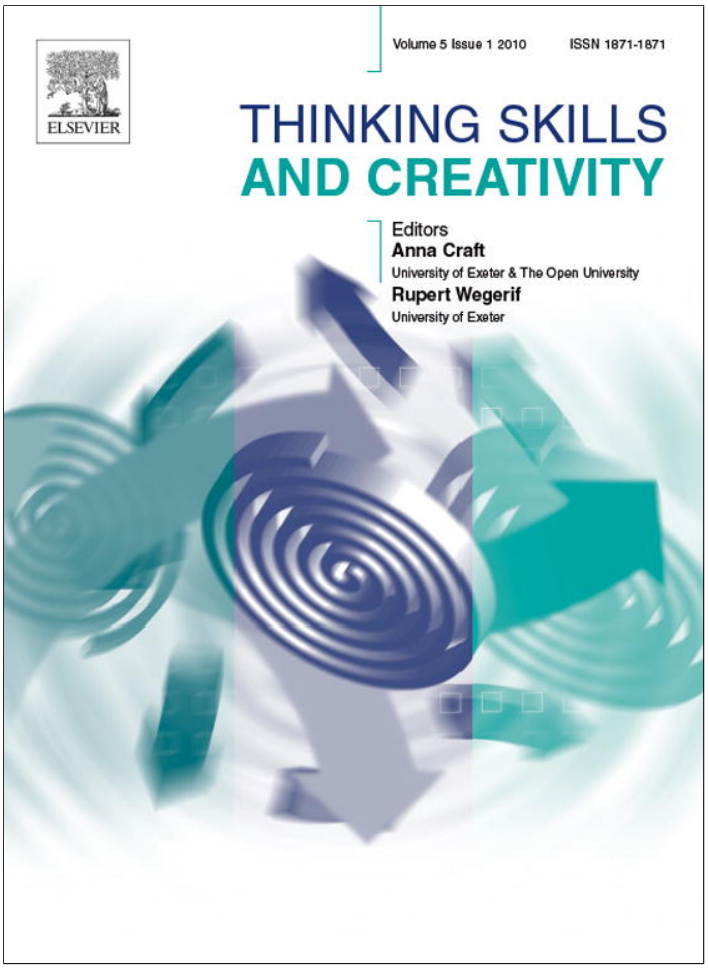

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Playing with Thinkertoys to build creative abilities through online instruction

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ABSTRACT

Although the importance of teaching creativity in higher education has been widely recognized, empirical research addressing the success of such attempts, has been scant. The purpose of this study is to develop and evaluate the effects of an online Creative Thinking Program. The program included a series of modules whose design, content and instructional media were conceptually based on past theoretical contributions and research identifying criteria affecting the success of creativity training. Pre- and post-measures revealed a significant increase in the participants' creative self-efficacy as well as their creative abilities as measured by the Torrance Tests of Creative Thinking. We discuss the implications of the results for developing creativity skills in university instruction as well as in organizational training programs.

1. Introduction

Because of its fundamental role in innovation and entrepreneurship, the creation of new ideas has become a key concern for many organizations and businesses (Runco, 2004). Managing creativity is the hottest area of demand in Corporate America and a "must-have skill for today's managers" (Nussbaum & Tiplady, 2005, p. 31). Not only is creativity one of the cornerstones of organizational success (Dewett & Gruys, 2007), but also business students perceive creativity skills as important to their career and believe they can be learned (McCorkle, Payan, Reardon, & Kling, 2007). A stream of academic research corroborates the important role of creativity to organizational innovation, performance and survival (e.g., Amabile, 1988; Perry-Smith, 2006; Tierney & Farmer, 2002). On a broader scale, the U.S. Council on Competitiveness has indicated that "innovation will be the single most important factor in determining America's success through the 21st century" (Wince-Smith, 2006, p. 13).

Universities and colleges are clearly in a position to play a key role in developing an innovative workforce by preparing students to develop the skills to think creatively (Vance, 2007; Wince-Smith, 2006). Yet despite the increasing attention to this need as highlighted in the popular press and some journals, efforts in higher education have neglected pedagogical research (McCorkle et al., 2007). Although a few exceptions (e.g., Cheung, Roskams, & Fisher, 2006; Clapham, 1997; Dewett & Gruys, 2007) most of what has been published reflects anecdotal, descriptive data (Ma, 2006; Runco, 2004; Scott, Lerittz, & Mumford, 2004). Bull, Montgomery and Baloche (1995), for example, surveyed those teaching creativity at the college level in an attempt to identify the components they perceived as most important in their courses. Driver (2001) reported what

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students perceive as the most critical classroom environmental elements in preparing them for creative workplaces. Other studies reporting on the results of creativity training in university settings have largely focused on brief treatments in an experimental setting (Cheung et al., 2006).

What is lacking is empirically driven research into the nature and effectiveness of creativity courses in higher education—particularly in the business curriculum (Dewett & Gruys, 2007). Successful, quantitatively evaluated programs need to be established in order to facilitate the teaching and research of creativity at the college level. In this study, we examine how a series of training modules, embedded within a broader course as well as presented as a stand-alone course, might influence key aspects of creative thinking: divergent thinking and creative self-efficacy. In doing so, our intent is to develop and present an empirically evaluated pedagogy with sufficient clarity that it can be replicated by other educators and/or serve as a basis for comparison in future research.

Divergent thinking reflects the ability to generate multiple alternatives and solutions and includes components such as flexibility, fluency, and originality (Runco, 1991; Scott et al., 2004). We focus on divergent thinking due to its importance in business endeavors such as strategy, new product development and entrepreneurship. Reviews (e.g., Batey & Furnham, 2008; Scott et al., 2004) present a multitude of evidence supporting divergent thinking as a distinct ability related to creative performance.

Researchers have begun to examine how individuals' views of themselves might influence creativity (Shalley, Zhou, & Oldham, 2004). Creative self-efficacy "captures one's feelings about whether or not he or she can be creative or feels confident that he or she can be creative in a given task" (Jaussi, Randel, & Dionne, 2007, p. 249). By affecting cognitive processing, motivation, affective beliefs and selection processes (Bandura, 1993) creative self-efficacy should influence whether one visualizes creative success, sets creative performance goals, copes with demands for creativity and decides to engage in creativity efforts. Reviews of the limited research on creative self-efficacy (Beghetto, 2006; Mathisen & Bronnick, 2009) support direct, and even reciprocal links between creative self-efficacy and creative effort (initiation of projects, creative work involvement) and performance (teacher and supervisory ratings). Only a few studies have addressed the effects of training on creative self-efficacy and only one study (Mathisen & Bronnick, 2009), that we know of, has examined the direct link between creative self-efficacy and divergent thinking but was limited to fluency only. By expanding the analysis to multiple components of divergent thinking, we hope to gain a better understanding of the how training, more specifically online course instruction, affects creative self-efficacy as well as the process by which creative self-efficacy leads to creativity outcomes.

2. The Creative Thinking Program

The online Creative Thinking Program (CTP) developed and used in this study is based on a synthesis of lessons learned over the years of research in creative thinking. These insights were used to influence the instructional design, course content and instructional media used in the module assignments. Specifically, three important factors guided the design of the CTP: psychological safety as a core component in the instructional design, a model-based approach as the foundation for course content, and an emphasis on establishing creative self-efficacy that guided the selection of the course text. Shown in Appendix A are 3 of the approximately 10 assignments that comprised the online CTP.

2.1. Instructional design

Arguably the most important factor in any Creative Thinking Program is the establishment of a sense of psychological safety on the part of the student (Cheung et al., 2006; Bull et al., 1995). Creative thinking, by its very nature, asks students to move out of their comfort zone, take intellectual risks and explore new ways of thinking in order to generate new ideas. If a student does not feel safe to do this, no amount of training or coaxing will be productive. There is some evidence to suggest that providing a safe environment for exploration is more important than the collection of techniques taught in the course (Bull et al., 1995).

This important factor of psychological safety is realized in the instructional design of the CTP through online delivery, supportive assessment of student work and an opportunity to resubmit unsatisfactory work. The online delivery of the course allows students to engage in developing personal creative thinking skills in an environment of their choosing, thus ensuring an element of safety in the fulfilling the course requirements. This aspect of the program differs sharply from other educational efforts that include or exclusively use group activities in traditional classroom settings (e.g., McIntyre, Hite, & Rickard, 2003; Driver, 2001; Dewett & Gruys, 2007). The evaluation of the students' work for the module assignments was also made as nonthreatening as possible by providing specifications (e.g., length requirements, time expectations) for credit. Furthermore, students were assured of a satisfactory evaluation if they demonstrated engagement in the processes outlined in the assignments thereby eliminating fears associated with evaluation of a final product. By evaluating the assignments on a pass/fail basis, concerns about potential and trivial point deductions were mitigated. In order to further alleviate stress of grading that commonly accompanies undergraduate work, three virtual "tokens" were provided that the student could redeem to resubmit an unsatisfactory assignment if needed. Although a token has yet to be used for this purpose, this feature remains in the course to provide a "safety net" for the students.

2.2. Instructional content

A second factor found to be related to the success of a CTP is the use of a model-based approach to guide the development of course content. While some programs consist of a collection of techniques that are independent of a cohesive framework, a comprehensive review of the creativity training research indicates that those developed with model-based content have a higher success rate (Scott et al., 2004). Our program content is based on a stream of literature identifying the cognitive factors related to creative thinking. Creative thinking is most likely to occur when attention is defocused, thinking is associative, and multiple concepts are simultaneously active (Ansburg & Hill, 2003; Friedman, Fishbach, Forster, & Werth, 2003; Martindale, 1999; Martindale & Dailey, 1996). Creativity is often dependent on the generation of new ideas and the ability to find new connections between existing concepts previously thought to be unrelated. Defocused attention allows multiple concepts to become active in short term memory to facilitate the search for these new combinations. Associative thinking allows an escape from fixed, rule-based thinking by allowing free associations to guide thinking rather than pre-established rules. Assignments within each module (see examples in Appendix A) included visualization and relaxation techniques to encourage an ability to defocus attention, diagram-based techniques to support the mental state of having multiple concepts simultaneously active, and other general techniques to promote associative thinking. A further component of the model is the use of authentic challenges; this component is supported in reviews of creativity training programs (e.g., Scott et al., 2004). Again, Appendix A provides an example of some module assignments that exemplified this component (Stone Soup challenge) and several other assignments (not appended) allowed students the opportunity to create a challenge of their choosing.

2.3. Instructional media

A third factor guiding the design of the online CTP was the important goal of increasing the students' creative efficacy. Self-efficacy is the willingness to engage in activities believed to be within our abilities while avoiding those believed to be beyond our abilities (Bandura, 1977). Self-efficacy is perhaps as important as any other factor in creative thinking and development since a willingness to try new ways of thinking lies at the core of success. Supportable belief in one's own ability to develop creative thinking abilities is of utmost importance since belief in this context often leads to self-fulfilling prophesies (Nickerson, 1999). In other words, individuals who are confident in their ability to be creative are more likely to gain the momentum, put forth the intensity of effort and persist in the face of obstacles to generating many original and diverse ideas (i.e., divergent thinking). Such persistence is necessary since creativity is demanding, requiring time and effort, and carries a high risk of failure (Mathisen & Bronnick, 2009).

In an online course, the instructional media bears much of the burden of establishing this sense of self-efficacy as well as providing the bulk of the informational content. For this reason, the instructional media chosen for use with the module assignments was *Thinkertoys* (Michalko, 2006), which includes a collection of many creative thinking techniques. While there are numerous books on creative thinking techniques (see review by Ross, 2006), *Thinkertoys* is distinguished by its ability to offer convincing evidence that the reader is capable of improving his or her creative thinking abilities. Wall Street Journal reported that the text will "change the way you think". During the development of the assignments over a 3-year period during which time several different texts were used, anecdotal evidence from students' comments has provided corroborating support for this claim. Furthermore, in a recent analysis of the plethora of techniques available, Thinkertoys was cited as most representative of the publications that provided informative descriptions and application examples (Ross, 2006).

The first four chapters of the text comprise a section titled "Initiation", and collectively they provide a foundation for understanding the cognitive processes associated with creative thinking in simple yet convincing terms. The remainder of the book consists largely of techniques, each illustrated by one or more optical illusions that demonstrate how the technique can be used to avoid limiting options and conclusions. For example, an illustration that can be viewed as either an old woman or a young woman might illustrate how we need to be able to shift perspectives in our thinking to find alternative but equally valid points of view. Each technique is accompanied by a step-by-step blueprint to help make the techniques easy to understand and apply, thereby developing the students' sense of accomplishment and confidence. Interesting and authentic examples of how the techniques have been used for successful innovation in specific organizations also contribute to the development of the students' creative self-efficacy and potential applicability. For example, by asking imaginative questions (i.e., the Stone Soup technique), such as "What if we used it for this or that?", Spencer Silver invented 3M's post-it notes with the use of the glue that no one wanted (Michalko, 2006). See Appendix A for an example of how many of these features are incorporated into the assignments.

3. Methods

3.1. Participants and procedure

Data were collected from 51 students who participated in the study through a Principles of Management course ($N = 25$) or a stand-alone free elective course (Creative Inquiry) during the fall semester 2007 ($N = 26$). About half of the subjects were sophomores, only 2% were freshman, and the rest were equally divided among junior and senior rank. Sixty-five percent were female. The average age of the sample was 19.76. The majority ($N = 29$) of the students were business majors, 26%

were in the arts and social sciences and the remaining students were studying engineering and physical sciences fields. The questionnaires and creativity tests were administered by one or both of the authors.

The courses were taught by the first or second author and with the exception of on-location pre- and posttesting, both offerings delivered content in a pure online method. The courses accepted students from any discipline and used identical content and schedules for administration of the online CTP, which spanned the first 6 weeks of class. During the first week, a pretest Torrance Tests of Creative Thinking (TTCT) was administered on location in group settings. This was followed by module assignments due at three weekly intervals. It concluded with a posttest the week following submission of the last assignments. After the posttest TTCT, the stand-alone course was concluded and the Principles of Management class continued for a full semester.

3.2. Measures

As noted earlier, much of the literature (both in organizational and educational contexts) has focused on the antecedents or variables that positively influence creativity and innovation. Confidence in one's own creativity has been widely noted as an important goal and outcome of creativity training (Anderson, 2006; Cheung et al., 2006) as well as a significant predictor of creativity in the workplace (e.g., Gist, 1989; Tierney & Farmer, 2002). Therefore we also felt it was important to assess the effects of the CTP on one's creative self-efficacy. We used the three item measure (e.g. "I feel that I am good at generating novel ideas"./"I have confidence in my ability to solve problems creatively"./"I have a knack for further developing the ideas of others".) that was developed with established reliability in the seminal work on this construct (Tierney & Farmer, 2002). A five item response scale ranging from "Strongly Agree" to "Strongly Disagree" was used with this measure.

Despite being the most referenced and widely used test of creativity (see review by Kim, 2006), and the specific recommendations for the TTCT in evaluating the effects of educational and training efforts (Torrance, 1966, 1987), its use in university and college assessments has been scant. Our decision to use the TTCT measures included these factors, its established reliability and predictive validity (e.g. O'Neil, Abedi, & Spielberger, 1994; Plucker, 1999; Torrance, 1972; Treffinger, 1985), as well as the two parallel versions for the specific purpose of pre- and posttests.

The TTCT measures the cognitive abilities to make many new connections (i.e., fluency) or new ideas, the ability to make different kinds of connections (i.e., flexibility), and the ability to make unusual connections (i.e., originality). Both verbal and figural (which includes some drawing activities) forms are available. We used the TTCT-verbal form which includes seven subtests: Asking, Guessing Causes, Guessing Consequences, Product Improvement, Unusual Uses, Unusual Questions and Just Suppose. The scoring of the TTCT provides evaluations of three separate dimensions of creativity which are the cognitive abilities associated with fluency, flexibility and originality. Fluency has a quantitative focus, reflects the ability to produce a large number of ideas, and is based on the total number of relevant responses. The flexibility score represents the variety or range of ideas produced and therefore reflects the ability to shift approaches or strategies. Assessments of originality represent the unusualness of the responses and therefore the ability to produce ideas that are innovative, statistically infrequent, or uncommon.

For most ability assessments, it is important to also look at normalized scores that allow some comparison within a defined group (Scholastic Testing Service, Inc., 2008). Standardized averages of fluency, flexibility and originally, by both grade and age, are provided by the TTCT Scoring Service, a division of Scholastic Testing Service, Inc. (STS). These average or composite standardized scores weigh each of the dimensions equally and are based directly on percentile ranks and therefore appropriate for use with various statistical procedures (STS, 2008). In our analyses, we used five scores for each subject, including the raw scores for fluency, flexibility and originality, as well as standardized averages of the three based on age and grade (i.e., higher education).

In administering the TTCT, we strictly adhered to the instructions in the Directions Manual (Torrance, 1990) and used the instructions for each activity as specified in the manual. To enhance objectivity and mitigate any bias or errors in scoring of open-ended responses, we had the tests (both pre and post) professionally scored by the TTCT Scoring Service. These scorers are specially trained and experienced and therefore capable of scoring with a very high degree of reliability.

4. Results

The correlations among creative self-efficacy, fluency, flexibility and originality are shown in Table 1. Shown in the table are the expected and obvious significant links among the various divergent thinking scores. More interesting to note however is that while there were no significant correlations between creative self-efficacy and the divergent thinking components at the pretest, there were marginally significant links after participation in the program. This pattern hints at a potential interactive effect of creative self-efficacy and divergent thinking. Perhaps the salience, exposure and understanding of creativity and divergent thinking techniques affected the correlation between the two. This suggestion is similar to a relationship proposed, but not empirically supported in a recent study. Jaussi et al. (2007) hypothesized that creative self-efficacy would interact with creative personal identity, the importance one places on creativity in his or her self-definition, in affecting creative performance. An increase in role identify could have very well occurred consequent to the increased knowledge of successful creative endeavors, as exemplified in Thinkertoys, as well as the obvious improvement in the student's own creative aptitude over the course of the program.

Table 1
Correlations—TTCT scores and creative self-efficacy.

Variable	1	2	3	4	5	6	7
1. Pretest fluency							
2. Pretest flexibility	.91**						
3. Pretest originality	.96**	.90**					
4. Pretest creative self-efficacy	.15	.19	.11				
5. Posttest fluency	.66**	.61**	.64**	.1			
6. Posttest flexibility	.58**	.66**	.57**	.06	.80**		
7. Posttest originality	.62**	.55**	.62**	.12	.97**	.78**	
8. Posttest creative self-efficacy	.39**	.42**	.35*	.65**	.24†	.28*	.25†

* $p < .05$.
** $p < .01$.
† $p < .10$.

Table 2
Mean scores for measures before and after creativity program.

	Pretest		Posttest	
	Mean	S.D.	Mean	S.D.
Fluency				
Raw score	77.59	24.31	95.31	24.69
National percentile	49.29	21.77	70.62	38.85
Flexibility				
Raw score	43.04	9.61	49.20	8.39
National percentile	52.14	23.36	61.77	19.96
Originality				
Raw score	54.86	19.85	71.14	22.32
National percentile	66.63	21.17	76.38	19.28
Standard score age				
Raw score	102.75	14.75	108.18	13.64
National percentile	55.75	23.79	63.67	20.72
Standard score grade				
Raw score	104.92	13.89	114.47	11.18
National percentile	57.33	22.15	73.90	16.87
Creative self-efficacy				
Raw score	11.65	1.47	12.43	1.47

The means and standard deviations of the TTCT scores and creative self-efficacy both before and after the training are presented in Table 2. The National Percentiles indicate the ranking relative to others in the same age and grade categories. A ranking is expressed as the percent in the group for which the student's score is higher. For the raw scores, the percentile rank is the average for age- and grade-based categories. These descriptive statistics identify improvements across the board for all components of divergent thinking as well as for creative self-efficacy.

In order to assess statistically significant differences in divergent thinking skills and creative self-efficacy, we used paired comparison *t*-tests, which are appropriate with a repeated measures design and a pre/posttest of differences. The results of these analyses, as well as the means and standard deviations of the differences are presented in Table 3. These results support statistically significant improvement for scores on fluency ($p < .0001$), flexibility ($p < .0001$), originality ($p < .0001$), standard age-based average ($p < .01$), standard grade-based average ($p < .0001$) as well as creative self-efficacy ($p < .001$). Additional analyses (General Linear Models due to uneven cell sizes) revealed no significant effects of gender, age, class rank, course selection, and major area of study on these differences or

Table 3
Difference means and results of paired samples *t*-tests.

Variable pair	Mean	S.D.	*t*-Statistic	*p*-Value
Fluency	17.73	20.16	6.28**	<.0001
Flexibility	6.16	7.50	5.86**	<.0001
Originality	16.27	18.40	6.32**	<.0001
Standard average (age-based)	5.43	12.04	3.22*	<.0022
Standard average (grade-based)	9.55	10.82	6.31**	<.0001
Creative self-efficacy	0.72	1.25	3.98**	<.0002

* $p < .01$.
** $p < .001$.

improvement scores. In other words, the significant improvements were not moderated or limited by these differences.

5. Discussion

In this study, we developed and evaluated an online pedagogy designed to increase the creative self-efficacy and divergent thinking skills of students in a business curriculum. The results suggest that participation in the program significantly enhanced the students' creative self-efficacy as well as their actual creative abilities as measured by the TTCT. The significant increase in the students' creative self-efficacy, alone, is an important outcome of the CTP. Our study builds on the limited studies that have analyzed the effects of training on creative self-efficacy (Mathisen & Bronnick, 2009). The results of this study suggest that online instruction through a series of modules such as employed in our CTP, can have significant and beneficial effects on one's confidence in their creative abilities.

The development of creative self-efficacy for those entering the workforce should certainly be a key focus of creativity programs in higher education. Students with higher levels of creative self-efficacy have been found to be more confident about academic abilities in general and more ambitious in pursuing higher levels of education (Beghetto, 2006). In addition, the creative self-efficacy of employees has been linked to supervisory ratings of creative performance (Tierney & Farmer, 2002) and found to mediate the effects of supervisory support and expectations for creative performance (Tierney & Farmer, 2004). Only one study that we know of (Mathisen & Bronnick, 2009) has looked at the correlation between self-efficacy and divergent thinking and their measure was limited to fluency. They suggest their mixed results across various samples may have been attributable to their narrow measure of divergent thinking and called on future research to address the link using a more comprehensive measure. In doing so, we analyzed the link between creative self-efficacy, fluency as well as originality and flexibility, with some interesting patterns and findings. Future research should continue to address these links as well as a potential interactive effect of creative self-efficacy on divergent thinking skills and creativity.

This research contributes to the disparity between the ever-growing demand for universities in general, and business schools in particular, to prepare students for a creative and innovative workforce and the current knowledge and published literature that exists regarding these efforts. More specifically, this study adds value to this stream of research in several ways. First, we used the TTCT to measure improvements in creative thinking, heeding suggestions that assessments of creativity courses in higher education use more rigorous and valid measures (e.g., Dewett & Gruys, 2007). The TTCT is commonly accepted as one of the best measures of creativity and may be a more appropriate measure for adults (Almeida, Prieto, Ferrando, Oliveira, & Ferrandiz, 2008). In several longitudinal studies, the TTCT has been found to significantly predict creative accomplishments 10–20 years later (e.g., Torrance, 1972, 1981). Since subjectivity with this type of open-ended response test has been cited as a potential major problem (O'Neil et al., 1994), we had the TTCT professionally scored by STS to avoid this bias. Scores on the TTCT, specifically the verbal, yet not figural, have been found to predict 50% of the variance among publicly recognized creativity achievements and participation in creative activities after a 20-year period (Plucker, 1999). Again, this measure of creativity is the most widely used and referenced and is highly recommended for use in educational context, yet also used in the corporate world (see review by Kim, 2006). While a couple of studies (Clapham, 1997; McIntyre et al., 2003) have used the TTCT to measure the success of creativity training in higher education, both have used the figural form and in only one of those, whose training encompassed a single 10-30 min session, were the assessments sent to STS for professional scoring. The important factors guiding the design, content and instructional media used with the online CTP presented in this paper could explain the more supportive and consistent improvements in creative thinking as measured by the TTCT that occurred with the participants in this study.

Second, to our knowledge, this is the first research to assess the success of a CTP that was developed and administered online. Furthermore, we tried to present this creativity training program in a way that can be easily replicated by educators, researchers and those responsible for management training and development programs. Past research suggests creativity training with the use of a composite of techniques tends to be most effective, yet confusion remains as to the actual components used in different studies (Ma, 2006). Many researchers reporting the benefits of teaching creativity have used their own uniquely designed methods for teaching, making it difficult to replicate and corroborate. We presented a CTP in which the content, design, and delivery (e.g., online instruction) can be easily adapted for use in future research and in training efforts both in business schools and in industry. In addition, the CTP measures (both TTCT tests and scoring) and tools (*Thinkertoys* publication) are commercially available and therefore easily obtainable by those who want to use this framework for training or research purposes. Thus, the practical usefulness of the results of this study spans both the higher educational context (e.g. business school instruction) and management training and development programs in industry.

A couple of studies (e.g. Cheung et al., 2006; Dewett & Gruys, 2007) have shown some promise with traditional courses focused solely on creativity and innovation. However, given the limits on introducing new courses to curricula, the ability to successfully incorporate creativity training into an existing course is extremely critical and previous efforts are still in question (McIntyre et al., 2003). We were successful with this type of integration, in part due to the online nature of the module assignments. Other educators should be able to use this same framework concomitantly as a project in teaching any course in the business school or any other discipline.

Borrowing from our framework, organizational leaders can also facilitate organizational creativity training through the use of these types of modules or a similar design. Benefits of our program include the online nature of this training and the relatively low cost because it is essentially self-taught through andragogy (Forrest & Peterson, 2006). Given the increasingly

problematic costs of creativity consultants and customized creativity training, there is a need to "develop streamlined creativity training programs that can be easily delivered and do not sacrifice effectiveness" (Clapham, 1997, p. 33). However, it is certainly possible that employees may respond differently than students (Clapham, 1997), so future corroboration of the training and results with organizational employees is certainly warranted and of value. Most scholars recognize that creativity results from a "confluence of several factors (e.g., intellect, personality, thinking style, environment)" (Batey & Furnham, 2008, p. 410). If the focus or goal is to increase creativity in business endeavors then future studies of this type would do well to assess the transfer of this training to subsequent creativity in the specific context of the organizational environment (Batey & Furnham, 2008).

While there is some debate about whether creativity is domain-general or domain-specific (e.g., Chen, Himsel, Kasof, Greenberger, & Dmitrieva, 2006; Sternberg, Grigorenko, & Singer, 2004) the distinction may have the most relevance and importance to the development of creativity training programs (Baer, 1998). One potential problem is when domain-specific training does not generalize to other contexts. While there was some specificity to the *Thinkertoys* examples, goals and challenges in the module assignments, the training focused on very general divergent thinking techniques or processes and our results (with measures of general divergent thinking) suggest the training was not too limited in this respect. In other words, although the CTP was comprised of some domain-specific elements, the subjects' general divergent thinking, as measured by the TTCT, improved significantly. Nonetheless, it is important to recognize that instruction with the goal of improving creativity in a specific domain (research and development) or very specialized task (product development) may want to build on this more general training of initial requirements such as divergent thinking, with greater specificity. This strategy is consistent with a nested hierarchical view of the creativity domain distinction (Baer, 2005) and training that assumes some specificity is likely to be more successful in the development of creativity within a very specialized domain (Baer, 1998).

While we believe this research makes some significant contributions, we acknowledge some limitations. For one, we lacked a control group as it would have been extremely cost prohibitive given the financial cost of not only the purchase of the TTCTs but their professional scoring as well. There are always tradeoffs; in this case, we believe the limitation of not having a control group was outweighed by the use of the most valid and recommended test for evaluating creativity training and instructional efforts. While the TTCT is the "test of choice" with respect to its validity, thoroughness, reliability, etc., it is limiting because of the considerable time and expense to administer and score (O'Neil et al., 1994).

We used self-report measures of creative self-efficacy. Self-report measures of creativity are common, particularly when used in conjunction with other criteria and their predictive validity has been supported in past research (Batey, 2007). Nonetheless self-report measures of creativity or any other personal characteristics are susceptible to all types of biases (Baer, 1998). Prior research (Furnham, Batey, Anand, & Manfield, 2008) suggests self-reports are more likely to reflect attitudes and opinions rather than actual ability. We intended to capture a self-view or self-concept rather than one's actual ability and as such, few alternatives to self-report measures exist. Our attempt was to distinguish one's opinion of how creative they are (creative self-efficacy) from their actual divergent thinking skills (as measured by the TTCT), and the correlations, while again marginally significant at the posttest, do support distinctions among them.

Finally, it is important not to confuse divergent thinking with creativity and recognize that is a significant, yet insufficient trait for creative achievement (Batey & Furnham, 2008). Divergent thinking represents only one variable in the more comprehensive models or definitions of creativity. For example, Shalley et al. (2004) suggest that creativity is a function of personal characteristics of the individual, characteristics of the context as well as the interactions among them. Plucker, Beghetto and Dow (2004) similarly suggest that creativity results from the interaction among creative aptitudes (e.g., cognitive abilities such as divergent thinking), process and environment. Divergent thinking is one such personal characteristic by which creative ideas are generated while others include personality, motivation, knowledge, etc. (Batey & Furnham, 2008). However, divergent thinking, along with creative self-efficacy, appears to hold a great deal of promise given their benefits from training, and as a result have been the focus of much of the instructional efforts aimed at improving creativity.

Business and industry are holding academics accountable for developing the skills that are vital to the performance of our country's workforce and creativity can be taught in university programs (e.g., Courture, 2006; Wince-Smith, 2006). Unfortunately, both teaching and research on creativity are inadequate (Anderson, 2006; McCorkle et al., 2007). Perhaps one reason for the void is that educators at the college level face a daunting array of possibilities and approaches when trying to develop or select a Creative Thinking Program. The critical component missing from creativity education is clarity regarding the content of instruction, method of delivery, length of training, etc. (Scott et al., 2004). We hope the development and successful evaluation of the easily replicable online Creative Thinking Program presented here will provide a stepping stone toward the teaching and research of creativity in higher education.

Appendix A. Sample assignments used in the Creative Thinking Program

A.1. Brutethink assignment

Read the chapter Brutethink on page 157 of *Thinkertoys*.

(1) Summarize in your own words how the technique works (~5 sentences).

(2) Explain how the quote from Sun Tzu at the beginning of the chapter relates to the technique (~3 sentences).
(3) Describe three examples presented in the text illustrating how it has been (or might be) used in business (1–2 sentences for each example).
(4) Describe one visual illustration used to help explain the technique (1–2 sentences).
(5) In this activity you will be using the Brutethink technique to generate ideas. One of the most frequently used techniques to help "think outside the box" or to break the patterns of routine thought is to use a random word as a trigger to help coax our brains to make an unusual or unexpected connection. As described in the text, our brains naturally want to find connections between two concepts, no matter how different they may seem at first. You will find this random word technique in almost any of the creativity books on the market, though the name Brutethink is used by our textbook author to give it a memorable label in his book.

Apply this technique to list unusual uses of a paperclip. Use a quota of 30 unusual uses; that is, do not stop generating ideas until you have at least 30 ideas. Once you get the hang of this technique and can enter "idea generation" mode, the 30 ideas will just roll effortlessly from your mind! Even a quota of 100 would not intimidate you.

A.2. Chilling Out assignment

Read the chapter Chilling Out on page 203 of *Thinkertoys*.

(1) Summarize in your own words how the technique works (~5 sentences).
(2) Explain how the quote from Sun Tzu at the beginning of the chapter relates to the technique (~3 sentences).
(3) Describe three examples presented in the text illustrating how it has been (or might be) used in business (~1 sentence for each example).
(4) Describe one visual illustration used to help explain the technique (~1 sentence).
(5) Use the general BLUEPRINT for the Chilling Out technique to help you relax and generate alpha waves as you try to come up with more ideas about how to design a unique and innovative umbrella. Try this first by just relaxing as described in the blueprint and note any ideas that come to you. Then choose any three of the specific relaxation techniques listed in the chapter (e.g., Tripping in the Past, the Jell-O Syndrome). Write a short reflection for each technique you tried to describe any ideas that came to you as well as how well the technique did (or did not) work for you (~3–5 sentences for each technique).

A.3. Stone Soup assignment

Read the chapter Stone Soup on page 239 of *Thinkertoys* and complete the following:

(1) Summarize in your own words how the technique works (~5 sentences).
(2) Explain how the quote from Sun Tzu at the beginning of the chapter relates to the technique (~3 sentences).
(3) Describe three examples presented in the text illustrating how it has been (or might be) used in business (1–2 sentences for each example).
(4) Describe one visual illustration used to help explain the technique (1–2 sentences).
(5) Choose five of the imagination-spurring (i.e., Just Suppose) questions on page 242 and try to formulate answers for them. For each question you choose, record the answers and ideas that were generated as a result.
(6) Use the BLUEPRINT on page 243 in applying the Stone Soup technique.

At the end of this document is a reprinted announcement about the Solid Green initiative to improve recycling efforts related to the trash from football game days. Doubling the number of bins may mitigate the problem somewhat but certainly there are some other "what if" scenarios that could lead to more creative ideas for this challenge. Please generate at least five "what if" scenarios related to this challenge and try to answer the questions posed by your scenarios as instructed in the BLUEPRINT. Try to think of all the other interesting and exciting consequences that would happen IF the "what if" were to come true. (It also may help here to practice the Brutethink technique to try and think of interesting and unusual uses of this trash as you can. Do not limit yourself to the uses you have seen or hear about, but rather think of as many new uses as you can.)

Report on your questions, answers, as well as possible solutions to this challenge that you generated as a result of this technique. Certainly some of the ideas you generate may be practically useful and effective but do not worry about those criteria in trying to apply this blueprint. Improbable or impossible "what-if" questions, answers and consequences are encouraged for this exercise. The purpose is to train your imagination to aid in developing creative and innovative ideas for a challenge.

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