J. EDUCATIONAL TECHNOLOGY SYSTEMS, Vol. 16(3), 1987-88

THE EFFECTS OF NONEXAMPLES ON PROCEDURE LEARNING

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ABSTRACT

Research has shown that nonexamples are an effective strategy in teaching concepts. The purpose of this study was to explore the use of common errors (CE) as an effective strategy in teaching a procedure (i.e., a set of steps that one follows to achieve a goal). A total of fifty-six sophomore students were randomly assigned to an experimental and a control condition in their regular classrooms. The experimental design was pretest-posttest. Materials and task involved two sets of identical slide projectors and tape recorders to teach the procedure for color correction of color transparencies. The experimental group received instruction on an extra sample of colors most commonly confused with each of the six colors of the standard color wheel. Results indicated that application-level learning of procedures was significantly facilitated by the presentation of common errors (CE) in addition to examples. In conclusion the use of common errors of great divergence is beneficial. The use of common errors is more effective when they are made apparent, or when a clear distinction between a correct and incorrect response is taught.

Several instructional theorists have advocated the pairing of "matched" or "close-in" nonexamples with examples for teaching concepts at the application level [1, 2]. In essence, these are pairs of positive and negative instances with minimum within-pair variation of irrelevant attributes [1, 3, 4]. The use of minimally different positive and negative examples was found to be superior to exclusively positive example sequences in concept attainment [5]. Their importance in instruction is that they reduce common errors in learning, specifically overgeneralization [6, 7]. However, a limitation in the use of matched

example-nonexample pairs (E-NE) is that the supporting research and theory is established only in the context of concept learning. Would the teaching of common errors, paired with correct performance, also be beneficial for learning procedures and principles at the application level?

The teaching of common errors has in fact been proposed for learning other content types, such as procedures, without specific research support [8-11]. A literature search revealed no research on the use of matched E-NE for procedure learning nor on the prevention of common errors in learning to use or apply a procedure. Based on the value of matched E-NE for teaching concepts, the authors propose that we can and should prepare learners to avoid common errors in procedure learning as well. The purpose of this study is to test this proposition.

The specific research question is whether or not presenting common errors matched with the correct performance will facilitate procedure (or rule) learning. The independent variable is the presentation of a common error matched with the correct performance of the procedure. The dependent variable is performance of the procedure at the application level (i.e., with previously unencountered instances).

We hypothesize that students receiving presentation of common errors matched with correct performance will perform better than students receiving only the correct performance.

METHODS

Students

The students for this study were thirty-four (15 male and 19 female) second year advertising-design majors from the College of Visual and Performing Arts enrolled in a second semester beginning photography class and twenty-two (10 male and 12 female) third year students majoring in advertising at the Newhouse School of Public Communications, Syracuse University. Although both groups of students were involved with the production and application of visual media, neither group had prior knowledge about the content area used in this study. The students were asked to participate in a study requiring approximately twenty-five minutes of normal class time. No payment or grade was associated with the study. On the day of the experiment students willing to participate were randomly assigned by coin toss to one of two identical lecture rooms. Assignment was eighteen students in the non-treatment group and twenty students in the treatment group.

Design

The research design for this study was the Pretest-Posttest design [12]. The statistical design was a *t*-test with unequal standard deviations [13].

Task and Materials

The task was the procedure for correcting the color of color slides. It was presented via slide tape mechanism utilizing two matched pairs of Kodak Carousel slide projectors and Wollensack slide tape synchronizing machines. The classrooms used for the experiment were identical lecture halls. Light level was controlled to provide adequate illumination for written test responses while still providing for proper slide viewing. Screens were pretested to assure color fidelity. The audio tapes were recorded simultaneously except for the segments of treatment differences. A professional narrator was used for the audio recording.

Valuable lessons were learned during a pilot test. Initially the color slides chosen were copies of a variety of scenic and portrait slides. Variations in color, accomplished by copying the slides through Kodak color correction filters, were the magnitudes .05, .10, and .15 of each of the six colors. In the pilot study a floor effect (i.e., very low scores on the posttest) was achieved for both the common error (CE) and non-common error (non-CE) groups. After reviewing the results and discussing the study with the pilot study students, the following changes in the materials were incorporated in the final study. First, pilot study students indicated that many of the slides "looked good" even if the color balance was off. Therefore, the variety of slides was limited to only original portraits photographed with identical backgrounds and lighting. Thirty different people were photographed to provide a pool of 108 slides for use. Second, the color magnitude variations of .05, .10, and .15 in the pilot study were difficult for the students to discriminate. In the final study the magnitude of color was changed to .10, .20, and .40 of the six colors using standard Kodak color correction filters. Thus, the task was simplified, providing more intense colors for both the CE and non-CE groups.

After the pretest the slide tape presentation indicated the purpose of the instruction: "To correct an out-of-balance photograph, add an equal amount of its opposite color." The students were then presented the following steps constituting the procedure:

1. decide if a color is out-of-balance;
2. determine which color is out-of-balance;
3. determine to what degree the color is out-of-balance;
4. identify the opposite color, and
5. add an equal amount of the opposite color.

All five steps were presented in one slide, with the audio tape instructing the students to read the information presented (see Figure 1).

Each of the steps was then presented individually on the left side of the screen with an example of that step provided visually on the right half of the screen. At the same time the audio tape provided a description of the example. No practice was provided.

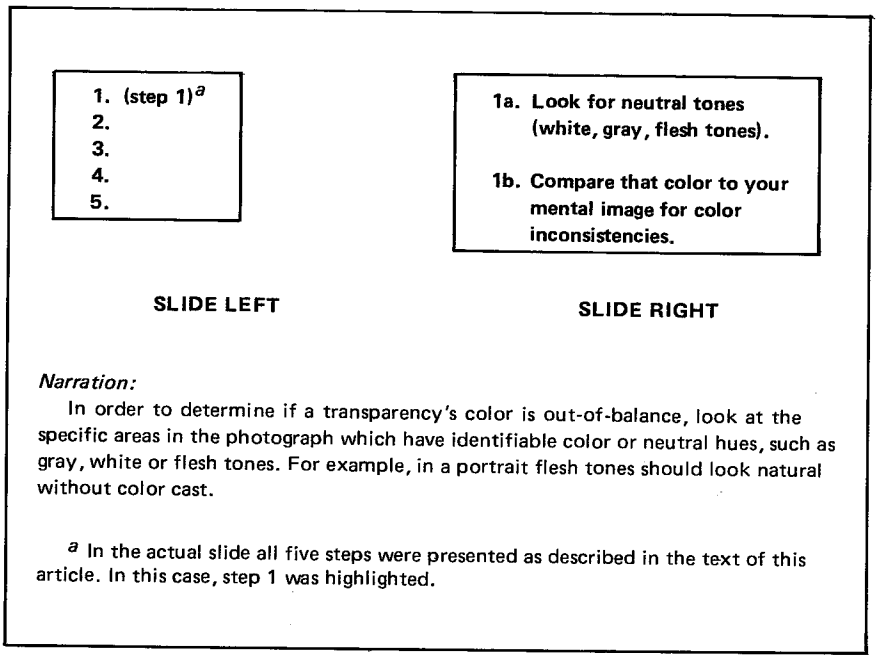


Figure 1. An example of the slides presented and the narration provided.

Treatments

Instruction was identical for both the CE and non-CE groups, with two exceptions. First, in step two of the generality for the procedure, the non-CE group only received a sample of each of the six colors of the color wheel. The CE group received a sample of each of the six colors of the color wheel and at the same time were presented samples of the colors most commonly confused with each of the six colors. The audio tape cautioned CE students not to confuse the colors (i.e., not to make the common error). Samples of the CE and non-CE presentations are provided in Figure 2.

On the basis of color photography teaching experiences and the results of the pilot study, the common errors were determined to be adjacent colors on the standard color wheel (see Figure 3).

The second difference between the two groups occurred with the examples. After completing the instruction for the five steps of the procedure, six examples were provided. The non-CE group was provided with only the color imbalance (i.e., the correct response) in the examples. The CE group was presented with the same color imbalance (correct response) and with the common errors. Figure 4 provides examples of the CE and non-CE presentations.

(NON-CE)

SLIDE LEFT	SLIDE RIGHT
1. 2. (step 2) 3. 4. 5.	red

Narration:

The next six slide sets will present the actual colors of the color wheel. Try to create a mental image of the colors as they are presented. The actual colors are presented on the right. In this slide the color red is shown.

(CE)

SLIDE LEFT	SLIDE RIGHT
1. 2. (step 2) 3. 4. 5.	red yellow magenta

Narration:

The next six slide sets will present the actual colors of the color wheel. Try to create a mental image of the colors as they are presented. The actual colors are presented on the right. In this slide the color red is shown at top center with yellow on the left and magenta on the right. At times, the color red is confused with magenta or yellow.

Figure 2. A comparison of the slide sets and narration for the generality.

COLOR	COMMON ERROR
RED	MAGENTA OR YELLOW
GREEN	YELLOW OR CYAN
BLUE	CYAN OR MAGENTA
CYAN	GREEN OR BLUE
MAGENTA	RED OR BLUE
YELLOW	GREEN OR RED

Figure 3. The common errors for the task.

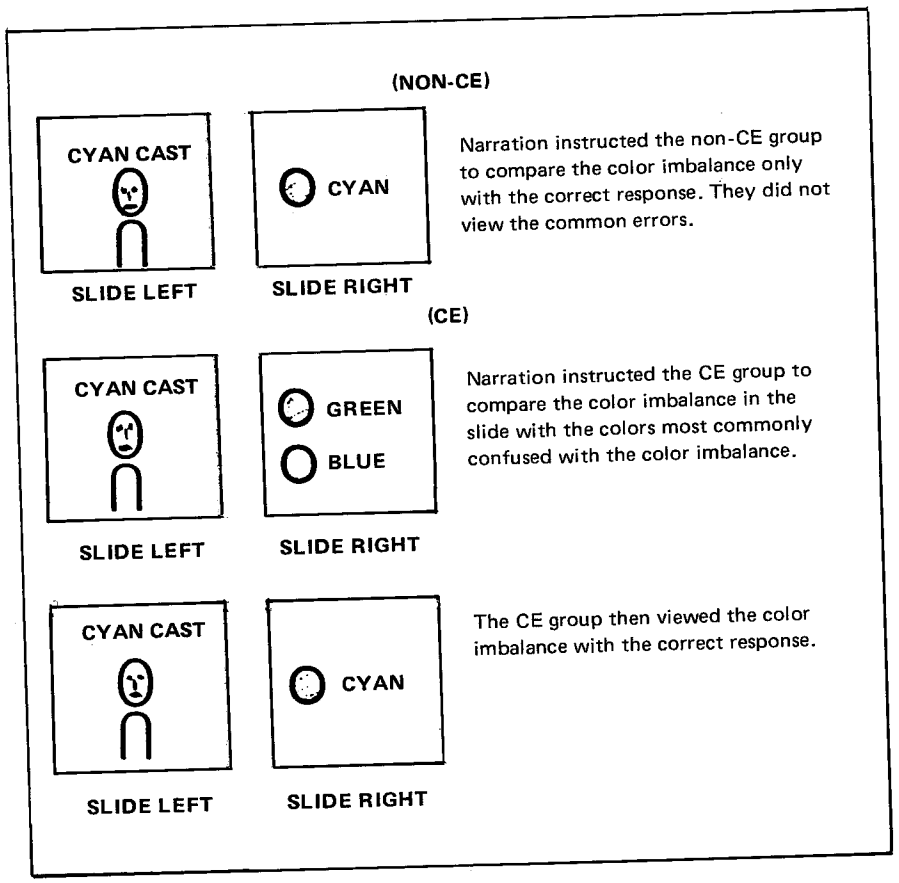


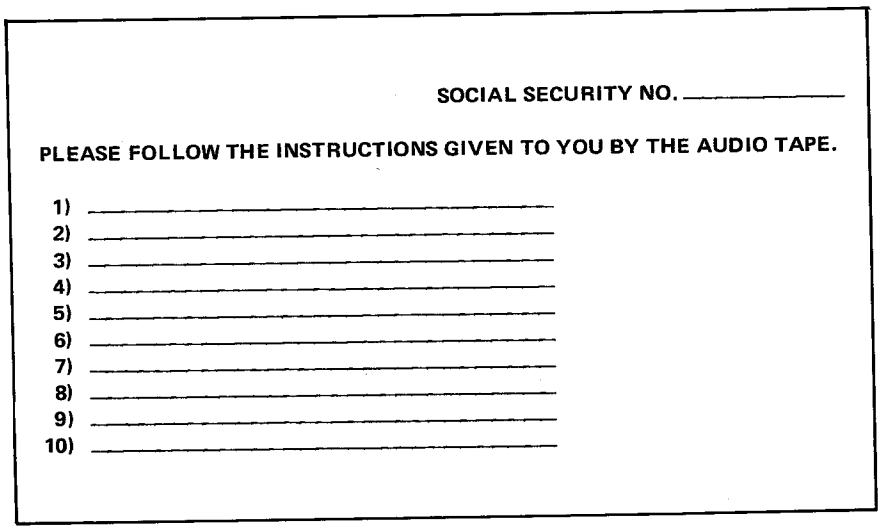
Figure 4. The examples for the non-CE and CE groups.

Tests and Measures

The slides for a ten-item pretest (Figure 5), a twenty-item posttest, and the six examples were selected at random from a pool of slides generated for that purpose. All test slides were previously unencountered portraits of Caucasian subjects holding a white, gray, and black test card. Slides varied in magnitude of imbalance from neutral (no color imbalance) to .10, .20, and .40. The type of imbalance varied from red, green, blue, cyan, magenta, and yellow. Color variation was controlled by the use of the standard Kodak color correction filters. All subjects were photographed with identical lighting and background.

Procedure

After random assignment to two separate classrooms, students were handed a pretest form (see Figure 5). Instructions for the administration of the pretest were provided by slide tape. Students viewed the slides and responded by recording the color imbalance, if any, they perceived. Following the pretest, copies of the standard color wheel were distributed to the students (see Figure 6). The slide tape presentation on the procedure for color correction was then given. Finally, the twenty-item posttest was administered requiring the students to indicate the color imbalance, if any (see Figure 7).


SOCIAL SECURITY NO. _____

PLEASE FOLLOW THE INSTRUCTIONS GIVEN TO YOU BY THE AUDIO TAPE.

1) _____
2) _____
3) _____
4) _____
5) _____
6) _____
7) _____
8) _____
9) _____
10) _____

Figure 5. The pretest form.

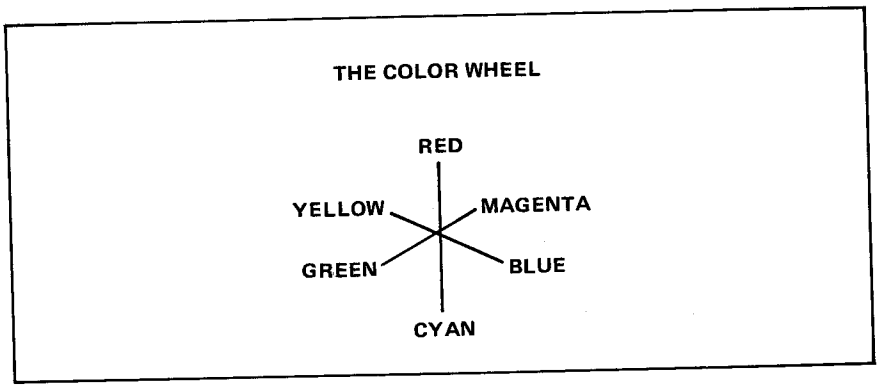


Figure 6. The color wheel provided to the students.

SOCIAL SECURITY NO. _____

1. a) COLOR BALANCE (CIRCLE ONE):

NEUTRAL RED GREEN BLUE CYAN MAGENTA YELLOW

b) DEGREE:

.05 .10 .15

c) THE AMOUNT AND COLOR NECESSARY TO ACCOMPLISH COLOR CORRECTION.

COLOR _____ AMOUNT OF CORRECTION _____

2. . . .

(TWENTY QUESTIONS TOTAL)

Figure 7. The posttest form.

RESULTS

The sample size and different cell sizes indicated that the t-test with unequal standard deviations would be appropriate. Analysis of the pretest results revealed no significant differences between the groups ($t = 0.87, p > .20$). Analysis of the posttest results revealed that application-level learning, as shown by the number of correct responses, was facilitated by the presentation of common errors in instruction ($p < .05$, one tail). Further, a review of the individual posttests

Table 1.

		Mean	*S.D.*	*N*
non-CE	Pretest*	11.25	12.68	16
	Posttest**	42.20	10.82	18
	Common Errors**	6.05	1.89	18
CE	Pretest*	14.50	9.73	20
	Posttest**	48.75	9.73	20
	Common Errors**	4.90	1.67	20

Pretest CE vs. Pretest non-CE:
$t = .87$ $df = 17$ $p > .20$ one tail

Posttest CE vs. Posttest non-CE:
$t = 1.95$ $df = 17$ $p < .05$ one tail

Common Errors CE vs. Common Errors non-CE:
$t = 1.99$ $df = 17$ $p < .05$ one tail

* Percent score out of ten questions.
** Percent score out of twenty questions.

provided data indicating that there was a lower number of common errors (as opposed to uncommon errors) in the CE group ($p < .05$, one tail). The hypothesis as stated in the introduction section is thus supported. (See Table 1.)

DISCUSSION

The results of this study show that performance significantly increased as a result of the presentation of common errors in instruction for procedure learning at the application level. The number of common errors was reduced by appropriate teaching of such errors. The results of this study support Ali [8], Gropper [9], and Merrill [10], strengthening the hypothesis that the teaching of common errors may be a valuable strategy for other than concept learning (i.e., procedures or principles) at the application level.

Unique to this study was the selection of materials that allowed for very specific control of variables. The slides produced for this study were identical in every respect except for a variety of faces and color. Changes in color were controlled in measured increments. This level of control rarely exists in other contexts.

Given the results of the present study, we conclude that presentation of common errors can be beneficial. However, common errors should be just that: Errors commonly made for the procedure. It is probably pointless to teach mistakes that are generally not made. Also, it is likely that the use of common errors is most valuable when the common error is made apparent and a clear distinction exists between a correct and incorrect response.

Further research is needed to determine the value of teaching common errors in principle learning, as well as replicating this research in procedure learning. In conducting such research, particular care should be addressed to the accurate identification of common errors.

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