groups.

Table 11 presents the amount of time used to remove the object from the mold.

Table 11

TIME USED BY STUDENTS TO REMOVE THE FOAMED OBJECT FROM THE MOLD

Time Intervals	Numbers of Pupils Using Time Intervals		
	High Ability Group	Average Ability Group	Low Ability Group
5		6	3
10	4	6	3
15	1	4	2
20			1
Total Group Scores	5	16	9

The average time needed to remove the object from the mold was 10 minutes. The minimum was 5 minutes and the maximum was 20 minutes. Except for one student, the time varied from 5 to 15 minutes with the maximum required being approximately three times the minimum. Results indicate little differences in the time required by the three ability groups. Time required varied as much within groups as between groups.

Table 12 presents the total amount of time required to perform the laboratory work culminating with the finished project.

Table 12

TOTAL TIME USED TO PERFORM THE LABORATORY WORK

Time Intervals	Numbers of Pupils Using Time Intervals		
	High Ability Group	Average Ability Group	Low Ability Group
60 - 64		1	
65 - 69		1	
70 - 74	1	1	
75 - 79	2	2	1
80 - 84		2	3
85 - 89	1	3	1
90 - 94			1
95 - 99		4	1
100 - 104			1
105 - 109	1	2	
115			1
Total Group Scores	5	16	9

The average total time necessary to perform this phase of the laboratory work was 85 minutes. Four of the five high ability students completed the project in this amount of time, or less. The one who exceeded the average time was a grade 8 student, indicating as previously discussed, that the younger students used more time to perform the work.

The average ability students were the least consistent in time used. They varied from 60 minutes to 105 minutes. Seven students used less than the average time while six students used more.

The low ability students were evenly divided with four using less than the average amount of time and four using more than the average.

Observation of results indicates that the high ability group used slightly less time than the other two groups; however, the maximum time used was approximately 1-1/2 times the minimum.

Frequency of Film Viewing

Table 13 presents the frequency of film viewing during participation in the instructional system.

Table 13

FREQUENCY OF FILM VIEWING

Times Viewed	Numbers of Pupils		
	High Ability Group	Average Ability Group	Low Ability Group
4		2	2
5	1	2	1
6		4	2
7		1	1
8	2	4	3
9		2	
10	1		
11	1	1	
Total Group Scores	5	16	9

There was a large variation in the number of times the students viewed the films, with an average total of seven times for all four films. Viewings varied from a minimum of four, or one time for each film, to a maximum of eleven.

Students of high ability viewed the films more times than those of low or average abilities. Four out of five high ability students viewed the films more times than the average.

Students of average ability viewed the films from 4 to 9 times. Eight students viewed fewer times than the average for all the students and six viewed more.

Low ability students viewed the films less than the average for all the students. Five students viewed the films less than seven times. Three students viewed the films more.

As the students proceeded through the system, it was noted that the younger students viewed the films most. Older students viewed least.

Student Errors in Programmed Instruction Books

Table 14 presents the total number of student errors in use of the programmed instruction books. A total of 28 students completed the instruction books.

Table 14

TOTAL STUDENT ERRORS IN THE PROGRAMMED INSTRUCTION BOOKS

Number of Errors	Numbers of Pupils Making Errors		
	High Ability Group	Average Ability Group	Low Ability Group
0	3	7	3
1	1	5	2
2	1	3	1
3			1
4			
5			
6			
7			1
Total Group Scores	5	15*	8*

*Two students omitted use of books

Students made an average of one error during completion of the four programmed instruction books.

Three high ability students made no errors. One made one error, and another made two errors. This group made fewer errors than the average or low ability students.

Average ability students made from 0 to 2 errors in the instruction books. Seven students made no errors. Five students made one error and three students made two errors. It appeared that this group did nearly as well as the high ability group.

Errors made by low ability students varied more than the other groups. Number of errors ranged from 0 to 7. Three students of this group made no errors. The low ability students made a few more errors than did the high or average students.

Of the two students who did not complete the instruction books, one was low ability and one was average ability. The observer noted that these students did not read the student's guide carefully and were inattentive. These students, however, completed the laboratory work satisfactorily.

Student Evaluation of Work

Table 15 presents results of evaluations of the completed foamed objects. All the students completed an object. The evaluation of their work varied from well made to poor.

Table 15

STUDENT EVALUATION OF THE FOAMED OBJECT

Evaluation	Numbers of Pupils		
	High Ability Group	Average Ability Group	Low Ability Group
Well Made	3	4	2
Average	2	9	5
Poor		3	2
Total Group Scores	5	16	9

Students of high ability had three objects evaluated as well made and two objects rated as average. Students of average ability had four objects evaluated as well made, nine as average, and three as poor. Low ability students had two objects rated as well made, five as average, and two as poor.

Results indicated that the high ability students produced a better object than the others. However, variability within ability groups is almost as great as between groups.

Five students produced objects rated as poor; however, these five students immediately repeated the laboratory work and produced foamed objects evaluated as average or well made. In this sense, the system was still successful as the students recognized their errors, made the necessary corrections, and then satisfactorily completed the laboratory work.

Chapter V

CONCLUSIONS

Purpose

This study was designed to determine the extent to which, and the amounts of time in which, a polysensory instructional system for teaching knowledges and skills used in the expandable polystyrene plastics process enabled pupils to acquire predefined knowledges and skills.

The study investigated the effectiveness of a polysensory instructional system for teaching selected expandable polystyrene plastics knowledges and skills to students of high, average, and low abilities. The system consisted of four single-concept sound films, four programmed instruction books, and four laboratory experiences.

Procedure

The systems were used experimentally with 30 junior and senior high school students. On the basis of scores on the Numerical and Verbal sections of the Differential Aptitudes Test (Form L) students were classified into high, average and low ability groups.

All students received an orientation to the plastics industry by viewing a sound film strip and a 16 mm sound color-film. Students then were directed to use the system on an individual basis. Single-concept sound films were viewed once or several times. The students then completed the programmed instruction book which guided study of information and procedures shown in the film. After completing the programmed instruction book, students were directed to perform the laboratory work which consisted of performing the operations shown in the film and presented in the book. This sequence was repeated for each of the four subunits of the system.

Results of the instruction were measured by use of a performance pretest, knowledge pretest, programmed instruction books, evaluation of laboratory work (using a performance checklist), and student evaluation of the foamed object (ice bucket).

Results

Performance scores on the laboratory work exceeded minimum acceptable performance scores.

Time individual students used to perform the laboratory work varied. The maximum performance time was approximately 2-1/2 times the minimum.

Time required varied as much within ability groups as between groups.

Total performance scores indicated that variation within groups was as great as that between groups.

Total time necessary for laboratory work varied as much within groups as between groups.

Frequency of film viewing varied between groups with the high ability group viewing the films most often and the low ability group viewing the films least often.

Errors in use of the programmed instruction books were minimal; however, low ability students made slightly more errors than those of average or high abilities.

Project evaluation indicated that all students performed successfully. High ability students performed most successfully and there was relatively slight difference between the performance of average and low ability groups.

Conclusions

The data obtained in this study indicated that this method of instruction was successful in teaching knowledges and skills necessary for performing the expandable polystyrene process. Each group of students exceeded the minimum acceptable performance criteria. Performance exceeded expectations.

Differences in general mental ability did not appear to be a major factor in performance. Performance within groups varied as much as performance between groups. Total performance scores of all students were above the minimum acceptable level.

Amounts of time students used to complete the system varied. But time used was only slightly related to ability. This indicates that by use of such systems all students can acquire such knowledges and skills at varying rates of speed. The fact that variation of time needed was as great within groups as between groups indicates a value for flexibility in such instruction at various levels of student ability.

The numbers of times students viewed films varied within groups. The fact that high ability students viewed the films most often might be attributed to the higher anxiety levels of this group and their need to succeed. It also might be due to a situation in which these students better recognized problem situations in the films and felt a need for clarification. Further, these students might have developed repetitive habits as a result of previous experiences with instruction and education.

All students indicated that they considered the programmed instruction books to be valuable. Some used the review pages as a basis for performing laboratory work; others did not. This would seem to support more general evidence that few students learn in identical fashion. It also would tend to support the use of a variety of instructional media.

Data indicated that in substantial degree students can, themselves, evaluate their own work of this type if they are familiar with measures of expected proficiency. They also can diagnose difficulty and take appropriate measures to improve performance of this type. The fact that five students evaluated their projects as poor, determined the probable causes, and then independently improved their performance indicates the feasibility of this type of self-evaluation.

Implications

The results of this study indicate the feasibility of utilizing polysensory instructional systems for this type of learning. Through the use of such systems students progress at their own rates with little presentation of information or procedures by the instructor. The enthusiasm with which students utilized the system indicated the probability of a presently untapped readiness to accept individual responsibility for learning if given the opportunity.

If the systems approach were more fully implemented the role of the instructor could be conceived more as that of an instructional manager. Less time would be spent on preparation and presentation of instructional materials. The system itself would provide more of the materials and procedures necessary for learning.

In such situations more time could be spent by the instructor on activities such as:

Leading discussion groups or providing leadership for activities such as creativity, problem solving or group dynamics.

Organizing or producing supplementary instructional materials.

Guiding the students into situations facilitating enlargement of concepts, procedures or skills taught by the system.

Wider use of such systems also has implications for planning educational facilities. Instructional areas would need to be provided for work by individuals and small groups. An instructional resource center would be necessary to provide easy student access to equipment and materials. Facilities should be designed to promote flexibility and change.

Use of systems such as the one tested in this study also has implications for curriculum development, class scheduling, instructional personnel, student grouping, grading, evaluation, and teacher training.

BIBLIOGRAPHY

Allen, W. H. "Media Stimulus and Types of Learning," AV Instruction, XII (January, 1967), 27-31.

Beck, L. F. and A. A. Lumsdaine. "The Comparison of Two Methods of Teaching the Assembly and Disassembly of a Portable Radar Station." Technical Report SPC 269-7-19. Instructional Film Research 1918-1950. Special Devices Center, Port Washington, L. I., N. Y., 1951.

Briggs, Leslie J. "A Procedure for the Design of Multi-Media Instruction," AV Instruction, XII (March, 1967), 228-253.

Briggs, Leslie J., Peggy L. Campeau, Robert M. Gagné, and Mark A. May. Instructional Media: A Procedure for the Design of Multi-Media Instruction, Critical Review of Research, and Suggestions for the Design of Multi-Media Instruction, Critical Review of Research, and Suggestions for Future Research. Pittsburg, Pennsylvania: American Institutes for Research, 1966.

Brown, James W., Richard B. Lewis, and Fred F. Harcleroad. AV Instruction Materials and Methods. San Francisco: McGraw-Hill Book Company, 1964.

Carpenter, C. R. "Approaches to Promising Areas of Research in the Field of Instructional Television," New Teaching Aids for the American Classroom. Stanford University: The Institute for Communications Research, 1960.

Curl, David H. Self-Instructional Laboratories for Teaching Operational Skills. U.S.O.E. No. OE-5-16-010, University of Chicago, 1965.

De Cecco, John P. Educational Technology. New York: Holt, Rinehart and Winston, Inc., 1964.

Edwards, Lauton. Industrial Arts Plastics. Peoria, Illinois: Charles A. Bennett Co., Inc., 1964.

Finn, James D. "Audio-Visual Development and the Concept of Systems," Teaching Tools (Fall, 1956), 163-164.

Gagné, Robert M. (ed.) Psychological Principles in System Development. New York: Holt, Rinehart and Winston, Inc., 1962.

Gaskill, Arthur L. and David A. Englander. How to Shoot a Movie Story. New York: Morgan and Morgan, Inc., 1959.

Gerlach, Vernon S. and John M. Vergis. "Self-Instructional Motion Pictures," AV Communications Review, XIII (September-October, 1965), 196-204.

Harby, S. F., J. A. Murnin and W. Hayes. "Daylight Projection of Film Loops as the Teaching Medium in Perceptual-Motor Skill Training." Technical Report 269-7-26, Pennsylvania State University Special Devices Center, Port Washington, L. I., N. Y., 1953.

Harby, S. F. "Evaluation of a Procedure for Using Daylight Projection of Film Loops in Teaching Skills." Human Engineering Report 269-7-25, Pennsylvania State College Special Devices Center, Port Washington, L. I., N. Y., 1944.

Heinich, Robert. "Application of Systems Thinking to Instruction." The Systems Engineering of Education II. Los Angeles: University of Southern California, 1965.

Herman, Lewis. Educational Films: Writing, Directing and Producing for Classroom, Television, and Industry. New York: Crown Publishers, Inc., 1965.

Jaspen, Nathan. "Effects on Training of Experimental Film Variables, Study II: Verbalization, Rate Development, Nomenclature, Errors, How-It-Works, Repetition." Technical Report SDC 269-7-17, Instructional Film Research Program. Pennsylvania State College Special Devices Center, Port Washington, L. I., N. Y., 1950.

Jaspen, Nathan. "Especially Designed Motion Pictures: I. Assembly of the 40 mm Breechblock." Technical Report SDC 269-7-19. Instructional Film Research 1918-1950. Special Devices Center, Port Washington, L. I., N. Y., 1951.

Kemp, Jerrold E. Planning and Producing Audio-Visual Materials. San Francisco: Chandler Publishing Company, 1963.

Kennedy, John L. "Psychology and Systems Development," Psychological Principles in System Development. Edited by Robert M. Gagné. New York: Holt, Rinehart and Winston, Inc., 1962.

Keppel, Francis. "Technology Serves Your Learning Program." The Instructor, LXXVI (June-July, 1966), 39-55.

Lefkowith, Edwin F. "The Validity of Pictorial Tests and Their Interaction with Audio-Visual Teaching Methods." Technical Report SDC 269-7-49, Pennsylvania State University Special Devices Center, Port Washington, L. I., N. Y., August, 1955.

LeMaster, Leian Kenneth. "Filmed Demonstrations with Manual Class Demonstrations, U. S. Conventional Demonstration in Introductory Woodwork." Unpublished doctoral dissertation, Pennsylvania State University, 1961.

Lichtblau, Leonard R. "Slides for Perceptual-Motor Skills: An Examination of Some of the Factors Which May Make Slides Effective in Teaching a Perceptual-Motor Skill in a Junior High School Industrial Arts Shop." Unpublished doctoral dissertation, New York University, 1958.

Maccoby, Nathan and Fred D. Sheffield. "Theory and Experimental Research on the Teaching of Complex Sequential Procedures by Alternate Demonstration Practice." Symposium on Air Force Human Engineering, Personnel, and Training Research, Pub. 516, National Academy of Sciences-National Research Council, Washington, D. C., 1958.

Mager, Robert F. Preparing Objectives for Programmed Instruction. San Francisco: Fearon Publishers, 1962.

Mars, Walter J. "Self-Instruction in the Operation of Common Audio-Visual Instructional Devices," New Media in Higher Education. Edited by James W. Brown and James W. Thornton, Division of Audio-Visual Instructional Service, National Education Association, Washington, D. C., 1963.

McPherson, J. J. "Let's Look at the Systems Concept of Educational Planning." Educational Media Branch, Office of Education, U.S. Office of Health, Education and Welfare, Washington, D.C. (n.d.).

Meierhenry, Wesley C. ed. "Needed Research in the Introduction and Use of Audio-Visual Materials: A Special Report," AV Communication Review, X (November-December, 1962), 307-316.

Morrill, Charles S. "Setting Programmed Instruction Objectives Using Systems Methodology," Trends in Programmed Instruction. Washington, D. C.: National Education Association, 1964

Nelson, H. E. and K. Moll. "Comparisions of the Audio and Video Elements of Instructional Films." Technical Report SDC-7-18, Instructional Film Research Program. Pennsylvania State College, Special Devices Center. Port Washington, L. I., N. Y., 1950.

Neu, D. Morgan. "The Effect of Attention Gaining Devices on Film-Mediated Learning." Technical Report SDC 269-7-9, Instructional Film Research Program, Pennsylvania State College Special Devices Center, Port Washington, L.I., N.Y., 1950

Ricker, Philip E. "An Experimental Comparison of Four Methods of Presenting Basic Properties of Magnetism." Unpublished doctoral dissertation, Colorado State College, 1965.

Rokusek, Henry James. "An Experimental Comparison of the Relative Effectiveness of the Automated Lecture-Graphic and Programmed Methods of Teaching." Unpublished doctoral dissertation, University of Maryland, 1964.

Roshal, Sol M. "Effects of Learner Representation in Film-Mediated-Perceptual-Motor Learning." Technical Report 269-7-5, Pennsylvania State College Special Devices Center, Port Washington, L. I., N. Y., 1949.

Schram, Wilbur. Programmed Instruction Today and Tomorrow. New York: Fund for the Advancement of Education, Ford Foundation, 1962.

Silvern, Leonard C. Testbook in Methods of Instruction. 2d ed., Los Angeles: Hughes Aircraft Company, 1962.

Slaughter, Robert E. Technology in Education. Washington, D.C.: U.S. Government Printing Office, 1966.

Smith, Wendell I. and J. William Moore. Programmed Learning: Theory and Research. Princeton, New Jersey: D. Van Nostrand Company, Inc., 1962.

Snyder, Vance B. "Use of Teacher-Produced Instructional Films in Industrial Arts Education: a Study to Determine the Effectiveness of Teacher-Produced Instructional Films in Teaching Perceptual-Motor Skills in a Public School Industrial Arts Shop." Unpublished doctoral dissertation, New York University, 1961.

Stewart, Donald K. "A Learning Systems Concept as Applied to Courses in Education and Training." Unpublished paper, Articulated Instructional Media Program. University of Wisconsin, Madison, Wisconsin, 1964.

Stolurow, Lawrence M. "Implications of Current Research and Future Trends." Journal of Educational Research, V (June-July, 1962), 542.

Swanson, Robert S. Plastics Technology. Bloomington, Illinois: McKnight and McKnight Publishing Co., 1965.

Teach, William C. and George C. Kiessling. Polystyrene. New York: Reinhold Publishing Co., 1965.

Trow, William Clark. *Teacher and Technology: New Designs for Learning*. New York: Appleton-Century-Crofts, 1963.

Vandermeer, A. W. "The Economy of Time in Industrial Training: an Experimental Study of the Use of Sound Films in the Training of Engine Lathe Operators." *Journal of Educational Psychology*, XXXVI (February, 1945), 65-90.

Vandermeer, A. W. and John Cogswell. "Instructional Effect of the Film: How to Operate the Army 16 mm Sound Projector Set." Technical Report SDC 269-7-29, Pennsylvania State University Special Devices Center, Port Washington, L. I., N. Y., September, 1952.

Zuckerman, J. V. "Commentary Variations: Level of Verbalization, Personal Reference and Phase Relations in Instructional Films on Perceptual-Motor-Tasks." Technical Report SDC 269-7-4, Instructional Film Research Program, Pennsylvania State College Special Devices Center, Port Washington, L. I., N. Y., 1949.

Appendix A

JURY FOR EVALUATING INSTRUCTIONAL PROCEDURES AND APPROACHES USED IN THE SINGLE-CONCEPT FILMS AND PROGRAMMED INSTRUCTING BOOKS

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JURY FOR EVALUATING CONTENT OF SINGLE-CONCEPT FILMS

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Appendix B

Table 16

RAW DATA COLLECTED IN THE STUDY

Subject	Grade	Percentile Rank	Knowledge Pretest	Performance Pretest	Unit 1		Unit 2		Unit 3		Unit 4		Total Time	Total Score	Film Viewing				Errors in Books				Object Evaluation
					Time	Score	Time	Score	Time	Score	Time	Score			1	2	3	4	1	2	3	4	
1 ..	11	55	8	0	20	40	15	28	20	45	5	12	60	125	2	1	2	1	0	0	0	0	W
2 ..	9	80	11	3	25	35	15	27	25	42	10	12	75	116	1	1	1	2	0	0	0	0	W
3 ..	10	55	8	0	35	38	15	28	35	45	10	12	95	123	1	1	1	1	..	..	..	..	P
4 ..	11	20	8	0	25	34	20	26	20	43	10	12	80	115	2	1	2	2	0	1	0	0	A
5 ..	11	25	2	0	35	39	15	28	35	43	5	12	95	122	1	1	1	1	0	1	0	0	A
6 ..	9	45	10	0	20	40	15	28	45	38	15	12	95	118	2	2	2	1	0	0	0	0	A
7 ..	11	60	10	0	20	40	15	28	25	45	5	12	65	125	1	1	1	1	0	1	0	1	A
8 ..	10	20	5	0	30	39	15	26	20	40	15	11	80	116	1	2	2	1	0	0	0	0	A
9 ..	12	76	10	0	35	39	15	28	25	44	10	12	85	123	2	2	2	2	0	0	0	0	W
10 ..	6	60	9	0	40	38	30	28	15	38	15	12	105	116	2	3	2	1	0	1	0	0	A
11 ..	11	15	7	0	25	39	20	28	30	45	5	12	80	124	1	3	2	2	0	1	0	0	P
12 ..	8	45	7	0	35	37	25	28	30	38	15	12	105	115	2	2	2	3	0	0	0	0	A
13 ..	11	60	14	0	20	40	20	28	30	39	5	12	75	119	2	1	1	1	0	0	1	0	A
14 ..	9	15	5	0	35	38	15	28	30	39	15	12	90	117	1	1	1	1	0	2	2	3	A
15 ..	12	50	6	0	35	39	20	27	20	45	5	12	80	123	2	2	2	2	2	0	0	0	A
16 ..	11	25	8	0	25	39	20	28	35	42	20	12	100	121	2	1	2	1	0	1	0	1	W
17 ..	11	70	7	0	30	40	20	28	25	45	10	12	85	125	2	2	2	2	0	0	2	0	W
18 ..	9	25	9	0	25	33	20	25	20	45	10	11	75	114	1	2	3	2	..	..	..	..	A

19 ..	12	20	12	0	65	27	20	25	20	44	10	12	115	108	2	1	1	1	1	1	0	1	P
20 ..	12	30	9	0	30	39	15	28	15	42	10	12	70	121	2	1	1	1	0	0	0	0	A
21 ..	9	97	12	0	25	36	15	28	25	45	10	12	75	121	2	2	2	2	1	1	0	0	A
22 ..	6	75	11	0	20	37	15	28	25	41	10	12	70	118	3	3	3	2	0	0	0	0	A
23 ..	10	35	10	0	25	39	15	28	30	45	10	12	85	124	2	1	2	1	0	0	0	0	W
24 ..	11	65	11	0	30	39	20	26	20	42	15	12	85	119	2	2	3	2	0	0	0	0	P
25 ..	12	30	8	0	35	33	15	27	35	45	10	12	95	117	1	1	2	1	0	0	0	0	W
26 ..	9	40	13	0	30	39	20	28	20	44	10	12	80	123	2	2	2	2	0	1	0	0	A
27 ..	11	15	8	0	20	36	25	24	35	45	5	12	85	117	3	1	2	2	0	0	0	0	W
28 ..	8	85	9	0	35	40	35	28	20	42	15	12	105	122	3	3	2	2	0	0	0	1	A
29 ..	9	55	11	0	40	38	25	27	25	44	5	12	95	121	3	2	2	4	1	0	0	0	P
30 ..	9	50	10	0	30	40	15	28	25	45	5	12	75	125	1	1	2	2	0	0	1	0	A

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TITLE
The Development and Testing of a Polysensory Instructional System for Teaching Knowledges and Skills Associated With the Use of Expandable Polystyrene Plastics
Project No. OE7-0031 Final Report

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SOURCE CODE

REPORT/SERIES NO. Final Report No. 18

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OTHER REPORT NO.

PUB'L. DATE June 30, 1968 | CONTRACT/GRANT NUMBER OEG-4-7-070031-1626

PAGINATION, ETC.
65p.

RETRIEVAL TERMS
Vocational Education
Occupational Knowledge
Occupational Skills
Learning Systems
Plastics Instruction

IDENTIFIERS
Vocational-Technical Education Research & Development (Project No. OE7-0031)

ABSTRACT
A self-instructional polysensory system comprised of four single-concept films, programmed books and laboratory work experiences was developed and tested. The system was designed to enable students to reach predefined levels of knowledge and capability needed to use materials and equipment for production of a plastic object. Thirty junior and senior high school students in three mental ability categories served as subjects. All subjects independently acquired predefined levels of knowledge and capability. Time used to reach those levels varied. Results indicated that such a system is an effective means of enabling pupils to acquire knowledge, manipulative skills and judgments of the types taught by the system.