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Research Article

Understanding Creativity

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Creativity has become highly valued in all aspects of life. Several decades ago the debate about creativity centered on whether creativity could be enhanced, or if it was something you were born with. Now researchers seem to be consistently proclaiming that it can. But the results are far from uniform. Even the programs with the most consistent record fail far too often to instill confidence, and other, often very popular programs, have a dismal record. From Creative Problem Solving to the Purdue Creative Thinking program, and from de Bono Thinking to Synectics and TRIZ. Which has the best record? Why? Why are they not more consistent? Are there other approaches that might improve these creative cognition enhancement approaches? This review uncovered those questions, and while it doesn't propose to present answers, it does attempt to point the way for future research to shed a little more light on the mysteries of creativity. It also proposes that all of these fragmented results may make a little more sense – and may begin to look like pieces of one whole, rather than discrete, conflicting data points – under the light of a Complexity Theory of Creativity.

Understanding Creativity

Over 40 years ago Paul Torrance (1970) commented that "Children are so accustomed to the one correct or best answer that they may be reluctant to think of other possibilities or to build up a pool of ideas to be evaluated later." Despite his best efforts, and the efforts of many others, creativity scores are declining in the United States (Kim, 2011). Could North America be losing a creativity race? A race we may not even know we're in? A race that may be more important than most of us realize?

In *A Whole New Mind* Daniel Pink (2006) argues that the "advanced" world is undergoing a shift from the information age to a conceptual age and that it is inventive, creative, and empathetic people who will thrive in this new world. "The most creative among us see relationships the rest of us never notice. Such ability is at a premium in a world where specialized knowledge work can quickly become routinized work – and therefore be automated or outsourced away" (p. 135). James Kaufman and his

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colleagues (2008) noted in *Essentials of Creativity Assessment* that "Because creativity, specifically the ability to solve problems creatively, is so universally useful, its relationship to any construct or aspect of human life is worthy of study" (p. 126). It seems to be universally acknowledged that creativity is a desired trait; it is the most used – over used? – word in LinkedIn profiles. According to Erick Schonfeld in *The Rise of the "Creative" Class* (2011) "In a time of high unemployment when traditional skills can be outsourced or automated, creative skills remain highly sought after and highly valuable. We all want to be part of the creative class of programmers, designers, and information workers. The term used to mean artists and writers. Today, it means job stability."

Most mainframe computer manufacturers disappeared in the space of about a year; the entire life cycle of the video rental business was barely more than two decades[1]; publishers of printed works have either reinvented themselves, or died; the music industry has been transformed, seemingly overnight; commonplace products, such as the thermostat and the smoke detector, are being given a new lease on life through enhanced functionality, coupled with an improved user interface and attention to aesthetic appeal, and they're commanding amazing price premiums for getting it right (see, for example, www.nest.com/ca/); the once proud Canadian technology giant – Nortel – is now but a memory, and Blackberry seems destined to follow; cars are becoming entertainment centres and communication hubs, that can also get you where you want to go, while looking great doing it. "Innovate or die" isn't just a catchy slogan. It seems that everywhere you look these days the business landscape is littered with the burned out hulks of those companies that didn't see change waves coming – even when they were tsunamis – or couldn't move quickly enough, or just weren't innovative enough. Their death and decay stands in sharp relief, starkly contrasting with their high-flying slayers; the rising stars – or, possibly, shooting stars... time will tell – of the corporate jungle. So it should come as little surprise that an IBM survey of 1,500 CEOs from around the world found that creativity was the number one thing that had to be instilled throughout an organization in order to be successful (IBM, 2010). These CEOs valued creativity over management discipline, integrity, even over vision.

In *Rise of the Creative Class – Revisited* Richard Florida (2012) suggests that we are undergoing a change at least as dramatic as the industrial revolution:

> It wasn't just the Internet, or the rise of new technologies, or even globalization that were upending our jobs, lives, and communities, though all those things were important. Beneath the surface, unnoticed by many, an even deeper force was at work—the rise of

creativity as a fundamental economic driver, and the rise of a new social class, the Creative Class (p. vii).

But it's not just corporations and the economy that need and value creativity. The human race faces global issues unprecedented in scope, scale and complexity. Complex political, social, resource, and environmental issues demand our most creative solutions, or entire societies – if not the entire human race – may go the way of the mainframe computer. Karpova, Marckett, & Barker (2011, p. 53) concluded that "Creativity becomes the focus when preparing current students and future citizens to deal with uncertainty and to adapt to continuous change both personally and professionally" and Csikszentmihalyi (1996, p. 4) noted that "for better or for worse, our future is now closely tied to human creativity." Arnold Toynbee in *Is America neglecting her creative minority?* said:

> This is all-important, because the outstanding creative ability of a fairly small percentage of the population is mankind's ultimate capital asset... the work of creative spirits is what gives society a chance of directing its inevitable movement along constructive instead of destructive lines (in Taylor, 1988, pp. 112-113).

So much of what makes life worth living are creative pursuits. Csikszentmihalyi (1996) found in his research that "When people are asked to choose from a list the best description of how they feel when doing whatever they enjoy doing most... the answer most frequently chosen is 'designing or discovering something new'." (p. 108). He went on to conclude that "Even though personal creativity may not lead to fame and fortune, it can do something that from the individual's point of view is even more important: make day-to day experiences more vivid, more enjoyable, more rewarding" (p. 344). In summing up their conclusions about creative endevours Scott, Leritz, & Mumford, (2004, p. 361) stated that "Few attributes of human performance have as much impact on our lives, and our world, as creativity". In discussing beliefs and misconceptions about creativity Sawyer (2012, p. 409) noted "Creativity is a healing, life-affirming activity. This belief is supported by the research".

If creativity could be the factor that keeps us all alive, and figures prominently in making life worth living, it follows that we should want more of it. But, is creativity a genetic gift bestowed upon some fortunate souls while others are left wanting, or is it something that can be nurtured in all of us? Can creativity be taught? Can it become, for each of us, an endless renewable resource that can be tapped into at any time? These are the questions that this review seeks to explore.

This review purposely took a broad view, casting a wide net in order to, perhaps, allow previous attempts at practical application to inform the theoretical. That is, to see if the research concerned with implementing creativity enhancement techniques paints enough of a picture for an existing creativity theory to emerge from the partially completed brush strokes, or if another picture may be emerging on creativity's canvas.

Challenges

"Solomon (1990), drawing from survey data, found that 25% of the organizations employing more than 100 people offer some form of creativity training" (in Scott, Leritz, & Mumford, 2004, p. 361). The perceived need for creativity has led to a proliferation of creativity enhancement programs, yet the research has not kept pace, leading to the potential for creativity "snake oil salesmen" and wasted time and resources (Puccio, Firestien, & Coyle, 2006). Some creativity enhancement methods have become quite popular, even with little research to support their use; for example de Bono's *Parallel Thinking and Lateral Thinking* (Sternberg & Lubart, 1999). On the other hand, many approaches that appear to offer a great deal of potential are virtually unheard of outside of academic circles, and some with great potential are rarely discussed even amongst creativity researchers.

One of the reasons that research on the enhancement of creativity has not kept pace with the rise in the number of programs may be the challenges inherent in the study of the enhancement of creativity. Particularly troublesome have been the definition of creativity and the assessment of creativity.

Definition

While most creativity researchers agree that the standard definition of creativity requires both originality and effectiveness, this definition leaves open the definition of the terms *originality* and *effectiveness*. It also does not address the question of who is to judge *originality* and *effectiveness*, or how (Runco & Jaeger, 2012).

Many creativity researchers differentiate levels of creativity by categorizing people or their creative products as either Big C or little c. But creativity is not a dichotomy, being either big or little – any more than it has three states – none, a little bit (little c), or a lot (Big C). There is a wide range of creativity unaccounted for between these dichotomies. The addition of "Pro c" and "mini c" (Kozbelt, Beghetto, & Runco, 2010) only confound the matter, resulting in more definitions of creativity. Creativity exists on a continuum (Amabile, 1996). If it were to be assigned an absolute scale from 0 to

100, 0 might represent the creativity of a rock, while 100 might represent the creativity of the primordial intelligence (or whatever conception of 'god' one may have... or whatever next best concept of the ultimate creative force one's less-than-100-on-this-creatvity-scale creative brain can come up with...) and creative theorists could spend countless hours discussing where the likes of Michelangelo, Da Vinci, and Einstein should fall on this scale – or, for that matter, where Big C, little c, pro c and mini c should land on this ultimate creativity scale. But this paper was written with more practical matters in mind. So, while I agree with Amabile's (1999) definition:

> A product or response is creative to the extent that appropriate observers independently
> agree it is creative. Appropriate observers are those familiar with the domain in which
> the product was created or the response articulated. Thus, creativity can be regarded as
> the quality of products or responses judged to be creative by appropriate observers, and
> it can also be regarded as the process by which something so judged is produced (p.33).

There is also value in Plucker, Beghetto & Dow's definition (2004, p. 90): Creativity is "the interaction among *aptitude, process, and environment* by which an individual or group produces a *perceptible product* that is both *novel and useful* as defined within a *social context*".

It should be clear that if a definition of creativity cannot be agreed on, it makes it challenging to assess. And if you can't assess creativity, how can you tell if a four-hour seminar on parallel thinking, or a two semester course covering meta-cognition and creative problem solving, along with other cognitive techniques and real-world exercises, actually do what they claim to do – enhance creativity?

Assessment

While there are issues related to the definition of creativity, many researchers have agreed that a creative idea or product is one which is *novel* or *original* and *useful*, *adaptive* or of *value* (Carson, 2010, p. 5). However, even if this definition of creativity is accepted, assessment remains an even more contentious issue. Torrance and Guilford have been advocates of simple tests that can be easily administered in a classroom setting and evaluated by anyone who takes the time to become familiar with the evaluation method. Other approaches have included personality inventories, biographical inventories, and behavioural tests.

Creativity research has been hampered by what is referred to as the criterion problem. "An absolute and indisputable criterion of creativity is not readily available (there is no one, single magic number or

test)" (Kaufman, Plucker & Baer, 2008, p. 53). This led Amabile (1977, 1996) to develop the Consensual Assessment Technique (CAT). The CAT consists of a number of judges, familiar with the domain in question, independently evaluating and ranking creative works.

While Amabile originally felt that the assessors did not have to be experts in the domain, they merely needed to be familiar with it (Amabile, 1977), years later she had concluded that experts were required (Hennessey & Amabile, 2010). However, it seems that, in practice, CATs were being performed with domain experts all along, (Kaufman et al., 2008), presumably because other researchers always felt there was a need for the assessors to be experts.

Amabile's CAT is considered one of the most effective means of assessing creativity (Kaufman et al., 2008).

> This particular method has been used extensively in creativity research. Because (a) it is based on actual creative performances or artifacts; (b) it is not tied to any particular theory of creativity; and (c) it mimics the way creativity is assessed in the 'real world,' the CAT has sometimes been called the 'gold standard' of creativity assessment (Carson 2006, p. 55).

While the CAT may mimic the way creativity is assessed in the real world, it does not mimic the way creative products are developed in the real world. The laboratory-like conditions and/or approach to these studies leaves little room for intrinsic motivation.

With respect to application of the CAT, Kaufman et al. (2008) state that "if you really don't care about the domain, then the choice of task is especially easy. You want a task that anyone can do at some level and that will not favor any group of subjects inappropriately" (p. 72). In this review of the literature, it appears that the creative efforts being asked of the participants (most often poetry writing or collage making) would typically favour groups of students inappropriately. The creative math or science student may not perform well on either of these common CAT tasks, and while some participants may be intrinsically motivated by these tasks, others would not be.

Amabile's research has indicated that extrinsic constraints tend to lower creativity scores, while intrinsic motivation tends to lead to increases in creativity. Yet there does not seem to be any CAT-based creativity research where the participants are given a choice in the task. Why not allow most (or more) participants to be intrinsically motivated by giving them choices; not just on the task performed, but also on the time when the task is completed and how long is spent on the task?

Allowing for a choice in domain and choice regarding time should reduce any possible confounding effect of intrinsic motivation.

The CAT has been used with a diverse range of tasks, but Kaufman et al. (2008) conclude that "the artifacts still must be of the same kind, however (e.g., poems, or all collages, or all stories). You cannot mix different kinds of artifacts and have expert judges produce meaningful comparative ratings of creativity. (To do so would be rather like asking which is more fruity, apples or oranges.)" (p. 67). I disagree. Of course we can compare apples and oranges – the former tend to be red or green, while the later are usually orange. We could compare apples and oranges on many different levels: colour, acidity, texture, sweetness, growing environment, etc. Similarly, the creativity of van Gogh's *Starry Night* could be evaluated and compared to the creativity of Walker's *The Color Purple*. One may question the validity and reliability of such a survey, but the comparison is possible.

Amabile's approach can be more time consuming and challenging to implement. The studies employing this approach use simplistic creative products which may not be representative of real-world creativity, and the subject only has the opportunity to be creative in one domain, which may not be the domain in which they feel most comfortable expressing their creativity. While the Torrance Tests for Creative Thinking (TTCT) give subjects multiple ways to express their creativity, the exercises do not require real-world creativity and many authors claim that TTCTs are only tests of divergent thinking, which may be a necessary, but not sufficient, ability for creativity. The TTCT also does nothing to evaluate usefulness, or value. While Amabile's approach doesn't explicitly evaluate usefulness, there is an implied *value* when a panel of independent judges evaluates a product as creative.

Regardless of the pros and cons of various approaches, the TTCT is the most commonly used measure of creative potential. Having a history of over fifty years, it has been used in many thousands of studies and it has a norms database based on tens of thousands of subjects. It is also the basis of a large longitudinal study spanning fifty years.

Given the popularity of this approach, its evaluation categories are referred to frequently in the literature and therefore they are defined here. Torrance, Ball and Safter (2008) provide the following:

- Verbal; the verbal TTCT is composed of written responses to questions posed about an illustrated scene in the response booklet.

- Figural: the figural TTCT consists of constructing pictures based on partially completed pictures, lines, or shapes, and giving the completed picture a title.
- Fluency: "the number of ideas a person expresses through interpretable responses that sue the stimulus in a meaningful manner" (Torrance, Ball & Safter 2008, p. 5).
- Flexibility is a measure of the subject's tendency to "break-set" or resist inertia in thinking and is scored based on the number of categories used in responses.
- Originality "is based on the statistical infrequency and unusualness of the response." (Torrance, Ball & Safter, 2008, p. 7).
- Elaboration is a measure of the tendency to go beyond the minimum required.

Cognitive Approaches

Given the wide range of factors that have been shown, or theorized, to have an effect on creativity, it is not surprising that a multitude of programs have been developed to enhance creativity; however, the vast majority of these have been cognitive programs related to the creative process. Some of the more popular of these are reviewed here, while less common cognitive approaches, and those lacking in research studies, are briefly discussed at the end of this section.

Brainstorming

In 1938, Alex Osborn began developing techniques to enhance idea generation at his advertising firm. He had found that, on their own, individuals were not coming up with the quantity, or quality, of ideas he felt they were capable of, and that conventional meetings seemed to be hampering idea generation (Amabile, 1996; Osborn 1952, 1963).

Osborn formalized his observations as a set of rules for an idea generation technique and coined the term brainstorming. Osborn (1952, 1963) published his set of rules for the now-famous technique in his seminal work *Applied Imagination*:

1. Criticism is ruled out. Adverse judgment of ideas must be withheld until later.
2. "Free-wheeling" is welcomed. The wilder the idea, the better; it is easier to tame down than to think up.
3. Quantity is wanted. The greater the number of ideas, the more the likelihood of useful ideas.
4. Combination and improvement are sought. In addition to contributing ideas of their own, participants should suggest how ideas of others can be turned into better ideas; or how two or

more ideas can be joined into still another idea. (Osborn, 1963, p. 156)

In 1954 Osborn founded the Creative Education Foundation and in 1955 he began a collaboration with Dr. Sidney J. Parnes, which led to the Osborn-Parnes Creative Problem Solving Process (see next section). Osborn (1963) cites many examples of success with brainstorming, but he does not cite any scientific studies that specifically focused on brainstorming, largely because he viewed brainstorming as just one step in a larger process:

> In summary, let's put group brainstorming in its place. For one thing, it is only one of the phases of idea-finding which, in turn, is only one of the phases of the creative problem-solving process. And let's bear in mind that group brainstorming is meant to be used—not as a substitute—but as a supplement. (p.191)

On the other hand, Stein (1975) notes that "Brainstorming is the most researched of all the procedures for creative problem solving." The research clearly supports the notion that brainstorming results in more ideas than techniques that allow or encourage judgment or evaluation during idea-generation. However, in terms of the quality of ideas resulting from brainstorming, the results are less conclusive, with some research supporting brainstorming, while other research shows no improvement when applying the technique. Research has also shown that group brainstorming holds no advantage over individual brainstorming (Scott, Leritz, & Mumford, 2004; Stein, 1975), fact which Osborn (1963) seemed to be well aware of:

> Despite the many virtues of group brainstorming, individual ideation is usually more usable and can be just as productive. In fact, the ideal methodology for idea-finding is a triple attack: (1) Individual ideation. (2) Group brainstorming. (3) Individual ideation. And, of course, each of these procedures can be far more productive if the deferment-of-judgment principle is consistently followed. (p. 191)

There are many challenges to effectively researching the premises of brainstorming. While accounting for quantity is a relatively straight forward task, determination of the quality of ideas presents challenges, such as: what is the defintion of quality, and who is the arbitor of quality. The choice of facilitator can have a large impact on the results and the degree of training or instruction provided. As noted by Stein (1975) in an introduction to his extensive review of the research regarding brainstorming (in excess of 120 pages in his two volume examination of stimulating creativity):

It should therefore not be surprising to the reader that studies by adherents of brainstorming support brainstorming while some other publications support it less strongly or not at all... It is insufficient to believe that the instructions as transmitted are adequate. It is important to know that the instructions have 'taken' and whether they have or not should be determined in some way other than with the same test that is used to determine the number and quality of ideas produced... It may still be that subjects who defer judgment produce more and better ideas than individuals who do not defer judgment. All that can be said is that in the studies previously mentioned and in those which shall be presented one cannot be certain that researchers were actually studying individuals who deferred judgment. And, if subjects were not deferring judgment then the researchers were not conducting a good test of brainstorming's hypotheses. (vol.2, pp. 38-39)

While Stein may sound, in the quotation above, like an "adherent of brainstorming", he goes on to produce a very extensive, and balanced view of the research published prior to 1975. Although it seems that virtually every facet of brainstorming has been studied "Brainstorming is the most researched of all the procedures for creative problem solving. It has been scrutinized from practically every angle and in terms of almost every variable" (Stein, 1975, p. 37); Osborn's (1963) recommended "individual-group-individual" technique has been neglected. "This tripartite sequence has not been studied. Research has concerned itself with the effects of two sequences— individual followed by group and group followed by individual" (Stein, 1975, p. 98) and the author of this paper has yet to find a study that makes any attempt to study the three step approach. Perhaps equally surprising is Stein's (1975) comment that "Actually, little if any effort has been expended in the study and evaluation of training in brainstorming alone. Such work has usually occurred when brainstorming has been included in another procedure that has included other techniques to stimulate creativity as in creative problem-solving" (p. 138).

Creative Problem Solving

Alex Osborn introduced Creative Problem Solving (CPS) in his 1952 book *Wake up Your Mind*. Osborn (1952, 1963) presented a revised and refined CPS model in his seminal book *Applied Imagination*. As discussed in the previous section, Osborn later teamed up with Parnes at the Creative Education

Foundation where the CPS methods continue to be refined, taught and researched (Creative Education Foundation, 2013).

CPS consists of six steps arranged in three stages: *explore the challenge* consists of objective finding, fact finding, and problem finding; *generate ideas* consists of idea finding; and *prepare for action* consists of solution finding and acceptance finding. Objective finding is often based on a wish, a goal, or a dissatisfaction. Often we may be given a vague, open-ended objective in a work situation. Fact finding is the process of collecting all available, relevant information related to the situation and may go beyond facts to include feelings, hunches, gossip, and/or assumptions. Problem finding involves exploration of the facts, a search for opportunities, reframing issues, and changing perspectives until a clear definition of a problem is arrived at. Idea generation is about brainstorming (see previous section). Solution finding includes strengthening and improving the best ideas, developing the evaluation criteria, and applying the evaluation criteria to select the most likely candidates. Finally, acceptance finding includes an analysis of what has to be done, by when, and by whom, in order to implement the solution (Creative Education Foundation, 2013). The process involves a deliberate alternation between divergent thinking and convergent thinking.

Parnes found, in a series of studies involving 350 students, that those who took the CPS course showed substantial gains in the quantity of ideas generated when compared to a control group. They also showed significantly superior quality on three tests of idea quality, greater improvement in quality in a fourth test – but not enough to be considered significant – and no superiority in a fifth measure. It was also noted that there was persistence in the effects. Parnes also noted that the CPS students showed an increase in the measure of dominance in a personality test, but did not show significant changes in measures of self-control or need-to-achieve. The dominance trait has been associated with creativity and includes characteristics such "as confidence, self-reliance, persuasiveness, initiative and leadership potential" (Parnes, 1971, p. 273).

In Torrance's (1972) survey of 142 studies he found that CPS, and variations of the model, were the most common methods used in the studies to teach children to think creatively, and it had the highest success rate, with 20 out of 22 studies reporting successful outcomes. In most studies the outcomes were determined based on the TTCT; however, several of them also focused on Guilford's alternative uses test.

Rose & Lin (1984) completed a meta-analysis of 46 studies, eight of which were based on CPS and its modifications. In their analysis, CPS showed the greatest effect size (ES = 0.63) with training

reportedly explaining over 40% of the variance in scores.

Synectics

Synectics is a creativity enhancing program developed by George Prince and William Gordon, beginning in 1944. Prince and Gordon observed an individual as he talked his way through an invention process. They went on to compare their results to other individuals, then they began recording group sessions. "The Greek word Synectics[2] means the joining together of different and apparently irrelevant elements" (Gordon, 1961, p.3).

Synectics research is based on the assumption that the creative process can be described, that such a description could be used to enhance the creative output of individuals or groups, that creative processes in arts and science are essentailly the same, and the creative process employed by individuals is analogous to that employed by groups. Synectics theory is based on the hypotheses that creativity can be enhanced if people "understand the psychological process by which they operate" (Gordon, 1961, p. 6), that the emotional component of creativity is more important than the intellectual, and that it is the emotional and irrational elements that have the greatest impact on the chances of problem solving success. Synectics seeks to make the strange familiar and the familiar strange by using metphors and analogies. Use of emotion is emphasized, for example, how it feels to be a spring (personal analogy), and judgement is deferred during idea generation. Other forms of analalogy applied in Synectics include:

- direct analogy, where the characteristics of one object or process are superimposed onto another to arrive at a new or enhanced product or process;
- symbolic analogy uses images to describe the problem, or its potential solution, often in a poetic way;
- fantasy analogy 'accept's Freud's wish-fulfilment theory of art, but turns it onto technical invention as well and uses it operationally." That is, wishes for the ideal product are expressed as fantastical ideas, without regard for any sorts of limitation;
- laws of physics can be ignored and magic is entertained as possible (Gordon, 1961, p. 48).

There is relatively little research published on the efficacy of Synectics training; however, Gordon (1961) did state:

To date Synectics research has shown that it is possible to teach at least certain people to adopt certain thinking habits which will increase the probability of success in problem-stating, problem-solving situations. Also it appears reasonable to expect that people with 'Synectics potential' can be identified. Further, it seems that once these thinking habits are learned they are never totally forgotten. These habits may grow hazy in the course of automatic, as opposed to conscious, employment, but they can be brought back clearly and distinctly through the formal use of the operational mechanisms at a conscious level (p. 154).

Purdue Creative Thinking Program

The Purdue Creativity Program, PCP (later renamed the Purdue Creative Thinking Program, PCTP) was developed in 1965 by John F. Feldhusen to increase the creative potential of children in grades three to eight. The program is designed to foster verbal and visual divergent thinking skills, increasing fluency, flexibility, originality and elaboration (all measures of the Torrance Test of Creative Thinking, TTCT, or the Minnesota Tests of Creative Thinking, MTCT, as they were called at the time). It consists of 28 lessons, with each lesson consisting of a three to four minute presentation about a creativity principle or idea for improving creativity, followed by a an eight to ten minute story about an American pioneer, followed by three or four exercises, linked in some way to the story, and designed to provide practice in the divergent thinking skills mentioned above. The lessons were originally broadcast over the WBAA radio station, but after the initial study, they were recorded and delivered by audio tape (Amabile, 1996; Feldhusen & Clinkenbeard, 1986; Feldhusen, Speedie, & Treffinger, 1971; Feldhusen, Treffinger, & Bahlke, 1970).

Feldhusen, Treffinger, & Bahlke reported that the initial research conducted using the program involved two classes each from grades three, four and five, with six comparable classes used as a control group. After the program, students in the experimental group were found to be superior to the control group on "verbal and non-verbal originality and language achievement" (1970, p. 87). Further research included 48 classes of fourth, fifth and sixth grades. The classes were selected randomly from a population of about 100. Two clsses at each grade level were randomly assigned to one of eight groups. Seven of the groups recieved a component, or a combination of components, of the three-component Purdue Creativity Program, and one group was the control group, being given pre and post

tests only. They found support for the material, with the printed exercises being particualarly effective.

Feldhusen, Treffinger, & Bahlke (1970) also disucss a another study of the program, completed by Robinson, involving 66 students with 33 students serving as a control group. The result was that the experimental group "made highly significant gains on all creativity scores derived from the MTCT" (p. 90).

Torrance's (1972) meta-analysis of 142 studies aggregates the Purdue Creativity Program with the Productive Thinking Program, the Myers and Torrance *ideabooks*, and a number of other programs, under the heading of complex programs involving packages of materials. Out of 25 studies he rates 18 as being successful. Closer examination reveals that five of the studies employed the Purdue Creativity Program and all showed at least some degree of success. However, it's interesting to note that Torrance states that without the involvment of the teacher in the use of the programs, the success rate is low. Yet most of the studies conducted using the Purdue Creativity Program did not include teacher invovlment. Feldhusen, Treffinger, and Bahlke (1970) even note, after reporting on three studies, that "New research is being conducted at Purdue to investigate other factors which may influence the effectiveness... including teacher invovlement..." (p. 89)

Feldhusen, Speedie, & Treffinger (1971) note that, in the exercises, the need for divergent thinking – many possible answers rather than one correct answer – is stressed. They go on to give an example of one of the exercises: "Suppose that Henry Ford had not invented an automobile, and..." Hopefully their intention is not really to take creativity so far that rewriting history is considered a good thing (while he may have been responsible for designing the Model A and Model T – and some might consider him the inventor of the assembly line – he did not invent an automobile).

While Scott, Leritz, & Mumford (2004) do not present their meta-analysis of 70 research publications in a way that would allow studies involving the Purdue Creativity Program to be separated out, it is clear that they aggregated them into their divergent thinking grouping, noting that it is one of the best know programs aimed at increasing divergent thinking. They stated that "Given the focus of creativity training on the development of creative thinking skills, it was not surprising that the largest effect sizes were obtained in studies employing divergent thinking" (p. 369). They also referred to the Purdue Creativity Program, along with the CPS, as "the more successful creativity training programs currently available" (p. 383).

Rose & Lin's (1984) meta-analysis only included three studies that used the PCTP and they didn't fare well. The PCTP was the second poorest performing classification, out of the six groupings they analyzed.

The Productive Thinking Program

The Productive Thinking Program, PTP, was developed in 1966 by Crutchfield, Covington and Davies. It is aimed at developing creative problem solving abilities and related attitudes in fifth and sixth grade students, and consists of 16 lessons. Each lesson presents a mystery to be solved and follows Jim and Lila Cannon as they learn to become detectives under the tutelage of their Uncle John, a science teacher whose sideline is being a detective. When indulging in his sideline, he goes by the name of Mr. Search (Trefinger & Ripple, 2013).

Torrance (1972) grouped the PTP with the Purdue Creativity Program and the Myers Torrance *ideabooks*, finding 18 of 25 studies reporting a successful outcome. In this case, success was defined as follows:

> ... a score of 1 was awarded if all the measured objectives of the experiment were attained. If the experiment had a single objective, such as increasing the degree of originality of thinking, a score of 1 was still assigned. However, if data were presented for fluency, flexibility, originality, and elaboration and the only statistically significant gain over the control group was in originality, a score of.25 was awarded. If 10 of 20 tests of significance reached the.05 level of confidence, a score of.50 was awarded (pp. 117-8).

Eight of the studies used the PTP. Of these, three resulted in no significant improvements over control groups, and two were rated as only partially successful. The partially successful studies showed significant differences in TTCT fluency and originality, but not flexibility or elaboration.

Rose & Lin's (1984) meta-anlysis included five studies employing the PTP. This was the worst performing group of the six groupings they analyzed. These studies showed a lack of significant improvement across all dimensions; verbal and figural; fluency, flexibility, originality, and elaboration. They even showed small negative average effect sizes for verbal fluency and flexibility – although not significant.

As with the Purdue Creativity Program, Scott, Leritz, & Mumford (2004) do not present their meta-analysis in a way that summarizes the results of individual programs. However, they did categorize

the Productive Thinking Program as a divergent thinking program, so the same comments apply as in the last section.

TRIZ

"The term 'TRIZ' comes from the Russian phrase *teorija rezhenija izobretatelskih zadach,* which means the 'theory of inventive problem solving'" (Rantanen & Domb, 2007). TRIZ was developed in the 1940's by Genrich Altshuller while he served in the Soviet Navy patent department. By analyzing thousands of patents, Altshuller came up with 40 principles that are intended to provide an objective, repeatable, engineering approach to innovation (Puccio & Cabra, 2010). TRIZ has been added to and evolved over the years and now, besides the 40 priciples, it also includes 76 standard solutions, evolutionary patterns, ideal final results, and a contradiction matrix (Birdi, Leach, & Magadley, 2012). While TRIZ has been widely used in organizations, there is little research on the tools as a creativity enhancement method (Puccio & Cabra, 2010). However, Birdi, Leach, & Magadley (2012) found that 140 engineers, working for an international engineering firm, who took a one-day TRIZ workshop, increased their motivation to innovate, improved their creative problem solving skills, increased their idea generation at work, and showed improvement in their ideas being implemented, all compared to a control group, and over an extended time period. In addition, expert ratings found that the trainees' ideas were more original, useful and persuasive.

Other Cognitive Approaches

Lesser-Known Cognitive Approaches There are many other lesser-known programs and courses that rely mostly on direct cognitive methods. Many are variations of the programs discussed in the previous sections, or on combinations of them. Some are widely available. Others are unique, one-off programs available only in one location, or from one instructor. These programs span the range of effectiveness illustrated by the programs discussed in the previous sections; from not effective, like many of the implementations of the PTP that were studied, to quite effective, like many of the implementations of the CPS program that were studied (Rose & Lin, 1984; Scott, Leritz, & Mumford, 2004; Torrance, 1972).

De Bono Thinking On the other end of the spectrum are some very popular programs that have been included in this "others" category because of a lack of research literature. Edward de Bono's Lateral Thinking and Parallel Thinking – along with CoRT and Six Thinking Hats, which are methods for

implementing his two thinking methodologies – have achieved great commercial success, with little or no research being done on their effectiveness. Sternberg and Lubart (1999) critisize de Bono and others for being primarily concerned with developing a creativity-enhancement program, while only being secondarily concerned with understanding it, and not at all concerned with testing its validity.

De Bono has written 57 books, mostly on thinking, and schools from over 20 countries have included his thinking tools in their curriculum. Yet Moseley and his collaborators note that "There is sparse research evidence to show that generalised improvements in thinking performance can be attributed to training in the use of CoRT or [Six] Thinking Hats tools." (Moseley et al., 2005, p. 139)

Cognitive Modelling Gist studied the use of cognitive modelling as a method to enhance creativity. Cognitive modelling is similar to behavioural modelling – from Bandura's Social Learning Theory – but rather than visual observation of the behaviours of a model performing a task, cognitive modelling involves "a process of attending (or 'listening') to one's thoughts as one performs an activity and utilizing self-instructional thoughts (or 'statements') to guide performance" (Gist, 1989, p. 788). Meichenbaum, (in Gist, 1989) found support for the use of cognitive modelling in improving the creativity of college students. Gist's (1989) study found that "the superiority of a training method based on cognitive modeling was impressive" and "cognitive modeling training enhanced self-efficacy" (p. 802).

Non-Cognitive Approaches

Attitude Basadur has examined five attitude scales: Preference for Active Divergence, Preference for Avoiding Premature Convergence, Valuing New Ideas, Creative Individual Stereotypes, and Too Busy for New Ideas. According to Basadur, Taggar and Pringle (in Puccio, Firestien, & Coyle, 2006, p. 25) "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". Basadur has shown that changes in attitude are a good predictor of gains from creativity training.

Flow In discussing 'flow' – "the kind of feeling that an Olympic athlete may have when running her personal best, or a poet may have when turning a perfect phrase" – and its relationship to creativity, Csikszentmihalyi (1996) observes that:

> … One obvious way to enhance creativity is to bring as much as possible of the flow experience into the various domains. It is exhilarating to build culture—to be an artist, a scientist, a thinker, or a doer. All too often, however, the joy of discovery fails to be communicated to young people, who turn instead to passive entertainment. But consuming culture is never as rewarding as producing it. If it were only possible to transmit the excitement of the people we interviewed to the next generation, there is no doubt that creativity would blossom. (p. 342)

This view seems to suggest that another form of modelling is possible, other than the cognitive modelling discussed in the previous section. While observing creative people at work may not be conducive to enhancing creativity, there may be value in learning about the thought processes and emotions of creative individuals.

Self-Statement Modification Self-statement Modification (SSM) is a form of cognitive behaviour modification and has been successfully applied by Meichenbaum (1975) for creativity enhancement. While it was a small study of 21 subjects, the self-instructional training group showed significant increases in flexibility and originality compared to a control group and to a group who appled Gendlin's focusing.

While SSM is considered, from the psychology point of view, a cognitive appraoch, from the point of view of creativity enhancement, it is viewed more as behavioural approach associated with attitudes regarding self, creativity, and the relationship between the two. Hence this method's location here, under non-cognitve, rather than under congnitve approaches.

Domain Knowledge Amabile (1996) argues that no creativity will take place without some level of knowledge and skill in a given domain. Further, Simonton (1999) notes that virtually all eminent creators display curiosity outside of their primary domain, giving rise to the concept of 'T' shaped domain knowledge – depth and experience in one domain, with wide breadth of knowledge across many domains – and its positive relationship to creativity. Therefore, it appears that creativity can be enhanced by developing a particular expertise, while being well informed in a variety of areas.

Metacognitive Metacognition is, literally, cognition about cognition. Furthermore, cognition is related to all of our mental abilities, including perceiving, learning, remembering, thinking, understanding, reasoning, problem solving and decision making. Thus, metacognition can be *thought* of (pun intended) as thinking about thinking, thinking about learning, or thinking about problem

solving. As noted by Kozbelt, Beghetto, & Runco (2010, p.32) "Metacognitive processes are also frequently tied to creative thinking". They go on to note that tactical thinking is metacognitve, thus most, if not all, of the programs discussed in the cognitve approaches section above have a metacognitive aspect to them.

Much like SSM, metacognition has been included here, under non-cognitive approaches, because of its potential behavioural and attitudinal affects. Scott, Leritz, & Mumford (2004, p. 380), in their meta-analysis, concluded that "informing people about the nature of creativity and strategies for creative thinking is an effective, and perhaps necessary, component of creativity". Perhaps more important is the potential for metacogntion to positively impact self-efficacy. Albert Bandura (1995, p.2) defined self-efficacy as belief "in one's capabilities to organize and execute the courses of action required to manage prospective situations" Giving people the tools to be successfully creative should, as Bandura (1977, p. 193) notes, give them the "conviction that [they] can successfully execute the behavior required to produce the outcomes".

Motivation Amabile (1996) has written extensively about the effects of motivation on creativity. She concludes that intrinsic motivation is conducive to creativity, and that extrinsic motivation usually, but not always, has a deleterious effect. Amabile notes that the following can have a negative impact on creativity: expected reward, expected evaluation, peer pressure, surveillance, and constrained choice. These factors can all be seen to potentially affect creativity through an effect on motivation. Conversely, Amabile sees choice, control, a supportive environment, a stimulating physical environment, freedom, and play, as potential approaches to enhancing creativity.

Meditation Fink & Neubauer (2006) found that more original creative problem-solving responses are associated with of alpha synchronization, which has been associated with wakeful relaxation, whereas convergent tasks produce alpha desynchronization. Since meditation is known to produce alpha syncronization, it has long been hypothesized that meditation could increase creativity, but Krampen (1997), in his literature review, found inconsistent effects from long-term relaxation or meditation programs. However, Krampen's study on the short-term effects of relaxation exercises showed consistent, significant improvements in both divergent and convergent thinking.

Ostafin & Kassman's (2012) two studies, of a total of 157 participants, found that mindfullness training improved insight, but not non-insight, problem solving.

Discussion

Most of the literature reviewed seems to answer *yes* to the question "can creativity be taught?" "The overall results of this meta-analysis suggest that training does affect creativity" (Rose & Lin, 1984, p. 22). "Taken as a whole, these observations lead to a relatively unambiguous conclusion. Creativity training works... it was found that training stressing the cognitive processing activities commonly held to underlie creative efforts, specifically the core processes identified by Mumford et al. (1991), was positively related to study success... problem finding, conceptual combination, and idea generation, proved to be the most powerful influences on the effectiveness of training" (Scott, Leritz, & Mumford, 2004, p. 382). "It does indeed seem possible to teach children to think creatively" (Torrance, 1972, p. 132).

While these researchers seem to be emphatic regarding the virtues of creativity training, the results presented in the literature showed a great deal of inconsistency. Even CPS, the most consistently highly-rated program, was not consistently successful. Other programs ranged from mostly successful, to mostly not successful, and to inconclusive due to lack of data. This inconsistency suggests a need for caution when it comes to the practical application of programs intended to enhance creativity, and that further research is needed.

The definition of success regarding creativity enhancement interventions remains problematic, as does a lack of theories on what goes wrong when these programs don't work. The answers may be hidden in the long list of non-cognitive approaches to enhancing creativity.

A Complex Systems Theory of Creativity

Perhaps, within all these cognitive programs, there is more going on than just cognitive skills training – as suggested by Scott, Leritz, & Mumford (2004), who noted that confluence models were effective across criteria, and that motivational and personality approaches were positively related to performance.

Amabile (1996) has long argued for a componential theory of creativity, suggesting that domain knowledge, creativity skills, and intrinsic motivation must coincide in order for there to be creativity. And Csikszentmihalyi's (1996) systems approach to creativity argues that creativity has as much or more to do with culture than with an individual's personality, skills, abilities, or motivations.

I would argue that Amabile's componential model does not go far enough, while Csikszentmihalyi's systems approach goes off on what is effectively a tangent. That is, Amabile's model does not take into consideration environmental factors, except for considering how they may impact motivation, and it does not consider other factors of the individual such as alpha-coherence or self-effacacy; while Csikszentmihalyi's approach tends toward the realm of innovation (creativity implemented) and is concerned only with "Big C" creativity.

I propose that the all-encompassing view – the essential view – is to see creativity as a complex, with respect to the individual, operating within a complex environment. It also seems reasonable to imagine that these complex systems – the individual, other individuals, the sociocultural-political environment, and the physical environment – may react to changes non-linearly. That is, a small change in a factor, or system, could have a large effect on the observed end result – degree of creativity, in this case – while a large change in another factor, or system, may have minimal impact, or vice versa. Not only that, but a factor initially having a large impact as a result of a small change, may have declining impact as the size of the change increases – and vice versa. With many factors at play within several interacting systems, it would seem that the application of complexity theory will be needed to approach an understanding of creativity.

From domain knowledge to motivation, personality, knowledge of creativity tools, attitude, physical environment, social environment, cultural environment, and political environment; there seems to be little doubt that what impacts creativity is multifaceted, making the study of what might be called one small sub-factor[3] challenging, to say the least. How could we ever expect to see the impact of a brief seminar instructing students on how to come up with more ideas by applying the four rules of brainstorming to show up through the "noise" of other factors? There are just too many moving parts, with inconsistent relationships, and inconsistent impacts.

In *The Wisdom of Crowds*, Surowiecki (2005) illustrates that, in many situations, the average answer given by a crowd of people is often more accurate than that of any one expert. He explains how the right level of diversity, independence, and decentralization are required for crowds to live up to their potential. These three conditions correlate well with the five control parameters – which determine whether an organization will operate at the edge of chaos in the "space for novelty" – proposed by Stacey (1996, p. 179) in his complex systems theory of creativity within organizations: "the rate of information flow, the degree of diversity, the richness of connectivity, the level of contained anxiety, and the degree of power differentials". If creativity does indeed operate as a complex system –

following the principles of complexity theory – this would suggest that it is impossible to accurately predict the long-term outcome of various interventions; but it doesn't mean we should give up. It merely means that a holistic approach is required in order to fully understand creativity and its enhancement. Informing that holistic approach will require large sample sizes, with a large number of factors under consideration, along with multivariate statistical analysis. Or perhaps extensive qualitative research could go further in completing the picture of creativity that is still sorely fragmented and incomplete after over six decades of research. Regardless of the research approach taken, a complete theory of creativity would serve to light the way.

Even in the face of all these challenges, this literature review found that most studies showed creativity enhancement efforts have had a positive effect on creativity, but much remains to be done to explain what is going on when we attempt to enhance creativity, and to improve the consistency of results – or at least to make them more consistently positive, given that complexity theory would suggest we can never expect consistency.

About the Author

Philip Lambert is an engineer, a businessman, an entrepreneur and a creativity researcher. After working as an engineer and production manager in advanced manufacturing, Philip became a pioneer and entrepreneur in the field of online education. It was while building online learning companies that the interplay of creativity across diverse jobs – including graphics, new media, instructional design, software development, and marketing – sparked his interest, leading to his current research efforts. Philip is currently the Program Coordinator for the University of New Brunswick's Technology Management & Entrepreneurship program, where he mentors student entrepreneurs and teaches creativity. At the same time he is completing a PhD in creativity. His areas of research interest include: creativity theories, assessment of creativity, enhancement of creativity, online evaluation of creativity, teaching creativity online, creativity of product development teams in startup companies, the relationship between novelty and the success of crowdfunding campaigns, and the rejection of creativity (that is, the bias against highly novel ideas and products).

Footnotes

[1] Blockbuster, which became the largest video rental chain, was launched in 1985, but didn't become commonplace until around 1990. They filed for bankruptcy in 2010 (Phillips & Ferdman, 2013).

² More accurately, the word Synectics derives from Greek roots. (Editor's note).

³ For example, ideation could be considered a sub-factor within the cognitive-creativity complex, intrinsic motivation could be considered a sub-factor within the social-psychology of creativity complex and existence/effectiveness of a mentor might be thought of as a sub-factor within the creativity-supporting-environment complex.

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Declarations