Improving Attitudes Toward Creative Problem Solving Among Manufacturing Engineers

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Abstract

This field experiment investigated the effects of training on attitudes of manufacturing engineers toward creative problem solving. Training in a complete process of creative problem solving was administered to two groups of manufacturing engineers working in a large food processing manufacturing organization. The first group (N=65) were from various locations in the organization and the second group (N=47) were from intact work groups. The second group served as placebo control for the first group and vice versa. Measurments of attitudes toward the use of creative problem solving techniques were taken at three points in time (baseline, following the first training intervention, and following the second training intervention). Results showed that the training positively affected engineers' attitudes toward creative problem solving. In addition, the use of intact work groups for training purposes was found to result in more persistent long-term effects. Implications of these results for the literature on training in creative problem solving are discussed.

Attitudes toward creative problem solving are important antecedents to creative problem solving performance. Kraut (1976) suggests a causal chain of changes in attitudes leading to changes in behaviour leading to improved results, respectively. Rickards (1975) reports a field experiment in which results using creative problem solving techniques were no better than results using conventional techniques. The lack of success is attributed to an inability of the experimental participants to change their attitudes toward creative problem solving. Richards concludes it may be very difficult to change such attitudes toward creative problem solving until procedures adequate to change long held beliefs which work against its basic principles are found. Basadur, Graen and Green (1982) found that improvements in attitudes accompanied increases in creative performance after appropriate training in creative problem solving. Basadur and Finkbeiner, (1985) offer a model describing how attitudinal processes enhance cognitive processes of creative problem solving.

Although there is evidence it is useful to send people to training in creative problem solving, it is likely that unless their attitudes change, such training will not result in long-term changes in behavior. Many people who work in organizations have negative attitudes toward creativity and new ideas (Rickards, 1980; Shore, 1980). Kirton (1976) found that people in organizations who have more innovative styles incur more negative attitudes and mistrust by others. They encounter greater difficulty in getting their ideas accepted because they tend to propose more unusual solutions and may even redefine given problems in unexpected new ways. Others in the organization tend to have negative attitudes toward such creative approaches since the substantial changes they represent may evoke feelings of discomfort and apprehension. Unless we can improve these attitudes, training efforts in the techniques of creative problem solving will be fruitless. Attitudes of manufacturing engineers tend to be negative toward any form of creative problem solving. They tend to see no place for "creativity" in their structured, implementation-oriented environment where "practicality is so highly valued.

One of the reasons for such negative attitudes may be a misunderstanding of what "creativity" is. Many people are distrustful of training in creativity because they believe creativity is synonymous with abstract idea generation and excludes practicality and implementation (Leavitt, 1963). However, newer approaches to the study and application of creativity not only include problem solving, but also solution implementation and problem finding (Basadur et al, 1982). Increasing numbers of researchers emphasize that creative problem solving involves not only the solving of problems, but also the finding or initiation of problems (Mackworth, 1965). Problem finding includes opportunistic surveillance (Simon,1960) and problem definition (Dewey, 1977).

Unfortunately, such of the university training of North American managers and professionals has been much more analytical than creative (Leavitt, 1975; Taggert and Robey, 1981). This is especially true of engineers (MacKinnon, 1962). Engineering students have been found to lose ground in their creative thinking skills during a standard four-year university curriculum (Altemeyer, 1966; Doktor, 1970). Some universities have recognized this problem recently and are offering courses in creative thinking in Business and Engineering (McKim, 1972; Weick, 1977). Simon, Newell and Shaw (1962) consider creative activity as a special class of problem solving characterized by novel and unconventional thinking, persistence, and problems which are vague and undefined initially (such that part of the task is to formulate the problem itself). Creative problem solving requires the skill of thinking that on the surface appears to be impractical, temporarily separating such thinking from the opposite seemingly more practical kind of thinking.

The Complete Process of Creative Problem Solving

Guilford (1967) distinguishes between convergent thinking and divergent thinking. The former involves logical, mathematical thinking to solve "single correct answer" problems; the latter involves the use of the imagination to generate ideas to solve problems which have many possible correct but different answers. Taggert and Robey (1981) describe right and left brain activity as a physiological explanation of the divergent-convergent thinking duality. Guildford suggests that the need for divergent thinking production is characteristic of creative problem solving. Similarly, de Bono (1971) distinguishes between vertical and lateral thinking. Many other writers present various versions of what creative problem solving is. Most describe processes requiring the use of the imagination to create novel solutions to problems; some also emphasize the discovery of problems and the implementation of solutions (Osborn 1963; de Bono, 1971; Prince 1970; Gordon 1971; Parnes, Noller and Biondi, 1977; Leavitt, 1975; Mackworth, 1965; Getzels, 1975; Basadur, 1982). Some people believe that creative problem solving performance and innovation can be increased by training (e.g., Simon, 1960; Joyner and Tunstall, 1970). While this belief has generated some research into understanding and testing of processes of creative problem solving, most of the training effort has been put into developing training programs by practitioner-oriented people based on partial processes or unresearched concepts and techniques (MacKinnon, 1977). Some such programs can cause negative attitudes toward creative problem solving (Grossman, 1982).

Basadur, Graen and Green (1982) provide empirical evidence that it is worthwhile to train people in a complete process of creative problem solving which takes into account both divergence and convergence and problem finding and implementation as well as idea generation. They also show that such processes are partly attitudinal and partly cognitive. Basadur (1979) provides a model showing how the attitudinal and cognitive effects of such training relate to one another and to creative performance in organizations. Basadur and Finkbeiner (1985) identify more precisely those attitudinal processes and provide scales to measure them. They point out that inadequacies in these attitudes prevent people from using cognitive creative processes on the job.

In this research, we are studying methods of improving attitudes identified by Basadur and Finkbeiner (1985). Specifically, these two attitudinal concepts are "preference for ideation" ("active divergence") and "tendency to make premature critical evaluations of ideas" ("not deferring convergence" or "preference for quick convergence"). A person with a high "preference for ideation" ("active divergence") would likely find value in novelty and unusual "wild" ideas, seemingly far removed from the current problem; enjoy taking different points of view about a given situation and generating multiple options; would rarely feel a "problem is solved", rather would enjoy going back to generate new solutions and improve the problem further; is not content with standard solutions to a problem but rather prefers new and novel new frames of reference; sees each idea as merely a stepping stone to additional ideas. In contrast, a person with a high "tendency to make premature critical evaluations of ideas" (low "preference for deferring convergence", or high "preference for quick convergence") is someone who has a high need to be decisive, dislikes wasting time with apparently non-productive trains of thought, is quick to find the flaw in an idea or point of view and eliminate it from consideration quickly; feels each idea ought to be evaluated sequentially, before proceeding to the next one; tends to not want to risk making a mistake; believes there is one "best way" or one "right answer" to solve a problem; has a low tolerance for ambiguity; and prefers to optimize rather than satisfice.

These are the two basic attitude concepts identified by Basadur and Finkbeiner (1985) which need to be improved for creative problem solving on the job to improve. The "preference for ideation" is viewed as more of an <u>active</u> concept of idea generation. The low "tendency for premature critical evaluations of ideas" is more of a <u>passive</u> concept, a latitude to tolerate new ideas.

<u>Attitudes and Attitude Change</u>

Changing attitudes of any kind is not an easy task according to the literature. As noted by McGuire (1969), perhaps no area of research in social psychology has been as active as the formation and change of attitudes. Much theoretical and empirical work has been devoted to the study of the persuasion process through which attitudes can be changed. One approach is the cognitive response approach to the study of persuasion (Petty and Cacioppo, 1981). This approach postulates that attitude change processes can best be understood by taking into account the thoughts that arise in the persuasion situation. To the extent that the persuasion situation elicits thoughts that are favourable, attitude change in the direction advocated should be facilitated. However, if negative thoughts are elicited, attitude change should be inhibited.

Based on this theoretical framework, a person's thoughts during a persuasion attempt regarding a given topic appear to be related to the change that takes place in the attitudes toward the object of the persuasion. In the present study, the complete process of creative problem solving training may be seen as an attempt to persuade manufacturing engineers to engage in creative problem solving in their jobs. However, negative attitudes toward creative problem solving may be a barrier to the use of the creative problem solving techniques by the engineers. As noted above, engineering education tends to discourage such attitudes. Hence, it is of interest to determine the extent to which the training (as a persuasive communication attempt) was able to effect changes in the manufacturing engineers' attitudes toward creative problem solving. If this attitudinal barrier could be overcome, then the manufacturing engineers might be more open to learning to use creative problem solving techniques and they might begin to incorporate such processes into their repertoire of job-related skills. From an attitude change perspective, the attitude measurements can be viewed as an attempt to monitor the negative or positive thoughts generated before and after the attempts of persuasive communication. The provision of appropriate training in creative problem solving techniques should enable manufacturing engineers to make more accurate judgments regarding the usefulness of the approach in their work. Also, the creative problem solving training may serve to dispel stereotypes of creative individuals (e.g. they are "bizarre").

One objective of this study was to investigate the attitudinal changes that follow the company encouraged practice of creative problem solving. Basadur et al. (1982) provided empirical evidence that company training affected attitudes toward creative problem solving after two weeks back on the job. The present research proposes to extend this research in two ways. First, the persistence of effects of training on attitudes after substantially longer periods of time (up to 10 weeks back on the job) is investigated. This represents a tougher replication of the original experiment. Second, the relative effects of training on attitudes of two different kinds of training groups are compared. These groups differ by the amount of knowledge to be found back on the job of the new techniques. Two different training group situations will be examined. In one, the participants in the training were from different and diffuse locations. In the other, the participants were from the same location, and all of the engineers at that location were participants in the training. Hence the first group of participants were more or less alone in their new attitudes upon return to work; whereas, the second group participants found common understanding of their new attitudes. In the training literature there is evidence that new learning has greater staying power in supporting environments than in nonsupportive environments (Hinrichs, 1976; House, 1968).

The second group was drawn from a single manufacturing location whereas the first group was drawn from a variety of manufacturing locations. Members of the second group, upon their return to their location, should find more support for their new attitudes since all their colleagues were exposed to the same training experience. For the first group, the participants would return to a less understanding environment, being a minority on the job among a majority of colleagues never having experienced the training. There would be far less peer reinforcement and far less concentrated self support for the newly learned attitudes in the first group. The problem of "re-entry" after training designed to effect attitudinal and behavioral change is a well known one in the training literature (Goldstein, 1980; Schein, 1961).

Hypotheses

The purpose of this research is to find out if training of manufacturing engineers in a complete process of creative problem solving will result in a positive change in attitudes which are associated with the effective use of creative problem solving techniques on the job. Below are the hyotheses for the effects of the training.

1. Training manufacturing engineers in creative problem solving will lead to the following attitude changes which will persist 5 weeks after the training:

   H_{1a}:an increase in preference for ideation (active divergence)

   H_{1B}: a decrease in tendency to make premature critical evaluations of ideas (quick convergence)

2. Training manufacturing engineers in creative problem solving as members of a natural work group which returns to work to the same location as a unit all having experienced the same training compared to members that come to the training from different work groups then return to diffuse work locations following the training will lead to the following attitude changes which will persist 5 weeks after the training:

   H_{2A}: a greater increase in preference for ideation (active divergence)

   H_{2B}: a greater decrease in tendency to make premature critical evaluations of ideas (quick convergence)

Method

The participants were drawn from a large consumer goods manufacturing organization. The organization has an interest in increasing organizational creativity to produce more idea generation and strategic thinking by manufacturing engineers. The overall objective of the training was to enable engineers to develop new procedures and processes to increase profitability and improve costs. The organization's top management team had requested training in a complete process of creative problem solving in an attempt to promote an increase in creative performance of these manufacturing engineers. These manufacturing engineers were known to be "efficiency minded", achieving excellence in performing their routine work assignments daily. However this same tough minded orientation toward optimizing the day-to-day routine was working against the manufacturing engineers attempting to also be "adaptability-minded", that is, using creativity to develop new routines, anticipate new opportunities and find new problems (opportunistic surveillance) (Simon, 1960), and solve old persistent problems in new ways. As mentioned above, such efficiency-minded people tend to regard such activity as less important than using their strong analytical skills as they attempt to ensure that the current approach to production is as near to perfect as possible (Leavitt, 1975; Simon, 1960; Kolb, 1976).

Procedure

The creative problem solving training treatment was based on a "complete process of creative problem solving" (Basadur, 1982). The 24 hours of training (3 days) were intensive and primarily experiential. Briefly, training experiences included a series of diverse tasks which permitted and encouraged participants to attempt to discover concepts not considered before, such as ideation-evaluation (see below) and the value of divergence in thinking. For example, participants individually defined a problem from a case and then compared definitions with other participants, discovering that the sample problem could then be viewed in many different, yet fruitful, ways. Another important aspect of the learning by doing emphasis was that the teachings and emerging skills were also applied to real-world work problems in addition to case studies. For example, each person generated an individual work problem and then developed a solution and implementation plan before leaving the training session. These processes encouraged transference of creativity concepts to personal frames of reference. One important fundamental of the training is that it is a "complete" process. Much creativity training stresses only divergent thinking and only in idea generation for solution finding. An example of such a partial approach is "brainstorming". Creativity processes which take into account evaluation and go beyond solution finding to problem finding and implementation considerations are termed "complete" processes.

The problem solving process trained is based on two major concepts. First, it is seen as having three different stages. It separates problem finding (Stage 1) from problem solving (Stage 2) and from solution implementation (Stage 3). For perspective, brainstorming would be seen as only a part of the second stage). The second important feature of the process is that within each of the three critical stages, there is a common fundamental process. This is a two-step process called "ideation-evaluation". Ideation is defined as idea generation without evaluation (putting aside the judgment capability). This is the diverging aspect of the two-step process. Evaluation is the reverse. It is defined as the application of judgment to the generated ideas to select the best one(s). This is the converging aspect of the two-step process. Both aspects are believed essential to creativity (Farnham-Diggory, 1972).

There are three major premises underlying training based on this view. First, for most people, the ideation step is more difficult than the evaluation step of the ideation-evaluation process. Our society, general training, and school systems tend to reward and hone our evaluation capabilities and preferences and promote their use virtually to the exclusion of ideation (Thurstone, 1950; Wallach, 1971; MacKinnon, 1962, 1977; Osborn, 1963, Taggert and Robey, 1981. Over a period of time evaluation starts to dominate. For example, some research has shown that engineering students, upon graduation, are less able to use their imaginations than when they entered, 4 years earlier (Altemeyer, 1966; Doktor, 1970). Second, even within the above context, there are individual differences. People differ in their relative preferences, aptitudes, and/or abilities in the two steps of the ideation-evaluation process (Guilford, 1967; Kolb, 1976). Some people may be relatively better in ideation or in evaluation. Third, while the training is designed to strengthen both steps of the ideation-evaluation process, it is expected to have the most effect on that step of the ideation-evaluation process that is least developed in each trainee.

Henceforth, in the rest of this article when reference is made to a "complete process of creative problem solving", what is meant is this three-stage process emphasizing the ideation-evaluation principle at each of the three stages in turn: problem finding, problem solving, and solution implementation. Thus, the notion is that it is not sufficient to merely "solve" a problem creatively. Creativity must also be applied to the implementation of a solution and to the discovery of the problem in the first place. In other words, nothing creative has happened until something "gets done" and also when the problem to be solved has been created.

A great proportion of the training time is devoted to developing the two attitudes of preference for active divergence (ideation) and preference for deferring convergence (low tendency to make premature critical evaluations of ideas). A supportive workshop climate is developed and participants are encouraged and rewarded for displaying these attitudes in interacting with others on group problem solving activities and in individual problem solving work. Trainees are provided many opportunities for discovery that such cognitive skills do work and in all three stages of the process to further improve the two related attitudes to further induce practice of the skills.

From this manufacturing organization, 65 manufacturing engineers from eight different locations were invited to a three day (24 hours) intensive training program in this complete process of creative problem solving as described above. A second similar group of 47 manufacturing engineers were invited to a second training program five weeks later. The only major difference was that the second group of manufacturing engineers were all from the same single location.

Design

The design is a field experiment using non-equivalent groups (Cook and Campbell, 1976).

0_1	X	0_2		0_3	(E)
0_1		0_2	X	0_3	(C)

The second group (n=47) first acted as control (C) for the first (E) group (n=65). Then the first group (E) served as control for the second group (C). Measures (0_1) were taken on both groups just prior to the training of the experimental group (0_2). Five (5) weeks later, the measures were repeated (0_2), just prior to the training of the second group, formerly the control group (C).

This second group was not aware of the first group and vice versa. All the participants were told the questionnaire they were filling out was non-evaluative and merely to help better understand the training so it could be improved over time. Complete confidentiality was assured. Questionnaires were always returned directly to the trainers who were "outsiders" (non-members of the organization).

After an additional five weeks, the measures were repeated (0_3) with both groups, E and C.

The procedures of this research were such that the experimental design and measures were meshed with organizational events. The measures were introduced to the participants as non-evaluative aids to developing future training.

Instrumentation

The six item "preference for ideation" scale was used to measure the "active divergence" attitude and the eight item "tendency to make premature critical evaluations of ideas" scale was used to measure the "quick convergence"/"not deferring convergence" attitude. The two scales were randomly mixed into one 14 item questionnaire identical to the procedure used by Basadur and Finkbeiner (1985).

The questionnaire was filled out each time period by each trainee (self-report), and by each trainee's immediate superior about the trainee. The superior's questionnaire about the trainee was developed by altering the self-report questionnaire slightly to make it grammatically compatible with describing someone else. Thus there were two measures of the two attitudes of all the participants prior to training, 0_1, and 5 weeks after training the first (E) group, 0_2, and 5 weeks after training the second (C) group, 0_3.

The schedule of events was as shown in Table 1. As can be seen in Table 1, the first observations on the two measures were taken from the focal engineer's (self-report) and his immediate superior's (boss-report) perspective at day one before any training had taken place. The three-day training was conducted immediately thereafter (days one to three). The treatment group (N=65) received training in the complete process of creative problem solving (Basadur, Graen and Green, 1982) and the placebo control group (N=47) received a two-hour talk on the theory of the complete process of creative problem solving. Five-weeks later, the treatment group was followed up back on their jobs with the second wave of questionnaires and the placebo group was assembled for follow up and training. During the next three days, the group that had previously served as the placebo control group was trained in the complete process of creative problem solving. Finally, five weeks after this latter training both groups were followed up with the questionnaire back on the job.

Analysis

The design of the study was a 2 x 3 repeated measures multivariate analysis of variance (Bock, 1963). The two groups (initial and delayed training) and three measurement periods on two dependent variables (Preference for ideation and Tendency to make premature critical evaluations) comprised the details of the design. A protected procedure was employed such that the univariate results were not interpreted unless the multivariate tests were significant. Moreover, a priori contrasts were calculated on the gains from time one to time two for group one versus

Table 1

Schedule of Events

	Cronbach Reliability Estimates	
Day	Self-Report	Boss Report
<u>DAY 1</u>		
Preference for Ideation ...	.72	.94
Premature Critical Evaluation ...	.80	.95
<u>DAYS 1 to 3</u>:		
Train Treatment Group (N=65)		
Placebo Control Group (N=47)		
<u>DAY 38</u>		
Preference for Ideation ...	.94	.97
Premature Critical Evaluation ...	.94	.97
<u>DAYS 38 to 40</u>:		
Placebo Treatment Group (N=65)		
Train Holdout Group (N=47)		
<u>DAY 75</u>:		
Preference for Ideation ...	.98	.99
Premature Critical Evaluation ...	.97	.98

group two and on the gains from time two to time three for group one versus group two. Finally, the patterns of means were examined for compatibility with the hypothesis.

Results

The overall multivariate analysis of variance demonstrated significant ($p<.001$) time and treatment by time effects for both self-report and boss report. As shown in Table 2, all gains over both five-week periods were significant (time effects). In contrast, the differences between the gains of the two groups (treatment X time effects) were not all significant. The gains in preference for ideation measures taken from both self and boss reports failed to show significant differences between groups for the period from the pretest to posttest one. Though these two treatment X time effects were insignificant, the remaining six treatment X time effects were significant (five at .001 and one at .05).

The patterns of means are shown in Figures 1 and 2. As can be seen in Figure 1, in terms of preference for ideation the gains from pretest to posttest one showed no real differences between the trained and placebo group for either self or boss report. In sharp contrast, the gains from posttest one to posttest two revealed differences between the two groups from both points of view as predicted. Whereas, the differences in gains between the two groups were .94 and -.08 for the first time period, they were 3.01 and 2.08 for the second time period for self and boss respectively. As mentioned above, the .94 and -.08 differences were not significant, but the 3.01 and the 2.08 were significant

Table 2

Repeated Measures Mean Sqaure and F Values

	Pretest to Posttest One		Posttest One to Posttest Two	
	Mean Square	F-Value	Mean Square	F-Value
Preference for Ideation:				
Self Report:				
Time ...	24.25	5.40*	52.41	10.61**
Treatment X Time ...	12.22	2.72	124.23	25.16**
Boss Report:				
Time ...	44.68	17.02**	76.56	15.54**
Treatment X Time ...	.07	.03	59.36	12.04**
Premature Critical Evaluation:				
Self Report:				
Time ...	136.28	14.71**	68.70	4.17*
Treatment X Time ...	124.09	13.40**	666.36	40.47**
Boss Report:				
Time ...	150.34	24.60**	730.15	51.57**
Treatment X Time ...	28.60	4.68*	240.27	16.97**

* $p \le .05$.
** $p \le .001$.

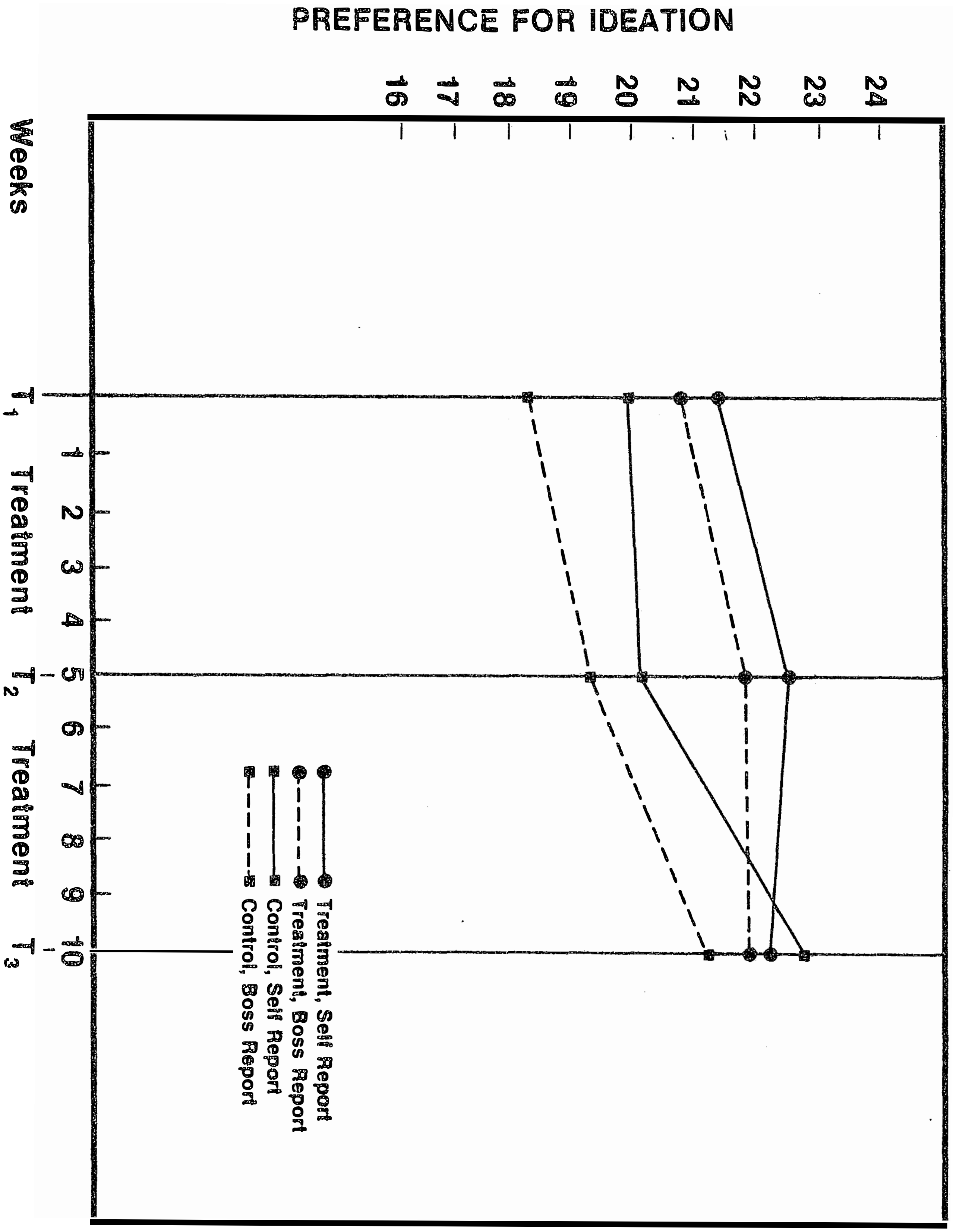
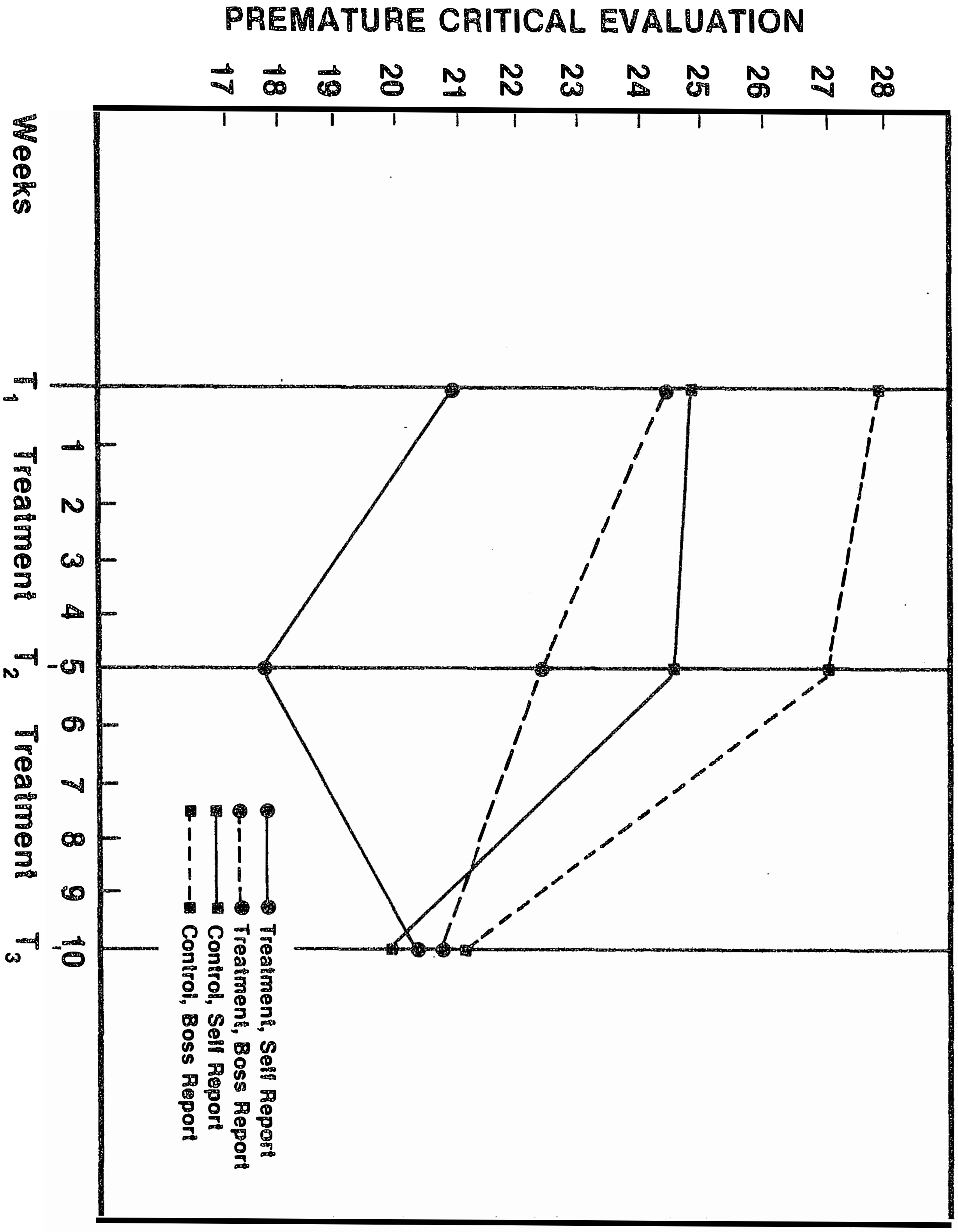

PREFERENCE FOR IDEATION
16
17
18
19
20
21
22
23
24
Weeks
T_1
1
2
3
4
5
6
7
8
9
10
Treatment
T_2
Treatment
T_3
Treatment, Self Report
Treatment, Boss Report
Control, Self Report
Control, Boss Report

Figure 1

Figure 2


PREMATURE CRITICAL EVALUATION
17
18
19
20
21
22
23
24
25
26
27
28
Weeks
T_1
1
2
3
4
Treatment
T_2
5
6
7
8
9
Treatment
T_3
10
Treatment, Self Report
Treatment, Boss Report
Control, Self Report
Control, Boss Report

($p \leq .001$). These positive differences in gains indicate the predicted advantage for the trained over the control group.

The patterns of means for tendency to make premature critical evaluations shown in Figure 2 reveal that all four differences between groups on gains support the hypothesized training effect. The gain differences were 3.02 and 1.50 for the first period and 6.99 and 4.20 for the second period. All of these differences between group gains were significant.

Thus, the results show support for the effectiveness of training on both preference for ideation and tendency to make premature critical evaluations under family-type training but only on tendency to make premature critical evaluations under missionary-type training.

Discussion

The purpose of this research was twofold. First, the study documents the effects of training on the attitudes of manufacturing engineers toward creative problem solving and second, the study attempts to determine whether engineers trained in natural work units experienced more persistent long-term attitude change than engineers from diverse work units who returned to diffuse locations following training sessions. Results showed significant treatment X time effects for both self-report and supervisor report measures of engineers' attitudes toward creative problem solving. Specific attitudes hypothesized to be affected were Preference for Ideation ("active divergence"), and Tendency to Make Premature Critical Evaluations of Ideas ("quick convergence"/"not deferring convergence"). The training in the complete process of creative problem solving appeared to result in engineers having more positive attitudes toward active divergence and deferral of convergence. That is, from before to after the training, the engineers increased their preference for generating different points of view and new or novel solutions to problems and increased their preference for keeping an open mind on ideas until they can be further explored and developed.

In addition, the effects on trainees belonging to two different types of training groups were compared. One group consisted of engineers from various locations in the organization who returned to those diffuse locations following the training. The second group was comprised of engineers that were part of intact work units and who returned to those work units following the training sessions. It was hypothesized that the engineers from intact work units would experience stronger attitude change effects five weeks after the training sessions. This hypothesis was supported. Both measured attitudes toward creative problem solving (Preference for Ideation and Tendency to Make Premature Critical Evaluations of Ideas) showed more long-term positive change in the intact work group condition (Group 2) than the diffuse work group condition (Group 1).

Based on these results, it is possible to speculate upon what happened in these work groups following the training. Following the training sessions, the engineers trained in intact work groups returned to their jobs along with others that had participated in the training. They found peer support for creative problem solving activities on the job that persisted five weeks following the training. In essence, these engineers had acquired a common "language" through which they could talk to one another about creative problem solving. This training condition resulting in strong and persistent training effects. In sharp contrast, engineers in the diffuse work group condition returned to various work units throught out the plant following the training. These engineers apparently found less peer support for creative problem solving activities. They were speaking a "foreign language" that others in their work units were unable to understand. Hence, the effects of the training on attitudes toward creative problem solving were not as strong nor as persistent as those found in the intact work group training condition.

The results of this field experiment extend knowledge of the effects of training in creative problem solving in a number of ways. First, this research provides a stronger test of the effects of training for two reasons. The research design included three waves of data collection and training interventions at two time points. This design makes it possible to monitor the effects of the training for a longer duration of time than previous studies. A second reason why this research constitutes a stronger test of training effects is the nature of the sample. Participants in the creative problem solving training sessions were manufacturing engineers whose previous professional socialization had reinforced convergence on problem solutions and an emphasis on efficiency. The fact that the training described in this study was able to positively change the attitudes of these engineers toward the use of creative problem solving shows that appropriate training can result in positive effects even in populations whose attitudes may be difficult to change.

A second purpose of this study was to examine the long-term effects of engineers belonging to two different types of work groups during and after the training sessions. It was found that the use of intact work groups who work together following the training enhances the effects of the training. The groups having members from various locations in the plant showed less positive attitudinal responses to the training.

This study has demonstrated that training can positively influence manufacturing engineers' attitudes toward creative problem solving and has identified an important aspect of the training situation, the use of intact work groups. Attitudes are important antecedents to the use of creative problem solving on the job. The results of this research point to methods of training that can positively change those attitudes and therefore enable the development of more creative and adaptive organizations.

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