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A STUDY TO EXPLORE THE EFFECTIVENESS OF COLOR PHOTOGRAPHS IN INTRINSICALLY PROGRAMED AUTOMATED INSTRUCTIONAL MATERIALS. FINAL REPORT.

BY- RUST, GROSVENOR C.
SOUTHERN ILLINOIS UNIV., CARBONDALE

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COLLEGE FRESHMEN VOLUNTEERED FOR THIS LABORATORY EXPERIMENT USING SELF PACING ON INDIVIDUAL TEACHING MACHINES FOR LIBRARY ORIENTATION. SLIDES PRESENTED TO ONE GROUP (COL) COMBINED COLOR PHOTOGRAPHS AND PRINT, WHILE THE OTHER GROUP (PRN) SAW SLIDES WITH ONLY PRINT CONTENT. PRE-TESTS INCLUDED STANDARD ABILITY TESTS, AND A LIBRARY USAGE TEST, ALSO ADMINISTERED AFTER THE EXPERIMENT. THE TWO GROUPS (N-64) SHOWED NO SIGNIFICANT DIFFERENCES IN GAIN SCORES ON THE USAGE TEST, NOR IN TIME SPENT ON THE PROGRAM. LOW ABILITY STUDENTS PROFITED MORE FROM THE COL VERSION. BEHAVIOR REQUIRED DURING THE PROGRAM WAS EVALUATED FOR EACH SUBJECT ON A SPECIAL SCALE BY AN OBSERVER, AND THE COL GROUP PERFORMED SIGNIFICANTLY BETTER. THERE WERE NO DIFFERENCES IN ERROR RATE, BUT THE COL GROUP COMPLETED BRANCHING FRAMES SIGNIFICANTLY BETTER. A SLIGHTLY REFINED REPLICATION FOR UPPER DIVISION COLLEGE STUDENTS SHOWED RELIABILITY OF THE USAGE AND PERFORMANCE TESTS, AND SIGNIFICANT DIFFERENCES ON GAIN SCORES AND PERFORMANCE IN FAVOR OF THE COL GROUP. (LH)

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A Study to Explore the Effectiveness of Color Photographs in Intrinsically Programed Automated Instructional Materials

Project No. 5-0845
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Grosvenor C. Rust

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Southern Illinois University

Carbondale, Illinois

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I. INTRODUCTION

Photographs have been used in learning situations since the early days following their inception. Their presence has been accepted much of the time as highly contributory to better understanding. The matter of research to support this idea has not been ignored for there have been a number of studies concerned with the value of pictures in educational usage. Some of them have supported picture use with various qualifying conditions involved and many others have either been negative or not significant in their findings.

This need to know more about the effectiveness of pictures in learning by one's self lies in the nature of most of the current programed instruction. The idea of programed instruction is largely the result of studies experimenting with the arrangement and sequence of printed symbols which represent words and ideas. Further, if the only instruction given is in terms of printed symbols, then the learner must know the meanings represented by those symbols. Therefore, wouldn't accurate photographs,specifically made for a self-instructional program help a student learn better since meanings would probably be clearer for him?

In addition, the writers of such programs are, in many cases, carrying the responsibility for all of the instruction given in entire segments of a curriculum. Highly fundamental experiences upon which many succeeding learning skills are founded have to be developed.

Therefore, if there is a taxonomy of learning objectives, there would, as well, be a taxonomy of methods by which learning can be effected. There is a naturalness about turning to iconic representation (photographs and other forms of pictures) to develop accurate fundamental experiences that will implement curriculum content.

Furthermore, most persons today are highly conscious of pictorial media in educational materials. The common involvement of people with the motion picture, television, highly illustrated periodicals, and a great many other sources of non-print visual stimuli tends to make them more responsive to visual pictorial learning than to print alone.

To increase the usefulness of this study, certain minor hypotheses were tested in addition to the major analysis. These were examined as time and funds permitted. It has been a study for the purpose of illumination and better understanding rather than one that sought for a final verdict. The need for this study became apparent concurrently with the writer's involvement in another research problem. (16)

The Problem

If iconic representation (picture) develops more than one thought stimulus at a time and can provide for a complex of perceptual experiences, it would be reasonable to expect that a pictorial intrinsic program could rely on picture more and on caption and printed information less and still produce as good a grade of instruction as a similar intrinsic program which depended entirely upon symbolic representation in the medium of print. The major problem was to determine the effect of the iconic materials (color photographs) on the improvement of performance and the gain in learning in a given instructional situation utilizing intrinsically programed study materials.

The null hypothesis tested is there is no significant difference in the terminal functional behavior of the subjects when the information is presented by means of automated instructional materials incorporating color photographs, and by means of similar instructional materials containing no photographs (or other pictures).

One of the best determinants of adequate instruction is the quality of behavior one is able to observe when what has been taught in the learning experience is applied in a practical situation. In accepting this premise this study thus holds its attention to observing functional terminal behavior rather than only the results of a (given) written test.

Purposes and Importance

This study was carried out to relieve the apparent dearth of carefully controlled research aimed specifically and exclusively at the effectiveness of pictures in intrinsic (branching) programed materials.

Furthermore, although this study was concerned primarily with the application of iconic representation (color photographs) to intrinsic programed instruction there are implications for research, utilization, and the design of educational media. The

importance of a study such as this is emphasized by the large amount of activity devoted to developing media to be used as basic instruction which depend upon pictorial and other visual content. Thus, investigation of an assumption that programed pictorial materials may be more effective than programed non-pictorial materials provides some direction for those preparing any kind of instructional materials as well as for those interested only in programed instruction.

Furthermore, during the last decade there has been rising emphasis on perceptual sensory stimuli in plans for the learning experiences of the curricula for higher as well as primary and secondary education. It has created a demand for more knowledge about the effectiveness of pictorial content. This demand has been intensified by refinements in the technology associated with the use of computers for teaching. These advancements allow for the use of pictorial materials in the learning programs designed for computer assisted instruction. The adaptability of the intrinsic (branching) program to this form of educational technology was one of the motivational factors behind the submission of the proposal for this study.

Instruction having objectives related to task performance; the application of procedures and rules; and skill in making an analysis of the factors of a problem, should benefit significantly by having a more positive understanding of the role of photographic material in programed instructional materials.

Review of Related Research

In spite of the fact that iconographic representation has been historically an intrinsic part of communication between human beings, there is surprisingly little research which is clear or very definitive concerning the effectiveness of transferring ideas thru the medium of the picture.

Popular and textbook writing for educational use has rather consistently extolled the values of the picture ever since John Amos Comenius inserted drawings into his seventeenth century Latin book, but much of the research about pictures done in recent years has wound up asking more questions and suggesting more ideas for further research than providing positive information upon which to advance the art of teaching.

The literature examined in preparation for this study was delimited by the premise that our evaluation of pictures must be related to direct instruction. In other words, in order to be counted relevant there must have been reliance on the picture at least for part of the instruction given in connection with the

research reported on. A study of pictures related to the psychology of perception or discussions of the esthetics of pictures in learning is not considered to be within the scope of this study.

At the time of the inception of this study (1960), no analytical studies were on record as dealing with the effectiveness of color photographs in the instructional content of programed material. A number of popular research-related discussions about programed materials mention pictures or drawings as being in the programs. In some of them, pictorial material was inserted mainly as relief from the monotony of print.

A bit of exploratory experimentation close to the thinking behind this study is the result of the curiosity of Kenneth Dale Issacs (1962-) of the Illinois Institute of Technology. His experiments have been more centered on devices and on environment for making pictorial impact in teaching than on an analysis of functional behavior as a result of pictorial stimulation in learning situations. However, when, as interviewed by Gowran, he says he is concerned with instruction that relies on the "incredible ability of the eye to take in meaningful images which can be used later," (8) he is very close to the rationale behind this study which is concerned with the influence which stored pictorial images have on terminal functional behavior.

Other studies such as those of Buswell (1), Barnes (6), Brown (12), Gagne´and Foster (7), Spaulding (10), and Lefkowith (15), have made valuable contributions to knowledge in connection with pictures. However, they were not particularly useful in connection with the problem to which this investigator has given his attention. Their concern was with various factors related to the application of pictures within the framework of education but not with the general aspect of direct teaching effectiveness or with programed instruction in particular. In addition, the finding of a large number of pictorial studies where the effect of the independent variables was not significant bore heavily on the design of this experiment. The possibility of some common overly-influential factor in this situation became apparent. It was decided such a factor probably was related to the mode of evaluation used. The literature revealed the common use of evaluation instruments requiring written responses to measure the effect of pictorial (non-verbal symbolic) stimuli. The evaluative procedures reported seemed even less congruent to pictorial instructional procedures when the behavioral objectives were perceptual-motor in the immediate functional situation and were cognitive with respect to the application of principles learned to various activities beyond the range of the immediate experimental learning experience.

The influence of these observations led to the designing and inclusion in this experiment of a performance rating scale as one of the major parts of the evaluation procedure.

There is one recent study, that of Magne and Parknas (1963)[1] which, although not involved with programed learning, nevertheless supports the findings of this study in connection with the premise that the recurrent non-significance of differences between picture and no picture groups in so many studies is, at least in a substantial part, due to the almost exclusive use of verbal (most of the time written) test procedures to evaluate results of all experimental procedures.

The Magne and Parknas study obtained significant differences in favor of the picture group when their evaluation instruments were compatible with the kind of behavior being taught.

The literature dealing with computerized instruction or research utilizing computers in connections with pictorial elements in learning is too immature to give more than encouragement that this kind of equipment is capable of presenting and controlling instruction that is at least partially dependent upon pictorial elements. Continued study in this area is contemplated by this investigator.

In summarizing the literature review, it seems sufficient to point out that research in connection with instruction through iconographic stimuli (pictures) in general is not truly definitive and is even less helpful in the particular area of programed instruction.

Plan of the Study

The study was divided into four stages. The first was devoted to the preparation of the experimental program and the performance rating instrument. The experiment was run as the second stage. Analysis of the data was undertaken at this point. Some of the indications of this analysis suggested that further research would be profitable with respect to certain facets of the experiment. The third stage then consisted of the running of the

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[1]Author's note: This study had not been published at the time the experiment was conducted and had not been reported in American educational research journals.

subsidiary experiments on certain of these facets. The final report was prepared as the last stage.

Definition of Terms

In this study the terms"iconographic stimulus" and "picture" refer to projected images of color photographs twelve by eighteen millimeters as part of the two-by-two slides projected on a screen. The term "print" is used to describe the captions or descriptions prepared in symbols of the alphabet. Two alternate versions of a program were developed. Both were presented on slides. The one utilizing pictorial material as an integral part of the basic instruction was called the "Picture-Print" program. The other contained no pictures and relied on print as the sole method of instruction. This version was named the "Print" program.

The study employed two groups for each experiment. One group was labeled "picture" group. This group received instruction from the program which relied on iconographic material (pictures). The group which saw no pictorial material was defined as the "print" group. Therefore, the term "print" does not refer to material printed on paper whether the reference is concerned with a group of subjects or the instructional program. The term "performance rating scale" is the name given the evaluation instrument which was used to test the effectiveness of the instruction in producing the desired functional terminal behavior.

"Learning Room" describes a room specially built to isolate subjects from interference and distraction while they were studying the programs.

Specific terms used in connection with the "hardware" used in this experiment will be defined as they are introduced.

II. METHOD

Preparation of Materials and Measurement Instruments

Materials

This study has, as its predecessor, another experiment,(16) which used a course of study consisting of four units of programed material relied heavily on color photographs plus printed captions to do the teaching. These were presented to students on 2 x 2 slides. This pictorial program was employed as the mode of instruction for the control group of the present study.

To obtain the experimental program it was necessary to convert the highly visualized program of photographic material to a similar branching program having no pictures at all. Each of the pictures in the previously used program was analyzed and its content carefully expressed in print form, being very careful that the instruction presented in print form should have as near as at all possible the same instructional content as the frames which had consisted of picture and caption. The result was an entirely new program using exactly the same branching pattern as the pictorial program and as near as possible being a duplicate of the instructional content. This program was labeled the "print only" program. Since the subject matter being taught was identical frame for frame, it was considered quite safe to assume that any differences which might appear in the evaluation of learning which took place among the subjects employed in this study would be due to the variable of "no picture" which was introduced by this method.

Appropriate forms were designed to manage the records for each of the two groups from which the data were obtained.

All the instruction with these programs was given on a specially designed teaching machine using random selection projection of the slides. This equipment was housed in a special soundproof projection booth attached to the learning room used in the experiment to which previous reference has been made. The student subject studied the program by controlling the projection equipment from a remote control panel having a digital system keyboard.

This control panel was especially designed to minimize learner attention to the electro-mechanical equipment in the experiment. This hope was realized in that mistakes and fumbling due to the fact that an electro-mechanical device was being used in place of the more traditional pencil and paper were the negligible to such a degree as can be very comfortably ignored.[1]

Measurement

Performance Test

The study of a non-verbal communicating agent like the picture requires a non-verbal mode of assessing the effect of the use of the picture in a teaching situation. In almost any learning situation dealing with ability to perform, the sought-for objective is efficient functional behavior of some sort at a level of proficiency that is determined by the stated objectives. No known previous attempts to evaluate perceptual-motor and cognitive terminal behavior emerging from instruction with pictorial programed materials for library training had been made.

For this study the writer invested a substantial amount of time and energy to devise a performance measuring instrument[2] which could be relied upon to discriminate between adequate and inadequate performance in the use of the library for enrichment and research purposes. To evaluate non-verbal teaching materials with no more than verbal, written responses was ruled out as incompatable with the behavioral objectives of the programed materials used. It was recognized that such an instrument should measure both a student's knowledge about the library facility and his ability to apply the principles taught so he could actually put his hand quickly on the material he wanted. The instrument used was constructed after examining (Silvern and Linn, 1957) certain well tested performance evaluation devices used for similar kinds of behavior in industrial training applications known to this researcher through his previous consultation activities in that area. It required the subjects to function in the actual environment of the library in response to problems which were given to them by a competent examiner.

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[1] A detailed description of the development of the mechanical equipment used in this study is presented in Appendix A of the final report to which previous reference has been made. See footnote p. 2

[2] See Appendix "B"

This performance measuring instrument was in the form of a rating scale which utilized a five-point scale. It correlated +.05 with the criterion pretest and +.65 with the post-test. The time used by a subject to complete the sections of the assignment required by the rating scale was recorded to the nearest second by the examiners. This performance test thus provided both information on accuracy of performance and the time taken by the subject to complete the test.

Criterion Test

In order to measure the amount of verbal knowledge the subjects had about the library and its use, a written criterion test was devised. After examining apparently the only presently published library usage test[1] which had a degree of standardization and upon finding that it was not satisfactory for the library in which the experiment was conducted as well as being too strongly oriented toward the larger amount of detail required of the beginning professional librarian, it was decided that it would be necessary to prepare a carefully designed test which would function as the pretest and the post-test for the experiment. Although this test was used very successfully by an earlier experiment (16) involving this researcher, it was further refined for this study. The reliability as tested by Kuder-Richardson formula 20 ranged from .76 to .83.

Measures were obtained from the University Student Records on a number of dependent and independent variables for each subject. Some of the dependent variables were: the time it took the student to complete the program; the number of by-passes the student successfully passed during the program; the gain score on the library usage test; and the number of errors made by the subjects while studying the program. The error rate was recorded for the major experiment by the use of a twenty-one pen Esterline-Angus Recording Device.

Standardized Tests

A number of independent variables were obtained. These were the students' scores on the verbal part of the School and College Ability Test, their English Proficiency scores (which included measures of reading comprehension and reading vocabulary), and the pretest on knowledge about the library.

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[1] Bureau of Publication, Teacher's College, Columbia University, New York.

Procedure

The subjects used were volunteer freshmen taken from the beginning English classes at Southern Illinois University. They were randomly divided into two groups on the basis of when they registered for the library program. The first person was assigned to group 1 and the second person following would be assigned to group 2, and so on. Group 1 was labeled "picture group" and group 2 was given the designation, "print group".

Each student registered for all of the four units of the library program. He was allowed to sign up for all or part of his training in advance. Some students took all four programs in one session. This usually required two hours or more. Other students took two programs in one session and two in another session or, one program in one session and two in the next, and one in the third, or they might have taken the four programs successively in four separate sessions. There was no attempt to regulate the manner in which the subject completed his study. The schedule allowed was largely determined by a subject's class program. Each subject was required to finish the program of study within the limit of the normal University quarter.

Immediately following the instruction, the subjects were allowed to take the post-test. Most subjects completed the tests within three or four days after finishing the program of study on the machine.

After taking the criterion post-test, the performance evaluation using the rating scale was made. Three performance tasks were presented to the subject on a 4 x 6 card. The subject was required to find the catalog cards for books on a particular subject in the card catalog. He was then to look for a book by the title and the author in the author-title card catalog, find it on the shelf, and write out a call card for the book. The third task on the test required the subject to use the Reader's Guide to Periodical Literature in order to find in which periodical a certain article had appeared. This task required the student to work from knowledge of the title and the author of an article without information as to the name of the periodical in which it appeared. Subjects were then required actually to locate the article in the proper periodical on its shelf position in the library.

The evaluation of performance in the functional situation was made by examiners who observed the subjects as they proceeded through the library completing the tasks required by the performance test. An initial pilot trial of the use of the test showed that the examiner was unlikely to cause an amount of apprehension sufficient to interfere with the obtaining of reliable data.

Each subject had two records as a result of his instructional experience. One was his data card and the other was the print-out record of his behavior on the teaching machine. A follow-up questionnaire was distributed to the subjects at the end of the quarter in which they had the instruction.

III. RESULTS OF THE EXPERIMENT

Appraisal of Groups

For three groups of subjects: the picture group, the print group, and the "casualties"[1]:Table 1 lists the following information: the means of the English proficiency test[2] and its sub-tests, reading vocabulary and reading comprehension, the verbal section of SCAT, the criterion pre-test, the criterion post-test, the gain score, and the number of subjects (N). Table 1 also lists the "t" value for each of the scores between the picture group and the print group and the confidence level, "p".

It can readily be seen that the picture and the print groups were significantly different on almost all variables except reading comprehension for which the "t" was close to significance at the .10 level of confidence. These significant differences determined the use of analysis of covariance. When the criterion pre-test scores were held constant, there was no significant difference between the two groups. The same held true when the reading comprehension scores were held constant. However, when the SCAT scores were held constant, the difference between the two groups was significant at the .05 level of confidence. But, when both SCAT scores and the criterion pre-test score were held constant, this significant difference disappeared. It was concluded that there was no real, significant difference between the picture group and the print group on the gain score.

There was a total of 18 subjects, casualties, whose data were not used in the analysis. These were subjects who did not complete the four programs because of various reasons, or who completed the four programs, but did not return for the criterion post-test. The question was raised that perhaps subjects who drop

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[1]This term used to identify lost data due to illness, personal problems, etc., of subjects.

[2]Cooperative English Test, Higher Level 11-16, #645, Buros.

TABLE 1

Means of Scores

	SCAT	English Proficiency	Reading Vocabulary	Reading Comprehension	Reading Total	PRE	POST	GAIN	N
PICTURE	58.9	87.5	25.6	26.0	51.7	63.4	77.8	14.5	30
PRINT	67.9	99.4	30.9	29.4	60.3	67.7	78.9	11.1	34
t (PICTURE:PRINT)	2.89	2.40	2.57	1.68	2.38	2.54	--	--	64
p	.01	.02	.02	.10	.05	.02	--	.05	
CASUALTIES	67.5	100.4	29.1	30.1	59.2	65.4	--	--	18

TABLE 2

Analysis of Covariance on Gain Scores Holding SCAT Constant

Source	MS	df	F	p
Within	36.44	61	5.23	<.05
Between	190.64	1		

TABLE 3

A Comparison of the gain scores of the print and picture groups with respect to the scores of four independent variables at three levels of achievement.

			PRINT		PICTURE	
Independent Variable	Level	Range	N	Average Gain Score	N	Average Gain Score
Pre Test	High	70-77	12	6.42	7	10.86
	Med.	60-69	20	13.05	14	14.00
	Low	44-59	1	26.00	9	18.00
SCAT (verbal)	High	74-96	10	13.20	1	6.00
	Med.	55-73	18	10.89	19	14.37
	Low	32-54	5	7.20	10	15.50
English Proficiency	High	113-126	6	14.50	3	15.00
	Med.	71-112	24	10.56	21	14.00
	Low	23-71	3	6.50	5	16.00
Reading Vocabulary	High	33-44	11	11.73	8	12.12
	Med.	18-32	22	10.68	19	13.89
	Low	11-17	0	--	3	17.67
Reading Comprehension	High	33-44	11	11.45	5	9.40
	Med.	18-32	19	10.79	21	15.00
	Low	11-17	3	11.00	4	18.00

out from the program differ significantly on some independent variable from the subjects who stay in the program. It can be seen that the means of the dropped subjects are fairly close to the means of the subjects in the print group. Therefore, it was concluded that these subjects were not really significantly different respecting any of the variables from the subjects who completed the program. There was no further analysis of the data from dropped subjects.

Comparison of Gain Scores of the Print and Picture Groups

A comparison of the gain scores of the print and picture groups with respect to the scores of four independent variables at three levels of achievement provided a profile of the experimental results. Each of the independent variables was subdivided into levels of high, medium, and low scores. Subjects in the picture group and in the print group were analyzed separately. Each subject was placed into the high, medium, or low division on the basis of his criterion pre-test score; on the basis of his SCAT scores; on the basis of his English proficiency scores; on the basis of his reading vocabulary scores; and on the basis of his reading comprehension scores. In each of these divisions the average score of subjects at any given level was then determined. The range of each independent score, the N of persons falling within that range, and the gain scores of the persons falling within that range are given in Table 3.

It can be seen that those with high criterion pre-test scores in both picture and print groups gained less than those with medium and low criterion pre-test scores. This was to be expected, and can probably be explained by the operation of the ceiling effect which is typical of many tests. After visual inspection of Table 3, it was decided to compute t-tests on the gain scores between corresponding levels for the experimental and control groups, and within levels in each group on two variables: the reading comprehension scores and the SCAT scores.

Within Groups: Within the print group, a between-levels comparison shows no significant difference in gains between high, medium, and low reading comprehension subjects. This can probably be explained by the simplicity of the text which was used in the print program. The text was usually not more than one to two sentences long, and difficult words were purposely omitted.

However, there was a significant difference between the levels in the picture group. The 't' between the high and medium subjects was a -2.68, significant at the .02 level of confidence. That is, the gain score is in favor of the medium group of subjects.

The "t" between the high and the low subjects is a -4.19, significant at the .001 level of confidence. Between the medium and low subjects, the "t" is barely significant. (t= -1.92; p = .10)

Between Groups: In the medium SCAT range there was no significant difference between the picture and the print groups. The "t" was equal to 1.60, non-significant. In contrast, for the low SCAT range the "t" was significant at the .01 level of confidence, the "t" being equal to a 3.15, gain in favor of the picture group. This indicated that the picture treatment was better for subjects who had low SCAT scores than the print treatment. However, it did not make a lot of difference which treatment subjects in the middle SCAT range received although there was a very slight advantage for the picture group which could scarcely be called significant. (Subjects in the high SCAT range were not compared because of the low N in the picture group.)

On the reading comprehension breakdown, there was no significant difference between the high picture and the high print subjects. In the medium reading comprehension range the difference is only significant at the .10 level of confidence (t=1.89) between the picture and the print subjects.

However, in the low reading comprehension range we find a significant difference between the picture and the print groups at the .05 level of confidence (t=2.99). In both the medium and the low levels the picture subjects did better. This seemed to indicate that the picture treatment was better for subjects in the medium and low reading comprehension ranges than was the print treatment.

In summarizing the reading comprehension analysis, those having the lower reading comprehension scores in the picture treatment gained more from the program than those having high reading comprehension scores. There was no difference between the levels in the print group. A possible explanation is that the pictures handicapped those scoring high on reading comprehension. In other words, the better readers quickly scanned and comprehended the print material and gave either a brief glance at the picture or skipped it entirely (following their behavior in textbook and magazine reading). This would result in their not paying attention to that part of the program which was taught by means of the pictures. The slower readers or those which generally comprehend written material less ably, probably have learned to utilize pictures whenever available as a source of information and would tend to study the pictures on the slides as well as the print material.

Time to Complete Program

When the picture and the print subjects were compared on program time (the time that they spent on all four units of the program), there were no significant differences. The print subjects spent an average of 101 minutes on the four units of the program; whereas, the picture subjects spent an average of 103 minutes on the program.

There was also no significant difference between the picture and the print groups on the time they used in completing the simulation items of the program.

Time on Simulation Items and Performance Test Scores

Two questions were considered in this analysis. One sought to know the difference between the picture and the print groups regarding the effect of the simulation items on performance in the terminal functional behavior and the other asked, "Do subjects who spend a lot of time answering the questions on the simulation frames, also spend a lot of time performing a task on the performance rating scale?", and conversely, "Do subjects, who spend a short amount of time completing the simulation frame tasks in the program, go through the performance tests at a very fast rate of speed?" When the square analyses were made, there were no significant differences between subjects scoring on the rating scale (that is, high or low) and the subjects speed on the simulation frames in the program (that is fast or slow). In this analysis, picture and print subjects were analyzed separately.

Learning Schedule on Program Units

The subjects in the experiment were allowed to schedule their program sessions at will. Thus, a number of different sequence and time combinations resulted· that is, some subjects took one session to complete all of the four program units, some took four sessions to complete all of the units, and some chose still other scheduling combinations. Also, there were those who completed all the programs in one day: whereas, others took more than two weeks to complete the program.

"Does one pattern of scheduling enable subjects to learn more (as measured by gain scores) than another pattern?" A look at Table 4 shows the answer to this question was positive. The analysis indicated that it seemed preferable for subjects to take the total library program in two sessions, and that the program

TABLE 4

Learning Schedule

(Picture and Print Groups Combined)

Time Elapse In Days (Unit 1 to Unit 4)	Sequence of Units Taken	N	Average Gain
3 days	2 units + 2 units or 1 unit + 3 units	15	16.2
3 days	All Other Possible Sequences	17	13.2
3 days	2 + 2 or 1 + 3	17	11.6
3 days	All Others	26	11.2

should be completed within three days. Further, it was best not to take the whole program at one sitting. This seemed to be the best for both the picture and the print subjects. Picture and print subjects were first analyzed separately, and then they (since no gross differences occurred) were combined into one group. Table 4 shows the combined group data dor this analysis.

Analysis of Rating Scale Scores

It will be recalled that the rating scale had three parts. The first analysis dealt with the total score for the entire test.

A t-test was run between the picture and the print subjects on this total. (t=1.81, df=72) This was significant only at the .10 level of confidence. When Part 3 of the rating scale, the most difficult task, showed the greatest variance in scores, a t-test was run between the picture and the print groups on Part 3 only. This "t" was significant at .001 level of confidence (t=3.57, df=72). This difference was in favor of the picture group.

Analysis of Time as a Factor in Study of Picture Frames

The programed instruction for Unit 4 in the Picture group was broken down into the information frames which showed a picture and those which did not show a picture. The Unit 4 record charts for each picture slide were then analyzed as to the amount of time spent by each subject on each picture frome in the picture group. The amount of time spent by each subject in the print group on the equivalent slide was also obtained. The time per frame was compiled in seconds from the Esterline-Angus record charts. This indicated, that on the average, picture subjects spent 11.75 seconds perframe on the picture slides; whereas, on the equivalent slides, the print group spent an average of 10.60 seconds. This difference was significant at the .01 level of confidence. This analysis was not done for Units 1, 2, and 3 because of the great amount of staff time required to transform the appropriate time from the Esterline-Angus record charts into usable tabular data.

Error Rate

The record charts (Esterline-Angus) were also analyzed for program error rate. These included the error rate on the review questions, the error rate on the by-pass questions, and the error rate on reinforcement (diagnostic) questions. The error rate on review questions refers to three questions at the beginning of each

unit pertaining to material learned in the previous lesson. The error rate on by-pass questions refers to how many subjects made or failed to gain the by-pass. The error rate on reinforcement (diagnostic) questions refers to all of the multiple choice questions within the program which were not by-pass qualifying questions. These diagnostic questions usually queried subjects about material taught in one to three slides previous to the question. There was no significant difference between the print and the picture groups in error rate on review questions or diagnostic questions.

Relationship Between Mode of Instruction and By-Pass Success

Unit 2 contained one by-pass which was a picture by-pass. It was a picture of a number of library books which were presented in a certain arrangement, and the subject had to tell by answering three different questions whether or not these books were placed in proper order and, if not, what should be done with them. The print version of this by-pass was simply a diagram of several Dewey decimals, and the student was required to decide whether or not they were in order. In the picture group, an average of 1.22 by-pass questions were correctly completed; whereas, in the print group an average of 0.49 by-pass questions were correctly completed. The difference between the two groups was significant at the .05 level of confidence ($t=2.43$, $df=7$).

In Unit 3 of the program there were five possible by-passes none of which contained pictures. Here, there was an average of 1.52 by-passes successfully completed by the picture subjects and 1.93 by-passes successfully completed by the print subjects. This "t" was not significant.

IV. DISCUSSION

The natural characteristics of any medium being researched dictate much of what can be extracted as useful information and data.

Any attempt to study the picture must recognize at the outset that this medium is a stimulus form that develops many complex responses in the educational processes. Some of these responses are observable and many are not. Some of them involve overt behavior and others appear to be only covert mental responses. It is difficult to know anything about these latter responses.

The results of the collection of data for this experiment are a number of kinds of information on the behavior of the subjects. These data were studied carefully for clues to a more definitive understanding of the effectiveness of the application of pictorial instruction to intrinsically programed material.

The limits of time, funds, and personnel precluded the examination of some of the more complex data which were recorded by the instruments attached to the teaching machine. These may have been valuable if they had been examined. The reader must be reminded that this particular study was not established as a large scale study in either design or funding, and consequently was basically limited to a pilot-sized study which, however, has by concentrated effort and the help of additional non-grant assistance been able to go beyond the limit of the single hypothesis for which the study was funded under its grant contract.

The Gain Scores:

Since programed materials have a special value for meeting variability in groups of learners, more than an analysis of gain scores for the <u>whole</u> group was considered desirable. The "whole group" analysis showed the picture treatment to be significantly better if the level of probability were accepted at a higher value. (<.05). Therefore, since variability in learners tends to occur within groups, an analysis <u>within</u> the two groups was made.

As might be predicted, the most significant factor relating to the effectiveness of the picture was low ability in reading comprehension. It was here that the pictorial influence was most evident in its effectiveness toward a better learning experience. (Significant at the <.001 level).

The middle ranges in the picture group were much as middle ranges usually are--little affected by anything but extremes in treatment.

A possible explanation for the value of the picture to the subject having a low level of reading comprehension may lie in the fact that he may have an ability deficiency in connection with reproducing some form of iconographic representation in order to understand and respond to the symbolic representation of which any written (paper and pencil response) test consists. Of course, this explanation is really more of a hypothesis much in need of testing than a reason.

The Performance (Rating Scale) Test:

Probably the most useful result of using a performance rating instrument lies in the ability of that test to uncover the most difficult part of a task area for which a subject is receiving instruction. Obviously, changes and improvements in the teaching situation can be made. It was the difficult area that proved the worth of the pictures in the instruction for the group which received them.

The more difficult and unfamiliar material was most responsive to the use of pictures. Thus, the pictures in the teaching machine program appeared to have provided picture images retained in the minds of the picture group subjects which were to become cues to correct responses when an exact replica of common terminal functional behavior in the use of library materials was presented to them by the performance test. (Significant, <.001)

This writer can conceive of no other way to evaluate accurately one of the most valuable principles of programed instruction in a learning situation; namely, determing in advance the terminal functional behavior desired of the learner.

As has been demonstrated in this study, written tests do not provide this, when other than verbal behavior knowledge is being taught.

Time on Simulation Items and Performance Test Scores:

The simulation items were part of the basic content of both picture and print only programs. The slides in both cases, with one exception which is discussed elsewhere, were identical. (Both the instructions for doing the task and the reinforcement questions and diagnostic content were all print) Therefore, the time for carrying out the exercise as recorded by the machine was the only measurable variable explicitly related

only to the simulation items which could be economically analyzed.

It was not surprising that it failed to influence significantly since there were no real differentials in the learning stimuli other than such things as would relate to personality factors and the like.

Program Time:

It was thought that the picure groups would go through the program faster. This was not the case. They took longer but the difference was not significant. Perhaps they found the pictures more interesting than the print subjects found their characters to be.

Theoretically, the picture subjects could have picked up what they needed to know faster from the pictures. The reason they did not may lie in the print oriented learning-set twelve or more years of schooling had developed in them. This provides still another opportunity for research.

Error Rate:

Examing errors by simply counting them is not a very revealing statistical procedure for any intrinsic program when one wants to compare groups. The reason most probably lies in the fact that errors are part of the teaching procedure and most likely would not reflect any great differences between groups nor would they relate particularly to effectiveness of instruction. Actually, they tend to tell more about the program than they do about the learner.

The Amount of Time Subjects Studied Picture Frames:

The analysis of the machine record of time subjects spent on looking at the pictorial material suggests there was a greater degree of involvement in the instruction when pictures were present than when there were no pictures.

In the study, the picture subjects "stayed with it" longer. Noticing this, it was then not surprising to find that the picture group behavior proved to be better when the "going got tough". Evidently the greater time on the content of each pictorial instructional slide resulted in more effective learning, as compared to the same content given in print form on slides.

The By-Pass Analysis:

The most significant aspect of the analysis of the behavior on the by-passes was seen in the apparent ability of the picture to communicate ideas teaching arrangement and order as principles in finding library materials. The insertation of a pictured book

arrangement as an item to determine eligibility for skipping some of the instruction showed that the subjects not having pictorial material could go on only whatever pre-experiment training (with its mental images) was brought to the situation by the learner. That this was inadequate was shown by the data.

V. CONCLUSIONS AND IMPLICATIONS FROM THE MAJOR EXPERIMENT

The preceding discussion of the results of the major experiment represents the findings directly related to the hypothesis presented for this study. Although this report does not conclude with this main experiment but proceeds to investigate certain subsidiary questions, the conclusions presented at this point relate only to the findings of the foregoing experiment.

The subsidiary experiments will be handled separately as an addition to the main report. This procedure has been chosen since the subsidiary studies do not fall under the specific experimentation covered by the proposal submitted for the grant which supported this investigation. These subsidiary experiments represent only additional analyses and minor experiments related to programed materials which were thought to be of interest to those who read the report.

As was pointed out in the levels analysis section of the treatment of results previously described, it was observed that the subjects whose scores fell in the middle and lower ranges of their college ability tests showed significantly better understanding and matter of knowledge gained when the pictorial program was the mode of instruction. This same differential also appeared in connection with the reader of lower ability.

It will be concluded then that the intrinsically programed instructional program on library usage having carefully designed pictorial content as part of the instructional mode produces a greater gain in learning for the student whose reading comprehension is either moderate or low than a similar program having no pictures.

Thus, when one stops to consider the general use of programed materials he will see that they have a particularly valuable application in providing the slower learner with an opportunity to equalize himself with those who grasp things more quickly. The further step taken by this study suggests that within this set of values of programed materials there can be the additional value of incorporating the pictorial stimulus as an additional improvement in instructional technique for the slower reader.

It can be concluded that there is probably no reason to be concerned about the picture changing the amount of time required for

studying, since no significant differences were observed in the amount of time on the program between the picture group and the group not having pictures.

As was the case immediately above in relationship to the program time, the study also would conclude that the bringing into the instructional program of simulation frames does not increase the time required enough to be significant.

Because the students were allowed to set up their own schedules for the study of the programed course in library instruction, there emerged several distinct patterns of a schedule for taking the four lesson units. As was indicated in the results discussion, some students completed all of the four programed units in one long sitting, others took four separate sessions to finish and still others took the course units in combinations such as two at one sitting and two at another sitting or three at one sitting and one at a successive time and so forth. A general conclusion that might be drawn from the analysis suggests that it is preferable to study programed material, at least programed material presented by way of a teaching machine using intrinsically programed material projected from slides, in moderate sessions probably not more than an hour at one time. Also, these sessions probably should not be overly extended. It is questionable whether the matter of a given number of days would be applicable to all kinds of programed experiences. Of course, the length of programs would vary greatly. This investigator would like to recommend as a result of the observation of students at work, that "crash schedules" for remedial or make up work with programed materials be avoided. This suggestion is made recognizing that further research on the matter of ways of studying programed materials needs to be conducted.

In the very important area of the performance of a learner in the terminal functional situation it can be concluded that pictorial instruction contributes significantly to increased accuracy and efficiency in the use of a large university library. It is not unlikely that similar results can be had in a wide range of other instructional areas having objectives that are cognitively organized perceptual-motor functions.

At first glance, the results of comparing the picture and non-picture subjects for differences in time spent studying the instruction slides seem to contradict the findings of the over-all program time comparison. However, remembering that the total programs contained simulative material and diagnostic material, it can be concluded that the greater time spent on the individual pictorial instruction slides was more than made up in faster progress with the

other program content, apparently due to a better grasp of the content by the picture subjects.

For the three kinds of program content which could produce stimuli provocative of error; (review items, diagnostic items and by-pass qualifiers) the conclusion must be that the influence of the pictorial material is not likely to be observable where the only behavior called for lies in the area of symbolic representation (verbal, either written or spoken). The implication is strongly toward the idea that values of pictorial instruction are more surely realized in overt behavioral responses than in spoken or written symbolic responses.

One further conclusion drawn from the major experiment relates to success with by-passes. Problems presented in pictorial form will be handled better by those who have received their instruction thru carefully designed pictorial experiences in the programed material they study. In other words, the mode of instruction will influence the mode of response.

In summary, the several analyses conducted in this experiment indicate that pictorial instruction created specifically for intrinsic programed materials will produce a more effective self-instructional experience on the use of a library than a similar program that does not use a pictorial approach.

The implication drawn is simply that, at least in similar kinds of subject matter, pictorial instruction will provide a more effective means of teaching.

Recommendations

Further research with respect to the employment of pictorial and other forms of iconographic representation needs to be conducted. For example, the aspect of the motivational power pictorial material can exert in an instructional program needs studying.

Another problem lies in the identification of the elements which constitute a picture that will teach. Also, some mode of dissecting the complex mental reaction patterns set in motion by pictures could be outstandingly useful to the design of picture content that was to be used in instruction.

More future research with forms of pictorial instruction needs to be carried out recognizing that all which is learned from a photograph is not comprehended in terms of explicit written or printed symbolism, but is a translation from the iconic representation of an idea thru a context of experience into the intellectual life of the learner. Each picture provides a complex message. Each message is constructed of a maze of sign stimuli which tend to elicit many different responses.(4)

SUBSIDIARY EXPERIMENTS

SUBSIDIARY EXPERIMENTATION

At the end of the major experiment, it was decided to extend the investigation to include upper division classmen. The subjects for these sub-studies were mostly college seniors in a 400 level instructional materials course (N=62). One of the motivating factors for doing these subsidiary experiments was the desire to determine the generalizability of the earlier results.

The hypothesis developed here stated that the null hypothesis of the major experiment would apply to the upper division students as it did to the freshmen used in the major experiment.

Certain minor modifications to the programed material were made to better relate it to the senior subject. One example of this modification was to make the entrance to by-passes in unit three more difficult by requiring a sharper knowledge of the material being skipped.

As in the main experiment, subjects were given the criterion pre-test and the criterion post-test and, also, the rating scale evaluation of actual performance in the library.

The written criterion test was a refinement of the original test. The changes were largely to produce a more polished test and to upgrade certain items to include upperclassmen. This refined criterion test was the result of improvements which evolved thru validation and use with a number of freshman English classes, the basic Instructional Materials classes, students specializing in library science, and the professional librarians on the staff of Morris Library.

Final refinement of the performance evaluation instrument occurred in these subsidiary experiments. These were largely administrative and mechanical in nature rather than conceptual or functional.

Results

Independent measures were obtained for both the picture and print groups. These were scores from the School-College Ability Test, reading comprehension (Cooperative English Test - Higher Level, #645, Buros), the grade point average, and letter grade in the course. There was no significant difference between scores of the two groups for either the SCAT or reading comprehension. However,

there was a significant difference between the two groups on the criterion pre-test score. This was significant at the .001 level of confidence.

Due to the significant difference on the criterion pre-test scores, an analysis of covariance rather than variance was run on the gain scores. This analysis of covariance made an adjustment for the criterion pre-test score. There was a difference in favor of the picture group at the .05 level of confidence.

The rating scale was administered to the picture group. The correlation between the rating scale and the criterion post-test was equal to .65 which was significant at the .001 level of confidence. The correlation between the rating scale and the criterion pre-test score was .06. The criterion post-test correlation indicated that the rating scale correlated well with the criterion test; particularly, since it is typical that rating scales do not correlate very highly with written measures.

This is one indication that the criterion test was a valid general measure of ability to use the library. In addition, the fact that such a low correlation was attained between the rating score and the criterion pre-test score indicated that the rating scale as well as the criterion test measured what the subject learned during the program rather than the library knowledge with which the subject came into the program, prior to instruction. Kuder-Richardson reliabilities were .86 for the criterion pre-test and .77 for the post-test.

In the rating scale, one of the tasks which subjects were required to perform was to fill out the call card as if they were checking a book out of the library. It was hypothesized that the subjects in the picture condition would write down the date of the book and the call number more often than would subjects in the print type condition. Chi-Square analyses were run using the dichotomies, date and no date on the one hand, and picture and print on the other hand. However, there was no significant difference whether total groups (picture and print) were used or whether the groups were broken down into male (picture and print) and female (picture and print) subjects.

A second hypothesis was made that the males would differ from the females in the proportion of subjects who write down the date of the book. Again, X^2 results of male picture subjects versus female picture subjects, and male type subjects versus female type subjects indicated that there was no significant difference between the sexes on this variable.

A third hypothesis was that the subjects would circle their status rather than making a check, an X, or an underline more often in the picture group than in the print type group. This was because pictorial group subjects saw a correctly filled out call card in which their status was circled. The print group did not see the word "status" circled. They were just told that they should mark their status. The X^2 analysis of total picture subjects versus total print subjects was equal to 3.00, df = 1. The p was significant at the .01 level of confidence.

Final Comment:

One of the findings of the study resulting from the use of several groups of college students suggests that such groups are useful for research in media variability because over a period of time the chance of any great fluctuations in characteristics of the subject groups becoming influential on data appears to be sufficiently minor as to be disregarded. This is suggested here since the practice of using human subjects for research in learning has traditionally been frocked with troubles in variability, attendance, and a number of other factors which make the administration of research dealing with human beings sometimes considerably difficult. The fact that this study was not troubled by any significant problems with respect to the type of subjects may be result of the simple fact of a certain amount of leveling which occurs in the policy on admissions of students for study in a university program.

Discussion and Conclusions from the Subsidiary Experiments

The analysis of covariance computed for the gain scores of the print-picture group involving the upper division subjects indicated a moderately significant difference in favor of the picture group. The null hypothesis is rejected on the basis of this analysis of the gain scores. In addition, the rejection of the hypothesis is further substantiated by the results of the analysis of the performance rating scale with these subjects. Since this was significant at the point .001 level of confidence, it is concluded that there is an equally effective use of the picture for instruction to teach library usage skills to upper division (seniors and juniors) college students when using programed material.

A further hypothesis stated that the subjects in the picture group in arranging to check out a book would write down on their call cards pertinent book information more often than subjects in the print group. The analysis in this respect was not significant; therefore, the hypothesis was not supported. (In connection with this hypothesis, the matter of sex was examined. As was the case immediately above, there was no significant difference between the sexes in this variable.)

The conclusion to be drawn from this analyses suggests that a single picture which tries to describe a series of steps such as checking a book out is not effective in programed materials.

A third hypothesis stated that picture subjects would more often follow the example given in the picture than would the print group who were instructed by words to do the same thing as the picture showed. The analysis was significant in favor of the picture group. Therefore, it is concluded that pictures used in programed material emphatically demonstrating a process can usually be counted on to provide better instruction than printed instructions will provide.

Recommendations from the Subsidiary Experiments

The program used for this research project demonstrated an ability to transcend the levels of student maturity and be effective at the extreme ends. This conclusion is drawn partially from the data and also on the basis of comments from the subjects as a number of them were orally interviewed at the conclusion of their learning experience. Further research with this concept is needed in order to develop firmer guide lines for the preparation of pictorial programed materials which can deal with subject areas needed by students on various levels of academic attainment.

It is also suggested that more research is needed to determine with a greater degree of accuracy exactly the kinds of picture portrayal that produces the greatest amount of learning. This, of course, will need to be concerned with the kind of terminal behavior desired.

SUMMARY

The study was conducted to determine the value of colored photographs as parts of frames of programmed instruction to orient freshmen to the use of the university library. The branching programs were presented to the subjects in the controlled laboratory situation by randon access slide projectors. The subjects were volunteer freshmen assigned randomly to two groups. One group saw the program with instruction frames combining colored photographs and print. The other group saw the program version in which the content of the pictures was translated into print. A written criterion test was given both as a pretest and a post-test. The performance rating scale measured the ability to perform assignments on the floor of the library. There was no significant difference between the picture group and the print-only group in the gain scores on the written criterion test. Only students with low SCAT scores and low reading comprehension scores profited significantly more from the picture versions. Better readers probably skipped the pictures as unimportant. There was no difference between the groups in time spent on the program.

The program contained special frames designed to simulate the terminal behavior being taught. During the program students were required to find catalog cards, books, and references in the laboratory room. On the performance rating scale the picture group performed better at the .001 level of significance. There was no difference between the groups on error rate. The picture group was able to complete by-passes significantly better than the print-group.

To conclude, most pictorial frames and simulation performance frames did not result in significantly greater gain scores on a written criterion test but did significantly improve performance of actual skills in the library.

REFERENCES

Books

1. Buswell, Guy T. How People Look at Pictures. Chicago: The University of Chicago Press. 1935.

2. Dale, Edgar; and others. "Research on Audio-Visual Materials," Audio-Visual Materials of Instruction, 48th Yearbook, Part I, National Society for the Study of Education. Chicago: The University of Chicago Press. 1949.

3. Lumsdaine, Arthur A.: and Glaser, Robert, Editors. Teaching Machines and Programed Learning. Washington, D.C.: The Department of Audio-Visual Instruction, N.E.A. 1960.

4. Osgood, Charles Egerton. Method and Theory in Experimental Psychology, New York: Oxford University Press. 1958.

5. Silvern, Leonard C.; and Linn, H. S. Guide to Performance Testing. Culver City, Calif.: Hughes Aircraft Co. 1957.

Articles

6. Barnes, Donald L. "Consistency of Pictorial and Multiple-Choice Responses to Orally Communicated Concepts," The Journal of Educational Research. 57, No. 7, March, 1964. p. 382-383.

7. Gagne, Robert M.; and Foster, Harriet. "Transfer to a Motor Skill From Practice on a Picture Representation," Journal of Experimental Psychology. 39, June, 1949. p. 342-355.

8. Gowran, Clay. "The Incredible Knowledge Box," Chicago Sunday Tribune Magazine, July 29, 1962. p. 8.

9. Rust, Grosvenor C. "A Transfer Approach to Programmed Training," Journal of American Society of Training Directors. XVI. No. 5, May, 1962. p. 50-54.

10. Spaulding, Seth. "Research on Pictorial Illunstration," Audio-Visual Communications Review.3,1955. pp.34-35.

11. Wendt, Paul R.; and Rust, Grosvenor C. "Pictorial and Performance Frames in Branching Programmed Instruction," The Journal of Educational Research. LV, No. 9, June-July, 1962. p. 430-432.

Research reports

12. Brown, James W. A Comparison of Verbal and Projected Verbal-Pictorial Tests as Measures of the Ability to Apply Science Principles. unpublished Ph.D. dissertation, The University of Chicago, 1947.

13. Church, Joseph. A Survey of Literature Bearing on Perceptual Aspects of the Effectiveness of Visual Aids. HRRL Memo Report No. 16, Washington, D. C., U. S. Air Force, Human Resources Research Laboratories, Balling Air Force Base, January, 1952.

14. Goodman, David J. The Comparative Effectivenes of Pictorial Teaching Materials. unpublished Ph.D. dissertation, New York University, 1942.

15. Lefkowith, Edwin F. The Effect of Pictorial Stimuli Similarity in Teaching and Testing. unpublished Ph.D. dissertation, The Pennsylvania State University. 1955.

16. Wendt, Paul R.; and Rust, Grosvenor C. A Study to Determine the Extent to Which Instruction to University Freshmen in the Use of the University Library can be Turned Over to Teaching Machines. Southern Illinois University, Carbondale, Illinois, 1963, Final report of research conducted under U.S.O.E. Grant No. 7-11-076.00 Title VII of Public Law 85-864.

17. Wendt, Paul R.; and Rust, Grosvenor C. To Test Refinements in Intrinsic Programming in Pictorial, Audio, and Performance Frames to Maximize the Probability of Desired Terminal Behavior. Southern Illinois University, Carbondale, Illinois, 1965, Final Report of research conducted under U.S.O.E. Grant No. 7-23-0907-189, Title VII, of Public Law 85-864.

Appendix "A"

Description of Physical Environment for the Experiment

Physical Environment

All students were given individual instruction. There was no group instruction for any of the subjects. All of the instruction was given by the teaching machine. For this they were seated in a small learning room in which was placed a desk upon which was a remote control panel the student used to operate the random access projectors. Also, on the desk, one on each side of the remote control panel, was a library catalog card file drawer (tray) which represented the subject card catalog and the author title card catalog. In addition, there was a small table and bookshelves. On the table was a set of dictionaries. The bookshelves contained a typical section of a stack (shelves) of books, as well as two sets of encyclopedias.

Three projectors were located in a room directly behind the student who was seated at this desk. The instructional material on 2 x 2 slides was projected by these machines through glass windows onto a screen which the student faced. This arrangement was designed in order to prevent noise from the equipment in the projection room disturbing the subject's ability to concentrate on the subject matter being given him.

Any one of 150 programed items could by called up for study pressing the proper keys on the remote control panel. All of the teaching used the intrinsic or branching type of programming as the medium of instruction. If a student became confused or was in need of special attention, he was able to ask for assistance by depressing a special call button which signaled an attendant nearby. However, this call button only occasionally was used by the students who were under instruction. The equipment proved to be very reliable and not many students asked for assistance.

The learning room as described was located on one of the lesser used floors of the library building. This location considerably reduced administrative detail.

For other research and the subsidiary experiments an automatic Print-out Device was installed which typed the information on tape. There was essentially no difference in the information obtained by this device than the one used in the major experiment except the matter of convenience in reading the records. The Print-out tape was obviously more simple to analyze than Esterline-Angus pen charts.

Appendix "B"

The Performance Rating Scale

This appendix describes the Performance Rating Scale developed by this investigator for the evaluation of the functional terminal behavior required by the design of this study.

This instrument was used in concurrent and subsequent experimentation conducted under another project carried on by Paul R. Wendt and this writer.(17)

Several small pilot groups were used to perfect the test. The results with these small trial groups are not included in the data given. These data functioned primarily as guidence in reaching the form of the test that provided the data that is given.

Performance Assignments and Rating Scale

Students were given these assignments in the Southern Illinois University Library and were rated by project observers using the Performance Rating Scale.

Do the following library assignments:

A. Show how you would find out if there are any books in the SIU Library on Veterinary Obstetrics.

B. Actually find this book on the shelves and fill out a call card for it---The Demon Lover.

C. Using the Readers' Guide to Periodical Literature, find out which 1949** magazine contains the article, "The Guy Who Gets Things Done" by Carey McWilliams. Then locate the article itself, that is, actually find the correct periodical and point out the article.

** The year 1949 purposely chosen to make this task more difficult for the student. The articles published in 1949 are found in two different volumes of the Readers' Guide instead of all being contained in one volume.

Date_____ Code_____

PERFORMANCE CHECK LIST

NAME_____ Class_____

Time

PART A

Score: 3 | 2 | 1 | 0 | -1 | -2 | -3

1. Goes directly to Subject Card Catalog . . . . . ☐
   a) Goes to Author-title Card Catalog; quickly catches error . . . . . ☐
   b) Goes to Author-title Card Catalog; slowly catches error . . . . . ☐
   c) Needs hint . . . . . ☐
   d) Needs explanation . . . . . ☐
   Other (explain)

_____
when S looks up from reading card

2. Goes to correct drawer for "see" card . . . . (Check for where S goes) ☐
   Goes to correct drawer for main heading . . . (first: main heading) ☐
   a) Goes to wrong drawer; corrects self (or "see")
      rapidly . . . . . ☐
   b) Goes to wrong drawer; corrects self slowly . . . . . ☐
   c) Needs hint . . . . . ☐
   d) Needs explanation . . . . . ☐
   Other (explain)

3. Uses guide cards within drawer accurately to locate section where card he wants is located . . . . . ☐
   a) Partial use of guide cards--may dip into a wrong section momentarily but goes on from section to section . . . . . ☐
   b) Fumbles through all cards--hard to distinguish any use of guide cards . . . . . ☐
   c) Ignores guide cards at first, finally uses them . . . . . ☐
   Other (explain)

4. Finds right catalog cards without trouble . . . . . ☐
   a) Some trouble but finally finds cards himself . . . . . ☐
   b) Has a lot of trouble but finds cards himself . . . . . ☐
   c) Needs hint . . . . . ☐
   d) Needs explanation . . . . . ☐
   Other (explain)

_____
when S completes task

Time	PART B	Score 3	2	1	0	-1	-2	-3
when S looks up from reading card	1. Goes directly to Author-title Card Catalog	☐						
	a) Goes to Subject Card Catalog; quickly catches error		☐					
	b) Goes to Subject Card Catalog; slowly catches error			☐				
	c) Needs hint				☐			
	d) Needs explanation					☐		
	Other (explain)							
when S starts to pull out a catalog drawer	2. Uses alphabetical guides on drawer front correctly	☐						
	a) Goes to wrong drawer; corrects self rapidly		☐					
	b) Goes to wrong drawer; corrects self slowly			☐				
	c) Needs hint				☐			
	d) Needs explanation					☐		
	Other (explain)							
	3. Looks up correct word in title of book	☐						
	a) Uses wrong word in title; corrects self rapidly		☐					
	b) Uses wrong word in title; corrects self slowly			☐				
	c) Needs hint				☐			
	d) Needs explanation					☐		
	Other (explain)							
	4. Uses guide cards within drawer accurately to locate section where card he wants is located	☐						
	a) Partial use of guide cards--may dip into a wrong section momentarily but goes on from section to section		☐					
	b) Fumbles through all cards--hard to distinguish any use of guide cards			☐				
	c) Ignores guide cards at first, finally uses them				☐			
	Other (explain)							

Time

when S starts down the correct row of books

Score: 3 | 2 | 1 | 0 | -1 | -2 | -3

9. Uses guide cards at top of shelf to find correct row of books
   a) Goes to wrong row; corrects self rapidly
   b) Goes to wrong row; corrects self slowly
   c) Goes to wrong row; needs hint
   d) Ignores guide cards; needs hint
   e) Needs explanation
   Other (explain)

10. S stays in the correct row of books when he finds it
   a) Leaves the correct row; corrects self quickly
   b) Leaves the correct row; corrects self slowly
   c) Needs hint
   d) Needs explanation
   Other (explain)

when S points to or pulls out the correct book

11. Scans quickly to locate book
   a) Scans slowly to locate book
   b) Realizes himself he didn't write down all of call number
   c) Doesn't realize at first that he needs to use second row of call number
   d) Must explain to S that he doesn't have all of call number or that he must use all of call number
   Other (explain)

12. Fills out call cards correctly
   a) Omits status
   b) Omits date in call number
   c) Omits status and date in call number
   d) Uses only first line of call number
   e) Any other combination

Time

when S finds the catalog card(s)

Score: 3 | 2 | 1 | 0 | -1 | -2 | -3

5. Finds both catalog cards for the book title without trouble . . . . . ☐
   a) Finds only one catalog card without trouble . . . . . ☐
   b) Finds both catalog cards with some trouble . . . . . ☐
   c) Finds one catalog card with some trouble . . . . . ☐
   d) Needs hint . . . . . ☐
   e) Needs explanation . . . . . ☐
      Check Ss problem: (1) confuses Demon & Demons
      (2) other (explain)

6. Copies down all of call number . . . . . ☐
   a) Copies first two lines (not date) . . . . . ☐
   b) Copies first line . . . . . ☐
   c) Copies first three figures . . . . . ☐
   d) Doesn't copy down number . . . . . ☐
   Other (explain)

7. Locates library division using call card or location chart . . . . . ☐
   a) Knows division wanted but not where it's located in the library . . . ☐
   b) Has to think a long time before using call card or location chart; or has to ponder the next step after using card or chart . . . . . ☐
   c) Needs hint . . . . . ☐
   d) Needs explanation . . . . . ☐
   Other (explain)

as S steps into correct library division

8. Heads for book shelves . . . . . ☐
   a) Goes to wrong location; corrects self quickly . . . . . ☐
   b) Goes to wrong location; corrects self slowly . . . . . ☐
   c) Needs hint . . . . . ☐
   d) Needs explanation . . . . . ☐
      Check Ss problem: (1) goes to periodical shelves
      (2) goes to reference shelves
      (3) other (explain)

Time

PART C

Score: 3 | 2 | 1 | 0 | -1 | -2 | -3

1. S realizes he should look for Readers' Guide . . . . . ☐
   a) S has a problem, corrects error himself rapidly . . . . . ☐
   b) S has a problem, corrects error himself slowly . . . . . ☐
   c) Needs hint . . . . . ☐
   d) Needs explanation . . . . . ☐

when S looks up from reading card

Check Ss problem: (1) immediately asks for help
(2) heads for periodical section
(3) heads for division card catalog
(4) heads for main card catalog

Other (explain)

2. Finds Readers' Guide without help . . . . . ☐
   a) Knows what R. G. looks like AND it's on tables; doesn't know division . ☐
   b) Knows only what R. G. looks like OR it's on tables; doesn't know division . . . . . ☐
   c) Explains how to find location of R. G. by using Author-title Card Catalog . . . . . (NOTE: if (a) or (b) is checked, you) . . . . . ☐
   d) Needs hint . . . . (must also check (c), (d), or (e)) . . . . . ☐
   e) Needs explanation . . . . . ☐

when S finds the Readers' Guide

Other (explain)

3. Gets correct Readers' Guide volume first time . . . . . ☐
   Gets wrong volume first (vol. 16) but realizes he must try vol. 17 . . ☐
   a) Gets vol. 16 first but must think very hard before he tries vol. 17 . . ☐
   b) Gets a volume other than vol. 16 or 17, but corrects himself . . . . . ☐
   c) Needs hint . . . (NOTE: (b) may be checked in addition) . . . . . ☐
   d) Needs explanation.(to (a), (c), (d) or correct behavior) . . . . . ☐

Other (explain)

4. Looks up article by author ___ or subject ___ first (check which) . . ☐
   a) Looks up author or subject first, doesn't find so tries title . . . . . ☐
   b) Looks up title first, then tries author or subject . . . . . ☐
   c) Needs hint . . . . . ☐
   d) Needs explanation . . . (NOTE: check Ss behavior in first volume) . . . . . ☐

Other (explain) (used, 16 or 17.)

Time

when S gets up from index table

Score

3	2	1	0	-1	-2	-3

5. Writes down all necessary information so he doesn't have to return to Readers' Guide . . . . . ☐
   a) Omits ONE of these: volume, date, page . . . . . ☐
   b) Omits title of periodical . . . . . ☐
   c) Omits volume number AND page, or volume number AND date . . . . . ☐
   d) Omits any other combination . . . . . ☐
      (NOTE: if S can correctly remember title of periodical without writing it down, it doesn't count against him.)

Other (explain)

6. Goes to Main Card Catalog . . . . . ☐
   a) Doesn't go to Main C. C.; corrects self rapidly . . . . . ☐
   b) Doesn't go to Main C. C.; corrects self slowly . . . . . ☐
   c) Needs hint . . . . . ☐
   d) Needs explanation . . . . . ☐
      Check Ss problem: (1) goes to periodical section of division he's in _____
      (2) goes to division card catalog _____
      (3) goes to location chart of dewey numbers _____
      (4) doesn't know how to proceed _____

Other (explain)

7. Goes to Author-title Card Catalog . . . . . ☐
   a) Goes to Subject Card Catalog; corrects self rapidly . . . . . ☐
   b) Goes to Subject Card Catalog; corrects self slowly . . . . . ☐
   c) Needs hint . . . . . ☐
   d) Needs explanation . . . . . ☐

Other (explain)

Time

when S starts to leave the card catalog

Score: 3 | 2 | 1 | 0 | -1 | -2 | -3

8. Looks up title of periodical . . . . . ☐
   a) Looks up wrong thing; corrects self rapidly . . . . . ☐
   b) Looks up wrong thing; corrects self slowly.. . . . . ☐
   c) Needs hint . . . . . ☐
   d) Needs explanation . . . . . ☐
   Check Ss problem: (1) looks up author of article____
   (2) looks up title of article____
   (3) looks up Readers' Guide____

Other (explain)

9. Goes directly to correct library division . . . . . ☐
   a) S has trouble but finally goes to correct library division . . . . . ☐
   b) Needs hint . . . . . ☐
   c) Needs explanation . . . . . ☐

Explain Ss behavior if (a), (b) or (c) is checked

10. Goes directly to periodicals section in the division library . . . . . ☐
    a) Thinks awhile before deciding periodicals are shelved separately from books; gets correct answer himself . . . . . ☐
    b) Doesn't realize periodicals are shelved separately from books or thinks all periodicals are in periodical room only; needs hint to get going . . . . . ☐
    c) As in (b) but needs full explanation . . . . . ☐

Other (explain)

11. Looks for periodical alphabetically using title of periodical . . . . . ☐
    a) Looks alphabetically using only first letter of title; corrects self . . . . . ☐
    b) Thinks it's a magazine with a similar title; corrects self . . . . . ☐
    c) As in (a) or (b); needs hint . . . . . ☐
    d) As in (a) or (b); needs explanation . . . . . ☐
    e) Other problem, needs hint . . . . . ☐
    f) Other problem, needs explanation . . . . . ☐
    Check Ss problem: (1) wants to use call number____
    (2) wants to use title of article____
    (3) wants to use author of article____

Other (explain)

Time

Score

3	2	1	0	-1	-2	-3

12. Looks for periodical by volume number or year rapidly . . . . . ☐
    a) Looks over most volumes slowly; gets correct volume . . . . . ☐
    b) Pulls out wrong volume on either side of correct volume . . . . . ☐
    c) Pulls out wrong volume not on adjacent to correct volume . . . . . ☐
  Other (explain)

13. Has no trouble figuring out Readers' Guide entries (uses page number to locate article quickly) . . . . . ☐
    a) S doesn't understand the R. G. code for ONE of these: vol. number, date, page . . . . . ☐
    b) S doesn't understand the R. G. code for BOTH of these: vol. number and date . . . . . ☐
    c) S doesn't realize that the title of the periodical is given in the Readers' Guide . . . . . ☐
    d) S doesn't understand the R. G. code for BOTH vol. number and page or BOTH date and page . . . . . ☐
    e) S has trouble with: (1) vol. number and date and page
       (2) title and vol. number
       (3) title and date
       (4) title and page
       (5) title and vol. number (or date) and page . . . . . ☐

  Other (explain)

when S finds article and shows it to E