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ABSTRACT

The purpose of this system is to teach rural high school students the process of forming objects with expandable polystyrene plastic beads. Instruction in the system generally follows a three-step sequence in which the student: 1) views one of the four demonstration films; 2) progresses through a corresponding programed instruction book; and 3) practices the aspects of the molding operation which were depicted in the film and programed text. The student guide provides an outline of the sequences of system events. Student self-evaluation is accomplished by means of the self-correction feature of the programed texts, performance checklists, and the "Ice Bucket Comparison Chart." Tests of the system, reported here, indicate that, overall, 97 percent of the objectives were attained by at least 80 percent of the students. The objects formed by the students were consistently rated "average" by the instructor/managers. (JK)

Technical Report No. 4

Research and Evaluation Division

A Self-Instructional System in Plastics

Northwest Regional Educational Laboratory
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PREFACE

This document is the fourth in a series of technical reports to be issued by the Research and Evaluation Division of the Northwest Regional Educational Laboratory. The reports will be published to provide people outside the Laboratory, e.g., funding, personnel, potential users and professional colleagues, with data to indicate the quality of Laboratory products.

This report is a brief description, analysis and history of a self-instructional system in expandable polystyrene plastics. Laboratory work on this system has been done in the program to improve instruction in small schools.

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DESCRIPTION OF THE SYSTEM

Instructional Objectives

The purpose of the self-instructional system in plastics is to teach high school students the process of forming objects with expandable polystyrene plastic beads. In attaining the objectives of the system, the student learns:

Pre-Expansion of Expandable Polystyrene Beads

To select the materials and equipment necessary for pre-expanding the raw expandable polystyrene beads

To pre-expand raw expandable polystyrene

Preparation and Assembly of Mold

To select the mold and necessary materials and equipment for preparing the mold

To disassemble, prepare and assemble the mold

Molding the Pre-Expanded Polystyrene Beads

To select the materials and equipment necessary for charging the mold

To charge the mold

To operate safely the autoclave

To cool the mold and remove the mold from the autoclave

Removing the Foamed Piece

To select the equipment necessary for removing the foamed piece from the mold

To remove the foamed piece from the mold

Instructional Equipment and Materials

The self-instructional system in plastics utilizes the following equipment and materials:

Fairchild Mark IV projector

Four film loops

Four programed textbooks:

Nish, D. Expandable Polystyrene Plastics--Instruction Book No. 1. Pullman: Department of Education, Washington State University, 1967.

Nish, D. Expandable Polystyrene Plastics--Instruction Book No. 2. Pullman: Department of Education, Washington State University, 1967.

Nish, D. Expandable Polystyrene Plastics--Instruction Book No. 3. Pullman: Department of Education, Washington State University, 1967.

Nish, D. Expandable Polystyrene Plastics--Instruction Book No. 4. Pullman: Department of Education, Washington State University, 1967.

One student guide

One instructor/manager guide

Four performance checklists (each can be used for pre-posttests)

Plastics hardware

Raw beads

Hot plate

Two four-quart pans

One lid

Screen strainer

Stirring rod

One three-quart water container

Air nozzle

Minute timer

Measuring cup

Newspapers or paper towels

Air-tight containers (three-pound coffee containers with plastic lids are recommended)

Nut driver

Screwdriver

Ice bucket mold

Wax

Rags

Source of compressed air

The "Ice Bucket Comparison Chart"

220-400 grit silicon carbide wet or dry abrasive paper

Instructional Procedures

Instruction in the system generally follows a three-step sequence in which the student: 1) views one of the four demonstration films, 2) progresses through a corresponding programed instruction book and 3) practices the aspects of the molding operation which were depicted in the film and programed text. The student guide provides an outline of the sequences of system events. Student self-evaluation is accomplished by means of the self-correction feature of the programed texts, performance checklists and the "Ice Bucket Comparison Chart."

The Films

The four demonstration films are color films with sound. They are in continuous loops and are enclosed in plastic cartridges for use in the Fairchild Mark IV projector. The student can view each film as often as he desires without rewinding.

The Books

The programed instruction is contained in four books. Each book corresponds with one of the demonstration films.

Within the books, a fact is presented and then a question relating to the fact is posed. The student is directed to select the correct answer from among the alternatives provided. Each alternate answer is keyed to a separate page of the text. If the student selects the correct answer, he is directed to proceed. If he selects the incorrect answer, he is given additional information and is then asked to answer the question again.

The Practice Sessions

The purpose of the practice sessions is to provide the student with the opportunity for application of knowledge and development of skills taught in the films and programed instruction books. In each session, the student is directed through a prescribed set of practice activities by means of the student guide and a checklist.

STUDIES OF THE SYSTEM

Nish Study

The original developmental work on the self-instructional plastics system was done at Washington State University by Dale Leroy Nish. Nish summarized his study of the system in the project report. *

The Nish study centered about the performance of thirty students in the sixth through twelfth grades. A pretest ensured that the participants initially possessed few or no performance capabilities or knowledge of expandable polystyrene plastics before using the system.

All participants exceeded the minimum acceptable performance criteria. There were, however, considerable variations in student performance in the following areas: 1) errors made in the programed textbook, 2) number of times the films were viewed and 3) amount of time taken to perform the molding operations.

These findings suggest that students using the plastics system can acquire elementary plastic molding knowledge and skills.

* Nish, Dale L. The Development of a Polysensory Instructional System for Teaching Knowledges and Skills Associated With the Use of Expandable Polystyrene Plastics. Pullman: Washington State University, 1967.

Northwest Regional Educational Laboratory Field Test Data

Achievement Data

The plastics system was available during the academic years 1968-69 and 1969-70 to students at eight rural high school test sites located throughout Oregon, Washington, Alaska, Montana and Idaho.

For purposes of the present study, two of the sites were used for intensive performance testing. Eighteen students at those sites were subjected to close observation while performing a series of plastic molding tasks. The molding tasks coincided with the objectives of the system.

Those participating in the present study were four female and fourteen male students who had recently completed the system. Table 1 summarizes the demographic characteristics of the participating students.

TABLE 1.--DEMOGRAPHIC CHARACTERISTICS OF STUDENTS PARTICIPATING IN THE NWREL STUDY

Grade	Male	Female
6	1	-
7	7	1
8	-	-
9	-	-
10	3	-
11	-	2
12	3	1
TOTAL	14	4

Selection of students to participate in the present study was effected in a quasi-random fashion by the instructors who were told to select "the ten or twelve students who had most recently completed the system." Prior to working with the system, none of the students could perform molding operations with plastics.

The objectives of the system have four general foci: 1) pre-expansion of expandable polystyrene beads, 2) preparation and assembly of mold, 3) molding and pre-expanded polystyrene beads and 4) removing the foamed piece.

An observational checklist was employed to evaluate objectives in these four areas.* Additionally, a rating procedure was used to evaluate the students' ability to form an object from plastic beads. The procedure required the instructor to compare the object molded by each student with the photographs on the "Ice Bucket Comparison Chart." The photographs were intended to illustrate both the good and bad aspects of completed molded objects. Ratings which corresponded to the various captions were recorded by the instructors. They were: 1) well made, 2) average, 3) deformed, 4) poor, 5) incompletely formed and 6) stuck in the mold.

Findings

Tables 2-5 list the instructional objectives in capital letters. Each objective is followed by the rating scale used to evaluate student performance.

* The checklists can be found in the data presentation section.

Dotted lines are used to differentiate between acceptable* and unacceptable performance. The corresponding percentage of students rated in the various categories is presented, as well as the percentage of students whose performance is rated as satisfactory.

Table 2 lists the objectives relating to pre-expansion of the expandable polystyrene beads. Eight of the thirteen objectives presented in Table 2 were successfully attained by 100 percent of the students; three were attained by 94 percent or more of the students and two were attained by 84 percent or more of the students. Thus, all of the objectives relating to the pre-expansion of polystyrene beads were attained by at least 84 percent of the students.

Table 3 summarizes student performance on the objectives relating to preparation and assembly of the mold. Four of the objectives were successfully attained by 100 percent of the students, while 89 percent of the students successfully attained the other four objectives.

Thus, 89 percent of the objectives dealing with preparing and assembling of the mold were successfully attained by at least 94 percent of the students with the remaining objective being attained by 89 percent of the students.

Table 4 summarizes the student performance on system objectives relating to molding the pre-expanded polystyrene beads. According to the data presented, 100 percent of the students performed in an acceptable

* Acceptable performance was defined by the system developers.

manner on 13 out of the 15 objectives; 95 percent of the students performed in an acceptable manner on one objective, while 82 percent performed satisfactorily on the remaining objective.

In general, at least 95 percent of the students demonstrated satisfactory performance on 93 percent of the objectives relating to molding the pre-expanded polystyrene beads.

Student performance on the objectives related to removal of the foamed piece is summarized in Table 5. It should be noted that objectives five and six are alternate procedures for objectives three and four.

As evidenced by Table 5, two of the four objectives were satisfactorily attained by 100 percent of the students. One of the remaining objectives, alternatives three and five, was satisfactorily attained by at least 90 percent of the students. The remaining objective, alternatives four and six, was satisfactorily attained by 75 percent or 44 percent, respectively, depending on the alternative chosen by the students. Relative to the objective measured by items four and six, one of the instructors reported that the air pressure apparatus at his site did not generate sufficient pressure to release the mold by the preferred procedure. Thus, the local adaptation called for loosening the molded object by direct application of air behind the edge of the object and the mold. As a result of the local conditions, the students' performance was perhaps unfairly rated in the "non-satisfactory" category.

In summary, at least 92 percent of the students performed satisfactorily on 3/4 of the objectives pertaining to removal of the foamed piece. As noted

above, measurement of the remaining objectives was obscured by an equipment failure at one of the sites.

Instructor Ratings of Foamed Objects

It will be recalled that instructors at the two sites were asked to rate the quality of the objects formed by the students in accordance with a set of photographs. The photographs were intended to illustrate both the good and bad aspects of completed, molded objects. The rating schema included the following categories: 1) well made, 2) average, 3) deformed, 4) poor, 5) incomplete and 6) stuck in the mold. Without exception, the instructors in the present study rated all of the students' work as "average."

Summary

In considering the 41 objectives, 100 percent of the students exhibited satisfactory performance on 66 percent of the objectives; at least 90 percent of the students exhibited satisfactory performance on another 24 percent of the objectives. At least 80 percent of the students exhibited satisfactory performance on another 7 percent of the objectives; fewer than 80 percent exhibited satisfactory performance on the remaining objective, although as previously noted, a deficiency in the air pressure system at one of the sites may account for the low ratings.

Overall, 97 percent of the objectives were satisfactorily attained by at least 80 percent of the students. The objects formed by the students were consistently rated "average" by the instructor/managers.

TABLE 2.--SUMMARY OF STUDENT PERFORMANCE ON PRE-EXPANSION OF EXPANDABLE POLYSTYRENE BEADS

	Percent by category	Percent of students performing satisfactorily
SELECTS THE FOLLOWING EQUIPMENT AND MATERIALS		
___ Hot plate ___ Pan ___ Screen ___ Timer ___ Stirring rod ___ Measuring cup ___ Paper towels ___ Raw beads ___ Air-tight container ___ Container of water		
___ Selects all of the equipment and necessary materials during the pre-expansion process before starting the pre-expansion process	39	
or		
___ Selects the equipment and materials when needed in the pre-expansion process	28	
___ Selects all but one piece of equipment or materials before starting the pre-expansion process	17	84
___ Omits two or more pieces before starting the pre-expansion process	17	
___ Does not know which pieces to select or selects pieces not necessary for the pre-expansion process	0	
(N=18) TOTAL	101	
PLACES THE PAN ON THE HOT PLATE		
___ Puts pan on hot plate	100	100
___ Does not place pan on hotplate	0	
(N=18) TOTAL	100	

TABLE 2.--SUMMARY OF STUDENT PERFORMANCE ON PRE-EXPANSION OF EXPANDABLE POLYSTYRENE BEADS
(Continued)

	Percent by category	Percent of students performing satisfactorily
FILLS THE PAN UP TO THE TWO-QUART MARK		
___ Water at the two-quart mark	72	
___ Slightly less or slightly more than two quarts (within 1/2")	22	94
___ Much more or less than two quarts	6	
(N=18) TOTAL	100	
TURNS HOT PLATE ON HIGH		
___ Hot plate on high	100	100
___ Hot plate on medium	0	
___ Hot plate on low or off	0	
(N=18) TOTAL	100	
MEASURES OUT ONE-HALF CUP RAW BEADS		
___ 1/2 cup raw beads	0	
or		
___ More or less than 1/2 cup (within 1/4" of mark)	100	100
___ Much more or less (1/4 or 3/4 cup)	0	
___ Doesn't measure out any beads	0	
(N=18) TOTAL	100	

TABLE 2.--SUMMARY OF STUDENT PERFORMANCE ON PRE-EXPANSION OF EXPANDABLE POLYSTYRENE BEADS
(Continued)

	Percent by category	Percent of students performing satisfactorily
HEATS THE WATER UNTIL IT IS BOILING RAPIDLY		
___ Water boiling rapidly	47	
___ Water steaming hot, but not boiling	41	88
___ Water warm	12	
___ Water cold	0	
(N=17) TOTAL	100	
PLACES THE SCREEN IN THE PAN OF RAPIDLY BOILING WATER		
___ Screen placed in pan when water is boiling rapidly	38	
___ Screen placed in pan when water is steaming, not boiling	62	100
___ Screen placed in pan when water is warm	0	
___ Screen placed in pan when water is cold	0	
(N=8) TOTAL	100	
POURS BEADS INTO THE SCREEN WHEN THE WATER IS BOILING		
___ Pours beads into screen when water is boiling	47	
___ Pours beads into screen when water is steaming	53	100
___ Pours beads into screen when water is warm	0	
___ Pours beads into screen when water is cold	0	
(N=17) TOTAL	100	

TABLE 2.--SUMMARY OF STUDENT PERFORMANCE ON PRE-EXPANSION OF EXPANDABLE POLYSTYRENE BEADS
(Continued)

	Percent by category	Percent of students performing satisfactorily
SETS THE TIMER AFTER POURING THE BEADS INTO THE SCREEN		
___ Set timer immediately or ___ Sets timer soon after (within one minute)	100	100
___ Does not set timer	0	
(N=18) TOTAL	100	
STIRS THE BEADS WHILE THEY ARE PRE-EXPANDING IN THE BOILING WATER		
___ Stirs slowly, after the beads rise to the top of the water	89	
___ Stirs slowly, but waits awhile before starting (after one minute)	11	100
___ Does not stir at all	0	
(N=18) TOTAL	100	
WATCHES THE TIMER AND REMOVES THE BEADS FROM THE PAN		
___ Removes the beads immediately when sand runs out in timer or ___ Removes the beads a little after sand runs out in timer (approximately 1/2 minute)	100	100
___ Removes beads a little before sand runs out in timer	0	
___ Pays no attention to timer and takes beads out at any time	0	
(N=18) TOTAL	100	

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TABLE 2.--SUMMARY OF STUDENT PERFORMANCE ON PRE-EXPANSION OF EXPANDABLE POLYSTYRENE BEADS
(Continued)

	Percent by category	Percent of students performing satisfactorily
SPREADS BEADS TO COOL AND DRY		
___ Places paper towels on table and spreads beads to cool and dry. Does this immediately after taking the beads from the pan	89	
___ Places paper towels on table and spreads beads to cool and dry. Waits awhile after taking the beads from the pan (1 or 2 minutes)	5.5	94.5
___ Spreads beads, but not on paper towels	0	
___ Leaves beads in screen	5.5	
(N=18) TOTAL	100	
PLACES BEADS IN CONTAINER		
___ Waits until beads are dry, places them in container and puts lid on container	72	
___ Places damp beads in container and places lid on container	22	94
___ Places damp beads in container; does not put lid on container	5.5	
___ Leaves beads on table; does not place them in container	0	
(N=18) TOTAL	99.5	

TABLE 3. --SUMMARY OF STUDENT PERFORMANCE ON PREPARATION AND ASSEMBLY OF MOLD OBJECTIVES

	Percent by category	Percent of students performing satisfactorily
SELECTS THE FOLLOWING EQUIPMENT AND MATERIALS		
___ Mold ___ Wax ___ Rags ___ Screwdriver ___ Nut driver		
___ Selects all of the equipment and necessary materials before beginning to prepare the mold	33	
___ Selects the equipment and materials when needed for preparing the mold	61	100
___ Selects all but one piece of equipment or materials before proceeding to prepare the mold	5.5	
___ Omits two or more pieces before starting to prepare the mold	0	
___ Does not know which pieces to select or selects pieces not necessary for preparing the mold	0	
(N=18) TOTAL	99.5	
REMOVES BOLTS WHICH HOLD MOLD TOGETHER		
___ Removes bolts using nut driver and, if necessary, screwdriver	61	
___ Removes bolts with difficulty due to improper tool use	39	100
___ Does not remove the bolts	0	
(N=18) TOTAL	100	

TABLE 3.--SUMMARY OF STUDENT PERFORMANCE ON PREPARATION AND ASSEMBLY OF MOLD OBJECTIVES
(Continued)

	Percent by category	Percent of students performing satisfactorily
APPLIES A COAT OF WAX TO THE MOLD		
___ Applies a coat of wax to inside of each half of mold	67	
___ Applies a coat of wax to all of the mold	28	95
___ Applies a coat of wax to inside of one half of mold	0	
___ Doesn't apply any wax to the mold	5.5	
(N=18) TOTAL	100.5	
LETS THE WAX COAT DRY BEFORE BUFFING		
___ Wax allowed to dry for approximately 5 minutes	88	
___ Wax allowed to dry for 3-7 minutes	12	100
___ Wax allowed to dry for 10 or more minutes	0	
___ Wax not allowed to dry at all	0	
(N=17) TOTAL	100	
BUFFS THE WAXED MOLD		
___ Buffs each waxed part thoroughly	89	
___ Buffs each waxed part, but not thoroughly	11	100
___ Buffs either half, but not both	0	
___ Doesn't buff at all	0	
(N=18) TOTAL	100	

TABLE 3.--SUMMARY OF STUDENT PERFORMANCE ON PREPARATION AND ASSEMBLY OF MOLD OBJECTIVES
(Continued)

	Percent by category	Percent of students performing satisfactorily
APPLIES SECOND WAX COAT		
___ Applies a coat of wax to inside of each half of mold	83	
___ Applies a coat of wax to all of the mold	11	94
___ Applies a coat of wax to inside of one-half of mold	5.5	
___ Doesn't apply any wax to the mold	0	
(N=18) TOTAL	99.5	
LETS THE WAX COAT DRY BEFORE BUFFING		
___ Wax allowed to dry for approximately 5 minutes	83	
___ Wax allowed to dry for 3-7 minutes	11	94
___ Wax allowed to dry for 10 or more minutes	0	
___ Wax not allowed to dry at all	5.5	
(N=18) TOTAL	99.5	
BUFFS THE WAXED MOLD		
___ Buffs each waxed part thoroughly	83	
___ Buffs each waxed part, but not thoroughly	11	94
___ Buffs either half, but not both	0	
___ Doesn't buff at all	5.5	
(N=18) TOTAL	99.5	

TABLE 3.--SUMMARY OF STUDENT PERFORMANCE ON PREPARATION AND ASSEMBLY OF MOLD OBJECTIVES
(Continued)

	Percent by category	Percent of students performing satisfactorily
ASSEMBLES MOLD		
___ Aligns marks, then replaces and tightens bolts	89	
___ Aligns holes, paying no attention to marks, then replaces and tightens bolts	0	89
___ Assembles mold, but does not tighten bolts	11	
___ Does not assemble mold	0	
(N=18) TOTAL	100	

TABLE 4.--SUMMARY OF STUDENT PERFORMANCE ON MOLDING THE PRE-EXPANDED POLYSTYRENE BEADS

	Percent by category	Percent of students performing satisfactorily
REMOVES FILLER PLUG		
___ Uses screwdriver and removes filler plug	100	100
___ Does not remove filler plug	0	
(N=18) TOTAL	100	
FILLS MOLD WITH PRE-EXPANDED BEADS		
___ Fills mold, taps or bounces mold, puts in more beads and repeats procedure until mold is full and replaces filler plug	94.5	94.5
___ Fills mold, but does not tap or bounce before replacing filler plug	5.5	
___ Fills mold, taps or bounces mold and replaces plug, but mold is not full of beads	0	
___ Does not know how to fill mold	0	
(N=18) TOTAL	100	
REMOVES AUTOCLAVE LID		
___ Removes lid carefully and easily. Indicates he knows how the lid operates	72	
___ Removes lid; procedure mostly trial and error	28	100
___ Does not understand how lid operates and cannot or does not remove the lid	0	
(N=18) TOTAL	100	

TABLE 4.--SUMMARY OF STUDENT PERFORMANCE ON MOLDING THE PRE-EXPANDED POLYSTYRENE BEADS
(Continued)

	Percent by category	Percent of students performing satisfactorily
PLACES CORRECT AMOUNT OF WATER IN THE AUTOCLAVE		
___ Places 2 cups of water in the autoclave	72	
___ Places 1-1/2-2-1/2 cups of water in the autoclave	28	100
___ Places one cup or less in the autoclave	0	
___ Does not put any water in the autoclave	0	
(N=18) TOTAL	100	
PLACES THE CHARGED MOLD IN THE AUTOCLAVE		
___ Places the mold in the autoclave	100	100
___ Does not place the mold in the autoclave	0	
(N=18) TOTAL	100	
REPLACES AUTOCLAVE LID		
___ Replaces lid carefully and easily. Indicates he knows how the lid operates	83	100
___ Replaces lid; procedure mostly trial and error	17	
___ Does not understand how lid is replaced and cannot or does not replace the lid	0	
(N=18) TOTAL	100	

TABLE 4.--SUMMARY OF STUDENT PERFORMANCE ON MOLDING THE PRE-EXPANDED POLYSTYRENE BEADS
(Continued)

	Percent by category	Percent of students performing satisfactorily
APPLIES HEAT TO AUTOCLAVE		
___ Places autoclave on hot plate and turns hot plate on "high"	100	100
___ Places autoclave on hot plate and turns hot plate on "medium"	0	
___ Places autoclave on hot plate and turns hot plate on "low"	0	
___ Doesn't place on hot plate or turn heat on	0	
(N=18) TOTAL	100	
PLACES PRESSURE GAUGE ON AUTOCLAVE		
___ Places gauge on autoclave at 15 lb. setting	100	100
___ Places gauge on autoclave at 10 lb. setting	0	
___ Places gauge on autoclave at 5 lb. setting	0	
___ Does not place gauge on autoclave	0	
(N=18) TOTAL	100	
SETS TIMER FOR AUTOCLAVE		
___ When pressure gauge sputters, sets timer immediately	83	100
___ When pressure gauge sputters, sets timer within 1 minute	17	
___ Sets timer before gauge sputters, but after heat is turned on	0	
___ Does not set timer at all	0	
(N=18) TOTAL	100	

TABLE 4.--SUMMARY OF STUDENT PERFORMANCE ON MOLDING THE PRE-EXPANDED POLYSTYRENE BEADS
(Continued)

	Percent by category	Percent of students performing satisfactorily
USES INSULATED GLOVES WHEN HANDLING HOT AUTOCLAVE		
___ Uses gloves when jiggling pressure gauge or handling hot autoclave	100	100
___ Uses gloves, but not all the time	0	
___ Does not use insulated gloves	0	
(N=12) TOTAL	100	
REMOVES AUTOCLAVE FROM HOT PLATE		
___ At the end of time shown by timer, immediately removes autoclave from hot plate and turns hot plate off	94	100
___ At end of time shown by timer, removes autoclave, but does not turn heat off	5.5	
___ At end of time shown by timer, turns heat off but does not remove autoclave	0	
___ Removes autoclave before time is indicated by timer	0	
___ Removes autoclave or leaves it on the hot plate without reference to time indicated by timer	0	
(N=18) TOTAL	100	
COOLS AUTOCLAVE		
___ Cools autoclave by placing it in a container and running or pouring cold water over the autoclave	100	100
___ Cools autoclave by setting it aside and does not pour or run water over the autoclave	0	
(N=18) TOTAL	100	

TABLE 4.--SUMMARY OF STUDENT PERFORMANCE ON MOLDING THE PRE-EXPANDED POLYSTYRENE BEADS
(Continued)

	Percent by category	Percent of students performing satisfactorily
CHECKS AUTOCLAVE FOR INTERIOR STEAM PRESSURE		
___ Uses gloves and jiggles gauge, to check for steam pressure	82	82
___ Jiggles gauge but does not use gloves	18	
___ Does not jiggle gauge	0	
___ Removes gauge with steam pressure still present in autoclave	0	
(N=17) TOTAL	100	
REMOVES AUTOCLAVE LID		
___ Removes lid carefully and easily. Indicates he knows how the lid operates	76	100
___ Removes lid; procedure mostly trial and error	23.5	
___ Does not understand how lid operates and cannot or does not remove the lid	0	
(N=17) TOTAL	99.5	
COOLS MOLD		
___ Fills autoclave with cold water to point where mold is covered	100	100
___ Puts some cold water on the mold, but does not cover the mold	0	
___ Does not cool the mold by using cold water	0	
(N=18) TOTAL	100	

TABLE 5.--SUMMARY OF STUDENT PERFORMANCE ON REMOVING THE FOAMED PIECE OBJECTIVES

	Percent by category	Percent of students performing satisfactorily
REMOVES BOLTS FROM MOLD		
___ Bolts are removed after mold is cool	100	100
___ Bolts are removed before mold is cool	0	
___ Does not know how to remove bolts	0	
(N=18) TOTAL	100	
PRIES MOLD APART		
___ Uses screwdriver and carefully pries mold apart. Prying is done at more than one place on the mold.	100	100
___ Uses screwdriver, but ice bucket is damaged by screwdriver	0	
___ Does not pry mold apart and does not use screwdriver while attempting to separate the mold halves	0	
(N=18) TOTAL	100	
REMOVES PRESSURE SCREW		
___ Uses screwdriver to remove pressure screw	92	92
___ Does not remove pressure screw	8	
(N=12) TOTAL	100	

TABLE 5.--SUMMARY OF STUDENT PERFORMANCE ON REMOVING THE FOAMED PIECE OBJECTIVES
(Continued)

	Percent by category	Percent of students performing satisfactorily
REMOVES ICE BUCKET FROM MOLD		
___ Places air nozzle in pressure screw hole and loosens mold using air pressure	44	44
___ Does not place the nozzle in pressure screw hole, but still loosens mold by directing air pressure into the pressure screw hole	0	
___ Loosens ice bucket by directing air under the edges of the ice bucket	55.5	
___ Does not loosen the ice bucket using air pressure and does not know how to proceed	0	
(N=9) TOTAL	99.5	
ALTERNATE PROCEDURE (ice bucket remains in 1/2 of mold containing filler plug)		
REMOVES FILLER PLUG		
___ Uses screwdriver to remove filler plug	90	90
___ Does not remove filler plug	10	
(N=10) TOTAL	100	
REMOVES ICE BUCKET FROM MOLD		
___ Places air nozzle in filler plug hole and loosens mold using air pressure	75	75
___ Does not place air nozzle in filler plug hole, but still loosens mold by directing air into the filler plug hole	0	
___ Loosens ice bucket by directing air under the edges of the ice bucket	12.5	
___ Does not loosen the ice bucket using air pressure and does not know how to proceed	12.5	
(N=8) TOTAL	100	

Affective Data

During the spring of 1969, an opinion survey was conducted among students and teachers using the plastic system at the eight rural high school test sites. Students were polled about their attitudes toward the system. One question asked was, "Would you recommend this system to your friends?" One-hundred-two of the 114 respondents, or 89.5 percent, replied in the affirmative.

Another question asked was, "Would you be interested in taking another course using a system like this one?" Ninety-three of the 100 respondents replied in the affirmative. These data would seem to indicate positive student acceptance of the system.

The instructor/managers of the plastics system were asked to respond to an opinion questionnaire at the same time student attitudes were polled. One question asked was, "Would you recommend this system to other teachers?" Seven of the eight respondents to the question, or 87.5 percent, answered in the affirmative. This finding would seem to indicate positive teacher acceptance of the system.

Summary

Achievement data from the Nish study and the Northwest Regional Educational Laboratory's rural test sites indicate that students demonstrate the ability to form molded objects from expandable polystyrene beads after using the self-instructional system in plastics. Additionally, 97 percent of the objectives were attained by at least 80 percent of the students. Attitudes of students and teachers toward the system were found to be quite positive.

EDUCATIONAL SPECIFICATIONS OF THE SYSTEM

System's focus:	Instruction in forming objects from expandable polystyrene beads at junior and senior high school level
Instructional mode:	Self-instructional with provisions for practice
Student performance:	Measured by observational guides and based on 18 rural high school and junior high students, at least 80 percent of the students attained at least 97 percent of the system objectives. All of the students in the sample were able to form a molded object which was rated as satisfactory by the instructor/manager.

HISTORY OF THE SYSTEM

Dr. Gordon McCloskey of Washington State University (Pullman) initiated a Vocational-Technical Education Research and Development Project in 1966. The project identified and defined clusters of capabilities essential for occupations often chosen by youth who do not complete college. Also identified were the psychological, sociological and economic factors that influenced students to seek educational programs for training in skills essential for employment. The information from the project supplied the basis for the design of prototpye vocational instructional materials.

The Elementary and Secondary Education Act of 1965 gave further impetus to the Vocational Project with funds available under Title III and the involvement of the Northwest Regional Educational Laboratory, established under Title IV. Cooperative efforts resulted in the identification, development and field testing of vocational instructional systems for plastics, speech, welding, Spanish, mathematics analysis, physical science and electricity.

Personnel directly involved in the plastics project included:

Washington State University: Gordon McCloskey, Arnold Gallegos, Dale Nish, Frank Nelson, Gerald Brunner and Dennis Gillis.

Northwest Regional Educational Laboratory: Roger Bishop, Chester Hausken, Walter Hartenberger, Ray Jongeward, Mark Greene, Joan Goforth, Al Selinger, Mary Ganzel and Gail Murray.