TRAINING FOREMEN IN WORK STANDARDS

results of an experiment in programmed instruction

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The "revolution in training"[1] that has taken place since B.F. Skinner[2] gained prominence as the founder of programmed instruction about ten years ago has placed industrial education and training in the United States in a new light. In fact, Dunnette and Bass have recently stated this revolution is having widespread repercussions:

> The emphasis on motivation in programmed instruction and its use of important principles of learning, such as reinforcement, immediate knowledge of results, and attention to individual differences help to explain its role in providing a critical breakthrough for behavioral science in industry.

This statement probably errs in the direction of over-optimism regarding industrial management's acceptance of this educational innovation, but it is suggestive of the excitement today surrounding programmed instruction (PI) and educational technology.

PI IN INDUSTRY

Research results are now starting to be published indicating the value of programmed instruction as contrasted with conventional methods of instructing adults in industry. For example, in one industrial study at IBM it was found that there was a significant difference in only one of three measures of achievement in a course on electricity made available in "automated" instructional form and in conventional instructor-classroom form, although the group trained by the programmed device completed the course in 18 per cent less time.[4] However, other non-industrial studies have also suggested that differences in achievement among matched groups trained by conventional and programmed techniques have been slight.[5] Savings in training time by using programmed instruction have repeatedly been claimed.[6] PI has been found useful in correspondence courses,[7] a productive training tool,[8] and well liked by users as a means for learning.[9] Finally, PI and conventional instruction have been viewed as equally worthwhile depending upon the needs of the learning group, their learning ability level, and their motivation to learn.[10]

In a recent review by Boocock of the literature pertaining to the psychology and sociology of learning, it was suggested that very little attention has been given to sociological variables related to what and how well students learn in the American school system.[11] We can assert with equal confidence that even less research has been conducted on adult learning in industrial training situations. This article reports on such a study that was small-scale and experimental. Both the experimental variable and the expected types of learning were carefully defined, considerations missing in many of the studies examined by Boocock.[12] However, seldom is experimental research perfect because practical concerns often force us to compromise downward from the ideal. The objectives, methods, and results of the training observed in this study were measured as well as possible within the scope of authority of the researchers. But in a dynamic industrial situation it is perhaps not possible to have as high a degree of experimental factor control as would be desirable.

PURPOSES OF THE STUDY

The study was initiated to evaluate the effectiveness of self-study with a 250-frame programmed text and a conventional text (essentially a printed textbook) as compared to the conference or classroom technique traditionally used to train foremen in industry. More specifically, the experiment was concerned with the following research questions:

- Do foremen given programmed instruction show a greater or lesser degree of improvement in knowledge of the subject-matter taught than foremen trained with conventional methods?
- Will the use of conventional materials (i.e., texts developed by training specialists employed by the organization which conducted the study, henceforth called the organization) made available to

foremen on a self-study basis produce the same or comparable results as programmed materials and the conventional conference method?

- What is the value of adding a discussion and summary to the use of programmed and text materials when used on a self-study basis by foremen?
- What is the relationship of the foreman's mental ability (as measured by the "personnel test for industry verbal test,"[13] a five-minute intelligence test, used to secure a crude measure of possible learning ability) to ability to use the self-study technique?
- What are attitudes toward the value and effectiveness of the different training methods among plant foremen?
- How much time would be required for completion by foremen of the programmed and conventional texts on a self-study basis?

A decision was made to begin the experiment at Plant X, one of three plants in a large firm, by using a supervisory training course entitled "Establishment of Work Standards." This "course" could normally be taught in four one-hour training conferences. Plant X was chosen because it was convenient for the researchers and management believed the foremen needed training in work standards.

An unknown number of the foremen participating in the study had been given an unknown number of hours of training on work standards since the company first started supervisory training in depth twenty years previously. This fact obviously contaminated our experiment.

The text material was programmed according to the Skinnerian or "linear" design, which involved filling in answers to questions in a progressive sequence of frames. The text was a "software" program — a "hardware" teaching machine was not used.

The initial experiment at Plant X provided an opportunity to field test the programmed text to determine the need for revisions. Further, the pilot run at Plant X would allow the researchers to review the adequacy of the design before extending its use to plants Y and Z. The latter plants were eventually included and chosen on the same basis as Plant X.

WORK STANDARDS

A work standard may be defined as a measurement of the amount of work that should be produced by a worker or group of workers in some set period of time.[14] In this study we were concerned with management-determined production standards, one type of work standard, which can be challenged by the union through the grievance procedure and result in a lawful strike against the organization during the life of the labor-management agreement or contract. As a result, the foreman has an important part in establishing and enforcing production standards, although industrial relations and industrial engineering personnel have made significant inroads in the foreman's responsibilities in this area.[15] Nevertheless, the behavior of a poorly-informed foreman could, if not forestalled by alert plant personnel, quickly shut down the plant if aggrieved union members walked out in protest against a perceived unfair standard. Because work standards strikes are permitted by the agreement, management considered it important that foremen be trained in the subject.

Also on occasion unions fabricate work standards grievances for "political" reasons to "clobber" management into "horse-trading" on matters of interest to the union. Since work standards are a strikeable issue, the union could use a disagreement on standards as an alibi for striking when the real issue was some other matter. Management could do little but denounce the union for irresponsible use of the grievance procedure.

All these considerations made training for foremen on work standards important, and over the years foremen had been given, as previously indicated, considerable conference-style training on the formal and more subtle informal aspects of work standards.

We have no way of knowing whether the experimental work standards courses, programmed and conventional, were of high quality educationally.[16] This is, of course, a tenuous consideration in any educational experiment. The programmed course was developed by a person with more than twenty-five years teaching in colleges and industry. It was revised by a person with about fifteen years of teaching and employment for several years as an industrial engineer. Both the developer and reviser were trained in programming through short courses at a university and through reading. The course materials were scrutinized during development by professional industrial engineers in a position to determine what foremen need to know about the subject.

Also, several foremen were asked to take the programmed course in an informal trial prior to the study at Plant X. Their suggestions were incorporated into the program used in that plant. All of these considerations should have contributed to the development of an educationally sound program but we cannot be certain.

EXPERIMENT AT PLANT X

Plant management and participating foremen at Plant X were oriented to the purposes of the study during a series of conferences held by the researchers. In addition, two tests were administered to 110 foremen. The first was the aforementioned PTI Verbal Test. This test provided a rough measure of their learning ability. The second test, called Test A, was a form of work standards subject-matter test developed by the organization in which the research was conducted. Test A served as a pre-test of the foremen's knowledge of the material.

On the basis of these two test scores, the researchers established four groups of sixteen foremen each. Groups of this size were considered manageable for training. Each group was carefully matched as to the average and range of scores on the two tests. Groups were also matched as to age and level of education completed. Fifty-odd foremen for whom we had test scores were not used as participants.

Each of the four groups was provided instruction using a different training method. The training was to be conducted by plant training personnel in the same manner as it would be carried out under normal operating conditions. Research personnel were present, however, to observe, assist and control where necessary. (This control was not foolproof, as explained subsequently.) The type of training received by each of the groups was as follows:

A-1 Four one-hour conference presentations as outlined in the conference leader's guide.

A-2 Conventional self-study text prepared for regular conference presentations with short question-and-answer sessions and a brief summary conference. Each individual proceeded at his own rate but was given no more than five hours' exposure to the materials.

B-1 Self-study using the newly programmed text with each individual proceeding at his own rate.

B-2 Self-study with a programmed text and a one-hour summary conference. Each individual proceeded at his own rate.

Thus, Group A-1 represented the traditional foremen training (i.e., by conferences) while A-2 duplicated the way in which foremen were trained in certain plants where there were generally not enough foremen to warrant a class. The B groups represented two possible variants in the programmed text method, with the A groups serving as controls.

GROUP COMPOSITION

Names (without their pre-test scores) of the foremen in each of the four groups were given to the plant training coordinator for establishing training schedules for the experiment. It became necessary to alter the composition of three of the groups due to vacations, production schedules, and other problems. Nevertheless, the groups were kept as closely matched as possible on the characteristics previously mentioned. Four persons dropped out prior to or during the first session for various reasons. Again, the match between groups was not seriously disturbed. But these were further compromised with ideal experimental conditions.

On completion of training, each group was administered an identical subject-matter test on work-standards, called Test B, a second or alternative form of the test used previous to training, and a brief questionnaire surveying the attitude of the participants toward (A) the value of material presented, and (B) the training method used for that group.

The results of these tests and questionnaires, as well as the time to complete training, and errors made in completing the programmed text were then analyzed by the research personnel. In this analysis, it was determined that as part of a conference used in training Groups A-1 and A-2 (but not for B-1 or B-2), a locally-prepared practice exercise had inadvertently been given to participants to complete in the conferences. This exercise was essentially another form of some of the problems used on the pre- and post-tests. In terms of the experimental design, the exercise might have biased the improvement in scores to an indeterminate extent.

Thus, while the intent of the post-test was to sample various conceivable types of specific questions on work standards as a means of testing the short-range learning of general concepts of work standards, the A-1 and A-2 Groups were being tested, at least in the problems, on their knowledge of how to solve specific problems. Since this exercise may have emphasized the specific form of problems in the test, we cannot interpret definitively the significance of the differences in score improvement between the A and B Groups. Our factor control for the differences between changes in subject-matter knowledge produced by each of the four methods was, therefore, somewhat more limited than anticipated.

RESULTS AT PLANT X

Examination of the data obtained produced three noteworthy results in spite of the bias that may have been introduced by the practice exercise:

A. *Subject-Matter Knowledge.* Comparisons of the figures in Table I show a marked improvement in the median D score of the B-2 Group as compared to the B-1 Group. This seems to indicate that the addition of the one-hour conference to the programmed text led to a substantial improvement.

Table I
PLANT X KNOWLEDGE IMPROVEMENT FIGURES

Group	Median Pre-Test	Range	Median Post-Test	Range	Median D Scores*
A-1	46	3 to 99	67.5	50 to 100	27
A-2	42	23 to 86	68	53 to 92	19
B-1	47	19 to 100	61	21 to 96	12
B-2	50	14 to 77	68.5	34 to 96	16.5

*"D" or Difference Score represents the number of points difference in raw score between the pre- and post-test computed on an individual basis.

Table II
PLANT X SUMMARY OF ATTITUDE SURVEY RESULTS BY TRAINING GROUPS

Results Item	Groups A-1	A-2	B-1	B-2
Value of Course	78	60	72	79
Effectiveness of Method	89	60	77	79

This result raises a question as to whether a programmed text can stand as self-sufficient. Unfortunately, meaningful comparisons between scores of the A Groups or between the A and B Groups cannot be made due to the possible problem of bias.

B. *Attitudes.* The figures in Table II are indices from the summary of data derived from the attitude questionnaire. (Indices were constructed by converting the responses to a 1-100 linear scale and averaging. There were four possible responses to an item question with the responses weighted on a scale of one through four. The weight of the items was multiplied by the percentage of the group responding to each item and the resulting figures totaled.) They are used here to compare the group reactions to the four methods of training in regard to the value of the course and the effectiveness of the training method.

The addition of the one-hour summary and conference to the programmed text improved the conferees' perception of the value of the material. The conventional text used on a self-study basis was rated fairly low on value of the course and method of presentation when compared to the method employed with the other groups. The regular conference was rated about the same as the programmed text/conference method on value but considerably higher on method.

C. *Training Time.* The substantial reductions in learning time mentioned by some advocates of programmed learning were not present. Although some foremen completed the program in considerably less time than they would have spent in a conference, most took about the same amount of time and some took more time. Conference time was carefully controlled and the time used by the self-study groups was logged under close supervision. (Table III reflects the median figures for time spent by each training group.)

It was tentatively concluded that the programmed text leads to an improvement in subject-matter knowledge in the shortrun but that this improvement is comparable to (rather than an improvement over) that produced by conventional methods. It was further concluded that the programmed text did not provide maximum training in a given amount of time and that the addition of summary conferences to the use of the text appeared to be a desirable training combination. It also appeared that the reaction of trainees to the programmed text was not significantly different from that toward orthodox adult conference methods.

Table III
INDIVIDUAL HOURS OF TRAINING FOR STUDY GROUPS
(Median Hours)

A-1	A-2	B-1	B-2
4	5	4.35	5.40

A distinct financial advantage of individual self-study is that if it were to be used instead of conferences it would eliminate the problems and costs of scheduling and conducting conferences. Also, when foremen are scheduled during the work day to attend training sessions, full attendance cannot be expected because of pressing production problems. To train everyone, multiple sessions convenient for all foremen are required. This, in turn, generates additional expense.[17] We are hopeful of finding the educational-economic optimum.

The two groups in Plant X who engaged in self-study plus the one-hour conference achieved results which suggested to the researchers that this methodology would be preferable educationally and economically to the others. The results also suggested that social interaction with a human instructor when added for only one hour achieved important results in comparison with the other conditions.

Further experimentation with the programmed text also seemed warranted in order to ascertain how it would work out in another experimental situation. The research results pertaining to the A-2 Group in this experiment encouraged additional study of the conventional text for use in self-study.

Based upon these findings regarding self-study techniques, three decisions were made:

1. Continue research at Plant X with a newly constructed work-standards equivalent subject-matter post-test (Test C) to determine whether there was a difference in long-run retention of learning among the four groups.

2. Begin replication and elaborative studies in Plant Y and Plant Z, using a revised design of the Plant X experiment and a revised version of the programmed text.
3. Exert more rigid controls to assure close conformance to the experimental design.

The first project regarding retention of learning was initiated. The retention test (Test C) was administered approximately ten weeks after the post-test (Test B) which was given at the conclusion of training. Table IV exhibits the results. Comparisons are also made with the pre-test (Test A).

In making such comparisons, it should be noted that the retention test consisted of all multiple-choice questions with no problems to be worked. Test C was, therefore, probably slightly easier than Tests A and B because the advantage given by substitution of multiple-choice questions for problems may be greatest for persons whose subject-matter knowledge is weakest.

Participants were asked whether they had done any additional studying or had had contacts with work standards personnel since taking the course. Answers are reflected in Table V.

These statistics would seem to indicate that although relatively few persons in the total study were motivated to any further study in establishing work standards (and most received no particular benefit), a large number were motivated in the B-2 Group and these were able to score higher on the retention test. Also, twice as many foremen exposed to the programmed text as opposed to those undergoing conventional instruction reported contacting work standards personnel. Possibly the novelty of programmed learning stimulated their interest and induced them to make these contacts.

Table IV
"D" SCORE SUMMARY OF INITIAL AND LONG-TERM CHANGES IN SUBJECT-MATTER KNOWLEDGE RESULTING FROM TRAINING

	Group			
Test Incidents	A-1	A-2	B-1	B-2
Percent Improvement Test A - Test B	27	19	12	16.5
Percent Improvement Test A - Test C	24.5	23	11.5	22

DESIGN OF THE STUDIES AT PLANTS Y AND Z

Preparations were then made for two new experiments subsequently scheduled at Plants Y and Z. A review of test data from Plant X indicated that the likelihood of improvement in an individual's subject-matter test score was a function of both his ability to learn (measured by the PTI test) and the amount to be learned (measured by the pre-test score). It was, therefore, considered worthwhile to develop an *ad hoc* Improvement Potential Index, designated as IPI, in assignment of foremen to experimental treatments by using the following formula:

$$\frac{\text{PIT Score} \times (100 - \text{pre-test score on work standards examination})}{100} = \text{IPI}$$

For example, a foreman might have a PTI score of 38 and a subject-matter pre-test score of 57. His IPI on the basis of the above formula would be 38 multiplied by 43, divided by 100, equals 16.34.

Next, plant training personnel and the plant supervisors at the two factories in the experiment were informed of the purpose and general design of the study. As at Plant X, the foremen were given two tests: The PTI Verbal Test and a work standards subject-matter test (Test A). IPI scores were established and were used to design four carefully-matched groups from each plant. The number of participants in each group was kept as close to fifteen as possible. The lowest number of the experimental groups to complete the training at Plant Y was twelve. In the experiment at Plant Z, one group had thirteen participants, two had ten, and one had six. Attrition due to illness and other reasons did not change the IPI scores appreciably and the comparison of results should be acceptable. The training given can be described as follows:

Table V
RESULTS OF ADDITIONAL SUBJECT-MATTER INTEREST

	Group			
	A-1	A-2	B-1	B-2
Number in group	16	15	15	14
Number men reporting contact or study	3	4	4	10
Percent change for these Men - Test B - Retention Test	0%	-4.0%	-6.3%	+5.2%

PLANT Y

A-1 Four one-hour conference presentations as outlined in the conference leader's guide.

A-2 Self-study using the conventional text prepared for the regular conference described above. Each individual proceeded at his own rate.

B-1 Self-study using the revised programmed text. Each individual proceeded at his own rate.

B-2 Self-study with revised programmed text as described in B-1 plus a one-hour discussion and summary. Each individual proceeded at his own rate.

PLANT Z

A-1 Four one-hour conference presentations as was used by the A-1 group in Plant Y.

A-2 Self-study using the conventional text as used by the A-2 group in Plant Y. Each individual proceeded at his own rate.

A-3 Self-study using the conventional text plus a one-hour discussion and summary conference. Each individual proceeded at his own rate. (It is important to note that this design was not used in Plants X and Y. It was used in place of the B-2 experimental arrangements in Plants X and Y.)

B-1 Self-study using the revised programmed text. Each individual proceeded at his own rate.

The self-study groups as well as conference groups met on a regular schedule. The time spent on self-study was recorded by each participant at the end of the class periods.

The experiments were controlled as closely as possible with a research representative observing the four one-hour conferences to assure close adherence by the instructor to the leader's guide and to prevent any attempt to prepare the trainees (intentionally or unintentionally) for post-testing.

As in the Plant X experiment, on completion of the training a subject-matter test (Test B) was given all participants. An attitude questionnaire was also given to each participant to secure his reaction to the training method. Results of the tests and questionnaires, the time to complete the exercises and the errors made in the programmed text were analyzed by the researchers.

The experiment at Plant Y closely followed the one for the earlier study made at Plant X. The only difference concerned the A-2 Group. At Plant X, self-study with conventional text was used, was followed by a one-hour discussion and summary. At Plant Y, the discussion and summary were omitted to assess the value of self-study with a conventional text without the benefit of a discussion and summary.

The Plant Z study included the evaluation of self-study using conventional materials without a discussion and summary, as well as with one. This was prompted by the success of the conventional text at Plant X, which, as previously mentioned, had generated much interest in self-study with conventional materials. The programmed text was used with only one group and without a discussion and summary.

RESULTS AT PLANTS Y AND Z

A summary of the data obtained from the experiments at Plants Y and Z appears below:

Plant Y

A. *Subject-Matter Knowledge.* Comparative figures in Table VI show substantial improvement (D-score - 17) by the Group (B-2) using a self-study programmed text plus a one-hour summary conference.

The regular conference (A-1) ranked second and resulted in a 14-point improvement. Groups A-2 (conventional text) and B-1 (programmed text), both self-study groups without discussion or summary, achieved relatively poor results. In contrasting the results from the A-2 and B-1 groups, the conventional text was clearly more effective than programmed materials. The most salient result of the total experiment is reflected in the results achieved in the B-2 Group. Programmed learning supplemented by human instruction apparently contributes most to subject-matter mastery. Again, by implication, the impact of interaction on the learning process seems of overwhelming importance.

B. *Attitudes.* The attitude questionnaire was identical to the one used in the experiment at Plant X. The figures in Table VII are indices devised (on the same basis as those explained previously) to show the group reactions to the four methods of training in regard to the value of the course and the perceived effectiveness of the training method.

The group responses to the questions regarding the value of the course did not vary much except for the B-2 Group which rated the value of the programmed course (with summary) as relatively low. Regarding the effectiveness of method, the A-2 Group rated the self-study text (without summary) some-

Table VI
PLANT Y KNOWLEDGE IMPROVEMENT FIGURES
(Median Scores)

Group	Pre-Test	Range	Post-Test	Range	D-Score
A-1	38	15 - 58	48	21 - 80	14
A-2	38.5	12 - 67	48	13 - 91	8.5
B-1	39	20 - 69	47	22 - 77	4
B-2	35.5	17 - 57	55	13 - 84	17

Table VII
PLANT Y SUMMARY OF ATTITUDE SURVEY RESULTS BY TRAINING GROUPS

Results Item	A-1	A-2	B-1	B-2
Value of Course	70	73	69	64
Effectiveness of Method	78	71	77	77

Table VIII
INDIVIDUAL HOURS OF TRAINING FOR STUDY GROUPS AT PLANT Y
(Median Hours)

	Groups			
	A-1	A-2	B-1	B-2
Individual hours spent	4	3.5	3.4	4.2
Summary and discussion hours	0	0	0	1
Total	4	3.5	3.4	5.2

what lower in comparison to the other group responses. Thus, the group which achieved the greatest improvement valued the course least; also, the B-2 group considered the novel training methodology employed in about the same way Groups A-1 and B-1 regarded the methods to which they were exposed.

C. *Training Time.* The time spent in conferences by the A-1 Group was carefully controlled at one hour for each conference. The time spent by each individual in the self-study groups was also meticulously logged. Table VIII reflects median figures for each group and the additional hour of discussion and summary for the B-2 Group.

Plant Z

A. *Subject-Matter knowledge.* Comparisons of the figures in Table IX show almost equal results obtained among the three self-study groups. A-3 was the only group that used the one-hour summary, and it should be noted it did not produce results superior to those obtained in the other self-study situations. The A-1 Group showed considerably less improvement in the median D-score. However, there was considerably less improvement to be made as compared to the other groups, judging by the pre-test median D-score in Group A-1 and the others' D-scores.

Table IX
PLANT Z KNOWLEDGE IMPROVEMENT FIGURES
(Median Scores)

Group	Pre-Test	Range	Post-Test	Range	D-Score
A-1	60	10 - 68	75	56 - 92	22
A-2	41	27 - 67	75.5	41 - 94	33.5
A-3	41.5	33 - 62	81	45 - 92	33
B-1	47.5	17 - 63	86.5	60 - 95	33.5

There was no group established for Plant Z which used programmed materials and a one-hour discussion and summary as in the B-2 Groups in Plants X and Y.

Several results of the self-study approach are worth discussing. Both groups using conventional materials (A-2 and A-3) produced practically the same results with D-scores of 33.5 and 33 respectively. The results of self-study with the programmed text were equal to but no better than the results obtained with the other two groups.

A close look at the measurements in Table IX suggests that the practical value of the exclusively conference method of training in work standards and comparable subjects is open to question. This study strongly indicates that a self-study method of training could be used with better results by the organization in which the research was conducted. This change would free the conference leader for other work (if not for other jobs).

On the basis of this experiment, one could question whether programmed learning is an economically effective training device, i.e., whether it can produce superior results which justify the costs of programming. It should be recalled that the programmed materials used in this experiment had been through several revisions, the last occurring after the experiment at Plant X. Probably little could be done to improve these materials educationally. It may be safely assumed from the results reflected in Table IX that conventional materials can be used with comparable results in a self-study situation without the cost of programming.

Table X
PLANT Z SUMMARY OF ATTITUDE SURVEY RESULTS BY TRAINING GROUP

Results Item	Groups A-1	A-2	A-3	B-1
Value of Course	57	54	47	70
Effectiveness of Method	82	71	64	73

B. *Attitudes.* The attitude questionnaire used in Plant Z was identical to the one used at Plants X and Y. Table X again shows the group reactions to the four training methods in regard to the value of the course and the effectiveness of the training method.

The B-1 Group responded with a relatively high rating of the programmed text for both course value and effectiveness of method. It is noteworthy that the A-3 Group had a lower estimate than the A-2 Group of both the course value and the effectiveness of method, the summary and discussion notwithstanding. These views of the A-3 Group could have been caused by a dislike of reading a conventional text or the contributions of the conference leader (or both).

C. *Training Time.* The time spent in conferences by the A-1 Group was carefully controlled at one hour for each conference as in the other experiments, and each individual's time in the self-study groups was carefully logged. Table XI reflects median figures for each group and the additional hour of discussion and summary for the A-3 Group.

SUMMARY AND CONCLUSIONS

Conclusions can be drawn on the basis of these studies which pertain to the mechanics of programmed learning, the value of self-study, attitudes toward self-study, and the influence of human interaction in the educational process in three industrial settings. How far these findings can be generalized depends, of course, on further research.

An examination of each frame in the revised programmed text used in the Plant Y and Z studies suggested that the material was clearly presented. Only two of the 234 frames showed a number of "mistakes" (detectable by crossouts and erasures) as compared with a high incidence of mistakes on numerous frames in the experiment at Plant X (which led to the revision). When comparing the results of the first programmed text used for the study at Plant X with the results achieved at Plants Y and Z using the revised materials, the quality of the revised materials, the quality of the revised programming appears to have been particularly important. Foremen at Plant Z who used the revised materials learned more than the foremen at Plant X who used the original text even though the learning potential of foremen in both plants was about equal. Also, the results were better at Plant Y, which may further suggest the impact of an educationally sound program.

The data from the three experiments reveal definite value in the self-study method for teaching work standards subject-matter as compared to other more orthodox training techniques. This conclusion appears to be further supported by the following summary tables on attitudes toward the method used, changes in subject-matter knowledge, and time spent by the various groups.

The data in Table XII suggests that the foremen's perception of the method and material is favorable to self-study.

The index of 83 for the group taught by the conference technique supports the conventional method of teaching from the standpoint of the trainees. By implication, this result is an endorsement of the value of human interaction in the learning process. The indices of 78 and 76 pertaining to self-study groups which used the programmed text represents a positive attitude toward the method, although these results are slightly less favorable than those obtained in conferences with no supplementary reading material. Interpretations must be cautionsly made on the basis of these data, however. It is generally expected that the subjects of an experiment will respond with enthusiasm to novelty. After continued use, interest in the novelty sometimes subsides and attitudes often become more like those in the control group of the original experiment. Nevertheless, the groups which used standard

Table XI
INDIVIDUAL HOURS OF TRAINING FOR STUDY GROUPS AT PLANT Z
(Median Hours)

	Groups A-1	A-2	A-3	B-1
Individual hours spent (median)	4	3.55	3.53	4.55
Summary and discussion hours	0	0	1	0
Total	4	3.55	4.53	4.55

texts (A-2 and A-3) apparently did not like these as much as the other foremen liked the approaches to which they were subjected.

Inferences favorable to the effectiveness of the self-study method can also be drawn from the average D-scores shown in Table XIII. (The group at Plant X is omitted because of the bias mentioned earlier.)

The self-study groups performed better than the groups taught by conferences according to these measurements. The conventional text materials produced much better results than the programmed text.

In making inferences on the basis of these data, attention should be directed to certain differences between the results obtained at the two plants. The average PTI score for Plant Y (25) was considerably lower than the score at Plant Z (34). The association between PTI scores and the post-test scores seems to point up dramatically the importance of some minimum of learning ability as a prerequisite for training results.

Turning to a summary of the hours used by the various groups, the time spent by the self-study group is much the same as the time utilized by the conference method. (One hour for conference-discussion was added to the A-2 Group and the B-2) The A-2 and B-2 groups, both of which used self-study, were respectively the shortest and longest in training time.

Table XII
SUMMARY OF INDICES MADE FROM THE ATTITUDE SURVEYS PLANTS X, Y, AND Z

	Groups				
Plants	A-1	A-2	A-3	B-1	B-2
Plant X	89	60		77	79
Plant Y	78	71		77	77
Plant Z	82	71	64	73	
Average	83	67	64	76	78

Table XIII
SUMMARY OF MEDIAN D-SCORES FOR PLANTS Y AND Z

	Groups				
Plants	A-1	A-2	A-3	B-1	B-2
Plant Y	14	8.5		4	17
Plant Z	22	33.5	33	33.5	
Average	18	21	33	18.7	17

Table XIV
SUMMARY OF INDIVIDUAL HOURS SPENT BY EACH GROUP IN PLANTS Y AND Z

	Groups				
Plants	A-1	A-2	A-3	B-1	B-2
Plant Y	4	3.5		3.4	4.2
Plant Z	4	3.5	3.5	4.5	
Average	4	3.5	3.5	3.9	4.2
Discussion and Summary	0	0	1	0	1
Total	4	3.5	4.5	3.9	5.2

PI MERIT

Any conclusions on the relative merits of programmed instruction in this experiment must take into account the participants' prior knowledge. All participants were presumably exposed to prior work standards training and most were supervising work operations where their performance was measured by direct labor hours. The training could be regarded as remedial. One might then infer that reading conventional materials could be more effective for remedial training while programmed instruction could possibly be more effective where the material is new to the student.

Nevertheless, the data obtained suggest that programmed materials have definite value in training foremen. The data do not establish categorically the superior value of a completely-programmed course.

The conventional text seemed quite effective for self-study and compared favorably on this dimension with the programmed materials. Conventional texts were not as well liked. The reasons for the dislike could be as various as the respondents, although one could offer the opinion that they are "dry."

There is also evidence that the self-study technique, with either type of text format, yields higher test scores with the addition of the summary and discussion of course content.

HUMAN INTERACTION

Obviously, we lack proof that specific interaction with a human instructor improved the scores because we do not know which students spoke or otherwise communicated with the conference leader. Maybe few interacted; maybe many. Perhaps simply being an observer in situations where others interact is sufficient. In future studies a measurement of interaction originations and responses could be taken in the conference room. It would also be worthwhile to secure measures of instructor competency, if possible. All these measures could then be related to pre- and post-test scores and other variables.

Much learning contains "depressed learning" spots where students display particular difficulty in grasping concepts without help from an instructor. For example, in mathematics-oriented problems, the student may fail to complete the problem if he cannot make an orderly transition from one step to the next in the solution. Perhaps it is precisely at this crucial juncture that the student requires interaction with the instructor or conference leader.

Turning to another consideration, quite possibly the essentially Skinner-type program used was less appropriate than a Crowder-type program, which may provide more depth, although this is controversial. Different results might have been obtained with a Crowder-type program or an "integrated" program which draws upon both approaches to programming. Or, perhaps it would have been most effective to use a linear program only for the descriptive information about work standards and to handle the problems separately, such as "homework" to be "passed in" to an instructor. Here again the possible role of the teacher should be noted. These alternatives suggest that the experimental alternatives are numerous and that designing experiments with the new education technology has many implications.

ECONOMICS

The economic aspects of programming are also of concern because they have a bearing upon the diffusion of this educational innovation. The programming of texts is obviously expensive because of the time involved in writing the program and the large number of frames used in a typical programmed course. Programs can cost up to several hundred dollars per frame. A completely programmed text is rather bulky and inconvenient. It also has little value for scanning the subject matter for review or for "brush up." Of particular importance in industry is the permanence of the subject matter and the number of trainees. If the subject matter changes rapidly and few persons require training, programming would be uneconomic. These considerations alone often preclude developing a completely programmed text.

The final conclusion which we would draw from this study is that the importance of social interaction to classroom formal education cannot be dismissed by those who automatically and uncritically believe the new educational technology will *pari passu* meet the needs of the future. At least for the foremen in this study, the opportunity to interact appeared crucial and conventional texts were quite acceptable. Possibly educational technology can replace the human instructor who teaches different kinds of persons on different topics in different settings, and the learning results would be unaffected. But there is evidence in this study that educational technological replacement was not especially effective in the circumstances previously analyzed. Only future research under controlled conditions will point to the specific conditions that make for successful learning with programmed instruction and indicate how far the conclusions of this study can be generalized.

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13. This test by Alexander G. Wesman is copyrighted by the Psychological Corporation, 1952.

14. John G. Hutchinson, *Managing A Fair Day's Work*, Report 15, Bureau of Industrial Relations, University of Michigan 1963, p. 1. This book contains an excellent discussion of an empirical study of work standards. It provides considerable technical information as well as an analysis of the human and organizational impact of standards.

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17. It should be noted here that the organization conducted a previous study to determine the feasibility of using subject-matter tests (much like university-level multiple-choice examinations) to determine the individual training needs of foremen. The study indicated that about 95 per cent of foremen tested accepted the idea of subject-matter examinations and believed this method was practical for determining training needs. If individual training could be isolated by subject matter testing and training provided individually, then all the expenses of group training could be avoided.

The programmed learning experiments shed some additional light upon the value of subject-matter testing among adults employed in industry, another subject which had not been researched in any depth. Of the 110 foremen originally tested in the experiment at Plant X, eleven (ten per cent) had scores of 75 per cent or more on the subject-matter pre-test. Eight of these foremen were included in the study at Plant X. Their post-test scores improved only three points, from an average of 75 points to an average of 78 points. Thus, for these foremen, four hours' training was not really required in this subject-matter area, and the time could well have been devoted to other matters, such as getting out production. Foremen in need of training could theoretically have been given the exact amount of training required and would not have attended training sessions covering subject-matter they had already mastered. In other words, if the testing were integrated specifically with the training sessions, the foremen who passed the test (s) could have been excused from attendance, thereby avoiding training expense and removal of supervisors from the work situation.