TRIZ Future 2012, Lisbon, Portugal

Does TRIZ change people? evaluating the impact of TRIZ training within an organisation: implications for theory and practice

Lilly Haines-Gadd

Birkbeck College, University of London / Oxford Creativity
TRIZ Innovation Centre
Hanborough business park
Hanborough
Oxford OX29 8LJ

Abstract

The author conducted research into the impact of TRIZ training within a global FMCG organisation, repeating the research of Birdi et al (2010) [1], which was conducted within a global engineering company. This research is based on Birdi et al's (2010) [1] model, which suggests that different individual and contextual factors are required for different parts of the innovation process (idea generation, followed by implementation). This study has highlighted potential mechanisms that underlie creative behaviour: namely, cognitive factors (creative thinking skills), and affective factors (motivation to innovate and creative self-efficacy); and developed further a method of measuring them.

The questionnaire (n=122) found that Birdi et al.’s (2010) [1] suggested mechanism of how TRIZ training improves idea generation - by improving levels of cognitive and affective factors - was partially supported. Trainees reported higher levels of creative self-efficacy, motivation to innovate, idea generation and patent submissions than non-trainees: while creative thinking skills were shown to be associated with higher levels of idea generation, no difference was found comparing trainees to non-trainees. Birdi et al. (2010) [1] predicted environmental support for innovation would influence idea generation and implementation, which was not supported, however as predicted, some of the measures of job-relevant capabilities were better predictors for idea implementation than training. Different levels of impact were found according to how much training the participants had received.

This study therefore suggests some of the mechanisms by which TRIZ improves innovative behaviour at work: by providing an understanding of the functional changes as a result of training, better evaluation can be conducted by measuring individual's changes in cognitive and affective factors, providing a more rigorous measure of the impact of TRIZ training.

The implications for practitioners in delivering the most effective TRIZ training are discussed (in terms of focus, structure and learning outcomes), as well as the limitations of TRIZ training and the other factors organisations need to consider in order to increase their innovative output.

This research contributes to the literature by being one of the few evaluations of innovation training
which is theoretically driven, conducted within an organisation, and repeats past work using the same training content (TRIZ).
The research was conducted as part of the author’s MSc in Occupational Psychology, and while she is a TRIZ trainer and practitioner herself, this research was conducted at an organisation which had received training in TRIZ from another consultancy.

**Keywords**: TRIZ training; evaluation; creativity; innovation

---

1. **Introduction**

Innovation is increasingly considered a key component of organisations’ success (Ford & Gioia, 2000), and research has shown that innovating firms grow faster and experience 4 times the sales growth of non-innovating firms (Roper et al., 2008).

Organisations are recognising that in order to maintain a competitive edge they need innovative employees and many are looking to training as one way of improving their innovative thinking abilities (Clapham, 2003), working on the basis that most employees are capable of being creative at work (Farr, 1990; Weisberg, 1986), and if they are not, it is due to lack of skills or motivation (Steinmetz, 1968).

1.1 **What is innovative behaviour?**

Innovative behaviour involves both the generation of creative ideas and their implementation for organisational benefit (Amabile, 1988, 1996; West & Farr, 1990). Creative ideas are defined as both novel and useful (Amabile, 1983; Mumford & Gustafson, 1988; Sternberg & Lubart, 1991, 1995, 1996; Ochse, 1990). While the literature often uses the terms “creativity”, “innovation” and “creative problem solving” as synonymous, creativity can be understood as a crucial part of the innovation process (Anderson et al., 2004): a two-stage process where creativity dominates in the first stage, followed by implementation (West, 2002). Creativity is therefore a necessary but not sufficient condition for innovation at work (Amabile, 1996). Successfully innovative individuals must therefore be able to generate creative ideas and then implement them (Birdi, 2007).

1.2 **How do we increase innovative behaviour? The impact of training**

Training tends to focus on improving abilities in the first stage of innovation process - generating creative ideas - as ideation is often the part of the creative process that individuals find the most difficult (Basadur et al., 1982).

Of the recent meta-analyses into the impact of training, most have criticised current research as relying too heavily on lab-based research, more research is therefore needed within organisations, to understand whether the positive results of creativity training found in experimental studies can be replicated in the workplace. Very little research has investigated the mechanisms which underlie creative ability (Runco, 2004) or seek to explain why individual and contextual factors influence an individual’s creativity (Choi, 2004).
Effective evaluation of the impact of training in the workplace should be theoretically driven; we should understand the mechanisms by which the training changes an employee (Birdi, 2005, 2007).

Birdi et al. (2010) studied the impact of TRIZ training within an engineering company. TRIZ (Teoriya Resheniya Izobretatelskikh Zadatch = Theory of Inventive Problem Solving) is a toolkit and problem solving process developed in the former Soviet Union. The TRIZ community analysed the most inventive patents and developed a series of tools for understanding and solving problems based on analogous thinking: there are heuristics for modelling problems conceptually in order to access innovative solutions, and tools for stimulating creative thinking (Altshuller & Altov, 1996). While training in TRIZ is becoming increasingly popular in the UK, very little research has been conducted into its impact (Birdi et al. 2010).

1.3 Evaluating training: how does training work? Influences on Idea Generation

Training can improve an individual’s ability to think creatively by providing them with methods or heuristics for generating more ideas (Amabile, 1983; Clegg et al, 2002; Scott et al, 2004b; Hennessey & Amabile, 2010); i.e. improving their creative thinking skills.

However for training to be most effective, it must also involve changes in intrinsic motivation to innovate (an interest and involvement in the work, driven by curiosity and enjoyment (Amabile, 1983)), as this have been shown to be critical for individual creativity at work (e.g. Amabile, 1983,1988,1996; Sternberg & Lubart, 1996) and for long-term behavioural change following training (Basadur et al, 1982). Nickerson (1999) suggested that affective factors such as motivation were more important than domain-specific knowledge or creativity-relevant skills.

Nickerson (1999) also suggested that beliefs about creative ability are critical: if people believe that creativity can be enhanced through learning, they are more likely to be motivated in and following training. Therefore investigating individual’s beliefs about their creative abilities is also important, as they may underlie and impact on their motivation.

Numerous studies report the positive association between creative self-efficacy and innovative behaviour (Axtell et al, 2000; Farr & Ford, 1990; Parker et al, 2006; Patterson et al, 2009; Tierney & Farmer, 2002, 2004; and creativity (Beghetto, 2006; Ford, 1996; Bandura, 1997; Phelan, 2001). Self-efficacy is conceptually distinct from motivation to innovate, as it incorporates elements of confidence, courage (Patterson et al., 2009) and one’s perceived ability for conducting a specific task (Bandura, 1997). Self-efficacy can mediate the relationship between motivation and performance (Bandura, 1982). Choi (2004) found that self-efficacy mediated creative ability, but it may also mediate motivation to innovate: this has not yet been investigated.

Few studies have investigated the impact of training on creative self-efficacy, but there is evidence that training can increase levels of creative self-efficacy (Robbins & Kegley, 2010; Mathisen & Bronnick, 2009; Locke et al., 1984; Gist, 1989).

2. Statement of Hypotheses

Hypothesis 1: Individuals who have been trained will show higher levels of innovative behaviour at work.
Birdi et al.’s (2010) suggested that training improved innovative behaviour by improving cognitive (creative thinking skills) and affective factors (motivation to innovate). TRIZ trainees should therefore show higher levels of both of these factors, and they should be associated with higher levels of innovative behaviour at work. Creative self-efficacy may also be improved by training and be associated with higher levels of idea generation.

**Hypothesis 2:**

*Individuals who have been TRIZ trained will show higher levels of creative thinking skills, motivation to innovate and creative self-efficacy.*

**Hypothesis 3:**

*Higher levels of creative thinking skills, motivation to innovate and creative self-efficacy will be associated with higher levels of idea generation.*

**Hypothesis 4:**

*Creative self-efficacy will mediate the impact of creative thinking skills and motivation to innovate on idea generation.*

One important way that this sample varied from Birdi et al.’s (2010) original sample is that the training programme was substantially different. In Birdi et al.’s (2010) sample, the trainees had all attended a single day of training. In this sample, three levels of training programme were available: there may be different levels of change in cognitive and affective factors as a consequence of amount of training completed. This may also effect training satisfaction and transfer.

**Hypothesis 5:**

*The more training attended, the higher the levels of creative thinking skills, motivation to innovate, creative self-efficacy, training satisfaction and transfer.*

3. **Methodology**

3.1 **Organisational Context**

The study was conducted at the UK site of an international fast moving consumer goods (FMCG) company. TRIZ training was offered to all 60 members of the Product Futures department.

However the response to the training so far was mixed, and it was uncertain how useful TRIZ had been and how much it was being used. Therefore the company was keen to undertake evaluation in order to understand whether TRIZ training had improved individual’s creative behaviour at work and resulted in more innovative ideas being implemented.

3.2 **Procedure**
The Product Futures department was compared to Applied Research, a similar department which hadn’t received any TRIZ training. A questionnaire was sent to 122 employees, all 60 members of the Product Futures department and all 62 members of Applied Research. 67 responses were collected – a 55% response rate – with no significant difference in response rate between departments.

3.3 Measures

Innovative Behaviour Measures:

Idea Suggestion

Respondents were asked how much over the last 3 months they had suggested ideas to others in 5 relevant areas of work. Responses were scored on a five-point scale item from 1=to a very great extent to 5=not at all, and were averaged to provide a single score (alpha=.76).

Idea Implementation

Respondents were asked how much over the last 3 months their ideas had been implemented in the same 5 areas as above. Responses were scored on a five-point scale item from 1=to a very great extent to 5=not at all, and averaged to provide a single score (alpha=.78).

Patent Submissions

Respondents were asked how many patents they had submitted in 2010.

Creativity Training Measures

Respondents were asked whether they had participated in any training, if so, how many months ago, and to what level (Level 1, 2 or 3). Respondents completed 19 measures of training satisfaction, averaged to provide a single score (alpha=.97). Respondents indicated how much they have consciously used TRIZ since attending training as a measure of training transfer. Responses were scored on a five-point scale from 1=Very frequently to 5=Not at all. Participants were also asked “why” to capture reasons for use or non-use of TRIZ, and asked to describe an example of where TRIZ had been applied to their work.

Individual Measures

Respondents rated their self-reported creative thinking skills on a 7-item measure. Responses were scored on a five-point scale from 1=highly skilled (i.e. can coach others in this) to 5=not skilled at all, and averaged to form a single score (alpha=.90).

Motivation to innovate was measured using a 4-item measure. Items were scored on a five-point scale from 1=Strongly agree to 5=strongly disagree, and averaged to form a single score (alpha=.80).

Creative self-efficacy was measured using Tierney & Farmer’s (2002) 3-item measure. Items were scored on a five-point scale from 1=Strongly agree to 5=strongly disagree, and averaged to form a single score (alpha=.87).
4. Results

**Hypothesis 1:** Individuals who have been trained will show higher levels of innovative behaviour at work.

T-tests were conducted to compare the difference between TRIZ trainees and non-trainees.

**Table 1: Results of T-Tests comparing TRIZ trainees and non-trainees**

<table>
<thead>
<tr>
<th></th>
<th>Trainees</th>
<th>Non-trainees</th>
<th>T Value</th>
<th>Df</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Standard Deviation</td>
<td>Mean</td>
<td>Standard Deviation</td>
</tr>
<tr>
<td>Idea Suggestion</td>
<td>2.86</td>
<td>.85</td>
<td>2.41</td>
<td>1.00</td>
</tr>
<tr>
<td>Idea Implementation</td>
<td>2.17</td>
<td>.76</td>
<td>1.98</td>
<td>.96</td>
</tr>
<tr>
<td>Creative Thinking Skills</td>
<td>4.00</td>
<td>.60</td>
<td>3.71</td>
<td>.70</td>
</tr>
<tr>
<td>Motivation to Innovate</td>
<td>4.23</td>
<td>.52</td>
<td>3.84</td>
<td>.58</td>
</tr>
<tr>
<td>Creative Self-Efficacy</td>
<td>4.27</td>
<td>.68</td>
<td>3.81</td>
<td>.67</td>
</tr>
<tr>
<td>Patent Applications</td>
<td>1.67</td>
<td>2.38</td>
<td>.43</td>
<td>.79</td>
</tr>
</tbody>
</table>

*p<.05, **p<.01

TRIZ trainees reported higher levels of idea suggestion at work (mean=2.90, SD =.85) than non-trainees (mean=2.41, SD 1.00), t(66)=-2.0, p<.05.

There was no significant difference between groups in number of ideas implemented (see table 2).

TRIZ trainees applied for more patents (mean=1.67, SD=2.38) than non-trainees (mean=.43, SD=.79) t(40)=-2.81, p=.008.

**Hypothesis 2:**

**Individuals who have been TRIZ trained will show higher levels of creative thinking skills, motivation to innovate and creative self-efficacy.**

There was no significant difference between trainees and non-trainees for levels of creative thinking skills.

TRIZ trainees showed higher levels of motivation to innovate (mean=4.23; SD=.52) compared to non-trainees (mean=3.84, SD=.58) t(67)=-3.02, p<.01; TRIZ trainees also showed higher levels of creative self-efficacy (mean=4.27, SD=.68) than non-trainees (mean=3.81, SD=.67) t(67)=-2.82, p<.01.

**Hypothesis 3:**

**Higher levels of creative thinking skills, motivation to innovate and creative self-efficacy will be associated with higher levels of idea generation.**
Levels of creative thinking skills were correlated with idea suggestions ($r = .42, p < .001$), patent applications ($r = .33, p < .05$) and idea implementation ($r = .43, p < .001$).

Levels of motivation to innovate correlated with idea suggestion ($r = .37, p < .01$), patent applications ($r = .42, p < .01$), and idea implementation ($r = .38, p < .01$).

Levels of creative self-efficacy correlated with idea suggestion ($r = .53, p < .001$), patent applications ($r = .47, p < .001$), 2009 ($r = .45, p < .001$), and idea implementation ($r = .56, p < .001$).

**Hypothesis 4:**

*Creative self-efficacy will mediate the impact of creative thinking skills and motivation to innovate on idea generation.*

To test for mediation, the Baron & Kenny (1986) steps were followed:

- the mediator was regressed on to the predictor variable to demonstrate a correlation
- the criterion variable was regressed on to the predictor variable to demonstrate a direct effect for the predictor on the criterion
- the criterion variable was regressed on to the predictor variable and the mediator

*Table 2 Summary of hierarchical regression analysis for the mediation effects of creative self-efficacy on creative thinking skills (n = 65)*

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Step 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta$</td>
<td>$\beta$</td>
</tr>
</tbody>
</table>

**Regression 1 a)**
- Creative thinking skills: $r = .75$, $p < .001$  
  - F: 86.29  
  - $R^2$: .56

**Regression 2 b)**
- Creative Thinking Skills: $r = .42$, $p < .001$  
  - F: 13.82  
  - $R^2$: .17

<table>
<thead>
<tr>
<th>Criterion Variable</th>
<th>Step 1</th>
<th>Step 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creative self-efficacy</td>
<td>.50**</td>
<td>.28***</td>
</tr>
<tr>
<td>Idea suggestion</td>
<td>.04</td>
<td>.11**</td>
</tr>
</tbody>
</table>

*a* $p < .05$, **$p < .01$, ***$p < .001$

As can be seen in Table 2, regression 1 demonstrated a correlation between the creative thinking skills and creative self-efficacy ($r = .75, p < .001$). Regression 2 demonstrates a direct effect of creative thinking
skills on idea suggestion ($\beta=.42, p<.001$), however when creative self-efficacy is added to the regression, it is independently significant ($\beta=.50, p<.001$), while creative thinking skills becomes non-significant, indicating complete mediation.

*Table 3 Summary of hierarchical regression analysis for the mediation effects of creative self-efficacy on motivation to innovate (n=64)*

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Step 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta$</td>
<td>$\beta$</td>
</tr>
</tbody>
</table>

**Regression 1 a)**
- Motivation to Innovate: $\beta=.76^{***}$
- F: 91.48
- $R^2$: .58***
- Change in $R^2$

**Regression 2 b)**
- Motivation to Innovate: $\beta=.37^{**}$, $\beta=-.07$
- Creative Self-efficacy: $\beta=.58^{**}$
- F: 10.29, 12.82
- $R^2$: .14**, .28***
- Change in $R^2$: .15**

*p<.05, **p<.01, ***p<.001

Criterion Variable
- a) Creative self-efficacy
- b) Idea suggestion

Looking at motivation to innovate, as seen in Table 3, regression 1 demonstrated a correlation between the motivation to innovate and creative self-efficacy ($r=.58, P<.001$). Regression 2 demonstrates a direct effect of motivation on idea suggestion ($\beta=.37, p<.01$), however when creative self-efficacy is added to the regression, it is independently significant ($\beta=.58, p<.001$), while creative thinking skills becomes non-significant, indicating complete mediation.

**Hypothesis 5:**

*The more training attended, the higher the levels of creative thinking skills, motivation to innovate, creative self-efficacy, training satisfaction and transfer.*

As only 2 people had completed Level 3 training, a new variable was created combining Level 2 and Level 3.

An independent samples one-way analysis of variance showed a significant difference between groups in levels of creative thinking skills, motivation to innovate and creative self-efficacy.
Table 4: One-way ANOVA showing difference in cognitive and affective factors

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Number</th>
<th>95% Confidence Intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lower</td>
</tr>
<tr>
<td>Creative Thinking Skills</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No training</td>
<td>3.71</td>
<td>.69</td>
<td>33</td>
<td>3.47</td>
</tr>
<tr>
<td>Level 1</td>
<td>3.66</td>
<td>.59</td>
<td>14</td>
<td>3.32</td>
</tr>
<tr>
<td>Level 2&amp;3</td>
<td>4.22</td>
<td>.53</td>
<td>22</td>
<td>4.00</td>
</tr>
<tr>
<td>Motivation to Innovate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No training</td>
<td>3.87</td>
<td>.60</td>
<td>33</td>
<td>3.66</td>
</tr>
<tr>
<td>Level 1</td>
<td>4.00</td>
<td>.62</td>
<td>14</td>
<td>3.62</td>
</tr>
<tr>
<td>Level 2&amp;3</td>
<td>4.36</td>
<td>.37</td>
<td>22</td>
<td>4.20</td>
</tr>
<tr>
<td>Creative Self-Efficacy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No training</td>
<td>3.84</td>
<td>.69</td>
<td>33</td>
<td>3.60</td>
</tr>
<tr>
<td>Level 1</td>
<td>3.83</td>
<td>.62</td>
<td>14</td>
<td>3.47</td>
</tr>
<tr>
<td>Level 2&amp;3</td>
<td>4.52</td>
<td>.59</td>
<td>22</td>
<td>4.25</td>
</tr>
</tbody>
</table>

*p<.05, **p<.01, ***p<.001
Table 5: Tukey HSD Multiple Comparisons

<table>
<thead>
<tr>
<th></th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Creative Thinking Skills</strong></td>
<td></td>
</tr>
<tr>
<td>No training</td>
<td>Level 1</td>
</tr>
<tr>
<td>No training</td>
<td>Level 2&amp;3</td>
</tr>
<tr>
<td>Level 1</td>
<td>Level 2&amp;3</td>
</tr>
<tr>
<td><strong>Motivation to Innovate</strong></td>
<td></td>
</tr>
<tr>
<td>No training</td>
<td>Level 1</td>
</tr>
<tr>
<td>No training</td>
<td>Level 2&amp;3</td>
</tr>
<tr>
<td>Level 1</td>
<td>Level 2&amp;3</td>
</tr>
<tr>
<td><strong>Creative Self-Efficacy</strong></td>
<td></td>
</tr>
<tr>
<td>No training</td>
<td>Level 1</td>
</tr>
<tr>
<td>No training</td>
<td>Level 2&amp;3</td>
</tr>
<tr>
<td>Level 1</td>
<td>Level 2&amp;3</td>
</tr>
</tbody>
</table>

*p<.05, **p<.01

Tukey HSD tests were used to examine the differences between levels of training (no training, Level 1, and Levels 2&3; see Table 8). There was no significant difference between no training and Level 1 for any of the measures. There was a significant difference in means between no training and Levels 2&3 and Level 1 and Levels 2&3 for creative thinking skills and creative self-efficacy, and a significant difference between no training and Levels 2&3 for motivation to innovate.

Table 6: T-tests showing difference in training satisfaction and use of TRIZ

<table>
<thead>
<tr>
<th></th>
<th>Level 1</th>
<th>Level 2&amp;3</th>
<th>T Value</th>
<th>Df</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Standard Deviation</td>
<td>Mean</td>
<td>Standard Deviation</td>
</tr>
<tr>
<td><strong>Training Satisfaction</strong></td>
<td>2.11</td>
<td>.66</td>
<td>3.13</td>
<td>.85</td>
</tr>
<tr>
<td>TRIZ Use</td>
<td>1.93</td>
<td>.83</td>
<td>3.00</td>
<td>1.07</td>
</tr>
</tbody>
</table>

**p<.01

T-tests were used to compare the level of training satisfaction and use of TRIZ according to amount of training completed. Significant differences were found in training satisfaction, with respondents completing Level 1 reporting a lower satisfaction level (mean=2.11,SD=.66) than those completing Levels 2&3 (mean=3.13,SD=.85), t(34)=-3.83, p<.001. Respondents completing Level 1 reported a lower level of TRIZ use (mean=1.93,SD=.83) than those completing Levels 2&3 (mean=3.00,SD=-1.07), t(34)=-3.81, p<.001.
Reasons for Using TRIZ

Respondents who reported using TRIZ “frequently” or “very frequently” gave reasons for this around TRIZ’s usefulness, seeing it being used by others, and job support for the use of TRIZ.

Respondents who reported using TRIZ “rarely” or “not at all” gave reasons for this which were focused strongly around the lack of opportunity. Other reasons were that, it wasn’t easy enough to use, it wasn’t needed and lack of support.

Consequences of TRIZ

Responses to this focused around the generation of many more and more novel ideas, including ideas which wouldn’t have been generated without TRIZ, and ideas which were more simple. More patents were generated, and patents extended as a result of TRIZ use. Respondents also reported more clear and structured thinking, better thought processes, faster problem solving, an objective focus and a new way of thinking.

Changes to training

Respondents focused on ease of use (or lack thereof). One respondent reported “level 1 was the download of the theory and level 2 was more about its application”. Many responses suggested that the training was easier to use, simplified, more pragmatic, in smaller chunks and more fun.

5. Discussion

5.1 Idea Suggestion & Patent Applications

The TRIZ trained group reported higher levels of Idea Suggestion at work than non-trainees, indicating the training may have improved their ability to generate ideas. Trainees reported submitting more patents than non-trainees.

5.2 Creative Thinking Skills, Motivation to Innovate and Creative Self-Efficacy

Birdi et al. (2010) suggested that improved creative thinking skills and motivation to innovate as a result of training provided the means by which training had a positive impact on innovative behaviour; therefore, it was expected to find higher levels of these factors in trainees compared to non-trainees, and for these factors to be associated with higher levels of innovative behaviour. Creative self-efficacy was also investigated, as previous studies have shown that it can be improved by training and have a positive influence on innovative behaviour (e.g. Robbins & Kegley, 2010; Mathisen & Bronnick, 2009).

Higher levels of motivation to innovate and creative self-efficacy were found in trainees compared to non-trainees, but unexpectedly there was no significant difference between the two groups in creative thinking skills. This may indicate a difference in training: the TRIZ training delivered in this company was different in content and length to the training in Birdi et al (2010), so it may be that the training this sample received was effective in changing motivation to innovate and creative self-efficacy, but not creative thinking skills.
Higher levels of these factors were expected to be associated with higher levels of innovative behaviour: medium-sized to large correlations were found between all of measures of innovative behaviour and these factors, with creative self-efficacy showing stronger relationships than the other two factors for idea suggestion ($r=.53$), patent applications ($r=.47$) and idea implementation ($r=.56$).

5.3 Creative Self-Efficacy

Creative self-efficacy completely mediated the effect of creative thinking skills, supporting Choi’s (2004) findings, and motivation to innovate (suggested by Bandura, 1982). This is an interesting addition to understanding the potential impact of training, and has practical implications: it is not enough to teach individuals creative thinking skills and motivate them towards the task of innovating: people must have confidence in their ability to be creative for training to be effective. As creative self-efficacy can be improved by training, it indicates that training programmes aiming to teach individuals creativity-relevant skills and motivation should include elements intended to raise creative self-efficacy. This can be improved by positive experiences (Bandura 1982; Patterson, 2002) and may explain the finding that training programmes including exercises and practical application of newly-learned skills are more effective (Scott et al., 2004b).

There is little research investigating the interaction of these constructs, and what there is often investigates self-efficacy as a generalised construct and/or a trait (e.g. Prabhu et al., 2008). More research is needed to uncover the relationship between creative self-efficacy, creative thinking skills and motivation to innovate.

5.4 Level of Training

How much training individuals attended was significantly related to the subsequent impact on creative thinking skills, motivation to innovate and creative self-efficacy. Crucially, the biggest difference was between Levels 1 and 2. This could mean that the training at Level 1 was not sufficient to change participants’ skill and affective orientation levels, and further training was required to increase this.

One explanation may be the fact that the training is much longer: if one of the most important outcomes from innovation training is increased self-belief and motivation then 1 day of training may be inspirational, but 5 days too hard to put into practice. An additional 5 days may give individuals the practice and confidence in the use of the tools to then see the benefits of increased affective orientation to innovation. Respondents who have completed Level 2 or 3 report higher levels of satisfaction with the training and use of TRIZ, suggesting that completing the advanced training is beneficial: this may be the reason. If this is the case, perhaps the most important part of innovation training is not the tools themselves but the self-belief than an individual can be creative. This has important implications for the focus on innovation training at work.

Another key aspect is that the training was not delivered by the same provider. The company where Birdi et al. (2010) conducted their research had created their own in-house TRIZ programme: this company had a consultancy run in-house programmes. It may be that this company’s Level 1 training was less effective in improving creative thinking skills: TRIZ is public domain, and the approaches taken by different companies can vary significantly in the choice of tools (Moerhle, 2004); this company may have been taught different tools.
This is also a different industry: Scott et al. (2004a) suggest that population and setting might moderate the effectiveness of training. TRIZ was developed for engineers, and Birdi et al.’s (2010) research was in an engineering company, while this sample is largely chemists and scientists. TRIZ may not have the same impact on this community: the tools in particular may be more suited to engineering problems, which might explain the different outcome in creative thinking skills.

5.5 Implications for Training

This research demonstrates the importance of making TRIZ training fun, easy to use and focuses on giving people confidence in using TRIZ. As beneficial effects of TRIZ training were shown without any change in actual thinking skills, this study demonstrates that perhaps the most important aspect of training is changing people’s feelings about innovation at work and improving their confidence levels in problem solving and generating creative ideas.

5.6 Implications for Organisations

People who use TRIZ most often report having support in their job, while the most commonly cited reason for not using TRIZ was the lack of opportunity. This suggests that organisations which have invested in training should not only support but also encourage the use TRIZ in order to see widespread organisational benefits.

6. Conclusions

This study provides modest support for Birdi et al.’s (2010) model of the different individual and contextual factors that influence the two stages of innovation: idea generation and idea implementation. The questionnaire developed from this model therefore forms a good basis for understanding the impact of innovation training at work. Birdi et al. (2010) suggested that training works by improving creative thinking skills and motivation to innovate: this study supports their positive influence on innovative behaviour at work, and higher levels in motivation to innovate were found in respondents who had been trained, indicating training has a beneficial effect on individual creativity. Not all of Birdi et al.’s (2010) findings were replicated – there was no evidence that creative thinking skills were higher in trainees, however this may be due to differences between the samples and the TRIZ training. Further replication of this study within organisations who have received TRIZ training would be vital for improving the generalisability of this questionnaire: however this study is rare in repeating the evaluation of training of the same content, when content is a key source of variation in outcome (Scott et al, 2004b).

Birdi et al’s (2010) model for understanding the various inputs to innovative behaviour at work has been partially supported. His questionnaire may therefore be an effective way to measure the impact of training – even after completion– however it could be improved by making it shorter via factor analysis. This study contributes to the literature as it has highlighted potential mechanisms that underlie creative behaviour: namely, creative thinking skills, motivation to innovate and creative self-efficacy; and developed further a method of measuring them.
References


Basadur,M., Graen, G.B. & Green, S.G. (1982) Training in creative problem solving: effects on ideation and problem finding and solving in industrial research organization *Organizational Behavior and Human Performance*, 30, 41-70


Farr, J.L. (1990) Facilitating individual role innovation. In M.A. West & J.L. Farr (Eds.), Innovation and creativity at work Psychological and organizational strategies (pp.207-230). Chichester: Wiley


Patterson, F. (2002) Great minds don’t think alike? Person-level predictors of innovation at work *International Review of Industrial and Organizational Psychology, 17*, 115-143


Steinmetz, C.S. (1968) Creativity training: a testing program that became a sales training program *Journal of Creative Behavior, 2*(3), 179-186


West & Farr, 1990