EFFECTS OF LOGO EXPERIENCE AND GRADE ON CONCEPT LEARNING AND CREATIVITY

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Abstract

The effects of a LOGO microcomputer experience on problem-solving and creativity was investigated using a novel graphics control group. Eighty-eight kindergarten and second grade students were assigned to a LOGO, Graphics Control, or Comparison group. The use of a programmed joystick for the Graphics Control group allowed the separating of the graphics component of the experience from the procedural programming component. Results revealed a significant grade effect both for total errors on problem-solving measures and for four of the five creativity measures (all p's < .001). No significant treatment group differences were observed, nor was there a significant grade by treatment group interaction (p's > .05). Possible alternative explanations and suggestions for future research are provided.

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Seymour Papert has suggested that experience with a procedural computer language such as LOGO may affect the way in which other kinds of learning take place (Papert, 1975, 1980). LOGO is a powerful programming language which is, nevertheless, accessible to children. Through the graphics interface, children control the movement of a triangular "turtle" and thus are able to draw on the screen. By teaching the turtle new words (e.g., "SQUARE") which are packages of commands, children begin their programming experience. Papert has proposed that even at the preschool level children may be able to take advantage of this type of programming. Others have suggested that because of the need to continually change and "debug" graphics projects, creative thinking may also be fostered by LOGO experiences (Clements, 1986; Clements & Gullo, 1984).

In spite of the predictions that have been made concerning the possible effects of LOGO experience on cognitive development, research results have not presented a clear picture of those effects, especially for the preschool and early elementary years (Battista & Clements, 1986; Clements, 1985, 1986; Clements and Gullo, 1984; Degelman, Free, Scarlato, Blackburn, & Golden,1986; Gorman and Bourne, 1983; Mayer, Dyck, & Vilberg, 1986). The patchwork of research results on the cognitive benefits attributable to computer programming in general, and LOGO in particular, is probably due to many factors, including the nature and length of the computer experience, the particular control and comparison groups used, different age levels examined, different dependent measures employed, and in some cases small sample sizes.

One purpose of the present study was to examine the effects of a LOGO programming experience on problem solving and creativity using a novel control group. Several studies have utilized a comparison group provided with CAI experience in order to assess the possibility of a Hawthorne effect or of general exposure to computers (Battista & Clements, 1986; Clements,

1986, 1987; Clements & Gullo, 1984). Clements and Gullo (1984), for example, compared a LOGO experience with a computer-assisted instruction (CAI) experience for first grade children. Although significant differences were observed on measures of cognitive style and divergent thinking, no significant differences were found on measures of cognitive development. The present study utilized a control group which we believe allowed a more sensitive evaluation of the unique features of LOGO. In this control group, the use of a joystick allows the retention of the graphics component of the LOGO computer experience, while withholding the procedural programming central to LOGO. The use of a program to govern joystick movement made the use of this control condition even more appropriate.

In addition to utilizing a novel control group, the present study provided individual computer time. Several earlier studies used either two or three students sharing each computer (Battista & Clements, 1986; Clements, 1986; Clements & Gullo, 1984). If, indeed, LOGO benefits are attributable to learning by doing, then it seems preferable to provide individual experiences with LOGO. One notable study in which individual time was provided found that increasing the amount of individual LOGO computer time resulted in significantly better performance on a conditional rule-learning task (Gorman & Bourne, 1983). Thus, the purpose of the present study was to compare the performance of kindergarten and second grade students on creativity and problem-solving measures following either individual LOGO computer experience, individual non-LOGO graphics computer experience, or no specific computer experience.

Method

Subjects

Eighty-eight students (44 kindergarten, 44 second grade) participated in the study. Within each grade, two classes were used. One class was designated the Comparison class, receiving no specific microcomputer experience; after matching on age, students in the other class were randomly assigned to treatment groups (LOGO or Graphics Control). Of the kindergarten students, 10 (5 male, 5 female) were assigned to the LOGO condition, 11 (4 male, 7 female) to

the Graphics Control condition, and 23 (11 male, 12 female) were included in the Comparison condition. Of the second grade students, 12 (6 male, 6 female) were assigned to the LOGO condition, 12 (4 male, 8 female) to the Graphics Control condition, and 20 (11 male, 9 female) were included in the Comparison condition.

Apparatus

Two Apple IIe microcomputers with color monitors were used. For the LOGO condition, a modified single-keystroke LOGO was employed. This LOGO included the naming, saving, and using of procedures; an erase command which provided motion by redrawing all but the last command; a print command; as well as the standard commands "Forward 10, Left 45, Right 45, Clearscreen, Setbackground color, Hideturtle, Showturtle, Penup, Pendown, Help."

For the Graphics Control condition, a program was written to provide the student with the ability to use a joystick to do many of the same actions as that enjoyed by the LOGO group. Thus, the Graphics Control group used buttons on the joystick for "Penup," "Pendown," and "Clearscreen." Movements of the joystick produced one of the following effects: "Forward 10, Left 45, Right 45." Keyboard control of printing and changing of background color was used. The Graphics Control program did not allow students to name, save, or use procedures.

Procedure

Students in the LOGO and Graphics Control groups received fifteen minutes of individual instruction twice a week for a period of eight weeks. Two students worked alongside each other (each with a separate microcomputer), with a trained experimenter present at all times to guide, observe, and provide help as needed. Students in the Comparison group did not receive any special microcomputer experience.

Before any student began work on the computer, the experimenter led them in "body" games, where the children played the turtle, practicing turns and forward "turtle steps." For the students in the Graphics Control condition, the experimenter pretended to be holding a giant joystick controlling the movements of the student "turtle." After the students felt comfortable

playing the turtle, they were introduced to the computer and the movement of the turtle (either through the single-keystroke LOGO or the joystick). Transparent overlays on the screen were used for the initial introduction to the computer. These overlays presented simple mazes or maps which the student had the turtle navigate.

For students in the LOGO group, the experimenter's goal was to have the students progress to the point where they were naming, saving, and using procedures in their graphics projects. The ability to successfully do this required thinking about turtle heading, turtle positioning, and turtle state (Hide or Show) at the end of procedures. If a student appeared at any point ready to move to the full LOGO language, the student was allowed to do so.

Dependent Measures

Following the eight weeks of computer experience, all students were tested on measures of rule-learning and creativity. Four rule-learning problems (two affirmatively defined concepts, two conjunctively defined concepts) were presented to each student. Stimuli varied on three dimensions: shape (square, circle), color (black, white), and size (large, small). A random sequence of the eight possible stimulus configurations was created and used for all four concept learning tasks. The sequence of the eight stimulus elements was repeated six times to create a total of forty-eight stimuli for each of the concept-learning tasks. A criterion of eight consecutive correct responses was used. All testing was individual and was done without knowledge of student treatment group.

The Torrance Test of Creative Thinking: Figural Test (Torrance, 1972) was used to measure creativity. Test booklets were commercially scored, generating standard scores (M = 100, SD = 20) on fluency, originality, abstractness of titles, elaboration, and resistance to premature closure.

Results

Table 1 presents the means and standard deviations of each dependent measure for each grade and treatment group combination. To determine whether there were significant differences

on any of the six dependent measures, scores on each of the six dependent measures were subjected to a 2 (treatment group) X 3 (grade) multivariate analysis of variance.

A statistically significant multivariate grade effect was observed, F (6, 77) = 37.535, p < .001. A univariate analysis of the total errors made on the rule learning problems revealed that the reduction in total errors from kindergarten to second grade (53.6 to 33.1) was statistically significant, F (1,82) = 11.583, p < .001. A significant univariate grade effect for four of the five creativity measures was also observed. A decrease in fluency from kindergarten to second grade (103.9 to 91.9) was observed, F (1,82) = 23.071, p < .001. Similarly, a decrease in elaboration from kindergarten to second grade (96.7 to 77.8) occurred, F (1,82) = 63.739, p < .001. In contrast, an increase in abstractness of title from kindergarten to second grade (97.5 to 112.4) was observed, F (1,82) = 9.517, p < .005. Similarly, an increase in resistance to closure from kindergarten to second grade (87.6 to 91.0) occurred, F (1,82) = 47.823, p < .001. The only measure for which no statistically significant grade difference was observed was originality, F (1,82) = 0.006, p >.10.

Multivariate analysis of the effect of treatment group revealed that treatment group differences were not statistically significant (F (12, 154) = 1.672, p > .05); similarly, there was no statistically significant interaction between grade and treatment group (F (12, 154) = 1.489, p > .10).

Discussion

First, a significant reduction in total problem-solving errors from kindergarten to second grade was observed. This finding is certainly not startling; the lack of significant treatment differences in rule-learning errors, however, is surprising. Others have found an effect of LOGO experiences on rule-learning (Degelman et al., 1986; Gorman and Bourne, 1983). One possible explanation for the lack of significant treatment effects in the present study relates to the use of a programmed graphics control group. It may be that short-term LOGO training does not have unique measurable effects on rule-learning problems when compared to a similar computer

experience which utilizes graphics. However, not only are there no significant differences between the LOGO and Graphics Control conditions, but the LOGO and Graphics Control groups are not significantly different from the Comparison group. The mean numbers of errors for the LOGO, Graphics Control, and Comparison groups (42.2, 42.2, and 44.5, respectively) do, however, show fewer errors for the computer experience groups. Statistically significant differences in creativity between kindergarten and second grade were observed. The general finding of earlier research has been an increase with age of performance on the Torrance measures of creativity. Wallach (1970) suggests that this developmental change reflects the "… cumulative impact of the various sources of information to which the child in our culture is exposed over time …" (p. 1232). The pattern of results observed in the present study, however, is not so clear. Only two of the Torrance measures (abstractness of title and resistance to closure) reflected an increase with age. Two other measures (fluency and elaboration) evidenced a significant decline from kindergarten to second grade. No significant grade differences were observed on the final measure of creativity, originality. Wallach (1970) has argued that fluency and originality are the two Torrance measures that are "… relatively distinguishable from intelligence" (p. 1233). Thus, on neither of these measures was there an increase from kindergarten to second grade. In contrast, Clements (1986) reported significant increases from first to third grade on fluency, flexibility, originality, and elaboration. Finally, in contrast to earlier studies, we found no significant treatment group differences on any measure of creativity.

The present study describes a new way to assess the effects of LOGO programming experiences on a variety of dependent measures. The similarity of the Graphics Control condition to the LOGO condition, combined with their essential difference of procedural programming, makes the Graphics Control treatment condition a good control group to employ in studies of effects of LOGO experiences. Future research on the effects of LOGO experiences should consider including a Graphics Control group, a CAI control group, and a no-treatment control group.

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Table 1

Means and Standard Deviations of Dependent Measures as a Function of Treatment Group and Grade

Treatment Group	LOGO	Graphics	Comparison
	Kindergarten		
Total Errors			
M	48.0	52.5	56.6
SD	25.6	19.7	28.8
Fluency			
M	109.5	108.2	99.4
SD	11.0	11.4	9.4
Originality			
M	87.8	88.7	87.2
SD	15.8	18.1	16.7
Abstractness			
M	91.0	105.2	96.7
SD	12.7	20.6	16.9
Elaboration			
M	93.1	98.1	97.5
SD	7.9	11.6	11.7
Closure			
M	83.6	88.1	89.2
SD	5.9	10.6	10.8

	Grade 2		
Total Errors			
M	37.4	32.8	30.7
SD	27.0	25.0	18.8
Fluency			
M	95.3	89.7	91.1
SD	10.8	14.6	16.6
Originality			
M	91.5	83.7	89.4
SD	16.3	12.4	17.4
Abstractness			
M	99.3	117.3	117.2
SD	14.2	23.3	25.0
Elaboration			
M	80.0	74.4	78.5
SD	7.6	8.5	11.5
Closure			
M	69.3	67.3	65.0
SD	12.1	14.0	17.1