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ABSTRACT

The purposes of this study were to: (1) produce self-control of academic behavior in a ninth-grade typing and an eleventh grade accounting class by providing continuous self-generated feedback through various devices; (2) to assess the relative merits of each device; and (3) to study those factors accounting for behavior change under self-monitoring conditions. A review of earlier self-monitoring studies suggested controls appropriate to the research design. The devices themselves proved no different from the controls. The accelerations in the last posttreatment baseline proved significantly different from all other phases for two sets of data. A third set of data yielded only a non-significant trend toward change during the last posttreatment baseline. Results suggest that: students demonstrate limited self-directed change of performance rates with these procedures; terminating the last phase conjunctively with the end of the school year explains the fixed interval scallop; and weighting daily work more heavily may reduce scalloping and assure the longevity of self-control through the end of the school year. (Author)

FIXED INTERVAL REINFORCEMENT AND CONTINUOUS DAILY FEEDBACK ON ACADEMIC PERFORMANCE A CONJUNCTIVE CONFOUNDING OF SCHEDULES.

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The behavioral approach applied to education has received most attention in the area of basic skills. Self-control procedures as developed in other areas of behavior analysis have only recently been applied in educational settings (Risley and Hart, 1968; Blackwood, 1970; Broden, Hall and Mitts, 1971). According to the theory of behavior analysis, self-control is described as having two components: a controlling response and a controlled response (Skinner, 1953). Both of these responses are emitted by the behaver.

The controlled response is that response which is manipulated by the controlling response. Thus the problem of producing self-control in any setting becomes largely one of discovering effective controlling responses which the behaver may readily emit to manipulate some other feature of his behavioral repertoire. Examples of controlling responses as sampled in the clinical and educational literature include such devices as self-monitoring through charts or informative feedback (Rutner, 1967; Kolb, Winter, and Morlow, 1968; Leitenberg, Agras, Thompson, and

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Wright, 1968; Jens and Shores, 1969; Duncan, 1969; McFall, 1970; Duncan, 1970; McFall and Hammen, 1971; Proden, Hall and Mitts, 1971; Bergar, 1972), self-application of aversive stimuli (Powell and Azrin, 1968), delay ofreinforcement (Goldiamond, 1965), behavioral antecedent changes (Ferster, Nurnberger, and Levitt, 1962; Azrin and Powell, 1968; Azrin and Powell, 1969; Marston and McFall, 1971), and the emission of private responses (Blackwood, 1970). This last category was further elaborated in Homme (1965) and Premack (1971).

The purpose of the present study was to produce self-control of academic behavior in highschool, business education students by providing continuous, self-generated feedback through various feedback devices and to assess those factors which contribute to performance gains under self-monitoring conditions. Attempts to use self-monitoring as an experimental treatment have met with critical reviews by Orne (1970), Kanfer (1970), Lichtenstein (1971), and Hausner (1971) because extraneous factors to self-monitoring procedures have not beed carefully examined or controlled. These criticisms may be listed an (1) demand characterists, (2) reactive effects, (3) poor control prior to manipulation, and (4) the questionable validity of self-generated data. Many of these criticisms influenced the design of this study and each will be discussed in the closing portion of the methods section.

Methods

This research was done in two classrooms. The first was a ninth-grade, second semester typing class with twenty-six females and three males. The second class was an eleventh-grade, second semester accounting class with sixteen females and five males. The teachers in both classes used past class performance and grades to stratify each class into high, middle, and low achievement groups. The students were then randomly

selected to receive one of three different treatment orders. This procedure provided twenty-four females and three males in the typing class and thirteen females and five males in the accounting class as experimental subjects. The remaining students were exposed to the same treatments, but their data were not included in the statistical analysis.

The response unit for the accounting class was any fill-in-the-blank item, row or column entry, or any mathematical computation. The dependent variable for this class was work rate alone without respect to correct or incorrect responding. (Since the students had both answer sheets and the teacher available during the class for individual help, it was felt that work rate alone was a sufficient pinpoint, without respect to correct of incorrect rates.) After classes, the reader periodically checked the students recording with the various devices to insure accuracy.

The response units for the typing class were gross words per minute and error rate for a three minute, once daily, timed typing. The sample for typing was changed every day during the experiment. Each student computed the total number of words typed by using the vertical scale in the text for each sample. The students then proofread their papers for errors. Thus, during the experiment, the final error rates were computed a day after the typing had been done.

Prior to the experiment, the students in both classes were instructed by the teachers to count the number of responses for either the entire class period in the accounting class of for the three minutes in the typing class and to post this count on a manila envelope used to hold all of their work materials. This type of self-recording was continued throughout the experiment and contrasted with recording on a rate computation sheet (RCS) which lacked visual, graphic display of the frequencies and the Standard Behavior Chart (SBC) which lent visual, graphic display

of the frequencies. The SBC is a six-cycle, semilogrithmic chart which permits the daily recording of behavior frequencies (Koenig, 1972; Pennypacker, Koenig, and Lindsley, 1972). During the first two days of each treatment phase, the experimenter visited the classes to train the students in the use of the new forms. At this time, one-third of the students continued working and recording as usual, while the other two-thirds received instruction for the RCS and SBC (one-half of these students for each form). After instruction in the forms, the students were asked to use whichever form was given them for two weeks. There was no differential reward given by the teachers for using the forms. Since most of the students in these classes were doing their daily work assignments, the reward was thought superfluous and even contradictory to the technique for producing self-control in this study. Each treatment phase was terminated by the teacher taking the forms from the students' envelopes and was interspersed with a week's baseline condition (i.e. posting a count on a manila envelope) before, between, and after the three treatment-order combinations. For purposes of this study, self-control is said to exist when celerations (accelerations or decelerations, depending upon the nature of the pinpointed response) are better under treatment conditions than under pre-treatment baseline conditions.

All students were exposed to all three types of recording within one of three treatment orders. The treatment designations were:

b1 ... baseline for counting alone.

b2 ... counting alone during treatment phase.

b3 ... baseline for RCS use.

b4 ... RCS use in treatment phase.

b5 ... baseline for SBC use.

b6 ... SBC use in treatment phase.

b7 ... last posttreatment baseline for all orders.

The three treatment orders were: first, b4,b2,b5,b6,b3,b4,b7; second, b5,b6,b3,b4,b1,b2,b7; Third, b3,b4,b1,b2,b5,b6,b7.

The control for demand characteristics, such as subjects guessing the hypothesis of the experiment by instructions, was accomplished by exposing all subjects to the hypothesis that all self-monitoring improves performance. Short baselines were inserted between treatment phases to assess the persistence of experimental effects. In order to eliminate a bias in the results due to intraclass communication, teacher commitment or differential teacher attention, and the presence of a novel person (the experimenter), the treatments were counterbalanced in a Latin squares fashion with the use of the old recording type continuing while the new recording types were introduced. As it was clear from the literature, self-monitoring is reactive for a number of reasons and thus serves as a poor control technique prior to manipulation. Therefore, an ability stratification relevant to prior classroom performance was obtained to assess the approximate levels of the individual performance before any type of self-monitoring was begun. The reliability of the self-recording was checked by each teacher during the term. The teachers commented upon the high reliability of these student recorded data. Since correlations between student identified and student-aide identified errors were high, these comments were reinforced. In this case, the student-aides and students were unknown to each other, and thus collusion was not a problem.

If certain variables are known to be reactive, it is only possible to examine the effects of one reactive variable against other reactive variables with the treatment (or treatments) of concern being hierarchically eliminated from other variables as controls. Thus the use of the SBC was contrasted with the use of RCS not because of any special properties ascribed to the C$, rather because it required recording responses.

The generality of findings based upon academic behavior sampled in classrooms is not as questionable as taking a small sample of behavior in clinical settings. For a good number of cases, the academic behavior is under the stimulus control of the classroom. The behaviors observed in the clinic can usually occur all day long. Thus the design was thought adequate to assess the production of self-control through daily self-generated feedback.

Results

The three sets of data were analyzed independantly in a 3 X 3 X 7 analysis of variance (n = 2 for accounting work rate, n = 3 for gross and error typing rates) on the mean rates during each phase for each subject. In order to accomodate the effects of using a logarithmic scale as a feedback device, a $\log_{10}$ transformation was performed on the raw data. Due to data loss by student absenteeism, one drop-out, and even one case of a student complaining about her difficulty performing the operations necessary to use the feedback devices, a least squares solution was used to predict the missing scores before the final ANOVA was run. All statistical analysis were tested at $p < .05$ difference according to Kirk (1968, 283-294). Scheffe's comparisons were performed at the same level for simple main effects.

The analysis for the accounting work rates showed significant differences for the main effects of Ability, Treatments (B), and Treatment X Order (B X A) interaction as in Table 1. The means for Ability ranked

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Insert Table 1 about here

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in the expected order of high ability highest, average ability next, and low ability last. Since the treatments themselves were of primary

concern, Scheffe's comparisons (at $p < .05$) were run for the main effects of Treatments and treatments within different orders. This procedure indicated no differences between treatments and pretreatment baselines for either level of analysis. Ranking the means of all phases and making all pair-wise comparisons showed that the last posttreatment baseline was significantly larger than the other phase means for the main effects, the first and third orders only approached significance. It seems obvious that where the main effect of Treatment differed under mean comparisons, their effects were highly masked by the Treatment X Order variable. For the simple effects, a tentative explanation would be that this acceleration is more likely to be observed following a phase in which recording on a new form is used than after a phase in which an old recording type is used. With respect to the continuous feedback through almost immediate knowledge of results provided by the teacher and answer sheets, the self-generated feedback did not implement accelerations significantly beyond those occurring through other available sources. With respect to the last posttreatment baseline, the superiority of the occurrence of final examinations and termination of the school year to serve as accelerators was far more significant than any source of feedback in this class environment. This last point is clarified with the analysis for words per minute data.

Table 2 indicates significant differences within the gross works per minute data for the same main effects as the accounting work rates.

Insert Table 2 about here

The means for Ability ranked in the same order as the previous data.

Pair-wise comparisons for the main effect of Treatment indicated that the recording for all types during treatment phases produced accelerations beyond all pretreatment baselines and that the last posttreatment phase mean exceeded the other, six, phase means. There was no difference between recording in treatment phases (b2, b4, b6) and their respective posttreatment baselines (b3, b5, b7). An anaysis of the simple effects within the Treatment X Order interaction and pair-wise comparisons for treatment within each order were performed. It was again obvious that the effects of treatments were masked by the order with the possible exception of one comparison. A comparison of treatment means (b2, b4, b6) with pretreatment means (b1, b3, b5) indicated significant accelerations for all recording types during treatment phases within the first and third orders. Perhaps the second order failed to achieve significance because the b2 mean fell so close to the end of the semester and by that time any novelty due to the presence of the experimenter was gone. A comparison of the last posttreatment baseline with all other phase means indicated significant accelerations for the mean within the first two orders. This last baseline terminated as before with final examinations and the end of the school year. It was thought that the presence of the SBC occurring before b7 for the third order accounted for the failure to achieve significance. These comparisons of SBC recording (b6) was contrasted with other recording types within treatment phases (b2 and b4) for all orders. None of these comparisons, however, achieved significance.

Table 3 sheds some light on this interaction. There is a positive acceleration of cell means with only two exceptions occurring as noted.

Insert Table 3 about here

The rank order is almost precisely the same as the original temporal sequence of phases. Using the data from Table 3 and mean comparisons for simple main effects, it is suggested that data points are positively accelerating with the only exceptions occurring where one of the three treatments is in effect. Thus the treatments are functionally related to major upward movements over baselines with the accelerations slowing during each posttreatment baseline. Without regard to treatment order, however, the last posttreatment baseline represented an acceleration, in general, which exceeded all other phase means.

The analysis of the error rate data in Table 4 indicated only the Treatment X Order Interaction as significant. None of mean comparisons, as performed in the other sets of data, for treatments within the different orders indicated significant differences. Considering the gross typing rate and error rate data together, it appears that as typing rates increased there was an increase in error rate, but not to a commensurate extent.

Insert Table 4 about here

As a demonstration of reliability for self-recorded data reliability, the error rate components (i.e., number of errors found by the typist and the number of errors found by the proofreader) were analyzed for the ninth grade typing class and the aides who rotated the responsibility of checking the papers. A technique suggested by Winer (1962, 124-128) was used to compare frequency of student error and the frequency of proofreader-identified error. Five days were randomly sampled and the analysis yielded the following coefficients for those days: .94 for the

first day, .90 for the tenth day, .96 for the twenty-seventh day, .82 for the fifty-second day, and .96 for the sixty-third day. These reliabilities were felt high enough to demonstrate accurate recording.

Discussion

The implications of this research are twofold: first, with regard to future educational research and, second, with regard to classroom practices. The impetus for this study came from and was in part planned and conducted by four high school teachers. Their active participation during workshops and in the initial planning insured a maximum of benefits for each student during the course of the study and at the same time permitted the conduct of this research from escaping the ubiquitous demands of running a classroom on a daily basis. While communications problems still existed, many difficulties listed in an earlier section could have been remedied either by working with fewer classrooms or by soliciting colleagues of the experimenter to instruct the classes in the use of the recording forms. Research conducted in this fashion has value for those most involved in the educational process--teachers and students. All of the teachers involved in this study noticed positive changes in their students and thus planned to continue self-monitoring in their future classes. Furthermore, the teachers have expressed interest in doing further research in their classes. Thus their participation will prove mutually rewarding to both researcher and teacher.

With regard to educational research, a few remarks seem noteworthy because of events which failed to occur. First, West (1969, p. 289), after a review of much research on the point, concluded that intensive practices of timed typing incurs high error rates. This result was not replicated under daily timed typings over a period of twelve weeks.

Perhaps the simultaneous self-monitoring of both words per minute and error rates accounted for the results.

Second, reviews of prior research have limited the demonstrated effectiveness of behavior modification to low ability and special education classrooms. Rosenfold (1972) reported a study in which money was employed as a reinforcement for sixth grade students having a high I.Q.(above 110 on the Lorge Thorndike) and money reinforcement plus stars on a publicly located paper for average and high I.Q.'s (106 or better) showed significant achievement gains. Rosenfold's findings, which ran counter to prior research, are replicated here because no significant Treatment X Ability interaction occurred.

As for the finding of persistent self-recording effects lasting after this recording is terminated (Leitenberg, et. al., 1968; McFall, 1970), both the data which did not reveal effects different from baselines (the accounting work rate and error rate) and the data which did reveal effects that were confounded with other reactive variables (words per minute data) indicated no lasting effects. In realationship to the administratively scheduled events of exams and the termination of the school year, the effects of self-monitoring were shown to be evaporable.

As for the suggestion that self-recording serves as a poor control device prior to behavior modification (Kanfer,1970), the self-monitored data in the form of behavior frequencies yielded the same ability stratification as that given by teachers prior to the study. Thus the stratification served as a proximate control for self-monitoring. The question of whether a teacher, working by herself, could produce self-control using these procedures remains open. An answer would entail surreptitious recording of student behavior frequencies before self-

monitoring was commenced. This recording would serve as a baseline for self-monitoring. The ability stratification used in this study was not precise enough to provide this information.

The implications for classroom practices are directly related to the analysis of the data. Even when the treatments proved effective over pretreatment baselines, the effects of these treatments did not effect the acceleration of rates obtained at the end of the school year. While a qualified demonstration of self-control was achieved, this control passed to the occurrence of administratively scheduled events. This finding suggests that, when possible, testing or the deadline for large projects should be intermittently scheduled to insure the longevity of student self-control. Weighting daily work more and terminal work rates less might have the same effects.

Another finding which holds implications was the fact that rate measures may be used to achieve ability grouping. While this measure has been used for such purposes in typing class prior to this research, the replication of this finding with a pinpoint as hetergeneously mixed as the accounting work rate lends generality to the practice. Further study with other types of curricula is necessary to insure this generalization.

The main conclusion to be drawn from the study is that the students did evidence self-control for some of the treatment conditions but not with regard to the last posttreatment baseline. The Standard Behavior Chart, while serving as an accelerator of performance rates, did no better than the other devices. In the accounting class, due to the presence of answer sheets and individual teacher help, the devices alone were no better than these other modes of feedback. The error rate data, which was gathered under delay conditions of one day before feedback,

confirms the superiority of immediate feedback for simple skill learning found by other researchers.

None of the treatment or baseline means were any better than the last posttreatment baseline. In graphic form, this behavior would, when plotted cumulatively represent a fixed interval scallop. Given the fact that the daily classwork played little part in grade determination and that this phase ended simultaneously with the end of the school year, this finding is in no way surprising. For educators who would make more of daily classwork, the grades for daily work should be weighted in proportion to a final examination with more frequent, terminal projects receiving equal weight as the final exam. Hopefully, this procedure would eliminate the accelerated performance prior to exam periods and the end of the school year. For the educational researcher working with treatments which are expected to generate only minimal control over student academic performance, this study would recommend the termination of experiments well in advance of the occurrence of the natural reinforcers in the school environment. Finally, by using the individual data from the charts, both teachers and experimenters could achieve an understanding of the students which is mutually helpful in evaluating student progress and the effects of some manipulation. The individual data revealed differences between drop-outs and high absentee students. Research making use of individual data will hopefully aid teachers to plan instruction according to individual needs and, at the same time, advance the science of education.

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TABLE L

ANOVA: ACCOUNTING WORK RATES

Source	df	MS	F
Order (A)	2	.0375	.160
at b1	1	0902	1.845
at b2	1	.0169	.346
at b3	1	.0916	1.873
at b4	1	.1665	3.404
at b5	1	.2439	4.99 *
at b6	1	.1127	2.304
at b7	1	.0905	1.851
Ability (C)	2	1.228	5.227 *
A X C	4	.0836	.356
Subj/ A X C	9	.2349	
Treatment (B)	6	.0645	3.59 **
at a1	6	.0641	3.58 **
at a2	6	.0314	1.75
at a3	6	.0918	5.12 **
A X B	12	.0614	3.42 **
B X C	12	.0271	1.51
A X B X C	24	.0256	1.43
B X Subj / A X C	39	.0179	

*p < .05

**p < .01

TABLE 2

ANOVA: WORDS PER MINUTE

Source	df	MS	F
Order (A)	2	.0375	.160
at b1	1	.1323	18.634 **
at b2	1	.0784	11.042 **
at b3	1	.0728	10.253 **
at b4	1	.0349	4.915 *
at b5	1	.0026	.366
at b6	1	.0017	.239
at b7	1	.0301	4.239 *
Ability (C)	2	.5918	13.035 **
A X C	4	.0849	1.870
Subj/ A X C	18	.0454	
Treatment (B)	6	.0092	13.578 **
at a1	6	.0174	25.83 **
at a2	6	.0106	15.82 **
at a3	6	.0099	14.77 **
A X B	12	.0144	21.405 **
B X C	12	.0009	1.343
A X B X C	24	.0011	1.617
B X Subj/ A X C	95	.0007	

*P $\leq$ .05
**P $\leq$ .01

TABLE 3

RANK ORDER FROM LOWEST TO HIGHEST
OF CELL MEANS WORDS PER
MINUTE DATA BY TREATMENT ORDER
WITH RAW SCORE MEANS IN PATENTHESES

ORDER	1st	2nd	3rd	4th	5th	6th	7th
First	1.4317 (27.01)	1.4775 (30.02)	1.5073 (32.16)	1.5295 (33.85)	1.5343 (34.22)	1.5515* (35.60)	1.5523* (35.67)
Second	1.5225 (33.30)	1.5481 (35.33)	1.5754 (37.62)	1.5814 (38.14)	1.6035 (40.13)	1.6085 (40.60)	1.6171 (41.41)
Third	1.4506 (28.22)	1.4950 (31.26)	1.5222 (33.28)	1.5296 (33.85)	1.5310 (33.96)	1.5423** (34.86)	1.5433** (34.94)

*These two phases are the only two in reverse order from their original temporal sequence for the first treatment order.

**These two phases are the only two in reverse order from their original temporal sequence for the third treatment order.

TABLE 4

ANOVA: ERROR RATE

Source	df	MS	F
Order (A)	2	.1563	.583
at b1	1	.0740	1.409
at b2	1	.0986	1.878
at b3	1	.1147	2.756
at b4	1	.0154	.293
at b5	1	.2934	5.589 **
at b6	1	.0374	.712
at b7	1	.1826	3.478
Ability (C)	2	.3628	1.352
A X C	4	.4509	1.681
Subj/ A X C	18	.2682	
Treatment (B)	6	.0089	.543
at a1	6	.0264	1.60
at a2	6	.0376	2.27 *
at b3	6	.0338	2.05
A X B	12	.0445	2.692 **
B X C	12	.0146	.883
A X B X C	24	.0142	.859
B X Subj/ A X C	95	.0165	

*$P \leq .05$

**$P \leq .01$