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AUTHOR	King, William A.	
TITLE	A Comparison of Three Combinations of Text and Graphics for Concept Learning. Technical Report 76-16.	
INSTITUTION	Navy Personnel Research and Development Center, San Diego, Calif.	
REPORT NO	NPRDC-TR-76-16	
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Using PLATO, a computer-assisted instruction system, a test was conducted to see if students respond most favorably to an instructional package that included no graphic display, still graphic display, or animated graphic display. Forty-five students at the Naval Training Center, San Diego, were the subjects. With the learning of the sine-ratio concept as the instructional objective, three different instructional packages were written, employed, and posttested. Scores showed that including graphic displays does not improve conceptual comprehension. (EMH)

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NPRDC TR 76-16

SEPTEMBER 1975

A COMPARISON OF THREE COMBINATIONS OF TEXT AND GRAPHICS FOR CONCEPT LEARNING

William A. King

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NPRDC TR 76-16 September 1975

A COMPARISON OF THREE COMBINATIONS OF TEXT AND GRAPHICS FOR CONCEPT LEARNING

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A study was conducted to determine how verbal instruction could be supplemented by visuals, and in particular, how to take pedagogical advantage of the excellent capabilities of the PLATO IV computer-based instructional system. Literature research disclosed little previous information of value on the subject. Three versions of a lesson on the sine-ratio concept were prepared, one with verbal text supplemented with

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animated graphics, one supplemented with still graphics, and one without graphics (text only). Forty-five students from the Basic Electricity/Electronics School at the Naval Training Center (NTC), San Diego, were randomly assigned to the three versions. A comparison of the pretest and posttest mean scores for each group revealed learning took place in each group, and a questionnaire administered after the posttest revealed that the students gave positive ratings to the instructional materials and presentations. The groups did not differ in time required for training. On the posttest, the animated graphics group had the highest mean performance, but none of the differences between groups were significant. It was concluded that these results are consistent with previous findings suggesting that graphics are more useful for teaching concepts involving time and motion than for concepts involving space, and more useful for tasks involving stimulus identification than for tasks involving terminology or comprehension.

FOREWORD

This project was performed under Technical Development Plan 43-03X.03A (Experimental Evaluation of PLATO IV Technology). PLATO terminals and support were provided as part of a joint services program of the Advanced Research Projects Agency.

Completion of the project would not have been possible without the cooperation and assistance of the staff of the Basic Electricity/Electronics "P" School, Service Schools Command, San Diego. The school worked closely with the author in furnishing students for tryout and evaluating the lesson materials.

The author is also indebted to Mr. Tony Sassano and Mrs. Betty Whitehill for programming the data management and lesson materials on the PLATO IV system, and to Dr. Richard Hurlock, Dr. Dewey Slough, and Mr. Patrick McCann for assistance in the statistical analysis and critical discussion of the manuscript.

J. J. CLARKIN
Commanding Officer

SUMMARY

Problem

As part of the evaluation of PLATO IV technology, this effort was planned to study ways to take advantage of the terminal graphic display capabilities for computer-based instruction. The research specifically examined how verbal instruction (text) for learning the sine-ratio concept could be supplemented by visuals (graphic displays).

Background

A search of the computer-assisted instruction (CAI) literature revealed no systematic study of the effects on concept learning of graphic supplementation of verbal instructional material. The few recent studies of this question outside the CAI field were of little help. The most comprehensive study, that of Dwyer (1971), concluded that verbal instruction should be used without graphic supplementation in learning the structural-functional concepts of a topic.

Approach

Three versions of a lesson on the sine-ratio concept were prepared, one in which verbal text was supplemented with animated graphics, one with still-graphics, and one without graphics (text-alone). Forty-five students from the Basic Electricity/Electronics School at the Naval Training Center (NTC), San Diego, were randomly assigned to the three versions. The hypothesis was that the animated graphics groups would have a higher mean posttest score than the still-graphics group, and the still-graphics group a higher mean score than the text-alone group.

Findings and Conclusions

A comparison of the pretest and posttest mean scores for each group revealed that learning took place in each group. On a questionnaire administered after the posttest, student ratings of the instructional material and presentation were highly positive. However, there was no significant difference between the mean posttest scores for the three groups. Students apparently learned as much about the sine-ratio concept from text alone as from text and still graphics or text and animation. Failure to find that graphics supplemented the learning and comprehension of a verbal concept involving space appears consistent with the literature. Careful format and sequence presentation of text and graphics on the PLATO plasma screen may be necessary to avoid producing simultaneous or competing attending behaviors.

CONTENTS

TABLES

INTRODUCTION

The PLATO system is outstanding among computer-assisted instruction (CAI) systems for its capabilities in presenting complex graphic images, a fact that is well documented (Bitzer, et al, 1970; Lyman, 1974). However, a search of the literature has revealed no systematic study of where and how to best apply these graphic capabilities for pedagogical purposes.

In a broader context, several researchers have recently studied the possibility of supplementing verbal instruction with visuals. Gorman found no significant differences when using simple line drawings or shaded line drawings when students were asked to identify exemplars of a concept (Gorman, 1973). Strang (1973) found that the learning of a typical vocational skill from a series of 35mm slides was enhanced by the addition of verbal instructions. Wells and his associates (1973) found that motion pictures were more effective than a sequence of slides or still pictures in teaching concepts involving time or motion, although there were no significant differences for learning concepts involving space.

The most comprehensive of recent investigations of methods of combining text and visuals for effective teaching was done by Francis Dwyer (1971). The study evaluated various ways to teach the structure and function of the heart. One group of students received oral instruction without any visuals. Other groups received the same oral instruction supplemented with illustrations of various types--i.e., simple line drawings in black and white (b/w) or color, detailed shaded drawings in b/w or color, and photos of an actual heart in b/w or color. Corresponding to different educational objectives, the students were given four criterion tests, a verbal-picture drawing test, a verbal-picture identification test, a verbal terminology test, and a verbal comprehension test. Significant differences were found between groups on the drawing and identification test scores. However, the terminology and comprehension test scores revealed that the oral presentation, without visuals, was as effective as the treatments with visuals. Dwyer concluded that the verbal instructions could be used without visuals for comprehending the structural-functional relationships in the topic. Learning content and subject population limitations in Dwyer's study should be noted and justify continued research on facilitation of training with visuals.

The present report describes an investigation of where and how to best apply graphic capabilities for learning in a CAI context. Three versions of an instructional lesson on the sine-ratio concept were compared. The first version comprised text and animated graphics, the second used the same text with still graphics, and the third used the text alone. The hypothesis was that performance on a posttest would be progressively degraded as the visual supplements were removed.

METHOD

Subjects

All subjects were students attending the Basic Electricity and Electronics School (BE&E) at the Naval Training Center (NTC), San Diego, California. The curriculum was an individualized course of instruction broken down into 14 modules. Trigonometry was not encountered by the student until he reached Module 12; consequently, a student was not eligible for participation in the CAI experiment if he had begun that module. The only other constraint on selecting a subject was that he had not had trigonometry in high school.

The Sine-Ratio Lesson and Test Materials

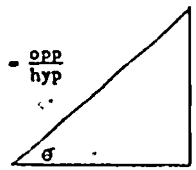
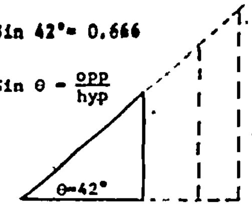
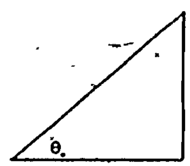
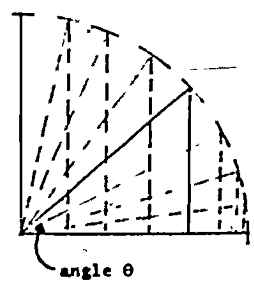
The overall training objective of the sine-ratio concept lesson was that the subjects should be able to comprehend the sine ratio to the point where they could (1) use the formula, $\sin \Theta = \frac{opp}{hyp}$, along with a table of sines to calculate the value R and (2) transpose this formula on the basis of the fact that it was an equation. The sine-ratio training materials were broken down into the following subconcepts: (1) right triangle, (2) ratio, (3) sine ratio, and (4) equation. A multiple-choice criterion test of 26 items was written, and each test item was visualized as fully as possible--i.e., the basic graphic images were laid out, with particular attention focused on the sequencing of change (animation) in their configuration. The text of the instruction, for the most part, consisted of simple declarative sentences written in answer to each test item.

Twenty-nine instructional displays were produced. There was one display for each of the 26 test items plus three found to be necessary for smooth transitions. The 29 displays comprised the first version of the lesson; the second version used the same text and key graphics without animation; and the third eliminated all graphics and served as a text-alone control.

The same criterion test served as both the pretest and the posttest, the only difference being in the order of the four possible choices of answers for each question. Table 1 shows samples of the way the information was presented in each version of the lesson.

TABLE 1

Samples of the Unit Displays

Unit Number	3rd Version Text Alone	2nd Version Text & Still Graphics	1st Version Text & Animation	Posttest Questions
17	No matter how large or small the right triangle may be, the ratio between the opposite side and the hypotenuse will remain the same as long as the angle θ remains the same.	$\text{Sin } \theta = \frac{opp}{hyp}$ 	$\text{Sin } 42° = 0.666$ $\text{Sin } \theta = \frac{opp}{hyp}$ 	If the angle θ is held constant and the hypotenuse is increased in length, the sine of θ will: a. increase *b. remain the same c. decrease d. vary in proportion to the hypotenuse
18	If the hypotenuse is held constant (e.g., hyp=1) and the angle θ is progressively decreased, the opposite side gets smaller and smaller until it disappears when θ = 0°. (Press NEXT to continue.) Therefore: $\sin 0° = \frac{opp}{hyp} = \frac{0}{1} = 0$ And if θ is progressively increased, the opposite side gets larger until it equals the hypotenuse in length when θ = 90°. (Press NEXT to continue.) Therefore: $\sin 90° = \frac{opp}{hyp} = \frac{1}{1} = 1$			If the hypotenuse is held constant, and θ is decreased from 45° to 1°, the opposite side will: a. increase to almost the length of the hypotenuse b. not change *c. almost disappear d. vary in proportion to the hypotenuse
19	The sine ratio in a right triangle has been calculated for each value of θ from 0° to 90° and arranged in tabular form like this: Degree — Sin 0 — 0.0000 1 — 0.0175 2 — 0.0349 etc. — ——— 88 — 0.9994 89 — 0.9998 90 — 1.0000			What is the sine of θ when θ = 31°? (See handout: Table of Sines) Sine θ = _______

Attitude Questionnaire

A questionnaire, designed to register the student's attitudes toward the CAI experience, was filled out by each subject before he returned to the BE&E School. It contained 41 questions divided among several topic areas: (1) PLATO terminal operating instruction, (2) typing problems, (3) clarity of the images on the plasma screen, (4) the moveable keyboard, (5) instructional effectiveness of the lesson, and (6) general appraisal of computer-based instruction.

Apparatus

All lessons and tests were mediated by the PLATO IV computer-based education system, the hardware of which has been described by Stifle (1972). Student terminals in San Diego were connected to the PLATO system at the University of Illinois. The training materials for the sine-ratio lessons were displayed on an 8-inch square plasma screen. Progress through a lesson was controlled by the student, who used a keyboard adjacent to the panel.

Design and Procedure

Forty-five subjects were randomly assigned to one of three treatment groups--(1) Text and Animation, (2) Text and Still Graphics, and (3) Text Alone. The pretest and posttest were identical for the three groups.

Implementation of the experiment can be broken down into the following stages:

1. Computer Specialists coded the pretest, the three versions of instruction, and the posttest in TUTOR language for display on the PLATO IV computer-based instructional system.

2. Each of the 45 students from the BE&E School were randomly assigned to one of the three versions of the lesson (15 to each version).

3. The student controlled the pacing of the displays by a keyboard, the use of which was explained to him in a brief introductory lesson. He had the option of repeating the viewing of each of the four sequences (subconcepts) that comprised the lesson. He did not have the option to repeat an individual display (unit).

4. The PLATO system recorded the students' answers to pretest and posttest questions and kept a tally of right answers. Latencies for test items and units of instruction and the sequence in which the student viewed the displays were also recorded.

5. Student performance data was assessed and displayed on the PLATO screen by the experimenter for analysis.

RESULTS

Gain Score Means

An analysis was made of the gain scores to determine whether the instruction produced an improvement in performance. Table 2 shows the pretest-posttest mean gain scores and their standard deviations. One score in Group 3 was lost and reduced n to 14 for that group. With a null hypothesis that the mean gain score equalled zero, the t-tests showed that learning took place between the pretest and posttest in each of the three groups.

TABLE 2

Mean Gain Scores and T-Tests

	Group 1 Text & Animation	Group 2 Text & Still Graphics	Group 3 Text Alone
n	15	15	14
M	15.36	15.76	14.[illegible]7
SD	7.83	11.99	11.91
t	7.60*	5.09*	4.58*

*p = < .001

Analysis of Covariance

Table 3 shows the mean scores for three measures of a student's background--the GCT, ARI, and the sine-ratio pretest--for Groups 1, 2, and 3. An analysis of covariance was performed to adjust the posttest scores for differences on the three background measures resulting from the random assignment of subjects to groups.

TABLE 3

Mean Scores for Background Measures

	Group 1 Text & Animation	Group 2 Text & Still Graphics	Group 3 Text Alone
General Classification Test (GCT)	57.8	55.2	55.0
Arithmetical Reasoning Test (ARI)	54.8	46.8	49.0
Sine-Ratio Pretest	71.8	62.9	67.4

Table 4 lists the correlation coefficients of the background measures against the mean posttest scores for each group.

TABLE 4

Correlations of Background Measures
With Posttest Performance

	Group 1 Text & Animation	Group 2 Text & Still Graphics	Group 3 Text Alone
General Classification Test (GCT)	.30	.40	.40
Arithmetical Reasoning Test (ARI)	.29	.03	.45
Sine-Ratio Pretest	.61	.35	.37

Table 5 shows the posttest and adjusted posttest means. Although the animated graphics group appeared to have scored higher than the other groups, the differences were not significant. The power of the F-test (Myers, 1972) against an alternate hypothesis of three points difference between groups, was approximately .40 for α = .05; thus, small differences were not likely to be detected.

TABLE 5

Adjusted Posttest Means

	Group 1 Text & Animation	Group 2 Text & Still Graphics	Group 3 Text Alone
Posttest Mean	87.1	78.7	81.0
Adjusted Posttest Mean	85.3	80.3	81.2
Adjusted Standard Error	2.3	2.2	2.0

Covariance analysis F(2,39) = 1.22

Mean Times

The mean total time required for each group of students to go through the instruction and the posttest is shown in Table 6. A computer program malfunction during data collection lost two data points in Groups 1 and 3, and one data point in Group 2. The differences between groups were not significant. The power of the F-test, against the alternative hypothesis that the groups would vary by more than 5 minutes, was approximately .50 for α = .05.

Table 7 gives the correlations of mean instruction and posttest times with means of the background measures. Note that only in Group 2 were the GCT and ARI scores good predictors (.64 and .61) of the time a student would take to complete instruction and the posttest.

TABLE 6

Mean Total Times in Minutes
for Instruction and Posttest

	Group 1 Text & Animation	Group 2 Text & Still Graphics	Group 3 Text Alone
n	13	14	13
M	37.6	33.1	35.7
SD	12.9	8.1	13.2

F(2,37) = 0.50

TABLE 7

Correlation of Mean Times with Background Measures

Predictor	Group 1 Text & Animation	Group 2 Text & Still Graphics	Group 3 Text Alone
General Classification Test (GCT)	.02	.64	.13
Arithmetical Reasoning Test (ARI)	.01	.61	.08
Sine-Ratio Pretest	.22	.13	.28

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Student Attitudes

Student rating of the instructional materials and their presentation was definitely positive. Table 8 shows the questions asked and the frequency with which each rating was chosen. A five-step scale was used on three basic dimensions--poor to outstanding, 0 to 100%, and never to always.

TABLE 8

Student Ratings of the Training Materials

Question	Selection of Ratings (n=41)					Mean Rating
	1	2	3	4	5	
Rate the instructional effectiveness of the training materials (poor-outstanding)	0	3	5	22	11	4
How well did you understand what you were supposed to learn? (0-100%)	2	2	7	21	9	3.8
The instructional material was presented too quickly--needed smaller steps (never-always)	21	15	2	2	1	1.7
Too much material was presented at one time on the screen (never-always)	30	8	2	1	0	1.4
Arrangement of the material on the screen was excellent (never-always)	2	0	1	15	23	4.4

DISCUSSION

The Data

Although the performance of the animated graphics group appeared highest, analysis of posttest mean scores showed no differences between groups. The data appear to show that a student could learn as much about the sine-ratio concept from text alone as from a combination of text and still or animated graphics. It is possible that the learning task employed was not sufficiently difficult to be sensitive to the effects of graphics.

The degree of learning in the text-only group may have been a reflection of the careful preparation which went into the development of those materials. Also the pre- and posttest questions were heavily weighted verbally and lacked dependence on visual graphics, thus making the learning task similar to the verbal terminology and verbal comprehension conditions in which Dwyer (1971) failed to find graphic facilitation.

Another explanation for failure to find differences between the experimental conditions is that trainees attending the BE&E School may have been accustomed to using verbal labels for the mental images of straightline, angle, triangle, etc. Graphic representation of these images would, therefore, have been superfluous or even a distracting redundancy. Graphics might be demonstrated to be more useful in the learning of more spatially complex concepts.

Possible Effects of Instruction System Delivery Constraints

Two major PLATO system constraints may have resulted in decreasing the influences of the experimental variables during the study. These constraints are: (1) the temporal and spatial manner in which text and graphics are generated on the display screen, and (2) the absence of audio capability at the time the study training materials were being developed.

The PLATO system takes a noticeable amount of time to generate a display on its plasma screen. The letters of the text come up in a series, so text is displayed from left to right and down the screen. The lines of the graphics are generated from source to terminal points and look as if they are being drawn as they make their appearance on the screen. Though this process is fast, blocks of text or complete graphics cannot be generated on the screen instantaneously as with motion pictures or television.

Audio might have prevented problems with integration of text and graphics. Had audio been available, the pacing of a student's viewing of the stimuli might have been better controlled. For example, appropriate pauses in the narration could have allowed verbally coded information to be repeated or supplemented with graphic coding. Without audio, the time allowed for reading a block of text could not guarantee that the display of an associated graphic would not act as an interruption or distraction in the form of a competing visual stimulus.

For most of the unit displays, the preceding constraints resulted in putting graphics and text on the screen as fast as possible and allowing the student to decide whether to examine the diagram or read the text first. Occasionally, pauses to allow reading before displaying a graphic were risked. In one case, in Unit 18 of the first version of the lesson (Table 1), the student had to press a key before the right-triangle would appear and animate through a series of right-triangles with decrements or increments in the value of θ.

Since these constraints presumably operated in proportion to the complexity of the graphics supplementing the text, they may have counteracted the expected advantages of the animated version over the still graphic version, and the latter over the text alone.

REFERENCES

Bitzer, D. L., Blomme, R. W., Sherwood, B. A., & Tenczar, P. The PLATO system and science education, Urbana, Illinois: Computer-based Education Research Laboratory, (CERL) Report X-17, University of Illinois, August 1970.

Dwyer, F. M., Jr. Color as an Instructional Variable, AV Communication Review, 19, 4, 1971.

Gorman, D. A. Effects of Varying Pictorial Detail and Presentation Strategy on Concept Formation. AV Communication Review, 21, 3, 1973.

Lyman, E. PLATO curriculum materials, Urbana, Illinois: Computer-based Education Research Laboratory, (CERL) Report X-41, University of Illinois, February 1974.

Myers, J. L. Fundamentals of experimental design, Second Ed., Allyn & Bacon, Inc., Boston, 1972, 89-90.

Stifle, J. The PLATO IV architecture, Urbana, Illinois: Computer-based Education Research Laboratory, (CERL) Report X-20, University of Illinois, April 1971, revised May 1972.

Strang, H. R. Pictorial and Verbal Media in Self-instruction of Procedural Skills. AV Communication Review, 21, 2, 1973.

Wells, R. F., Van Mondfrans, A. P., Postlethwait, S. N., & Butler, D. C. Effectiveness of Three Visual Media and Two Study Formats in Teaching Concepts Involving Time, Space, and Motion. AV Communication Review, 21, 2, 1973.

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