A Synthetic Analysis of the Effectiveness of Single Components and Packages in Creativity Training Programs

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ABSTRACT: This study used the method of meta-analysis to synthesize the effect of creativity training. The ProQuest Educational Journal, ProQuest Dissertation Consortium, ERIC, EBSCOhost Databases, the Creativity Research Journal, and the Journal of Creativity Behavior were searched to find studies evaluating the effectiveness of creativity training. The grand mean effect size of creativity training was .77. With the exception of training programs and age, no significance was found in the effect of moderators such as dependent variables, duration of training, and experimental design. The results further showed that the older the age of the participant, the larger the effect size, with the exception that the effect size for college students was smaller than that for high school students because of the large standard deviation. Experimental analysis of the effect of single techniques or components of training packages is suggested for future research.

The evolution of civilization depends on innovation, and innovation depends on creativity. In the economy, innovation is decisive for one product to gain a share of the market. Therefore, it is undoubtedly important to nurture and enhance creativity in students.

What is creativity? Different theorists describe creativity from different perspectives. Creativity might be hypothetically defined as the ability to reorganize one's available knowledge to solve a problem. Koestler (1964; cited in Mumford & Gustafson, 1988, p. 30) concluded from his literature review that "we cannot create something from nothing." That is to say that creativity must base itself on a preexisting repertoire of knowledge. Therefore, it can be inferred that knowledge is a necessary, but not a sufficient, condition of creativity.

Is creativity trainable? Torrance (1972) summarized the results of 142 studies designed to test approaches to teaching children to think creatively and found that the Osborn–Parnes Creative Problem Solving (CPS; Osborn, 1963; Parnes, 1967) training program and its modifications was the most successful. He used the percentage of attained measured objectives as his indicator of success. A large number of the studies were narrative reports. Of the 142 studies he reviewed, 103 used performance on the Torrance Tests of Creative Thinking (TTCT; Torrance, 1966a, 1966b, 1966c) as criteria. Torrance classified the training programs into nine categories. According to Torrance's evaluation, all categories of programs teaching children to think creatively were at least 50% successful.

Mansfield, Busse, and Kreplka (1978) qualitatively synthesized the effectiveness of creativity training programs. They classified programs into six categories: (a) the Productive Thinking Program (Covington, Crutchfield, Davis, & Olton, 1974), which emphasizes both divergent and convergent thinking abilities; (b) the Purdue Creative Thinking Program (Feldhusen, Speedie, & Treffinger, 1971; Feldhusen, Treffinger, & Gahlke, 1970), which consists of 28 audiotapes with accompanying printed exercises providing practice in divergent thinking skills; (c) the Parnes Program (Parnes, 1969a), which uses many techniques derived from suggestions by Alex

Osborn (1963), such as brainstorming; (d) the Myers–Torrance Workbooks (Myers & Torrance, 1964, 1965a, 1965b, 1966a, 1966b, 1968), which provide practice in activities requiring perceptual and cognitive abilities; (e) Khatena's Training Method (Khatena, 1970, 1971a, 1971b, 1973; Khatena & Dickerson, 1973), which provides instruction and practice in five thinking skills (breaking away from the obvious and commonplace, transposition, analogy, restructuring, and synthesis); and (f) other training programs such as *synectics,* which employs a variety of thinking skills to facilitate "making the strange familiar and making the familiar strange." Mansfield et al.'s categorization was different from Torrance's (1972). Torrance classified the Purdue Creative Thinking Program, the Myers–Torrance materials, and the Productive Thinking Program into a third category: complex training programs with packages of materials.

Mansfield et al. (1978) concluded: "Most evaluation studies of creativity training programs seem to support the view that creativity can be trained" (p. 531). However, regarding the transfer of the training effect to dissimilar, untrained tasks or to real-life creativity, the authors were not without reservations.

Rose and Lin (1984) used meta-analysis to gauge the effectiveness of creativity training programs. They analyzed only studies using the TTCT (Torrance, 1966a, 1966b, 1966c) or its modified forms as the assessment instrument. Training programs were classified into six categories: (a) the Osborn–Parnes Creative Problem Solving program (Osborn, 1963; Parnes, 1967) and its modifications, (b) Covington's Productive Thinking Program (Covington et al., 1974), (c) the Purdue Creative Thinking Program (Feldhusen et al., 1971; Feldhusen et al., 1970), (d) other creative training programs that combine several components of creativity, (e) school programs trying to improve students' creativity, and (f) other long-term programs such as creative dramatics, transcendental meditation programs, and kinesthetic experiences. They found that the overall mean effect size of creativity training was .468 and that the effect size on verbal creativity was higher than figural. They attributed this phenomenon partly to the nature of most of the training programs they analyzed, as most of the materials used in those programs were verbal. The results also showed that the Osborn–Parnes Creative Problem Solving program had the largest effect size (.629). However, contrary to

Mansfield et al.'s (1978) result from synthetic analysis, Covington's Productive Thinking Program produced a smaller effect size (.118) than that (.483) of the Purdue Creative Thinking Program.

Swanson and Hoskyn (1998) carried out a quantitative synthesis of experimental intervention studies with students with learning disabilities as participants. They found that the weighted average effect size of experimental treatments on creativity was .70 (the number of studies was 3, the number of dependent measures was 11, and the standard error was .09). This result could be considered as a moderate effect according to Cohen's (1977) criterion.

Scope (1998) conducted a meta-analysis to assess the effect of instructional variables on creativity. He identified 30 studies and yielded 40 effect sizes with a mean of .90 ($SD = 1.19$). The instructional variables included were (a) a review of previously taught materials; (b) structuring the new teaching materials such as using overviews, advance organizers, outlines, and reviews of objectives; (c) questioning; (d) responding to students; and (e) independent practice. He found no significant difference between the mean effect sizes of published and unpublished studies. He also obtained a nonsignificant correlation ($r = .06$) between the length of treatment and the magnitude of effect size.

Miga, Burger, Hetland, and Winner (2000) quantitatively synthesized eight studies to determine the strength of association between studying the arts and creative thinking. Their first meta-analysis based on correlation studies demonstrated a modest correlation (mean effect size: $r = .27$, $p < .05$). Their other two meta-analyses, based on experimental studies, showed a significant causal relation between arts study and performance on figural creativity measures but no relation to verbal creativity. This might also be attributed to the figure-centered content of arts study.

A recent quantitative review of the effectiveness of creativity training was conducted by Scott, Leritz, and Mumford (2004a). They classified the dependent variables into four categories and calculated their mean effect sizes: (a) divergent thinking (e.g., fluency, flexibility, elaboration, and originality), (b) problem solving (i.e., production of solutions), (c) performance (i.e., production of products), and (d) attitudes and behaviors (e.g., creative efforts initiated). However, they did not present the effect size of a certain training package or technique. The overall effect size obtained was .68, with a standard deviation of .65. Scott et al. (2004a)

made extensive testing of internal and external validity, which was equivalent to testing the effect of moderators. They dichotomized each moderator and calculated the mean effect size of each level. However, they did not test whether the means of the two levels were statistically different from each other. From the data in Tables 3 and 4 of their study, one can only know whether the mean effect size of each level was statistically different from zero at the .10 level.

In another article, Scott, Leritz, and Mumford (2004b) trained three judges to appraise, on a 4-point scale, the content of creativity training programs with respect to cognitive processes, training techniques, media, and practice/exercises; then, using cluster analysis, they assigned training programs to 11 types: analogy, open idea production, interactive idea production, creative process, imagery, computer-based production, structured idea production, analytical, critical/creative thinking, situated idea production, and conceptual combination. Finally, they used meta-analysis to assess the effectiveness of each type of training. As the categorization of these 11 types of training programs resulted from cluster analysis, there was no clear-cut definition for each type of training. Certain types of training may contain a similar technique (e.g., the *brainstorming* technique was stressed in open idea production, interactive idea production, creative process, critical/creative thinking, and situated idea production). However, it was not the purpose of Scott et al. (2004b) to find the effectiveness of a single component of training program or of a package. Their study showed an average effect size of .78.

This investigation extended Rose and Lin's (1984) study to include dependent variables other than the TTCT and tried to calculate the mean effect size for training package and component technique, if possible. Kobe (2001) mentioned the pertinence of assessing the effect of the particular components of creativity training. The focus of this study is not only on packages but also on techniques (in this study, *techniques, elements,* and *components* are synonymies). The definition of each technique was cited from the original studies. If the effectiveness of single techniques or components of creativity training packages were known, then creativity training would be more effective, and the process of creativity would be better understood. This study tried to classify creativity into two main categories: creativity without evaluation (such as brainstorming) and creativity with evaluation (problem solving), and measurements were independently taken for each category in fluency, flexibility, elaboration, and originality.

Method

Location of Studies

The *ProQuest Educational Journal, ProQuest Dissertation Consortium, ERIC,* and the *EBSCOhost Databases* were scanned for research evaluating the effectiveness of creativity training. The search term used was "creativity training." The *Journal of Creativity Behavior* and the *Creativity Research Journal* were systematically and manually searched. In addition, some usable empirical articles were located from references in research articles. To have been selected for this meta-analysis, studies must have contained empirical data for the calculation of effect size such as means and standard deviations of the experimental and control groups; $F(1, df)$; $\chi^2(df = 1)$; or t value. Studies with no control group (i.e., studies comparing the effectiveness of 2 different training programs) were eliminated because this kind of effect size was different from that of the studies with a control group in the creativity training experiment.

Coding of Data

The data required to be coded were the following: article, design, age, duration of treatment, definition of independent variable, definition of dependent variable, Ne, Nc, Me1, Mc1, SDe1, SDc1, Me2, Mc2, SDe2, SDc2, t value, F value, and chi-square value. The materials to be keyed in were marked by me in each located study and then keyed in by the research assistant. I then checked each article to see whether there were typing errors and corrected the errors immediately if I found them. I then wrote the conversion equations for Microsoft® Excel®. As the assistant did not need to make any judgment, but had only to key in the data correctly, there was no calculation of agreement percentage.

Calculation of Effect Size

Effect sizes were calculated from the means and standard deviations of the performance outcome of experimental and control groups or by converting values from other statistical tests such as t or F. Conversions

were based on the equations summarized by Cooper and Hedges (1994, pp. 232–239):

$$es = \frac{Me - Mc}{SDc} \qquad (1)$$

$$es = \frac{M_e - M_c}{\sqrt{\dfrac{(n_e - 1)SD_e^2 + (n_c - 1)SD_c^2}{n_e + n_c - 2}}} \qquad (2)$$

$$es = \frac{t(n_e + n_c)}{\sqrt{n_e n_c (n_e + n_c - 2)}} \qquad (3)$$

$$es = \frac{2\sqrt{F}}{\sqrt{df}} \qquad (4)$$

$$es = \sqrt{\frac{4(N-1)}{N}} \sqrt{\frac{\chi^2}{N - \chi^2}} \qquad (5)$$

$$es = \frac{Me2 - Mc2}{SDc2} - \frac{Me1 - Mc1}{SDc1} \qquad (6)$$

where *es* is the effect size, *Me* is the mean of the experimental group, *Mc* is the mean of the control group, *SDc* is the standard deviation of the control group, *Ne* is the sample size of the experimental group, *Nc* is the sample size of the control group, *N* is the total sample size, *Me2* is the mean of the experimental group on the posttest, *Mc2* is the mean of the control group on the posttest, *Me1* is the mean of the experimental group on the pretest, *Mc1* is the mean of the control group on the pretest, *SDc2* is the standard deviation of the control group on the posttest, and *SDc1* is the standard deviation of the control group on the pretest.

For studies that reported pre- and posttest, the effect sizes were calculated with a formula (Equation 6) suggested by Wortman and Bryant (1985). This equation was also employed by Gersten and Baker (2001). Goff (1992) also used analysis of covariance to statistically control the pretest difference when comparing the difference in posttest means between the experimental and control groups. Their work supports the legitimacy of taking into account the difference in pretest scores between experimental and control groups in calculating the effect size of posttest scores for an experimental design with pre- and posttest.

An equation was utilized depending on the nature of the data that were contained in the sampled articles.

Equation 2 was preferred to Equation 1 because the former gave more information. Equations 3 and 4 were utilized only if no means and standard deviations were given.

Creativity measured with a self-reported Likert-type scale was excluded in the calculation of effect size, but attitudes toward creativity, measured with Likert scale data, were included.

Classification of Creativity Training Programs

Types of creativity training programs were classified as follows:

1. Simple ideation training: The participant generates as many ideas or solutions as possible without being prompted to use other techniques.

2. Brainstorming: This technique was developed by Osborn (1963). It includes ideation and sharing ideation with others without evaluation. This skill includes warming up, looking into new information, and deferring judgment; making use of all the senses, targeting problems, incorporating into daily life, and sharing created products with others.

3. Incubation: This technique involves undedicated, inactive, relaxed, unconscious mental activity after having labored on a problem without success. It may lead to the random reorganization of ideas or knowledge in the brain and sometimes produce an unexpected "aha" insight.

4. Forced relation: Ideas are developed based on objects in the immediate environment.

5. Catalog: This technique consists of browsing through a categorized list of objects to expand the range of ideas.

6. Part improving: The participant itemizes important attributes or parts of a product and then considers whether each attribute or part can be changed or improved.

7. Morphological synthesis: The participant identifies different dimensions of a problem, lists all potential values for each dimension, and then utilizes one value of each dimension to produce possible novel combinations (e.g., all combinations of 5 shapes, 5 colors, and 5 sizes would produce 125 possible products; see G. A. Davis et al., 1972).

8. Attitude training: This promotes a positive attitude or affect toward creativity such as reducing anxi-

ety, being open-minded and receptive to new ideas, and knowing the importance of creativity to society and to personal development and interests.

9. Synectics: This is a term of Greek origin meaning "the joining together of different and apparently irrelevant elements." Gordon (1961) defined it as making the strange familiar by means of analysis, generalization, metaphor, and analogy; and making the familiar strange by means of looking at the problem from a different point of view, especially from the opposite side.

10. Idea checklist/SCAMPER: The idea checklist was proposed by Osborn (1963) for ideation and adapted by Eberle (1977) to develop SCAMPER. SCAMPER is an acronym for substitute, combine, adapt, modify/magnify/minimize, put to other uses, eliminate, and reverse/rearrange. The idea checklist involves using a list of items to form a new insight: *Substitute* means to replace an idea or item generated earlier with a new one; *combine* means to put two or more ideas generated earlier together to create an altogether new idea; *adapt* means an idea generated earlier is adjusted; *modify/magnify/minimize* means ideas are changed so that they become revised, larger, or smaller; *put to other uses* means using items or ideas to serve other purposes; *eliminate* means to omit items or objects and fill the gap with alternatives; and *reverse/rearrange* means to invert a sequence or change a pattern within an idea (see McIntosh & Meacham, 1992, pp. 28–29).

Composite of techniques. Certain of the aforementioned techniques were composed to form training programs by certain authors, and these studies were included in this meta-analysis.

11. Computer-aided creativity training program: This program includes computer graphic technology (enabling a person to manipulate text and graphic images to produce a graphic design) and Logo computer programming, which involves deciding on the nature of a problem and choosing, combining, and selecting information, knowledge, and solutions.

12. Purdue Creative Thinking Program (Feldhusen et al., 1970): This program consists of 28 audiotaped lessons for enhancing fluency, flexibility, originality, and elaboration followed by illustrations and practice.

13. New Directions in Creativity Program (Renzulli, 1973): This program was developed in ac-

cordance with Guilford's Structure-of-Intellect Model (Guilford, 1967), which consists of five operations—(a) cognition (i.e., discovery or recognition), (b) memory (i.e., retention of what is recognized), (c) divergent thinking (i.e., searching for a variety of answers to a question that may have many right answers), (d) evaluation, and (e) convergent thinking (i.e., searching for a right answer to a question).

14. Khatena's Training Method (Khatena, 1970, 1971a, 1971b, 1973; Khatena & Dickerson, 1973): This program consists of breaking away from the obvious and commonplace, transposition, analogy, restructuring, and synthesis.

15. Osborn–Parnes CPS program (Osborn, 1963; Parnes, 1967): This program can be reduced to four broader stages of a creative process—(a) identifying or defining, restating, constructing, and finding problems (i.e., identifying specific problems that must be resolved or presenting the objectives of a problem; a stage that needs cognitive ability, expertise, or both for gathering and analyzing the relevant knowledge and information and for identifying the main causes of the problem); (b) generating solutions (i.e., generating or combining solutions without evaluation; a stage that needs mostly divergent thinking skills); (c) evaluating solutions (i.e., using criteria to winnow generated solutions and checking whether a solution can lead to solving the problem; a stage that needs mostly convergent thinking skills); (d) elaborating a solution (i.e., selecting the best solution, implementing the solution, and elaborating the solution; refining the quality and effectiveness of the solution or product to increase its attractiveness and its acceptance by clients; see also Puccio, Wheeler, & Cassandro, 2004). Parnes's (1967) *Creative Behavior Guidebook* and Sociodrama (Haley, 1984) using the stages of CPS were included in this category.

Dependent variables are classified in Table 1.

Results

Nine valuable articles were regrettably excluded from this meta-analysis because (a) they had insufficient data convertible to effect size (Baer, 1996; Basadur, Graen, & Scandura, 1986; G. A. Davis et al., 1972; Flaherty, 1992), (b) they lacked empirical data of nonsignificant effect (Kolloff & Feldhusen, 1984; Reese, Parnes, Treffinger, & Kaltsounis, 1976), or (c)

Table 1. *Classification of Dependent Variables of Creativity Training*

Categories of Creativity	Main Indicators of Creativity and Their Definitions
Attitude	Welsh's Scales of Origence (preference for the unstructured, subtle, and open-ended vs. the structured, explicit, and organized; Welsh, 1975); Welsh's Scales of Intellectence (preference for the abstract and symbolic vs. concrete and pragmatic; Welsh, 1975); Adjective Check List scores (self-rated, personal characteristics related to creativity; Gough & Heilbrun, 1983); The How Do You Think Test (G. A. Davis, 1975), and Rating Creativity Characteristics test (Renzulli, Smith, White, Callahan, & Hartmen, 1976) are also included in this category.
Ideation without evaluation	Fluency (number of generated ideas).
	Elaboration (refinement of generated ideas).
	Flexibility (number of idea categories).
	Originality (uniqueness of idea).
	Composite score (composite score of multiple subscale of creativity measurement), such as TTCT, or other subtests without specification of fluency, and so on (e.g., creative strength
	Indicators, alternate uses, consequences, abstractness of titles, imagination, and resistance to closure).
Ideation with evaluation (problem solving)	Fluency of solution (number of generated solutions).
	Originality of solution (novelty).
	Flexibility of solution (number of solution categories).
	Elaboration of solution (e.g., well-crafted, complex).
	Quality of solution (effectiveness, usefulness, functionality, workableness of the product or solution) including efficiency of solution (high-quality solutions ÷ total generated solution).
	Composite score (composite score of multiple subscale of problem-solving measurement) such as the Gordon Creative Problem Solving Test (Gordon, 1987), Test of Inquiry in Social Studies (Muir, 1976), Student Product Assessment Form (invention score; Renzulli & Reis, 1997), or subtests without specification of fluency, and so on (e.g., knowledge about creativity, sensitivity).

Note. TTCT = Torrance Tests of Creative Thinking (Torrance, 1966a, 1966b, 1966c).

they lacked an intact control group without training (Basadur & Thompson, 1986; Borgstadt & Glover, 1980; Khaleefa, Erdos, & Ashria, 1997).

Altogether, 268 effect sizes from the remaining 34 studies in this investigation were converted from different statistics. Among them, 105 effect sizes were converted from pre- and posttests with means and standard deviations, 83 from posttests, 54 from t tests, 25 from F tests, and 1 from chi-square tests.

Although researchers conducting meta-analysis do their best to locate available studies, the number of relevant studies cannot be exhausted because new empirical studies available for meta-analysis might appear in electronic databases and journals day by day, and a large amount of relevant studies published outside the United States were not included in this meta-analysis. Therefore, the studies analyzed in this meta-analysis can only be regarded as a sample instead of a total population. Hence, statistical analysis is still necessary. In applying parametric statistics to test the significance of difference between mean effect sizes of independent variables, dependent variables, and moderators in this study, three assumptions underlying parametric tests were considered: (a) The residuals are independently

distributed, (b) the residuals are normally distributed, and (c) the variance of the residuals are homogeneous (Myers, 1972, p. 61). As "the distortion of tabled probability that occurs with non-normal distribution is not overly marked" (p. 63), the normality of residuals in this study was ignored. However, the homogeneity of variance and the independence of residuals were tested beforehand. When the assumptions were found to be violated, nonparametric statistics were applied.

To test whether the residuals were independently distributed, the residuals of the 268 effect sizes were created by using "center" in the *autoregressive integrated moving average* procedure to subtract each effect size from the mean effect size (SAS Institute Inc., 1984, p. 131), and then lag 1 autocorrelation was found to be significant, thus indicating the violation of assumption of independent distribution of residuals. No statistics were applied to test whether the grand mean of the 268 effect sizes (0.77, $SD = 0.74$) was significantly different from zero. Therefore, Cohen (1977) criterion was used for the judgment of the magnitude of mean effect size. According to Cohen's judgment, an effect size of 0.8 is large, 0.5 is medium, and 0.2 is small. Therefore, a grand mean effect size of 0.77 for

creativity training can be judged to be almost large. However, when the effect sizes of a study were averaged to represent the effect size of that study, then lag 1 of autocorrelation of the 34 residuals of the averaged effect sizes was not significant ($r = .15$, $SE = .17$, $p > .05$). The grand mean of the 34 independent effect sizes was 0.76 ($SD = 0.49$). The result of a one-sample t test revealed a significant effect of the creativity training programs, $t(33) = 9.17$, $p < .001$.

Moderators of the Effectiveness of Creativity Training Programs

Training programs. Creativity training programs were classified into 12 categories. The mean effect sizes of each training program are provided in Table 2.

Different authors used different components from the previously mentioned 10 components to form different composites for training programs. Only attitude training, synectics, simple ideation training, incubation, and SCAMPER (Eberle, 1977) were singly analyzed. A component of the problem-solving training program "problem identifying" was not mentioned earlier but was also specifically analyzed.

After the analysis, Levene's Test for Homogeneity of Variance showed that the variance of the residuals was not homogeneous: $F(11, 256) = 3.34$, $p < .001$. Hence, the nonparametric Kruskal–Wallis test was used instead of analysis of variance to test the significance of the difference of mean effect sizes between different training programs. The result of the Kruskal–Wallis test depicted that different training

Table 2. *Mean Effect Size of Creativity Training Programs*

Training Program	k	*M*	*SD*	Mr	>Md%	Studies
Attitude training	4	1.46	0.31	228	1.00	Greene & Noice (1988)
Simple ideation	14	0.99	0.44	180	0.79	MacDonald, Heinberg, Fruehling, & Meredith (1976); Glover (1980); Goff (1992)
Synectics	6	0.77	0.39	156	0.50	Gendrop (1996); Meador (1994)
Problem identifying	12	0.34	0.41	89	0.17	Butler, Scherer, & Reiter-Palmon (2003); Clague-Tweet (1981)
Incubation	8	0.2	0.29	55	0.13	Houtz & Frankel (1992)
SCAMPER (Eberle, 1977)	4	0.06	0.15	29	0.00	Mijares-Colmenares, Masten, & Underwood (1993)
The New Directions in Creativity Program[a]	5	1.41	0.21	228	1.00	Ford & Renzulli (1976)
Composite of techniques	92	0.84	0.98	126	0.39	A. D. Davis & Bull (1978); Goor & Rapoport (1977); Franklin & Richards (1977); Suwantra (1995); Meichenbaum (1975); Houtz & Frankel (1992); Clapham (1996, 1997)
Osborn–Parnes Creative Problem Solving program (Osborn, 1963; Parnes, 1967)	60	0.82	0.58	151	0.63	Basadur, Wakabayashi, & Takai (1992); Burstiner (1973); Fontenot (1993); Clague-Tweet (1981); Haley (1984); Reese & Parnes (1970)
Khatena's Training Method	24	0.82	0.61	147	0.63	Khatena (1970, 1971a, 1971b, 1973); Khatena & Dickerson (1973)
Computer-aided creativity training	30	0.63	0.65	117	0.43	Clements (1991); Kobe (2001); Howe (1992)
Purdue Creative Thinking Program (Feldhusen, Treffinger, & Gahlke, 1970)	9	0.61	0.23	133	0.56	Jaben (1985a, 1985b, 1987)
Total	268	0.77	0.74			

Note. k = the number of effect size; Mr = mean rank of effect size; >Md% = percentage of effect size larger than the median (0.58). SCAMPER = substitute, combine, adapt, modify/magnify/minimize, put to other uses, eliminate, and reverse/rearrange.
[a]Based on Guilford's Structure-of-Intellect Model (Guilford, 1967).

programs promoting creativity had different effect sizes: $\chi^2(11, N = 268) = 44.58, p < .001$. As the sample sizes of some training programs were too small, it did not make sense to make *post hoc* comparisons for the mean effect sizes. Because the Kruskal–Wallis test is based on rank, and some standard deviations were larger than means, the mean rank and the percentage of effect size larger than the median was also presented with respect to each category in the table to facilitate comparison. The high rank and large percentage mean large effect sizes.

Table 2 shows that the standard deviation of each of the categories of training programs was somewhat proportional to the number (k) of effect size: $r(10) = .89, p < .01$. Table 2 also shows that k for training packages was, for the most part, larger than that for components. This result indicates that the researchers paid less attention to the single techniques than to the package of the training program.

Creativity tests.   The effects of training on scores or subscores of creativity are presented in Table 3.

Levene's Test for Homogeneity of Variance showed that the variance of the residuals was not homogeneous: $F(11, 256) = 4.38, p < .001$. The result of the Kruskal–Wallis test showed that no significant difference was found between the mean effect sizes of different ways of measuring creativity (dependent variables): $\chi^2(11, N = 268) = 17.34, p > .05$.

The mean effect sizes of other moderators are presented in Table 4.

Experimental designs.   Experimental designs were classified into quasiexperimental designs, real experimental designs, and paired-samples experimental designs. Levene's Test for Homogeneity of Variance showed that the variance of the residuals was not homogeneous: $F(2, 265) = 6.79, p < .001$. The result of the Kruskal–Wallis test showed that no significant difference was found between the mean effect sizes of these three kinds of designs: $\chi^2(2, N = 268) = 1.60, p > .05$.

Ages of participants.   The participants' ages were classified in accordance with school levels. Levene's Test for Homogeneity of Variance showed that the variance of the residuals was not homogeneous: $F(4, 263) = 6.31, p < .001$. The result of Kruskal–Wallis test indicated that the differences between the mean effect sizes of the five groups were significant: $\chi^2(4, N = 268) = 11.33, p < .05$. The result showed a trend that the older the age of the participant, the larger the effect size; with the exception that the effect size of college students was slightly smaller than that for high school students.

Duration of training.   The duration of training was converted into hours. As students in school usually have from 10 to 15 min of break for each hour of class, a

Table 3. *Mean Effect Size of Creativity Training on Dependent Variables*

Dependent Variable	k	*M*	*SD*	Mr	>Md%
Attitude	25	1.34	1.18	164	0.56
Divergent thinking					
Originality	61	0.89	0.78	152	0.61
Fluency	74	0.74	0.72	130	0.53
Composite score	16	0.65	0.51	132	0.38
Guilford's Structure-of-Intellect Model[a]—evaluation, leadership, and creative thinking	8	0.46	0.28	102	0.38
Elaboration	13	0.44	0.35	123	0.31
Problem solving					
Flexibility	7	0.9	0.9	155	0.71
Fluency	18	0.73	0.68	130	0.39
Composite score	11	0.63	0.29	132	0.45
Elaboration	6	0.55	0.32	123	0.50
Quality	11	0.55	0.33	115	0.45
Originality	18	0.47	0.5	97	0.28

Note. k = the number of effect size; Mr = mean rank of effect size; >Md% = percentage of effect size larger than the median.
[a]Guilford (1967).

Table 4. *Mean Effect Sizes of Other Moderators*

Moderator	k	*M*	*SD*	Mr	>Md%
Experimental design					
Quasiexperimental design	75	0.65	0.52	125	0.44
Paired-samples design	33	0.71	0.46	143	0.58
Real experimental design	160	0.84	0.74	137	0.51
Age of participants					
Kindergarten children	17	0.49	0.34	115	0.47
Elementary school pupils	96	0.75	0.58	140	0.55
High school students	31	0.82	0.52	153	0.58
College students	92	0.79	1.01	117	0.36
Adults	32	0.91	0.61	161	0.66

Note. k = the number of effect size; Mr = mean rank of effect size; >Md% = percentage of effect size larger than the median.

training time between 40 min and 1 hr was coded as 1 hr. One morning was coded as 3 hrs. A Pearson correlation showed that there was no correlation between the duration of training and the effect size: $r(258) = -.1, p > .05$.

Discussion

The results of this study reveal that the grand mean effect size (0.77) of creativity training is large. The grand mean effect size is also larger than the overall effect sizes obtained by Rose and Lin (1984; 0.468), Scott et al. (2004a; 0.68), and Swanson and Hoskyn (1998; 0.70); and closer to Scott et al. (2004b; 0.78); but smaller than that of Scope (1998; 0.90). Overall, the finding of this study also confirms the result of Torrance's (1972) investigation; namely, that children can be taught to think creatively. Although no significant difference was found in the different dependent variables, data in Table 3 of this study reveals that the originality of divergent thinking had the largest effect size, whereas elaboration had the smallest effect size. These results confirm those of Scott et al. (2004a) and Rose and Lin. This study also found that creativity training programs tended to be more successful with older participants than with younger ones, with the exception that the effect size for college students was smaller than that for high school students because of the large standard deviation. This result is not comparable with that of Scott et al. (2004a) because they categorized age into two groups (younger than 14 or 14 and older), whereas this study contained five groups. The data in Table 3 of the Scott et al. (2004a) study showed that the younger group produced larger overall and per-

formance effect sizes but that the older populations showed greater effects with respect to divergent thinking, problem-solving, and attitude/behavior criteria. It would be interesting in future research to verify whether this phenomenon really supports Inhelder and Piaget's (cited in Mansfield et al., 1978) postulate that older students should be better than younger students at thinking in terms of possibilities.

With the exception of training programs and age, no significance was found in the effect of moderators. This result indicates that the kind of instruments measuring creativity, the experimental design, and the duration of training would not necessarily significantly influence the evaluation of the effectiveness of creativity training programs. The result of nonsignificant correlation between the duration of training and the magnitude of effect size found in this study is consistent with the finding of the Scope (1998) study.

The single techniques of creativity training whose effectiveness was investigated in this study were only attitude training, simple ideation, synectics, incubation, SCAMPER (Eberle, 1977), and problem identifying. It is suggested that in future research special attention should be paid to investigating the effectiveness of single training techniques or components of training packages such as the strategies for problem finding, solution searching, and solution evaluating in the Osborn–Parnes CPS (Osborn, 1963; Parnes, 1967) program; components of the Purdue Creative Thinking Program (Feldhusen et al., 1971; Feldhusen et al., 1970); or components of Guilford's Structure-of-Intellect Model (Guilford, 1967).

The package, "composite of techniques," was not well-defined in this study because it contains different

compositions composed by different authors. Further, the number of single composite of techniques was not large enough to form a category. Such lack of clarity is the reason why we need to focus more on component analysis in future research.

This study presents the meta-analysis results that Scott et al. (2004a, 2004b) did not present. It is hoped that the emphasis on the functional analysis of the components of a training package will invite more research into this aspect in the future. Once the effectiveness of key components of training has been confirmed, then not only will the training be more effective, but the process of creative thinking will be clearer. Such results would then have implications for the more rigorous construction of a scientific creativity theory.

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