SYSTEMATIC REINFORCEMENT: ACADEMIC PERFORMANCE OF UNDERACHIEVING STUDENTS[1]

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The effect of contingent tangible and social reinforcement on academic performance was investigated in an experimental classroom of 25 selected underachieving students. Measures were taken of both teacher and child behavior during a baseline and two experimental treatment periods. During Treatment I, a point system with tangible backup reinforcers was combined with contingent social reinforcers dispensed by the teaching staff to assess the effects on three measures of academic performance (i.e., per cent of time at work, work output per minute, and accuracy). During Treatment II, the contingencies for the tangible reinforcers were terminated while social reinforcement was continued to see if the positive effects of Treatment I on academic performance would persist. The results show that with combined tangible and social reinforcers, students' work time, rate of output per hour, and accuracy in all activities substantially increased. After termination of the tangible reinforcers, the students maintained their high rates of ouput per hour and accuracy for the remaining period of the study while the total amount of time at work returned to the baseline level.

A review of more than 30 previous studies, using some form of systematic reinforcement on two or more relatively "normal" (i.e., not emotionally disturbed) students in a fairly large classroom, reveals that only seven have dealt in some way with the task of elevating academic performance. Three studies used various types of social reinforcement such as teacher attention, approval, free-play time, and field trips to increase the per cent of time spent in appropriate study behavior. Wasik, Senn, Welch, and Cooper (1969), using teacher attention and approval, substantially raised the per cent of appropriate classroom responses of two disruptive, second-grade, minority group girls from disadvantaged circumstances in a class of 20 students. Bushell, Wrobal, and Michaelis (1968) and Hall,

Panyan, Rabon, and Broden (1968) produced substantial increases in study time with larger groups of 12 and 30 elementary students, respectively.

Four studies dealt with very aggressive, disruptive, or withdrawn students of varied ages and backgrounds and used token systems and tangible backup reinforcers to achieve an effect on rates of academic responses such as reading, arithmetic, etc. For example, Wolf, Giles, and Hall (1968) compared 15 sixth grade underachievers (i.e., averaged 2 yr below their norm for reading) living under urban poverty conditions, to a matched control group, on academic gains in reading, grades, and achievement test scores. The experimental group made significant gains in report card grades during the year (p < 0.005) and in Stanford Achievement Test scores (p < 0.01), as well as in their reading, math, etc. Martin, Burksholder, Rosenthal, Tharp, and Thorne (1968) tested the differential effects of varied reinforcement systems with nine highly disruptive, underachieving adolescents ranging in age from 13 to 18 yr and substantially increased their per cent of time actually at work.

One criticism of the studies cited above is that they have dealt with and reported on global percentages of time spent in appropriate behavior, grades, and achievement level, but in the process they have neglected to get

closer to more basic questions of academic performance such as: (1) Do reinforcement procedures raise the amount of students' time spent working, without accelerating efficiency (*i.e.*, problems solved per hour) or accuracy (*i.e.*, per cent correct answers), or do they raise all three in varying degrees? With these questions in mind, the specific objective of the present study was to test the effects of systematic reinforcement on the following measures of academic performance:

(1) Total work time (per cent of assigned classroom time student engaged in academic activities).

(2) Efficiency of academic activities (number of problems solved or units of work completed per unit of time).

(3) Accuracy of academic work (per cent of correct answers).

METHODS

Subjects

Elementary school teachers from three school districts were asked during the last weeks of the regular school year to identify children in their classes who were clearly underachieving for various reasons and thus would benefit from a summer education program. From the list of nominations, 30 minority children (blacks and Mexican-Americans) between the ages of 8 and 12 yr were selected. Because of migration of their family to other towns, five Mexican-American children dropped out at various stages of the study, leaving 25 subjects on which complete data were collected. The racial composition of the group included 11 blacks and 14 Mexican-Americans. The average age of the subjects was 10.1 yr and included 19 males and 11 females. The educational achievement of the parents was quite low: the average education of mothers was 7.0 yr and that of fathers 7.2 yr. The average family income was $3800 per year. Surprisingly, 40% of the children came from homes broken by separation, divorce, or death, which may have contributed to the group's educational problems.

The average achievement level of the group on the California Achievement Test fell 1.5 yr below the norm for the appropriate age. The overall mean grade point average for the preceding year was 1.47 (D), which also indicates significant underachievement.

The Setting

The experimental class was conducted in a modern, bright, air-conditioned school building. Observers watched from a large booth adjoining the classroom through a one-way mirror. Several microphones were located on the ceiling of the classroom so that observers could hear the verbal responses of the students and teachers, including whispered phrases. Classes were conducted from 9 a.m. to 3 p.m., five days a week, and included two 20-min recesses and 1 hr for lunch. To insure regular attendance in school, transportation was provided for students.

Experimental Conditions

The study lasted for 11 weeks, during the summer, which were divided into three periods: a three-week Baseline; a six-week experimental period labelled Treatment I, and finally, a second two-week experimental period, labelled Treatment II.

During the initial three-week Baseline (15 school days) the classroom was conducted in a conventional manner by a certified female teacher who directed the class and two male teaching aides. One of the aides was a certified teacher with several years experience with minority students and the other was a graduate student. The teacher and aides were instructed to respond to the children with commands, praise, disapproval, threats, removal, and paddling, as they saw fit, using the "normal classroom" as a model. The children received lunch, candy, toys, *etc.* from the school "store", without contingencies, at a rate comparable to that planned for the experimental periods. The students' rates of response (work, efficiency, and accuracy) to various types of academic tasks were recorded. The rates of approving, disapproving, and instructional responses for the teacher and aides were also continuously recorded.

Treatment I

The reinforcement program, involving a combination of social reinforcers from the teacher and aides and tangible backup reinforcers for points earned in classwork was put into effect during the six weeks of Treatment I. A point system, nearly identical to that used

by Wolf, Giles, and Hall (1968), was chosen as currency to "pay" students for work done instead of tokens due to ease of handling and control over losses, theft, trading, *etc.* Each child was given a booklet with his name on it, containing three sets of pages of differing colors, each page containing 50 squares. When a child earned points, the teacher or other staff checked the appropriate number of squares in the booklet. Two types of behavior were reinforced with points, academic work (*i.e.,* reading, arithmetic workbooks, *etc.*) and appropriate personal and social classroom behavior related to academic performance (*i.e.,* remaining seated, raising hand for teacher's attention, working alone without talking or striking neighbors). When an assignment was completed it was collected, graded by the staff, and points were assigned on a schedule using a weighted formula emphasizing accuracy of work (weight = 67%) and speed (weight = 33%). This procedure permitted relatively rapid feedback to the students concerning their academic performance.

Points were passed out contingently for the following types of personal and social behaviors as they occurred in the classroom: (1) 20 points for getting down to work quickly without disturbing others; (2) 20 points for working continuously for 10 to 20 min; (3) 10 points for working while a fight or loud noises were occurring nearby; (4) five points for raising the hand for attention; (5) five points for obtaining permission before leaving one's desk. With minor misbehaviors, such as talking to neighbors or calling loudly for the teacher, the child was first redirected into appropriate responses, given a warning of the consequences if inappropriate conduct persisted and finally if misbehavior continued, 10 to 50 points, depending on the seriousness of the behavior, were withdrawn from his book.

In a few instances when a child became aroused over a fight or verbal insults and continued to disrupt the class even after two sets of points were extracted from his book, he was removed from the situation without dramatics and placed in social isolation in the "timeout room". Release from this room could be achieved only by completing a math assignment with no point given. Plans had been made to take students home if they refused to finish the assignment in the timeout room but this contingency was never required.

To redeem their points the students were offered the following backup reinforcers:

(A) Green points: lunch. The first 25 points earned each morning were placed on a green page to pay for lunch. During the 11-week study none of the students ever failed to earn lunch. After lunch was earned, the students were able to choose which of the following two categories to have their points recorded in.

(B) Yellow points: school store items. These items from the store included candy, gum, toys, school supplies, goldfish, a few clothes, jewelry, makeup kits, baseballs, games of all kinds, *etc.*

(C) Red points: field trips. These weekly trips occurred on Friday afternoon and included fishing, boating, swimming parties, a trip to a farm, bank, hospital, and pet shop.

At the conclusion of the school day, the students' names were randomly drawn from a box and, in this order, went to the school store to redeem their points with tangible reinforcers. In order to maximize the pairing of teacher approval with material reinforcers, the teacher was assigned to the store and as she exchanged toys for points she expressed her approval to the child and urged continued academic performance.

Finally, the teacher and aides systematically applied social reinforcers to the students in the form of warm praise and support for study behavior and for the appropriate social behavior for which points were earned and/or disapproval for misbehavior. Staff social reinforcers were counted by an observer using the categories described later. The three components of the dependent variable, academic performance, were measured as during Treatment I, and the resultant rates were compared to those obtained during the Baseline to assess the effects of the experimental treatment.

Treatment II

To assess the potential long-range effects of the reinforcement system on rates of academic behavior, the point system was terminated during the last two weeks while the rate of teacher-mediated social reinforcement was continued. The children received candy, toys, lunch, *etc.* without contingencies as in the Baseline, while the systematic use of social reinforcement ap-

plied during Treatment I, was continued unchanged. This procedure was instituted to find out whether social reinforcement alone could maintain the academic performance of problem children who had been treated with six weeks of contingent tangible reinforcers, personally distributed by the teacher.

Measurement of Variables

1. Per cent of time at work. Two electric clocks, controlled by switches mounted on a panel, were assigned to each student. When the teacher gave a particular student an assignment, his "total-time" clock was turned on and remained on until the student completed the assignment or the teacher asked for it. When the student was actually engaged in working on the task, his "work-time" clock was turned on. Any interruptions in work such as talking to peers, fighting, running around the room, sleeping, *etc.*, resulted in the work clock being turned off while the total-time remained in motion. The most difficult timing decision was when the student stopped working to stare out of the window as if he were thinking about the task. A 1-min period was allowed for the child to return to the task before the clock was stopped. If it became obvious during this 1-min period that the student was responding to outside stimuli, and not working on the task, then the work clock was turned off. Five observers were assigned to the clocking task so that each had five or six children to watch. Observers were trained and periodically (one day each week) checked for reliability. The level of reliability varied from 74 percent to 97 percent with the averaging being 86 percent. These timing procedures allowed the computation of the percent of time that the student actually worked on any given assignment (work time/total time).

2. Rate of work output. The second measure of academic performance used was the rate of work output per unit of time. The numbers of various types of exercises and workbook problems completed per session were counted and the total divided by the number of minutes required. The goal here was to find out whether academic underachievers not only would work longer under contingent reinforcement, but would actually complete more reading, spelling, arithmetic, *etc.* exercises per unit of time as well. The number of units of each activity were recorded for each student for each day.

The nature of the unit varied considerably from simple math problems mimeographed by the teacher or contained in the math workbook, to reading a paragraph and answering questions about the reading, to the number of words written during a creative writing assignment. The crucial point is that the unit for each activity (*i.e.*, math workbook, reading comprehension, *etc.*) remained constant during the entire summer program. The difficulty of the exercises were gradually increased, over time, to control for increased performance due to the practice effect and maximize the learning progress of each student. The total number of problems completed on each activity was recorded and was then divided by the number of minutes the student worked on the activity that day.

3. Accuracy of work output. The third measure of academic performance employed was the accuracy of work completed (*i.e.*, the per cent of problems attempted that were done correctly). It became obvious that an increased rate of work done under the reinforcement program would be meaningless if most of the additional output was inaccurately executed.

4. The California Achievement Test. The students were administered the appropriate version of the California Achievement Test (CAT) during the first week of school. An alternative form of the same test was administered during the last week of school to assess what differences occurred during the summer program.

5. Teaching staff behavior. One observer was assigned the task of categorizing and recording the behavior of the teacher and aides, (using a modified version of the system reported by Thomas, Becker, and Armstrong, 1968), into three general classes: (1) Approving behavior; (2) Disapproving behavior; and (3) Instructional behavior. Approving and disapproving behaviors were recorded only when they followed discriminable child behaviors falling into appropriate or disruptive categories. Approving behaviors were directed at individuals, not the group as a whole, and included verbal support, praise and affection mixed with physical contact (*i.e.*, pats on the back, *etc.*) and smiles. Disapproving behaviors similarly incorporated negative remarks, scolding, sarcasm, and threats to individuals of loss of privileges, points, *etc.* Negative, disapprov-

ing physical contacts were counted when a child was forcefully guided or hauled back to his chair, out of a fight, or out of the room. Disapproving facial gestures were not recorded. Finally, three forms of instructional behavior were recorded: requests, commands, and rules stated to individuals, small groups, or the whole class. Simultaneous measures of teaching staff behavior were made by a second observer one day each week throughout the study. Reliability—computed by dividing the smaller count by the larger count for each category at the end of the observation—averaged .92 for all categories combined and ranged between .83 and .99 on individual observations of each behavior.

RESULTS AND DISCUSSIONS

Academic Performance

The first indicator of the overall effect of the reinforcement program on academic performance is the per cent of total available time that students actually worked (*i.e.,* "per cent of work time"), and is portrayed graphically in Figure 1. During the Baseline, the average amount of total time spent working was 39%. As. shown in Figure 1, the reinforcement program used during Treatment I produced an immediate upward shift in academic activity starting with the first day, resulting in a 57% average.

Terminating the point system at the beginning of Treatment II produced a drop in academic activity to 42%, which approaches the original Baseline rate.

An examination of Figure 1 reveals a trend of decreasing work time during the Baseline and also during Treatment I. Trend analysis was performed to ascertain if these two trends were significant.[2] The Baseline period produced a highly significant ($F = 89.3$; $p < 0.001$) downward trend, which indicates that the rate of work time had not reached a stable mean level. This finding suggests that if the "normal classroom" procedures had been continued longer, the level of work time would have dropped significantly lower than the 39% obtained during the three-week Baseline. Treatment I also evidenced a significant ($F = 20.2$;

p < 0.001) decreasing trend, although it was not as rapid as that in the Baseline. A visual examination of Figure 1 for Treatment I suggests that about the middle of the period, the work time leveled off. To test this observation, trend analysis was performed on the final 15 days (15 through 29) of Treatment I; the results ($F = 0.06$) are not significant. This finding indicates that for the last three weeks of Treatment I, work time varied around a consistent mean level. Finally, the data in Treatment II do not evidence a significant trend of any kind. The results in Figure 1 and Table 1 thus provide strong support for the positive hypothesized effect of the combined reinforcement system on the amount of student work time but they also indicate that a six-week reinforcement period was not sufficient to obtain a continual effect after the tangible reinforcers were terminated.

The second measure of academic performance, rate of work output (*i.e.,* the total number of problems completed divided by the number of minutes at work), was included in the study to find out whether the reinforcement system could raise not only the length of time worked but also the actual number of problems and exercises completed per unit of time. The results in Figure 1 and Table 1 indicate that for all seven types of academic activity, the rate of problem completion increased significantly during Treatment I. The range of percentage increase in output, comparing Treatment I to the Baseline, varies from 83% (math worksheets) to 410% (SRA Reading Laboratory exercises). It is clear that the sample of underachieving students accelerated output to an impressive degree during exposure to the tangible and social reinforcement system.

There appears in Figure 1 (middle), a trend of increasing output during Treatment I which is significant ($F = 77.8$; $p < 0.001$). This means that during the reinforcement program, the level of student efficiency in the seven academic subjects was significantly increasing. The data for Treatment II did not produce any significant trends which supports the contention that after the termination of the tangible reinforcers, efficiency continued at a level comparable to that obtained at the end of Treatment I, although the increasing trend in Treatment I did *not* continue in Treatment II.

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[2]For a discussion of the trend analysis techniques used in the paper, see: Lewis, 1960, pp. 334-420; Hays, 1963, pp. 539-566; and Bruning and Kintz, 1968, pp. 123-149.
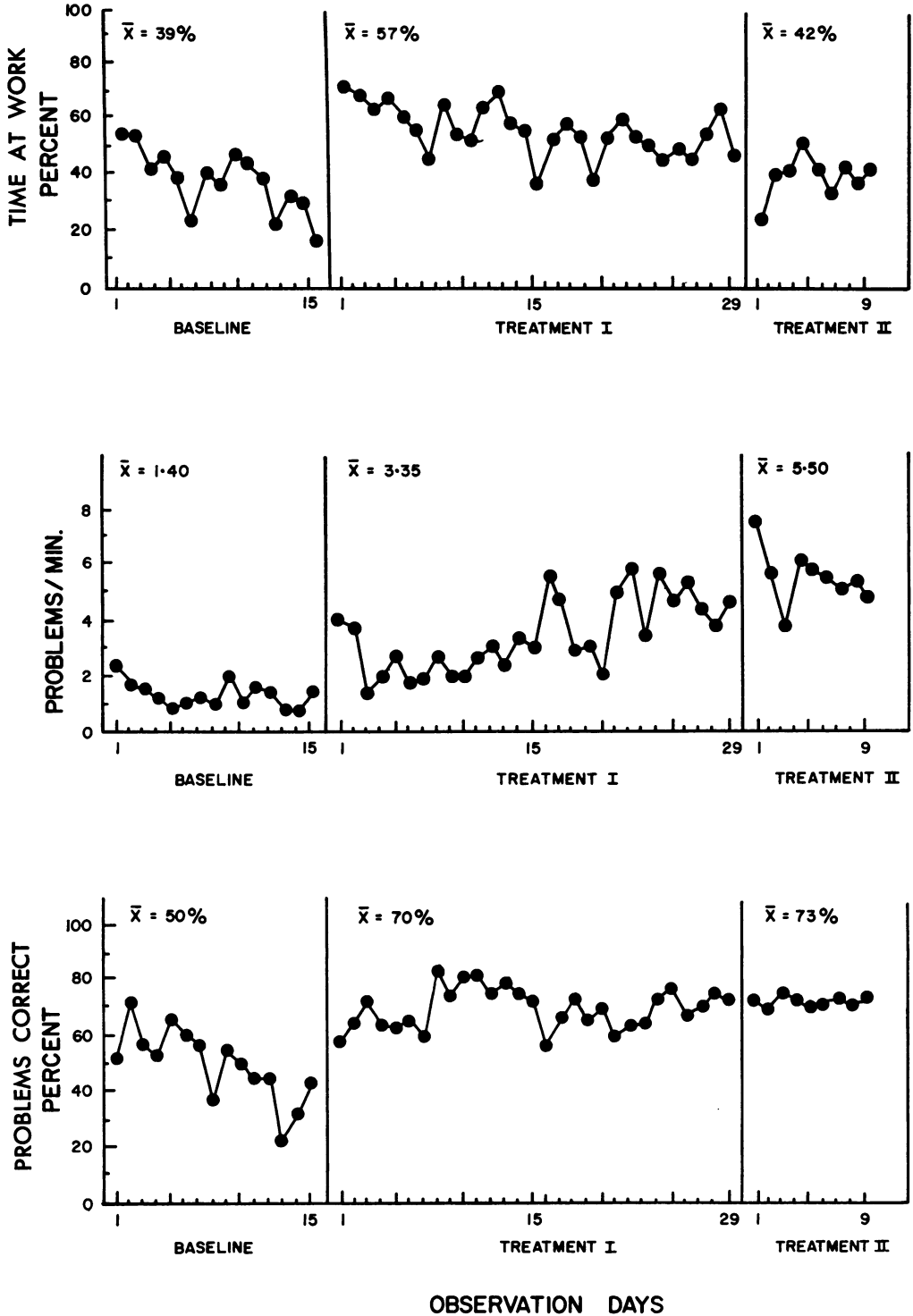
OBSERVATION DAYS

Fig. 1. (Top) Per cent of time at work: the number of minutes spent actually working on assignments divided by the total time assigned to the task. (Middle) Rate of work output: the number of exercises and problems done divided by the number of minutes. (Bottom) Accuracy of output: the number of problems and exercises done correctly divided by the total attempted.

Table 1

Rate of Work Output in Seven Academic Subjects: Comparison of Means, Significance
Tests, and Explained Variation for the Baseline and Treatment I Periods

| | Baseline versus Treatment I | | | | | |
| | Mean Problems Attempted/Min. | | | | | |
Academic Activity	Baseline	Treatment I	Percent Increase	t	P	ω^2
SRA Reading Workbook	0.97	2.90	189	4.24	0.001	0.25
SRA Spelling Lab.	0.90	2.34	160	6.20	0.001	0.42
SRA Reading Lab.	0.28	1.43	410	8.30	0.001	0.56
Merrill Workbook	1.37	2.70	97	5.25	0.001	0.34
Spelling Workbook	0.80	1.72	115	5.65	0.001	0.37
Math Workbook	2.01	6.19	208	6.15	0.001	0.41
Math Worksheets	2.65	4.84	83	6.94	0.001	0.49

The third measure of academic performance was accuracy of problem solving. The shifts in accuracy during the experimental periods for each academic subject are reported in Table 2 and illustrated in Figure 1 (bottom). The SRA Spelling Laboratory is omitted from this analysis because the students corrected their own work on this task and cheating and inaccuracies were quite possible. Performance on spelling tests was collected as a substitute. In these spelling tests, the teacher pronounced the word to be spelled and used it in a sentence. The children then spelled the word. Since the rate of words spelled was controlled by the teacher, this activity was not analyzed or reported in Table 2.

As manifested in Table 2, the combined reinforcement program in Treatment I was correlated with an increase in student accuracy over Baseline rates on all seven types of academic activity.

Comparing the effects of the experimental condition minus the tangible reinforcement (Treatment II) with the total reinforcement program (Treatment I) shows that the students maintained their high level of accuracy in all of the activities except the SRA Reading Workbook. The accuracy levels varied slightly between the two Treatment periods, but with the exception of SRA Reading Workbook, all of the differences were nonsignificant.

Trend analysis of the data concerning accuracy of work for the three experimental conditions revealed only one significant trend. The Baseline evidenced a significant downward trend ($F = 45.9$; $p < 0.001$) in level of accuracy. Again, it is not possible to ascertain how much lower the average level of accuracy

Table 2

Accuracy of Work in Seven Academic Subjects: Comparisons of Means, Significance Tests,
and Explained Variation for the Baseline and Treatment I Periods.

| | Baseline versus Treatment I Period | | | | | |
| | Mean Percent: No. Correct/Total | | | | | |
Academic Activity	Baseline	Treatment I	Percent Increase	t	P	ω^2
SRA Reading Workbook	32.4	62.2	92	4.90	0.001	0.29
SRA Reading Lab.	30.9	64.9	110	7.38	0.001	0.51
Merrill Workbook	53.3	68.2	28	3.65	0.001	0.18
Spelling Workbook	52.0	68.0	31	4.86	0.001	0.30
Math Workbook	51.6	72.9	41	4.91	0.001	0.30
Math Worksheets	58.7	75.1	28	4.88	0.001	0.29
Spelling Tests	46.7	71.9	54	6.12	0.001	0.39

would have dropped if the Baseline period would have been longer, but it is safe to assume that it would have been lower than the 50% recorded for the three-week Baseline period. This finding provides additional support for the significance of the improvement in accuracy observed during the reinforcement program.

The results concerning the three indicators of performance, work time, rate of output and accuracy, together provide support for the predicted effects of contingent reinforcement on the academic performance of underachieving minority children. They worked *longer, faster,* and more *accurately* during the tangible and social reinforcement system designed for this study.

The final indicator of academic performance utilized California Achievement Test scores. The pre-experimental average grade placement score was 3.60 years which increased during the program to 4.02. All but one child improved their performance and the average improvement was .42 years in grade placement during the 11 weeks of this summer program.

Teacher Behavior

The behavior of the teacher and aides as they attempted to control and direct the classroom were carefully recorded. During Baseline, the staff averaged 13 approving, supportive responses per hour; 27 disapproving responses per hour; and 55 instructional responses per hour. The averages shifted as predicted during Treatment I as approvals increased to 47 per hour, disapprovals dropped drastically to seven per hour, and instructions (requests, commands, etc.) dropped to 17 per hour.

When the point contingencies were terminated at the end of Treatment I, the average number of approving responses dropped from 47 per hour in Treatment I to 27 per hour during Treatment II. Social control was maintained during the Treatment II period with only a slight increase in the rate of disapproving responses (*i.e.,* a shift from seven per hour to nine per hour) while instructional remarks remained essentially unchanged (16 per hour).

Several significant findings emerge from this study. The first is that a limited teaching staff was able to raise substantially the level of academic performance of an entire class (25 students) of seriously underachieving students. One important consequence of this increase in academic behavior was a significant improvement in academic skills and curriculum material learned as indicated by achievement test scores. The results suggest that if these under-achieving students had been able to participate in the experimental program for a year they could have advanced academic skills and achievement up to a level comparable to their peers in the regular classroom.

Another significant finding was the shift in teacher behavior from social control responses to supportive and instructional responses during the reinforcement program. In the experimental period, the teacher and aides were able, for the first time, to give instructions for new tasks, explain intellectual concepts and ideas, and present curriculum material without having to shout over general noise and without numerous interruptions. The students' change in behavior allowed the staff to shift from control over misbehavior to teaching functions. In fact, during the experimental period the teacher and two aides were hard pressed to respond to the flood of student requests for assistance with long division problems, word meanings, spelling, *etc.*

A final finding to note is the "carry-over" effect or continuation of improved academic performance after the tangible reinforcers were terminated. Even though the total work time dropped in Treatment II to a level comparable to the Baseline, accuracy and efficiency were maintained at a level equal to Treatment I, after the tangible reinforcement was terminated. A number of explanations for these results may be suggested, and further studies utilizing more complete research designs will be needed to test them. First, perhaps the six weeks of reasonable pleasant interaction with the teaching staff and the reinforcers associated with their approval during Treatment I elevated the reinforcing quality of teacher praise, which in turn was able to maintain performance at a relatively high level. Also, the experience of operating successfully at a high performance level, may have resulted in the work becoming self-reinforcing and thus self-maintaining at a high level. Finally, perhaps improved academic skills alone, developed during the first nine weeks had a carry-over effect during Treatment II. Whether one or all three of these effects are operating, it is clear that the efficiency and accuracy of work was maintained under the program of social rein-

forcers in Treatment II. It is anticipated that such improvement will assist the student to achieve at a higher level when returned to a regular classroom.

A final comment is in order regarding the practical implications of the findings described above for school districts with a significant number of underachieving students. It appears to be possible, and perhaps more effective and less costly than present arrangements, to form separate classrooms of problem children where high-interest curricula and valued tangible reinforcers are used to improve student academic performance and skill levels so that they eventually can succeed adequately in the regular classroom with its more symbolic and social reinforcement systems.

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