

A Review of the Effectiveness of CPS Training: A Focus on Workplace Issues

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A major focus within the field of creativity has been on the development of methodologies aimed at deliberately nurturing creative thinking. These methodologies have attempted to mirror the creative process in ways that allow individuals and groups to explicitly call on and employ their creative faculties. In an attempt to uplift employees' creative capabilities many of these methodologies have been introduced into organizations through training programs, as well as through application to business challenges. Do these methods work? What is the empirical evidence that these deliberate creative process methods enhance employees' creativity? Though there are a handful of creative process methods, few have married the concern for application with an interest in demonstrating the benefits of these applied efforts through systematic research. Creative Problem Solving (CPS), one of the more popular creative process models, has been one of the rare exceptions. The purpose of this paper is to synthesize the research literature that reports on the impact of CPS training carried out within organizational contexts, that is training programs that involved professionals or students working on real business challenges. Additionally, the positive benefits of CPS are further examined through reports that cite the outcomes of applying CPS to business challenges. In a field replete with methods that have been commercialized, it is imperative to strike a balance between research and practice as an imbalance towards practice may foster a field dominated by individuals who offer untested products and services.

Introduction

The study of creativity is an applied science. The most widely accepted definition of creativity, the production of novel ideas that are made useful (Ford, 1995; Kaufmann, 1988; MacKinnon, 1978; Stein, 1974), underscores the applied nature of the creative act. For many creativity scholars, the purpose of their research is to foster a better understanding of creativity so that these insights might be used to deliberately facilitate creative thinking. Given the applied nature of creativity, it is not surprising that individuals have created models of the creative process that are intended to bring about creative solutions to problems. Indeed, a good number of consultants now earn their living training and facilitating members of organizations in creative processes and techniques. Four of the more widely known creative process models are Creative Problem Solving (Osborn, 1953), Syntectics (Gordon, 1961), TRIZ (Altshuller, 1979; Terninko,

Zusman and Zlotin, 1998), and Six Thinking Hats (de Bono, 1985).

It may well be that the preponderance of creativity books and workshops aimed at helping people to be more creative have contributed to the view that the field of creativity is imbalanced towards application and lacks scientific rigor. For some, the field of creativity probably appears to be a noisy and crowded bazaar in which merchants compete to sell their 'creativity wares'. This has led some creativity scholars to question the validity of methods that claim to enhance creative thinking. Sternberg and Lubart (1999) best captured this sentiment when they said:

These approaches lack any basis in serious psychological theory, as well as serious empirical attempts to validate them. Of course, techniques can work in the absence of psychological theory or validation. But the effects of such approaches is often to leave people associating the phenomenon with commercialization and to see it as less

than a serious endeavor for psychological study. (p. 6)

Sternberg and Lubart raise an important criticism; specifically they draw attention to the need to maintain a balance between research and practice. Research that is not guided by insights gained through practice may be unrealistic and of little practical value to organizations. While practice without research may result in products and educational experiences that are well-packaged but have no true substance; it may be that such creativity programs and methods act as nothing more than placebos that create the illusion of enhanced creativity. The purpose of this paper is to explicitly examine one applied creativity model, Creative Problem Solving (CPS), and to summarize the research evidence that demonstrates the positive effects of CPS training.

One of the major applications of CPS has been in organizational settings. Many writers have argued that employees' creativity is critically important to organizational innovation (e.g. Amabile, Burnside and Gyskiewicz, 1999; Amabile, Conti, Coon, Lazenby, and Herron, 1996; Basadur, 1995; VanGundy, 1987; West, 1997), and that innovation is essential to organizational success (Janszen, 2000). Ekvall (2000) reported that among various organizational philosophies and practices, creativity methods were believed by employees to have the second most positive impact on their creativity. Specifically, eighty-five percent of the engineers surveyed by Ekvall reported that creativity methods, like CPS, had a clearly positive influence on their creativity. Given the level of interest in promoting creativity in organizations, this review of CPS research is focused primarily on the benefits of CPS training for individuals in the workplace.

Creative Problem Solving: A Brief Overview

CPS is a model designed to capture the essence of the creative process. Using this approach, creative thinking can be deliberately applied to resolve open-ended problems. CPS is a structured methodology that is used to enhance creative thinking in individuals and teams. Given the applied orientation of the model, it is not surprising that it was a businessman who originally developed the CPS model. Alex Osborn (1953), introduced CPS in his seminal book *Applied Imagination*. Though the model and its guiding principles were first published in 1953, Osborn had applied creative problem-solving procedures, such as the

tool Brainstorming, in his advertising firm for many years prior to the release of his book. In the third and final version of his book, Osborn (1963) described CPS as a process comprised of three procedures: Fact-Finding, Idea-Finding, and Solution Finding.

It is important to make a distinction between CPS and Brainstorming. CPS is a model designed to make explicit the steps involved in the creative process. Brainstorming is a specific tool designed to enhance divergent thinking in groups. Brainstorming is one of many tools that are incorporated into the CPS process. In this sense the CPS model provides a framework for organizing tools that are used to carryout a range of activities associated with the creative process. Brainstorming has been primarily used to help groups engage in effective idea generation; however, many other tools are used in relationship to the various steps found within CPS.

Through his leadership Osborn established a creativity foundation (i.e., Creative Education Foundation) and an academic program (the International Center for Studies in Creativity at Buffalo State College) in Buffalo, New York, USA. Though Osborn passed away in the mid-1960s developments of the CPS process continued through his colleagues at the creativity foundation and faculty within the academic program. Osborn's chief collaborator was Parnes. The changes to the CPS model that have taken place over the years can be seen in the work of Noller, Parnes, and Biondi (1976), Isaksen and Treffinger (1985), Isaksen, Dorval, and Treffinger (1994), Basadur (1995), Miller, Vehar, and Firestien (2001), and Isaksen and Treffinger (2004). Although different authors have variously expressed CPS, there are two basic characteristics that exist across all approaches. First, the CPS process is comprised of multiple steps that capture the basic operations associated with the creative act, namely the need to define problems, generate ideas, transform ideas into solutions, and construct action plans. Second, all CPS models show a balance between divergent (i.e., generating a diverse set of alternatives) and convergent thinking (i.e., screening, selecting and evaluating alternatives) in every step of the process. This dynamic balance between divergent and convergent thinking is the hallmark of CPS.

The Creative Studies Project: The Landmark Study

The most comprehensive examination of the efficacy of CPS was the Creative Studies

Project conducted by Parnes and Noller (Parnes, 1987; Parnes and Noller, 1972a; Parnes and Noller, 1972b; Parnes and Noller, 1973). Participants in this study, freshman college students, were randomly assigned either to an experimental or control condition. The experimental group participated in four college-level creativity courses over a two-year period; CPS was the main process model taught as part of this curriculum. To assess the effects of this training, Parnes and Noller administered a battery of paper-and-pencil tests before, during and after the sequence of creativity courses. These measures included tests of cognitive ability drawn from Guilford's Structure-of-the-Intellect (SOI) model, personality measures, tests of problem solving and decision making skills, and college English tests.

Students who participated in the creativity courses showed significantly higher levels of performance across a large number of the measures. In regard to cognitive abilities, for instance, the students from the creativity courses showed significant gains on tests of cognition, divergent production, and convergent production. Those in the experimental group also outperformed the control group on creativity-related tests given as part of their English courses and showed greater levels of coping and problem-solving skills.

Many studies have examined the impact of CPS in educational settings. For more information on these studies see Torrance (1972), Torrance and Presbury (1984), Rose and Lin (1984), and Parnes and Brunelle (1967). A series of articles reporting on the meta-analytic evaluation of creativity training is also an excellent source for information on the impact of CPS (Scott, Leritz and Mumford, 2004a, 2004b). Scott et al. (2004a, 2004b) conducted their quantitative review of creativity training to examine whether such training indeed had positive effects. After evaluating a wide range of studies, that included investigations both in organizational and school settings, these authors (Scott et al., 2004a) concluded that among the various training programs CPS proved to be one of the most successful.

Since we know of no other paper that has provided a review of CPS training in organizational settings, and given the fact that many have argued that creativity is critical to organizational and professional success, this review paper highlights the impact of CPS training and application in the workplace. This review also includes studies carried out with university students who are employed in full-time jobs, as well as with students who worked on business related tasks. The criteria used to identify the literature to be included in

this paper were as follows: (1) training had to involve the full CPS process, not merely a tool or two; (2) for uniformity the CPS framework used for the purposes of training had to be based on the Buffalo, New York, tradition (see Basadur, 1995; Isaksen and Treffinger, 2004; Osborn, 1953); (3) the research participants had to be drawn from organizational settings or involve students working on real-business challenges; and (4) the impact of training had to be either empirically examined or explicitly documented. With these criteria in mind, an exhaustive literature search was conducted on a number of databases including Academic Search Premier, ERIC, PsychARTICLES, PsychINFO, and Educational Abstracts. An overall search for creativity-related literature yielded 42,537 hits. The search term Creative Problem Solving produced 1,366 hits. The number of published studies that met all four criteria cited previously was 17. This paper provides a review of these studies, as well as commentary on documented applications of CPS in organizational contexts. Table 1 provides an at-a-glance summary of these 17 published works, as well as two unpublished studies (Keller-Mathers, 1990; Puccio and Lehrberger, 1999).

Creative Problem Solving Training and Its Impact in the Workplace

Studies of the impact of CPS in the workplace can be broadly sorted into three categories; the influence on individuals' attitudes, the impact on individuals' behavior, and the effects on groups. Some researchers have focused their efforts on examining whether CPS training can alter employees' attitudes. The main question of interest in these studies is to what degree does CPS training develop attitudes that are likely to foster creative behavior? For example, this research has examined the impact of CPS training on employees' openness to divergent thinking; that is the production of many diverse and original possibilities. A second area of CPS research has focused on a change in observable behaviors. Here, for example, researchers have assessed whether CPS training improves employees' cognitive abilities, particularly those thinking skills deemed to be critical to the production of creative ideas, while others have examined whether CPS training improves behaviors related to job performance. Finally, some researchers have explored the impact of CPS training within the context of group work. These three areas of impact are reviewed in turn.

Table 1. Summary of the Sources Cited in this Review

Author (date)	Duration of Training Program or Nature of Application	Participants	Key Outcomes (when DV measured)
Basadur, Graen and Green (1982)	Trained group received two days of CPS training. Study involved placebo and control groups.	45 engineers, engineering managers and technicians	Trained participants showed significant improvement in regard to preference for ideation, practice of ideation and performance in problem finding. (Dependent variables measured two weeks after training.)
Basadur, Graen and Scandura (1986)	24 hours	112 manufacturing engineers (65 from diverse locations and 47 from intact work groups)	Training improved participants' attitudes towards divergent thinking. Impact higher for participants from intact groups. (DV measured 5 and 10 weeks after training.)
Basadur and Hausdorf (1996)	3 days	Business students (n = 522), Middle and lower management (n = 218)	Training significantly enhanced preference for ideation. (DV measured before and after training.)
Basadur, Pringle and Kirkland (2002)	Experimental group received half-day training in CPS. Placebo group received half-day training. Control group received no training.	Spanish-speaking South American managers. Experimental group (n = 149). Placebo group (n = 19). No-training control group (n = 68).	Training participants showed a significant increase in preference for ideation and decrease in tendency toward premature critical evaluation. (DV assessed before and after training.)
Basadur, Pringle, Speranzini and Bacot (2000)	12 days	Union-management bargaining team (7 management representatives and 7 union representatives).	Before and after training measures showed positive shift in attitude towards divergence. Case study approach showed the application of CPS to the negotiation process enhanced trust and collaboration.
Basadur, Runco and Vega (2000)	20 hours	112 managers from a large international consumer goods manufacturer	Skill in generating options was shown to contribute to generating higher quality options and evaluating options. (DV measured before and after training.)

Table 1. *continued*

Author (date)	Duration of Training Program or Nature of Application	Participants	Key Outcomes (when DV measured)
Basadur, Taggar and Pringle (1999)	Experimental group participated in a two-day CPS workshop. Placebo groups participated in experiences of similar length.	Experimental group (36 managers). Two placebo control groups (11 managers, 35 business students).	Training significantly enhanced attitudes towards openness to new ideas, the value of creativity, and not feeling too busy for new ideas. (DV measured before and after training.)
Basadur, Wakabayashi and Graen (1990)	3 days	90 managers and 66 nonmanagers	The 'Optimizer' style of problem solving demonstrated strongest positive change with respect to attitudes towards divergent thinking. (DV measured before and after training.)
Basadur, Wakabayashi and Takai (1992)	CPS training conducted over 4 hours. Placebo groups participated in experiences of the same duration.	Experimental group (60 Japanese managers). Two placebo groups (47 Japanese managers; 15 faculty members and university students).	Training significantly increased preference for active divergence and decreased preference for premature convergence. (DV measured before and after training.)
Firestien (1990), Firestien and McCowan (1988)	Approximately 40 hours	Undergraduate students. Trained group consisted of 22 five-member teams. Untrained group comprised of 18 five-member teams.	Analysis of communication behaviors within teams showed that trained participants smiled more, criticized others' ideas less, supported others' ideas more, and laughed more often during a group problem-solving activity. (DV measured at end of course.)
Firestien and Lunken (1993)	Master of Science in Creativity, which involved approximately 160 hours of CPS training.	38 graduate program alumni	Graduates of the master's degree program reported greater levels of flexibility in how they approached challenges, greater willingness to take risks, and an ability to integrate creative thinking into their personal and professional lives. (Likely range from several months to more than a decade.)

Table 1. *continued*

Author (date)	Duration of Training Program or Nature of Application	Participants	Key Outcomes (when DV measured)
Fontenot (1993)	8 hours	Business people whose jobs required creative thinking and problem solving (34 participants in experimental group and 28 participants in control group)	Trained participants generated a significantly larger set of data when they examined a problem situation. They also generated significantly better problem statements. (DV measured before and after training.)
Kabanoff and Bottger (1991)	Two 80 minute session per week over a period of 10 weeks.	MBA students (32 in trained group and 44 in control group)	Trained participants experienced significant gains in originality. (DV measured before and after training.)
Keller-Mathers (1990)	Graduate course in CPS, approximately 40 hours of instruction	35 graduate students, most held professional positions	Pre and post-instruction assessment showed that students applied the CPS tools up to one-year after training. (DV measured at 3 months, 6 months and 1 year after training.)
Puccio and Lehrberger (1999)	One to one half-day workshop imbedded in a week long leadership development program.	92 managers from a large newspaper and magazine publisher	Among the topics covered during the week long leadership program, CPS was viewed as one of the most valuable. Participants cited numerous examples of how they had applied CPS. (Data collected between 5 and 18 months after training.)
Runco and Basadur (1993)	20 hours	35 managers	Post-training gains showed significant increases in fluency and originality in producing solutions, as well as improved ability in judgments about original ideas. (DV measured before and after training.)
Thompson (2001)	Case study report on the application of CPS to three different plant maintenance challenges.	Cross-disciplinary teams from three different manufacturing organizations.	Application of CPS successful in resolving three different maintenance problems. Seven maintenance managers successful in establishing CPS groups in a variety of industries (e.g., food, automotive, defense, etc.).

Table 1. *continued*

Author (date)	Duration of Training Program or Nature of Application	Participants	Key Outcomes (when DV measured)
Wang and Horng (2002)	18 hours of CPS training spread over a year-long period	R&D workers (106 in experimental group; 35 in control group)	The training groups' fluency and flexibility increased significantly, as well as the number of co-authored service projects. (DV measured between 6 and 11 months after training.)

Changing Attitudes

Basadur has led the way in investigations focused on evaluating the effect CPS training has on employees' attitudes. Basadur's program of research spans more than two decades and a number of continents. To carry out his investigations, Basadur developed and tested scales useful in assessing employees' attitudes towards divergent thinking (Basadur and Finkbeiner, 1985; Basadur and Hausdorf, 1996). Over the years Basadur has examined five specific attitudes. The two original scales were Preference for Active Divergence and Preference for Avoiding Premature Convergence (Basadur and Finkbeiner, 1985; Basadur, Runco and Vega, 2000). More recently, Basadur developed three new attitude scales: Valuing New Ideas, Creative Individual Stereotypes, and Too Busy for New Ideas (Basadur and Hausdorf, 1996). Why the interest in changing employees' attitudes? According to Basadur, Taggar and Pringle (1999) 'unless attitudes toward divergent thinking are positive or become positive, training in creative problem solving involving divergent thinking is not likely to result in changes in behavior back on the job' (p. 78). Basadur, Runco and Vega (2000) empirically tested the hypothesized relationship between divergent thinking attitudes and development of creative-thinking skills. Using a casual model, these researchers found that changes in individuals' Preferences for Avoiding Premature Convergence was particularly effective in predicting gains in ideational and evaluation skills. For a similar study see Runco and Basadur (1993).

Basadur has carried out a series of studies in which he has experimentally tested the degree to which training in CPS changes employees'

attitudes (e.g., Basadur, Graen and Green, 1982; Basadur, Graen and Scandura, 1986; Basadur and Hausdorf, 1996). In his original study, Basadur worked with members of an engineering department within a large manufacturing company. The employees were placed in one of three study groups: trained (i.e., participants received two-days of CPS training); placebo (i.e., participants watched a film on creativity and afterwards took part in a 20 minute discussion); and control group (i.e., participants received no creativity training whatsoever). Post-study measures administered two-weeks after training showed that employees who received CPS training had a significantly higher preference for active divergence. In a subsequent study with engineers from a large consumer goods manufacturing company, Basadur, Graen and Scandura (1986) found once again that CPS training significantly enhanced employees' attitudes towards active divergence, as well as a tendency to avoid premature convergence. Employees' bosses also reported witnessing these positive changes in attitude. Analysis revealed stronger training effects among those employees who attended the program with colleagues from the same work site. In a more recent study, Basadur, Taggar and Pringle (1999) demonstrated, through a quasi-field experiment, that managers who participated in a two-day CPS training program expressed greater appreciation for new ideas, believed that creativity was not limited to a rare few, and valued the time required to develop new ideas.

Basadur expanded his research on CPS training and attitudes by replicating his work in other cultures and by investigating whether individuals with certain creative problem-

solving styles were more likely to shift their attitudes towards divergent thinking after training. Basadur showed that significant changes in attitude after CPS training could be achieved among managers in Japan (Basadur, Wakabayashi and Takai, 1992) and South America (Basadur, Pringle and Kirkland, 2002). In regard to creative problem-solving styles Basadur suggested that individuals whose natural inclinations were furthest from the nature of the CPS training would experience the greatest shift in attitude. Specifically, Basadur, Wakabayashi and Graen (1990) hypothesized and found that individuals whose natural preference was to develop solutions, as opposed to spending time discovering problems and playing with ideas, experienced significantly greater gains in preference for active divergence after CPS training.

Changing Behavior

Studies focused on changing behavior have examined how effective CPS training has been in enhancing creativity-related abilities, such as those skills associated with divergent thinking (i.e., fluency, originality and flexibility in thought) or with the creative process (i.e., problem finding, evaluating ideas, etc). Other studies within this area of focus have looked at how CPS enhances behaviors related to performance at work. As with research into attitudes, Basadur has also been one of the chief investigators of the effects of CPS training on skills. In fact, a number of his studies on attitude also included variables related to skill acquisition (e.g., Basadur, Graen and Green, 1982; Basadur, Runco and Vega, 2000; Runco and Basadur, 1993). Using before and after training designs, Basadur has shown that CPS training significantly improves such skills as generating many original solutions to problems (Basadur, Runco and Vega, 2000), accuracy in evaluating original ideas (Basadur, Runco and Vega, 2000; Runco and Basadur, 1993), fluency in generating solutions to problems (Runco and Basadur, 1993), enhanced ideation in problem finding (Basadur, Graen and Green, 1982), and improved problem-finding performance (Basadur, Graen and Green, 1982).

Kabanoff and Bottger (1991) tested the extent to which CPS training (i.e., a ten-week elective course) increased ideational fluency, flexibility and originality among MBA students with at least five years of work experience. Though there were gains in relationship to all three divergent-thinking abilities, these researchers found that the CPS training had its most profound effect on students' ability to

generate original ideas. Kabanoff and Bottger interpreted the training effects in the following way, 'The main difference between trained and untrained persons is the formers' willingness and capacity to defer judgment and not to exclude apparently strange, but original and potentially valuable ideas' (p. 143). Kabanoff and Bottger's study also included a personality measure. Analysis of this data showed that students enrolled in the creativity course differed significantly on several personality dimensions when compared to students in the control group. Specifically, individuals in the creativity course expressed higher scores for deference and lower scores on preference for achievement and dominance. Analysis showed that personality did not affect training outcomes.

Wang and Horng (2002) studied the impact of a 12-hour CPS course on R&D scientists and technicians. As with previous impact studies, these researchers found that training significantly improved divergent-thinking skills, specifically fluency and flexibility. Wang and Horng's investigation, however, went beyond divergent thinking and included an examination of the impact of CPS training on work-related performance. These researchers assessed three main indicators of R&D performance: number of papers published, number of technical reports written, and the number of service projects completed. R&D performance was measured 6 to 11 months after the employees completed the CPS course. Results showed a significant increase in the number of service projects completed by those who participated in the CPS training. Service projects, which are responses to customer complaints and technical problems, are one of the main job responsibilities of employees in this study. This study also yielded a curious result in regard to personality type. Though it is generally held that personality type is a stable trait (Myers & McCaulley, 1985), these authors found that pre and posttest comparisons of scores on the Myers-Briggs Type Indicator showed a significant shift from introversion to extraversion and from the thinking to feeling type among those who received CPS training.

Keller-Mathers (1990) conducted a study that assessed the degree to which participants in an introductory graduate course in CPS adopted creativity tools into their personal and professional lives. Keller-Mathers surveyed participants to determine their level of use of 13 different creativity tools prior to training and then at 3, 6 and 12 months intervals after training. Participants reported using a large number of tools both in their personal and professional lives up to one year after training. The tools that showed the greatest

level of transfer were Brainstorming, Idea Systems, Why/What's Stopping Me (i.e., a problem analysis tool), and the use of Invitational Stems for problem clarification (e.g., How to . . . , In what ways might . . . , etc).

Many of the studies reviewed thus far tended to focus on CPS training programs that lasted for no more than 30 hours and primarily looked at training effects immediately at the conclusion of the participants' CPS experience. The International Center for Studies in Creativity offers a Master of Science in Creativity and Change Leadership. This graduate-level program includes four courses with an explicit focus on CPS, which equates to approximately 160 hours of CPS training. Firestien and Lunken (1993) surveyed graduates of the program and used this information to report on the long-term effects of the training they received. Some of the key skill areas identified by graduates were improved sensitivity to problems, ability to make dramatic changes in their lives, and greater levels of flexibility in the ways they approached family, community and work problems. A number of other unpublished impact studies have been carried out on the courses and programs delivered through this Center, including the study carried out by Keller-Mathers described above (De Schryver, 1992; Hurley, 1993; Neilson, 1990; Pinker, 2003; Vehar, 1994).

Impact on Groups

The previous two sections of this paper focused on the impact of CPS training at an individual level of analysis; that is how CPS training changed a specific individual's attitudes and behaviors. CPS, however, is often applied in groups. The CPS model provides a framework through which group members can productively work together to resolve a complex problem. In fact, one of the primary ways in which CPS is deliberately and formally applied is in groups. The CPS framework provides a process that guides group members towards successful resolution of a challenge that requires creative thinking. Many creativity consultants offer facilitation services to clients that are based on the application of CPS. These consultants employ CPS to assist groups in developing new products, solving problems, creating strategic plans, developing vision statements, managing projects, etc. Though CPS is often applied in groups, few studies have measured the impact of CPS training at a group level. We will report on three studies that examined how CPS training has a positive effect on group work.

Fontenot (1993) conducted a study of the impact of CPS training on divergent-thinking

skills; especially as these skills are applied within groups engaged in the problem-finding aspect of the creative process. Fontenot set out to specifically test the degree to which an 8-hour CPS training program would significantly impact fluency in data finding, fluency in problem finding, flexibility in problem finding, and quality of the proposed problem statement. The business people in this study were randomly assigned to either a trained or an untrained condition. Working in small groups of three or four people, the participants were presented with a business case study and were asked to identify and define the problem associated with the case. Analysis showed that those trained in CPS significantly outperformed the untrained participants on all four problem-solving skills.

In a study designed to measure the effects of CPS training on the communication behaviors that occur in small groups, Firestien and McCowan (1988) and Firestien (1990) found that groups trained in a semester-long course in CPS (approximately 33 hours of instruction) responded more, i.e. got more involved in the group problem-solving process; criticized ideas less; supported ideas more; laughed more; smiled more; and produced significantly more ideas than the groups that did not receive training. Table 2 presents the communication behaviors analyzed in this study. All comparisons between trained and untrained groups were statistically significant. Though the study involved students as participants, the problem they worked on was a real challenge provided by a local business.

To undertake a cursory examination of the quality of the ideas created by the trained and untrained groups, two representatives from the organization that provided the business problem used a 100-point rating scale (0 = no value to 100 = maximum possible value) to evaluate the quality of the ideas generated by the students in the trained and untrained groups. These individuals worked independently to rate the ideas and did not know whether the ideas originated from trained or untrained groups. The expert raters' evaluation of the ideas were grouped together and the ideas were then sorted into five quality categories as follows: category 1 = 0–19 points; category 2 = 20–39 points; category 3 = 40–59 points; category 4 = 60–79 points; and category 5 = 80–100 points. Table 3 shows the distribution of the ideas across the five quality categories. As this table clearly indicates the trained groups generated many more ideas that were rated as holding the greatest possible value. Indeed, because the trained groups generated many more ideas in the allotted time period, they had more ideas along each point on the

Table 2. Effects of Creative Problem Solving Training on Communication Behaviors in Groups

Communication Behaviors	Mean Score for Untrained Groups (n = 18)	Mean Score for Trained Groups (n = 22)	F-Values
Total Responses	38.36	56.84	24.16 (p < 0.001)
Verbal Criticism	3.22	0.11	17.56 (p < 0.001)
Verbal Support	2.00	5.21	14.34 (p < 0.001)
Laughter	4.50	12.64	19.37 (p < 0.001)
Smiles	6.06	14.36	22.47 (p < 0.001)
Ideas Generated	14.00	27.32	40.72 (p < 0.001)

Table 3. Comparison of Quality of Ideas Generated by Trained and Untrained Groups

Quality Category	Untrained Groups	Trained Groups
5	281	618
4	500	1342
3	352	917
2	253	648
1	29	140

rating scale. As a consequence of generating so many more ideas, the trained groups outperformed the untrained groups in terms of the number of good and bad ideas generated. It would be useful for future research to build on this initial examination of quality output and incorporate more systematic methods for evaluating this potential positive effect of CPS training.

Basadur, Pringle, Speranzini and Bacot (2000) provided a case report on the application of CPS training to union-management bargaining. Before union-management negotiations proceeded, the 14-member negotiations team (i.e., 7 members representing the union and 7 representing management) participated in a 12-day CPS training program. During the negotiations the team deliberately employed aspects of their training to successfully resolve many issues, with the exception of those that related to monetary concerns. Basadur et al. reported:

For each non-monetary issue, emphasis on creating an expanded problem definition which incorporated high concern for satisfaction for both parties led to creative, integrative solutions. However, on the monetary issue, there was no effort devoted

to creative problem definition. The team reverted to zero-sum thinking and there was no opportunity to create a bigger pie. (p. 73)

These authors concluded that when Basadur's CPS model, called SIMPLEX, was explicitly used to guide negotiations, the process led to greater levels of trust, cooperation, and more creative solutions. However, when the process was abandoned, as was the case for the monetary bargaining issue, trust evaporated, no creative solutions were considered, and negotiations deteriorated into a lose-lose approach.

Real-World Applications of CPS

Another way of examining the efficacy of CPS is to demonstrate the successful application of this approach in organizational settings. The empirical investigations reported thus far provide evidence of the impact of CPS training through research investigations, many of which involved experimental designs. The value of such studies is that they are designed to inject scientific rigor into the study of the impact of CPS training – to go beyond mere testimonials and global commentary by participants involved in CPS training. As a result, many of these studies provide evidence intended to demonstrate cause-and-effect relationships between CPS training and various training outcomes. What these studies often lack is information that addresses the broader value-added benefits to organizations. For example, does the CPS process help teams successfully resolve real business challenges? Does the application of CPS increase profits or reduce costs? Do individuals trained in CPS use the principles and procedures in a way that directly benefits the organization? Answers to such questions can be found in examples of CPS applications in organizations. What follows are brief case examples

of the application of CPS in a variety of organizations.

Thompson (2001) documented the successful application of CPS in reducing plant maintenance costs. Thompson provided a detailed description of three case examples in which CPS was used to help teams identify specific ways in which costs might be reduced in a plant setting. For example, the CPS process was applied within Alcan Limited to resolve a machine problem. Through a facilitated application of CPS, a small team explored how they might reduce the regular maintenance required to operate a machine that delivered aluminium drink cans from one machine to another in the manufacturing process. Through the problem clarification stage of the process the group explored many potential causes that led to three specific topics worthy of further investigation. After further application of the CPS process, the group decided to focus their problem solving efforts on the redesign of the machine. It was during the exploration of ideas for a redesign of the machine that the group discovered the principal problem. The group realized that the movement of the can on a pin used to carry the product was the primary cause of the maintenance problems. By focusing their idea-generation efforts on the pin, the group was able to come up with a cost effective solution to a persistent problem.

Thompson (2001) also reported the successful application of CPS to a problem within Quaker Oats. This CPS session began by examining the problem of why there were syrup blockages in a heat exchanger unit. Problem clarification resulted in a more refined statement of the problem that led the team to focus on the predissolver, the machine that passes the product onto the heat exchanger. A number of potential solutions were examined and as a result of the application of an itemized evaluation tool (e.g., breaking a potential solution down into its advantages, limitations, and unique features) the team decided the most feasible solution was to introduce an intermediate heat exchanger between the predissolver and the heat exchanger. The costs of annual maintenance associated with this problem was estimated to be £17,000 and with lost production taken into consideration £42,500. According to Thompson, 'No solution to the problem had been forthcoming that met with general acceptance until the CPS exercise. Therefore, the outcome of the CPS study was significant' (p. 193).

Similar to Thompson's positive experiences in industrial settings, Firestien (1996) reported that the application of CPS to a persistent maintenance problem within a US forge plant

resulted in cost reduction of \$40,000 per week. During a CPS training session, employees at an automotive forge plant focused their problem-solving efforts on finding a way to prevent the steel gears made at their plant from sticking in the die and as a consequence breaking the dies. During an idea generating session, participants were asked by the facilitator, 'How can we use something that does not relate to this problem to help find a solution?' One of the participants made an association between sticking gears and food sticking on pans while cooking. The participant suggested using PAM, the aerosol cooking oil spray, to prevent the sticking. Through group discussion this initial idea was transformed into a workable solution. As a result, plant operators began to use a \$1.00 spray bottle and \$0.50 worth of soap and oil solutions to spray the dies before making the gears. This solution rectified the situation and saved the plant thousands of dollars.

Beyond the specific case examples, such as the three described above, Thompson (2001) provided an overview of the positive outcomes and benefits derived from his observations of maintenance managers who had been trained to lead groups through the CPS process. After their training, these managers conducted CPS sessions in such areas as overall plant maintenance, machine level problems, and new maintenance software design. According to Thompson, 'No CPS session was a failure' (p. 194). Some of the general outcomes and benefits associated with these sessions were: CPS was accepted by every group; groups valued the balance between divergent and convergent thinking; teams accepted ownership of the outcomes of the sessions; the experience created a high degree of job satisfaction; and departmental morale and individual self-esteem improved.

According to Firestien (1996) a CPS session produced a solution that brought in millions of dollars to a hospital in the United States. When Janet DiClaudio, Director of Medical Records, joined Candler Hospital in Savannah Georgia, 300 medical records were backlogged, and doctors were not coming to the Medical Records office to sign them. As a result, the hospital was unable to bill millions of dollars worth of services. To overcome this challenge, a CPS session was conducted. The challenge was defined initially as 'It would be great if we could get doctors to sign off on their records regularly and consistently'. As the group gathered data about the problem, they observed that the Medical Records office was some distance from where doctors typically congregated – the doctor's lounge. Some of the potential solutions generated during the

idea generation stage of the process focused on the location of medical records in relation to the doctors' lounge. Another set of ideas focused on ways to reward doctors for completing their records. The final solution involved a synthesis of these two ideas – that is, the group decided the best solution was to put a desk outside the doctors' lounge and reward doctors with graham cracker cookies for signing their records. As a result of moving a desk staffed with one Medical Records employee outside the doctors' lounge, the hospital billed \$4.5 million in backlogged records and has regularly reduced monthly accounts receivables by \$3.5 million.

Puccio and Lehrberger (1999) conducted an impact study of leadership development program within a large media company in the United States. CPS was one of six areas covered during this week-long training program. Surveys were distributed to 348 managers who had attended the training program; responses were received from 92 individuals. The range in time since the respondents had attended the training program was between 5 and 18 months. One question in the survey asked respondents to rate the degree to which they applied what they learned during the training program. The response scale ranged from 1 (not at all) to 5 (very often). CPS received the highest mean rating of 3.70. Respondents were asked to provide examples of how they applied aspects of the course. Numerous stories were offered, from the use of CPS to increase employee morale to the creation of new product ideas. For example, one participant reported the following:

I led a session at work on how we might improve our paper based on the results of a readers' survey. We used brainstorming to incorporate input. Several features of the paper were instituted as a result. I also use CPS to come up with new ideas for cover stories that are scheduled months in advance. The process creates a more positive environment because no one has to worry about getting shot down. (p. 67)

We shared the case examples of the application of CPS to provide a richer description of the benefits of this process. These brief case descriptions provide only a glimmer into the broad range of positive consequences associated with the application of CPS in real settings. There are numerous CPS practitioners, trainers, facilitators, and consultants. These individuals apply their skills in an ever increasing range of organizations, from schools to manufacturing sites, from hospitals to police departments, from museums to advertising firms. Given the extensive reach

and use of CPS, it would be highly beneficial if greater, more systematic, effort were focused on distilling and documenting the benefits of applying CPS in organizational contexts. A study that provides an excellent example of how these broader, more contextual, investigations might be conducted is found in Sutton and Hargadon's (1996) ethnographic study of the American design firm IDEO. The purpose of the study was to discover how this design firm could maintain such high levels of creativity for so many years (i.e., consistently produce innovative products). After a year-long study, these researchers concluded that IDEO's use of Brainstorming created a culture and ethos that inspired innovative design concepts. Studies that assess Brainstorming within laboratory settings do so within artificial environments and thus information derived from such settings cannot fully capture the value of this tool as it is applied in real groups and organizations. The results of Sutton and Hargadon's research, for example, revealed numerous beneficial outcomes of Brainstorming beyond the classic focus on whether Brainstorming groups generate more and better ideas than groups following other strategies (e.g., Nominal Brainstorming). Some of the broader implications of the use of Brainstorming in IDEO included: enhanced organizational memory of design solutions, improved acquisition of skill variety among designers, the positive climate found in Brainstorming sessions made a positive impression on clients, etc. Researchers interested in the impact and value of CPS would do well to pursue investigations of CPS as it is applied within organizational contexts, much like Sutton and Hargadon's ethnographic study of Brainstorming.

Conclusion

Creativity is a concept that is not well bounded. It is so ubiquitous that it is easy to relate creativity to all fields of endeavor. Many view creativity as a soft, fuzzy concept that is not easily understood. The word itself is often misapplied or used simply as a marketing ploy. To be a creativity expert one merely has to profess oneself as such. Given the air of mysticism often associated with creativity, it becomes critically important for those interested in teaching or training creativity to provide evidence that such programs attain their intended results. In a young field which has precious few oversight bodies or governance systems, it is imperative for research and practice to complement and guide one another. The purpose of this paper

was to demonstrate how one applied model, CPS, has endeavored to balance application with research.

Though CPS may be one of the applied creative process models that has received clear attention from researchers, there is still much work to be done. For instance, there would appear to be many more people who are applying CPS than those who are investigating or documenting the impact of CPS in organizational settings. It would be beneficial if greater effort were devoted to the dissemination of the various ways in which CPS is being applied in organizations, along with the outcomes of such efforts. Thompson's (2001) case study approach serves as an excellent example of how this type of work might be reported. Thompson's case examples provide detailed descriptions of how the CPS process was applied to plant maintenance problems. In these 'real-life' examples Thompson described precisely how the CPS process helped the participants successfully resolve these maintenance issues. Thompson also offered his observations about how the CPS process was received by those who worked in the plant environment.

Additionally, it would also be useful for investigators to compare training effects across different creative process models. Do they all produce similar effects? Do some models work best under certain conditions, on particular kinds of tasks or with certain types of people? Do particular process models yield unique outcomes?

Finally, since most studies were limited to examining effects immediately at the conclusion of training (see last column in Table 1), there is a need to look at the longer-term outcomes of CPS training. How long do training effects last? What aspects of training have longer-term effects? It would also be valuable to broaden the scope of attitudes, behaviors and other outcomes that might be directly impacted by CPS training. Such studies should go beyond the impact of CPS training on the individual and should consider how CPS training affects a team or unit within an organization. For instance, does CPS training improve work group climate, communication, interpersonal relationships, problem-solving outcomes, etc.? We hope that our review and synthesis of the CPS literature will serve as a catalyst for future work in organizational settings.

Note

Early drafts of this work were presented by the first author at the Creativity in the Workplace

– Summer School, hosted by the Ministère de l'Éducation Nationale and Institut de Psychologie, Université René Descartes – Paris 5, Paris, France in 2003 and by Firestien, Coyle and Masucci at the 50th Creative Problem Solving Institute in 2004. A more recent draft was presented at the 1st Creativity and Innovation Management Community Workshop, Oxford, United Kingdom, March 2005.

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