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ABSTRACT

This study investigating the use of visual cueing strategies within a self-paced instructional unit employed and modified an instructional unit on the human heart developed by Francis M. Dwyer. This unit and its accompanying tests were designed to assess visual learning in terms of student achievement on drawing, identification, terminology, and comprehension tasks. Ninety-two students at Pennsylvania State University were randomly assigned to four treatment groups. They were told the purpose of the study, assigned instructional booklets on a self-paced, individualized basis, and tested on the four criterion tests immediately following the completion of the experimental treatment. Findings indicated that simple and elaborate visual cueing techniques were equally effective in facilitating student achievement on the criterion tasks, and selective reduction of visual step size was superior to the use of larger step size in terms of total learning and tasks involving drawing. No significant conclusions could be drawn regarding the combination of elaborate visual cueing and reduced step size or treatment groups in terms of instructional efficiency.
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The Effectiveness of Elaborate Visual Cueing and Reduced Step Size in Facilitating Student Achievement on Different Instructional Tasks

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Introduction

Early research in visualized instruction subscribed to a conceptual framework which emphasized comparisons between different media types. While this approach has generated some useful information for the selection and utilization of media types, it has done little to develop a scientific base for improving the learning effectiveness of visual materials produced by instructional designers and teachers (Lumsdaine, 1960). A serious flaw in this approach is its failure to deal with visual instructional materials as combinations of distinct cues.

A more productive approach employs a conceptual framework in which research investigates the stimulus characteristics of visuals. Levie and Dickie (1973), in a state-of-the-art report, advocated research that ". . . specifies the relevant variables in terms of the attributes of media rather than in terms of the media themselves." They qualified this by adding, "Media attributes are properties of stimulus materials which are manifest in the physical parameters of media." (p. 860) Recent research efforts have moved in this direction by dealing with the stimulus characteristics of visuals in relation to specific educational tasks, (Dwyer, 1967, 1972; Trabasso and Bower, 1968; Berry, 1974; and Parkhurst, 1974).

The present study attempted to contribute to the conceptual base for visualized instruction by exploring two cueing strategies used in visuals. Specifically, its purpose was to investigate the effectiveness of elaborate visual cueing and reduced step size in facilitating student achievement on different instructional tasks.

The following hypotheses were proposed in an effort to generate information to assist designers of instructional visuals in selecting cueing techniques which are most effective for facilitating learning on specific educational tasks. This would represent design-by-knowledge rather than design-by-intuition.

H_1: The instructional treatments utilizing reduced step size will be superior to the larger step size treatments in terms of facilitating student achievement on the immediate and delayed criterion tasks.

H_2: The instructional treatments utilizing elaborate visual cueing will be superior to the simple visual cueing treatments in terms of facilitating student achievement on the immediate and delayed criterion tasks.

H_3: The instructional treatment combining reduced step size with elaborate visual cueing will be superior to all other treatments in facilitating student achievement on the immediate and delayed criterion tasks.

Presentation and Evaluation Materials

The instructional materials used to test the hypotheses proposed in this study were modifications of an instructional unit on the human heart developed by Dwyer (1965). Dwyer's materials were selected because they offered certain advantages for this study: (1) they were designed to explore the stimulus characteristics of visuals; (2) data were available for analysis from past studies in which the materials had been used; (3) subjects interacting with the materials were required to perform criterion tasks similar to those found in realistic learning situations;

and (4) the materials package included assessment tools possessing satisfactory realibilities (.81 - drawing test, .79 - identification test, .82 - terminology test, .76 - comprehension test, and .91 - total criterial test) using the Kuder-Richardson Formula 20 reliability coefficient, (Dwyer, 1972).

Dwyer's original instructional package was used, in part, as the basis for this study. The 2,000-word script, terminology lables, and criterial measures were all retained intact. Modified versions of the black and white, simple-line-drawing sequence served as the primary presentation mode in this study. Modifications were made to further this study's investigation and they occurred as the result of a task analysis performed on previous research results obtained from a study conducted by Dwyer (1971). Utilizing the task analysis, four instructional treatments were designed and produced to test the hypotheses of this study.

Experimental Treatments

Group	Treatments
I	Larger step size (37 visuals), simple visual cueing (static position indicators).
II	Larger step size (37 visuals), elaborate visual cueing (dynamic - process arrows, motion indicators, and shading).
III	Reduced step size (47 visuals), simple visual cueing (static position indicators).
IV	Reduced step size (47 visuals), elaborate visual cueing (dynamic - process arrows, motion indicators, and shading).

Each treatment consisted of an instructional booklet describing the human heart, its parts, and the internal processes occurring during the systolic and diastolic phases. Contained within each booklet was the 2,000-word instructional heart script accompanied by appropriate visuals of the heart. The booklets were divided into individual pages (or frames). Each page of the booklet consisted of an 8 1/2 x 11 inch sheet of white paper; occupying the top portion of the page was a 4 x 5 inch simple black-line drawing of the heart. Corresponding paragraphs of the instructional script were positioned on the lower portion of the page beneath the heart picture. Each illustration of the heart was labeled with appropriate terminology. It should be noted that interspersed review questions were not employed in the instructional treatment of this study since it was feared that they would have an equalizing effect on the experimental treatments. All treatments contained the same instructional script and printed terminology labels; they differed only in cueing strategies used.

Experimental Procedures

The sample population for this study consisted of 92 university students enrolled in The Pennsylvania State University. These subjects were volunteers obtained from two introductory university courses - Instructional Media 411 and Educational Psychology 14. For participation in this study, and as a motivational device, all subjects received extra credit in their respective courses. Each subject was required to attend two experimental sessions. During Session I, subjects were randomly assigned to one of the four treatment groups - resulting in an n = 23 for each treatment group.

In Session I, subjects interacted with their assigned instructional

presentations and completed four criterial tests. Before treatments were begun, subjects were arranged in separate treatment groups and told to read the directions on the cover of the instructional booklet. All subjects received the same directions. The printed information consisted of three points: (1) subjects were told that the purpose of the study was to investigate the effectiveness of visual illustrations and cueing strategies; (2) subjects were told that there was no time limit and that they, therefore, should progress at their own pace through the booklet (self-pacing; and (3) subjects would be tested on a battery of criterial tests immediately after completing the booklet. Subjects were also told verbally that they would be retested six weeks later in Session II. The subjects then interacted with their respective instructional booklets on an individual and self-paced basis. Although no time limit was imposed, subjects were timed so that efficiency scores could be computed later. Upon completion of the treatment, each subject was asked to take the drawing, identification, terminology, and comprehension tests. Subjects were permitted to take as much time as needed for each criterion test before proceeding to the next. Session II occurred six weeks later; the four criterial tests were retaken by subjects to measure delayed retention. All responses were recorded on optical scan answer sheets, except for the drawing test which required subjects to draw and label a representation of the heart directly on the test surface. Drawing tests were scored by an independent evaluator and forwarded for statistical analysis. All data were analyzed by analysis of variance techniques to determine if statistically significant differences existed among instructional treatments.

Statistical Analysis

The first part of the statistical analysis examined both criterion test reliabilities (K-R 20) and homogeneity of variance among treatment groups (Bartlett's Test).

Following this, interpretation of the study's findings was accomplished by a randomized factorial design. Specifically, a three-factor, repeated-measure design was used with two between-subjects factors (A and B) and one within-subjects factor (C). In notation form, the design can be characterized as $(A_2 @ B_2)$ in C_2, indicating two levels of factor A crossed with two levels of factor B, and both A and B nested in factor C. The independent variable in the study was the method of visual cueing used, while the dependent variables were test scores on the drawing, identification, terminology, comprehension, and total criterial tests.

Factors in Experimental Design

Between-Subjects Factors	
Factor A:	Step Size
	Level A_1 (Larger Step Size)
	Level A_2 (Reduced Step Size)
Factor B:	Cueing Technique
	Level B_1 (Simple Visual Cueing)
	Level B_2 (Elaborate Visual Cueing)
Within-Subjects Factors	
Factor C:	Time/Test Administration
	Level C_1 (Immediate Testing)
	Level C_2 (Delayed Testing)

A three-way analysis of variance (ANOVR) was conducted on the number of correct responses achieved by subjects on each criterion test, as well as on their combined total criterion score. An F-ratio with a p value of .05 significance level or less was considered sufficient to reject null hypotheses and to verify alternative hypotheses. An additional two-way analysis of variance (ANOVES) was performed separately on the immediate and delayed retention measures to reveal any significant findings obscured by collapsing data on the within-subjects factor of the three-way analysis of variance. Efficienty scores were calculated for each treatment group and analyzed by analysis of variance (ANOVES) techniques to determine if significant statistical differences existed.

Results

Criterion test reliabilities were obtained by calculating Kuder-Richardson Formula 20 reliability coefficients; the values obtained for the criterion tests were all of a satisfactory level (Drawing Test, .842; Identification Test, .854; Terminology Test, .868; and Comprehension Test, .789). Results from Bartlett's Test for homogeneity of variance conducted on the dependent variables (the criterion tests) were all non-significant at the .05 level, indicating that the subjects who received the instructional treatments could be viewed as having been drawn randomly from populations with common variance.

The analysis of variance procedures performed on the data resulted in either support or lack of support for the research hypotheses. The following table indicated the specific decisions made regarding each research hypothesis.

Decisions Regarding Research Hypotheses

Research Hypotheses	Criterion Measures: Drawing	Identification	Terminology	Comprehension	Total Test
H_1	Supported	Not Supported	Not Supported	Not Supported	Supported (Immediate Retention)
H_2	Not Supported	Not Supported	Not Supported	Not Supported	Not Supported
H_3	Not Supported	Not Supported	Not Supported	Not Supported	Not Supported

Based upon the data obtained in the statistical analyses of this study, the following findings were made in regard to the design of visualized learning materials.

Relative to the step size of visuals within a self-paced visualized instructional sequence, it was found that:

1. Instructional treatments containing identical printed scripts and word labels, but employing different visual step sizes, were not equally effective in facilitating student achievement on certain criterion tasks.
2. In the immediate retention condition, those instructional treatments employing selective reduction of visual step size had an overall facilitative effect on learning as evidenced by

the significant F-ratio of 4.098 (.05 level) for reduced step size treatments on the total criterion test measure. On individual criterion tasks, selectively reduced visual step size treatments had a facilitative learning effect on drawing (significant F-ratio of 5.062 at .05 level) but not on comprehension, identification, or terminology.

3. In the delayed retention condition, those instructional treatments employing selective reduction of visual step size had little facilitative effect on the criterion tasks. The overall learning effect present in the immediate retention condition did not occur in the delayed retention condition. Of the individual criterion tasks, only drawing appeared to be positively affected by selectively reducing visual step size.

Relative to elaborate visual cueing within a self-paced, visualized instructional sequence, it was found that:

1. Instructional treatments containing identical printed scripts and word labels, but differing in degree of visual cueing elaborateness present, were equally effective in facilitating student achievement on the criterion tasks (drawing, identification, terminology, and comprehension).
2. No advantage was gained in a visualized instructional sequence by utilizing elaborate visual cueing.

Relative to the interaction of selectively-reduced, visual step size and elaborate visual cueing within a self-paced, visualized instructional sequence, it was found that:

1. No statistically significant facilitative effect was achieved by combining these elements within a visualized instructional sequence.
2. An examination of treatment group means revealed, however, that in almost all instances, Group IV (combined treatment) means were higher than those of other treatment groups.

Relative to the efficiency of the instructional treatments included in this study, it was found that:

1. In terms of time spent on the instructional treatments, no statistically significant differences existed among the four experimental groups. It is important to note that selectively reducing visual step size (and thus increasing the number of visuals utilized) did not increase the time needed by subjects to interact with the learning materials.
2. None of the experimental treatments were significantly more efficient than others in facilitating student achievement on the criterion tasks.

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