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ABSTRACT

The effects of judgmental and non-judgmental computer assisted instruction (CAI) feedback on the self-esteem and mathematics achievement of remedial level junior high school students were examined. Each of 44 eighth-grade mathematics students was given a self-esteem pretest questionnaire, completed a basic mathematics facts drill and practice CAI program with varying degrees of judgmental feedback, and was posttested on the self-esteem scale. The basic CAI program consisted of three sets of randomly generated multiplication fact drill and practice problems, with factors ranging from one to nine. The systematic feedback in the CAI programs used either affirmation of response only, affirmation plus positive reinforcement for correct responses, affirmation with negative reinforcement for incorrect response, or affirmation plus positive and negative reinforcement. No statistically significant differences were found among the treatment groups, perhaps because of the short-term nature of the study. On the average, computer self-esteem scores increased somewhat for all the treatment groups, indicating that their attitudes towards CAI improved somewhat as a consequence of their exposure to the program. Twenty-one references are listed. (Author/LMM)

Examining the Effects of Varied Computer-Based Reinforcement on Self-Esteem and Achievement: An Exploratory Study

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Running head: Reinforcement in CAI

Abstract

In the present study, the effects of judgmental and non-judgmental CAI on the self-esteem and mathematics achievement of remedial junior-high students were examined. Each of 44 students was given a self-esteem pretest. The subjects completed a basic mathematics facts drill and practice CAI program with varying degrees of judgmental feedback, and were posttested on the self-esteem scale. Although no statistically significant differences were found among the treatment groups, this result was more likely due to the short-term nature of the study, rather than an absence of a relationship between judgmental feedback and learner self-esteem.

Examining the Effects of Varied Computer-Based Reinforcement on Self-Esteem and Achievement: An Exploratory Study

There is considerable evidence to suggest that computer-assisted instruction (CAI) is a highly effective mode of delivery for instruction (Kulik ,1983). Several authors have shown that CAI is especially effective for self-motivated, high-achieving learners (Hoffman & Waters, 1982; Gershman & Sakamoto, 1981; Menis, Snyder, & Ben-Kohav, 1980). However, recent attempts to utilize computers with migrant and minority students have also been successful (Crandall, 1976; Saracho, 1982) In addition, other studies have shown that CAI can produce achievement gains when used with low achievers in basic skills areas (Suppes, 1981). Specifically, CAI drill and practice programs, used as "electronic flashcards" with these students has been effective (Charp, 1981; Edwards, Norton, Taylor, Weiss & Dusseldorp, 1975).

In a recent study on the effects of CAI on student attitude, the authors concluded that the children who participated in CAI programs believed the non-judgmental nature and the infinite patience of the computer made learning more pleasant than coentional instructional strategies, such as teacher-directed practice and discussion (Lawton

& Gerschner, 1982). The positive attitudes of these students were attributed to the fact that the computer provided consistent feedback, never showed signs of anger or frustration, and left the students with a general feeling of having learned "better" (Clement, 1981). Other authors have also found that students' attitudes towards CAI are generally positive (Caffarella, Cavert, Legum, Shtogren, & Wager, 1980; Duby & Giltrow, 1978; Garraway, 1974; Smith, 1973). However, the effects of CAI on broader affective traits, such as self-esteem has not been established.

One of the key benefits of CAI, however, may be the control of reinforcement, appropriate to the characteristics of the individual learner, and the corresponding lack of teacher criticism. During the past decade, the educational community has concentrated much attention on the effectiveness of conventional teacher praise as a reinforcer. Several researchers have shown that praise can be an effective reinforcer used consistently and appropriately (Heller & White, 1975; Lipe & Jung, 1971; Meyer, Bachmann, Biermann, Hempelmann, Ploger, & Spiller, 1979). However, Brophy (1981) noted that praise is rarely used in a systematic way to reinforce desired behavior. Several studies have supported Brophy's contention that teacher praise can often have deliterious effects on student performance. Such praise is inconsistently provided, and students tend to feel demeaned when they are praised for correct responses on

tasks they view as simplistic or trivial (Bates, 1979; Meyer, et al., 1979; Silberman, 1969).

The effects of judgmental kinds of learner-computer interaction on the performance of low-achieving students requires further study. In addition, although much is known about the effects of teacher praise as a reinforcer in conventional classroom settings, little research has been done on the effects of positive and negative reinforcement in CAI, where the interaction can be controlled more or less absolutely. In this study, the effects of various types of reinforcements on both learner achievement and the self-esteem of low-achieving students were studied.

Methods

Subjects

The subjects of this study were 44 eighth grade mathematics students, drawn from three remedial mathematics courses. Placement in these courses was based on teacher recommendations and standardized test score results. The average Comprehensive Test of Basic Skills mathematics score for students in this study was the 39th percentile. The ethnic composition of the study group was primarily Anglo, with a minority of Hispanic and Black students.

Materials

Four CAI treatments were employed. The basic CAI program consisted of three sets of 10 randomly generated, multiplication fact drill and practice problems, with factors ranging from one to nine. After a brief, personalized introduction, the computer alerted the student to prepare for an upcoming problem and then "flashed" the problem across the screen in low-resolution graphics for approximately one second. The students were then shown the entire problem in regular computer text for approximately three seconds. For example, a typical problem might be: "8 X 8 = ?" The computer then prompted the student with, "The answer is ?" At this point, the student entered the answer and the computer displayed the correct answ for approximately 5 seconds. The students were the told to prepare for the next problem, whereupon the computer repeated the above procedure. The program was entirely computer-paced, displaying the problems and prompts at pre-defined rates, which the learner was unable to change. The program was modified to include four levels of systematic feedback.

Affirmation of response only. For the purposes of this study, affirmation of response refers to notifying the learner of the correct response, without any feedback as to the nature (correct or

incorrect) of the learner's response.

Affirmation plus positive reinforcement for correct response. Students were notified of the correct answer and systematically praised by the computer for giving the correct response. In this program, the positive reinforcement nsisted of the computer displaying a happy face, ringing a bell and displaying the word "right" in bold green print. No feedback was provided to the learner when the incorrect response was given.

Affirmation with negative reinforcement for incorrect response. Learners were provided with the correct response and systematic negative reinforcement when the incorrect answer was given. Negative reinforcement consisted of the computer displaying a frowning face, sounding a buzzer and displaying the word "wrong" in bold, red print. No feedback was provided to the learner when the correct response was given.

Affirmation plus positive and negative reinforcement. This feedback version was a combination of the latter two treatments.

Depeant Measures

In addition to the four levels of CAI treatments described, the students were assessed on their achievement and their self-esteem.

Achievement measure. The number of correct responses provided

by the learner for each of the three sets of 10 problems of the CAI program was recorded on magnetic disk. Validity of the CAI performance measure was established through expert review and comparison with print-based tests of multiplication fact mastery.

Self-esteem questionnaire. Prior to the CAI treatment, a pencil-and-paper Likert-type self-esteem questionnaire, developed by the author, was administered to the students This scale consisted of three parts. The first of the three parts contained 12 items and focused on the students' mathematics-related self-esteem. For example, the student was asked to rate statemen such as "I try hard in math" on a five-point scale, ranging from "all of the time" to "not at all." The second part of the scale contained 16 items and concerned general self-esteem questions such as "I get along well at home" and "I am popular." The third part of the questionnaire contained 8 items addressed the students' self-esteem relative to using the computer itself. Typical questions from this section were "I am smart enough to learn about computers" and "I am not afraid about working with computers." Each section of the scale utilized the same type of response format. The reliability of the self-esteem questionnaire was 0.87, using test-retest data obtained prior to the study. Validity of this measure was also established through coultation with experts in the field.

Procedure

After the subjects were pretested for initial levels of self-esteem using the self-esteem questionnaire, they were designated as relatively high or low in achievement and randomly assigned to one of the four treatment groups. The students then completed three sets of 10 problems. Scores from each of the sets were recorded. After completion of the CAI treatment, the subjects were postested for self-esteem using the same scale.

Experimental Design and Data Analysis

This experiment employed a completely crossed, 4 x 2 factoral design, featuring four levels of feedback (affirmation of response, affirmation with positive reinforcement, affirmation with negative reinforcement, and affirmation with positive and negative reinforcement) and two levels of achievement, high and low (based on CTBS scores). Dependent measures included three measures of posttest self-esteem (general self-esteem, computer self-esteem, and mathematics self-esteem) and one measure of performance from each of three trials with a basic skills mathematics program.

Posttest self-esteem scores were analyzed with MANCOVA procedures, with pre-test self-esteem as the covariate. Achievement

differences were also analyzed with MANOVA procedures for repeated measures designs.

Results

The means for the individual pretest self-esteem measures are contained in Table 1 and the means for the individual posttest self-esteem measures are contained in Table 2. The affirmation of response with negative reinforcement treatment consistently obtained the highest reported levels of self-esteem across each scale. However, although there is a general trend of improvement in computer-related self-esteem across all treatment groups, the differences among the treatment means within each scale were not statistically significant. In addition, there were no significant differences between high and low achievers.

The mean percentage of correct responses made during each of the three trials of the CAI program are contained in Table 2. The performance across treatments was uniformly high on all trials, averaging over 90 percent accuracy for both high and low levels of prior achievement. No significant diffences among the means were found for either CAI treatment or prior achievement level.

INSERT TABLES 1, 2, AND 3 ABOUT HERE.

Discussion

The purpose of this study was to examine the relationship between the judgmental nature of CAI feedback used and the resulting achievement and self-esteem of learners. While no significant differences were found, several important points warrant discussion.

The tentative hypothesis that non-judgmental, or neutral, feedback in CAI would produce the most favorable attitudes, and correspondingly, the highest levels of learner self-esteem was not supported by this study. This belief evolved from research in conventional instruction, which indicates that neutral feedback, as opposed to positive or negative reinforcement, produces the highest levels of achievement and motivation, when the learning task is simplistic in nature (Bates, 1979; Brophy, 1981; Meyer, et. al., 1979; Silberman, 1969). Although not supported in the present study, this lack of support may be due to the short-term nature of the study, ratr than an absence of the relationship itself.

Self-esteem is the product of many factors, including environmental factors such as family and friendships, and personal characteristics

such as attitude. An individual's level of self-esteem is determined through years of development. The participants in this study were subjected to the experimental program for only two instructional periods, for a total of approximately 90 minutes, with the actual treatment varying in time between 10 and 30 minutes. It is unlikely that any short-term change in instructional strategy, even those utilizing the bias-free capabilities of the computer, could produce noticeable changes in accumulated levels of self-esteem. The results of this study reinforce the strength of self-esteem as an evolved trait, in that no significant changes could be fostered through relatively short interventions.

While no differences were produced in the brief time-frame used in this study it is possible that longer term interventions might prove effective. One might expect that high levels of self-esteem, as well as low levels of self-esteemare cultivated through proper learning experiences and manipulations of the individual's environment. If so, then perhaps self-esteem can be improved through the long-term use of planned positive, and controlled learning experiences. Computer-based instruction offers a potentially powerful tool in controlling the nature of the learner-instruction interaction, and perhaps the resulting self-esteem.

The underlying assumption of this study is that CAI, by its nature, is only as judgmental as the designer dictates. Computers

can be programmed to be non-judgmental in their assessments of learner performance, since, unlike teachers, they possess no inherent emotions. Computers are only capable of displaying emotion that the programmer deems appropriate. Feedback that is demeaning, or subject to misinterpretation on the part of the student, can be avoided. Computers can be programmed to be completely consistent in their use of whatever reinforcement is necessary. Hence, CAI should be an ideal instructional delivery system icertain types of feedback and interactions are found to be destructive to the self-esteem of the individual learner.

Other factors may have hampered the present attempt to detect reliable, meaningful effects. There was an apparent "ceiling" effect on the self-esteem measures, leaving little room for improvement on the posttest. In addition, the CAI task, multiplication fact drill and practice, may have contributed to the ceiling effect, due to the simplicity of the task. Since subjects did very well on the drill and practice program, averaging over 90 percent in each of the four treatments, it seems probable that the negative reinforcement features of the treatments were rarely seen. The lack of negative reinforcement might well have contributed to the ceiling effects by causing the students to perceive the computer as a pleasant way to learn.

Some important general trends were detected in this study. For

example, on the average, computer self-esteem scores improved somewhat for all the treatment groups, indicating that their attitudes towards CAI improved somewhat as a consequence of their exposure to the program (see Tables 1 and 2). In addition, students in the "affirmation of response only" and "affirmation plus negative reinforcement" treatments performed slightly better than the other treatments. When the absence of negative reinforcement caused by the ceiling effects is considered, this result is consistent with the notion that "affirmation of response" alone yields the highest levels of both achievement and self-esteem.

Because of the important pedagogical effects of learner self-esteem and the emergence of CAI as an important instructional delivery system, further study is warranted. The learning task used in the CAI program should be expanded to include both drill and practice and a tutorial segment that provide the basic instruction in a new skill or skills. This expansion would eliminate problems caused by the students being too faliar with the subject matter. Next, the self-esteem measures should be expanded in order to detect more subtle changes in learner self-esteem, by adding more items, eliminating item-overlap, and possibly adding a teacher observation portion to the scale. Finally, the time frame of the study itself should be lengthened, in order to examine longitudinal effects of CAI on learner self-esteem.

The purpose of this study was to determine if student self-esteem and achievement could be affected through the use of reinforcement in CAI. Although statistically significant differences among treatment groups were not found, some general trends were detected that should be explored with future research. Further research will help to establish the feasibility of the computer in providing reinforcement that will systematically improve learner attitudes, confidence, and overall self-esteem.

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Table 1. General, mathematics and computer pretest self-esteem means for high- and low-achievers in computer-assisted instruction.

Achievement Level	Affirmation of Response Only	Affirmation w/ Positive R	Affirmation w/ Negative R	Affirmation w/ Pos. & Neg. R	Total
			General Self-Esteem		
High	26.67	26.56	25.67	28.29	27.10
	(n=3)	(n=5)	(n=3)	(n=7)	(n=18)
Low	25.33	26.20	26.67	27.43	26.39
	(n=6)	(n=9)	(n=3)	(n=7)	(n=2
Total	26.22	26.43	26.17	27.86	26.69
	(n=9)	(n=14)	(n=6)	(n=14)	(n=43)
			Mathematics Self-Esteem		
High	29.33	28.56	30.00	30.00	29.49
Low	27.33	27.20	29.57	25.00	26.90
Total	28.00	28.07	29.79	27.50	28.10
			Computer Self-Esteem		
High	31.33	27.00	27.00	24.29	26.67
Low	29.67	22.20	26.71	27.43	26.80
Total	30.78	25.29	26.86	25.86	26.28
			Total Self-Esteem		
High	87.33	82.12	82.67	82.58	83.26
Low	82.33	75.60	82.95	79.86	80.09
Total	85.00	79.79	82.82	81.22	81.07

Note: All cell sizes are identical to those listed under General Self-Esteem.

Table 2. General, mathematics and computer posttest self-esteem means for high- and low-achievers in computer-assisted instruction.

Achievement Level	Affirmation of Response Only	Affirmation w/ Positive R	Affirmation w/ Negative R	Affirmation w/ Pos. & Neg. R	Total
		Type of Feedback			
		General Self-Esteem			
High	28.67	29.40	31.67	28.14	29.17
	(n=3)	(n=5)	(n=3)	(n=7)	(n=18)
Low	26.00	27.78	28.00	28.71	27.64
	(n=6)	(n=9)	(n=3)	(n=7)	(n=25)
Total	26.89	28.36	29.83	28.43	28.28
	(n=9)	(n=14)	(n=6)	(n=14)	(n=43)
		Mathematics Self-Esteem			
High	32.67	31.80	33.67	29.14	31.22
Low	28.67	29.11	33.67	31.43	30.20
Total	30.00	30.07	33.67	30.29	30.63
		Computer Self-Esteem			
High	33.67	30.20	25.33	30.43	30.06
Low	30.50	28.56	33.00	25.86	28.80
Total	31.56	29.14	29.17	28.14	29.33
		Total Self-Esteem			
High	95.00	91.40	90.67	87.71	90.44
Low	85.17	85.44	94.67	86.00	86.64
Total	88.44	87.57	92.67	86.86	88.23

Note: All cell sizes are identical to those listed under General Self-Esteem.

Table 3. Achievement means for high- and low-achievers in computer-assisted instruction.

Achievement Level	Affirmation of Response Only	Affirmation w/ Positive R	Affirmation w/ Negative R	Affirmation w/ Pos. & Neg. R	Total
		Type of Feedback			
		Trial One			
High	96.67	91.11	93.33	92.86	93.09
	(n=3)	(n=5)	(n=3)	(n=7)	(n=18)
Low	96.67	86.00	83.33	82.86	87.36
	(n=6)	(n=9)	(n=3)	(n=7)	(n=25)
Total	96.67	87.82	88.33	87.86	89.76
	(n=9)	(n=14)	(n=6)	(n=14)	(n=43)
		Trial Two			
High	95.00	94.44	96.67	88.57	92.62
Low	90.00	92.00	96.67	92.86	92.32
Total	91.67	92.87	96.67	90.72	92.44
		Trial Three			
High	96.67	94.44	100.0	95.47	96.13
Low	92.22	92.87	96.67	93.57	93.45
Total	92.22	92.87	96.67	93.57	93.45
		Total Achievement			
High	96.11	93.33	96.67	92.30	93.95
Low	92.22	90.00	91.11	89.05	90.40
Total	94.17	91.67	93.89	90.68	91.89

Note: All cell sizes are identical to those listed under Trial One.