FOSTERING CREATIVITY:

A META-ANALYTIC INQUIRY INTO THE VARIABILITY OF EFFECTS

A Dissertation

by

TSE-YANG HUANG

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

May 2005

Major Subject: Educational Psychology

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Approved as to style and content by:

William R. Nash (Chair of Committee)	Joyce E. Juntune (Member)
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ABSTRACT

Fostering Creativity:

A Meta-analytic Inquiry into the Variability of Effects. (May 2005)

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Chair of Advisory Committee: Dr. William R. Nash

The present study used the method of meta-analysis to synthesize the empirical research on the effects of intervention techniques for fostering creativity. Overall, the average effect sizes of all types of creativity training were sizable, and their effectiveness could be generalized across age levels and beyond school settings. Generally, among these training programs, CPS (Creative Problem Solving) spent the least training time and gained the highest training effects on creativity scores. In addition, "Other Attitudes programs," which presumed to motivate or facilitate the creativity motivation, also presented sizable effect size as other types of creativity training programs.

As for the issue of creativity ability vs. skills, this analysis did not support the notion that figural components of the TTCT (*Torrance Tests of Creative Thinking*) might be measuring the relatively stable aspects of creativity proposed by Rose and Lin (1984). Because the figural form of the TTCT did not obtain the lowest effect size, the results indicated that the view of multi-manifestation of creativity is a more plausible explanation. And since neither the *Stroop Color and Word Test* or the *Raven*

Progressive Matrices was found in the studies, this issue was difficult to investigate further.

From the path-model analysis, it can be implied that a research design with a control group and student sample would more likely lead to publication, which would influence the effect size index. Unfortunately, from the information provided in the articles included in this study, there were not any quantitative data about motivation or related measurement of the participants, which is a major problem and impedes this study for creating a better path-model.

This study has many implications which merit investigation. One approach follows the concepts of aptitude-treatment interactions, which is focused on each individual's unique strengths and talent, and the goals of a creativity training program should help them to recognize, to develop their own creative potential, and finally to learn to express it in their own way. Another involves developing the assessment techniques and criteria for individuals as well as collecting related information regarding attitudes and motivation during the training process.

DEDICATION

To my lovely family and students

ACKNOWLEDGMENTS

First, I want to express my deep appreciation to Dr. Nash for the inspiring words in his class, Creative Thinking, "[Creativity] it helps us build our identity and confidence, it gives us something to share with others and the world, and it maintains our mental health by serving us well during times of great difficulty and stress," his attentive proofreading of my dissertation draft, and introducing Dr. Hill in the Department of Architecture to be on my committee who gave me many suggestions about applying creativity in real world situations.

Second, I appreciate the vigorous and innovative teaching style of Dr. Juntune, and really enjoyed her classes. Hopefully, some day I could also bring such excellent instructional methods to my prospective students.

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And last but not least, I would like to give thanks to my Lord, who leads me to the green pastures and beside the still waters; He restores my soul and guides me in my walk through the valley of the Baca.

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INTRODUCTION

Creativity is one of the most important assets in the human mind. Throughout history, it goes without saying that it always plays the essential role of cultural and technological evolution in every era. Besides, no matter what kinds of creativity it is or how small it is, unequivocally, it always has certain impact in everyday life. However, there are still many misconceptions about creativity (Gilhooly, 1999).

Seligman mentioned in his book, *What you can change and what you can't* (1993), from the view point of "biological psychiatry," that people waste much time doing something that cannot be changed because of the innate biological mechanism. However, on the other hand, the "plasticity" of the human being also provides an optimistic perspective about human nature. Therefore, the critical point is that people should have the knowledge and wisdom to know what can be changed and what cannot. The same idea applies in stimulating creativity, i.e., what aspects of creativity can be cultivated most effectively is the primary concern of this study.

Issues and research about fostering creativity have been emerging in every field over the half century since J. P. Guilford presented his address on creativity at the American Psychological Association convention in 1950. Based on these empirical studies, it had been demonstrated that creativity can be improved by various training programs (Rose & Lin, 1984; Scope, 1999; Scott, G., Leritz, L. E., & Mumford, M. D.,

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This dissertation follows the style of the *Creativity Research Journal*.

2004; Torrance, 1972). Even though many questions about training effects still remained to be explored (Feldhusen & Goh, 1995), a more comprehensive understanding regarding the nature of creativity needs to be depicted.

The Multi-dimensional, Interactive Process Model of Human Creativity proposed by Alexander, Parsons, and Nash (1996) could provide a framework to investigate the critical factors which relate to and might have influences on how creativity works. Moreover, while evaluating a creativity training program, this framework could also provide some directions to examine the issues involved in accessing creativity.

Statement of the Problem

Rose and Lin (1984) conducted a quantitative meta-analysis on the effects of creativity training programs. They found that overall verbal creativity components increased after training while figural creativity components did not show as much improvement. One possible explanation is that because these studies used the *Torrance Tests of Creative Thinking* (TTCT) as the assessment of creativity and was also the criteria; therefore, the findings might just reflect the so called "training to criterion" effect. Then, if the training programs are focused on these creative thinking skills which the tests are going to measure, it is not surprising to find such results.

However, the implication of such discovery is very valuable, for it may indicate that some creativity capacities seem more plastic than others which can be improved at once by creativity training. These creativity capacities could be categorized as "creative thinking skills," which can be developed through various kinds of teaching or training methods; and they can be identified as "conceptual and general strategic knowledge"

components in the Alexander, Parsons, and Nash (1996) model. In the meanwhile, some creativity capacities that do not show much progress could be categorized as "creative thinking abilities," which are more likely innate abilities that some individuals have in greater abundance than others. These kinds of creativity capacities would be related to the "biological" component. Because they seem based on genetic factors, they may be relatively more stable (Guilford, 1950) and would not show too much change after training.

As a whole, it can be concluded from the Rose and Lin (1984) study that creativity training has positive effects on creativity scores, but also suggests that there may be at least two different domains of creative behavior, ability and skill, involved in the process of creativity training. However, they did not explore further regarding the internal or external validity issues of the study.

Torrance & Safter (1999) categorized the study of creative behavior into three major domains: abilities, skills, and motivations. This concise viewpoint gives a useful and practical way to implement evaluations about creativity training programs. For instance, in Amabile's (1983) three componential theory of creativity: (a) domain-relevant skills, (b) creativity-relevant skills, and (c) task motivation, there are also three categories. Where the "domain-relevant skills" depends on innate cognitive abilities, innate perceptual/motor skills, and formal/informal education; and "creativity-relevant skills" depends on training, experience in idea generation, and personality characteristics. This model provides the implication of what aspects can be changed by the training. Another example was proposed by Necka (1986) in his triangle model of

creative giftedness. He also used these three domains to categorize different types of creative talent and differentiates each domain into different types. For example, motives might have five types: instrumental, playful, vocational, control, and communication motives. Abilities might have five types: associative, analogical, metaphorical, transformative, and abstractive abilities. Skills might have three types: field related knowledge, techniques of idea generation, and skills in avoiding hindrances. So, along these lines, it implies that even with the complexity of creativity and its expression, some aspects of creativity can be intervened to improve its function.

Creative behavior is indeed very complex and involves many aspects; especially, when we try to evaluate the effect of training programs (Feldhusen & Goh, 1995). Even so, considering these three domains: ability, skill, and motivation, while conducting and evaluating a creativity training program, is still very important. Just as in the results of Rose and Lin's study (1984), it had presented that some aspects of creativity measuring did not show as much improvement as others, and the studies included in their meta-analyses used only the TTCT as the measurement tool. If there is any study using other types of nonverbal measurement, such as the *Stroop Color and Word Test* (Golden, 1975) or the *Raven Progressive Matrices*, to measure the effect of training program, then, the results might provide more information about this issue. That means the effect of creative thinking ability and creative thinking skill might be separated by using different psychological measurement tools.

Another domain about studying creative behavior is focused on the issue of creativity motivation. Amabile has done considerable research on this issue (1983,

1985, 1987, and 1990). According to her experiments, they were convinced that motives were very crucial for the quality of creative performance, especially with regard to intrinsic motivation. However, the role of motivation in a creativity training program is still not clear. Does a training program process increase or decrease subjects' intrinsic or extrinsic motivation, and its effect on the assessment scores? Because motivation always can be considered as a latent variable in an intervention process (Ullman, 2001), the role of many other variables in a creativity training program might also play as moderators and mediators to fostering the training effect, just as Shadish and Sweeney (1991) discussed in the effectiveness of psychotherapies. Therefore, while evaluating the effect of a creativity training program, besides types of training programs, many variables should also be considered (e.g., subjects' age and occupation, training time period, measurement tools, etc.).

Generally speaking, particularly from the educator's position, creativity definitely can be taught to people (Torrance & Torrance, 1973), especially children (Shallcross, 1981), i.e., to think creatively, which is why there are many creativity courses and training programs designed to teach and help foster creativity (Davis, 1982; Davis & Rimm, 1985; Feldhusen, 1993; Treffinger, 1993). In spite of these beliefs and research findings, it is still unsure which domains of creative behavior have been improved by the intervention of fostering creative thinking techniques. Considering other variables together, i.e., the internal validity issues, such as how much improvement can be attained by certain intervention technique? What kinds of intervention techniques are more effective? And external validity issues must be considered, such as whether the

effectiveness of creativity training programs is able to be generalized to other age levels or beyond the student?

Purpose of the Study

This study used the method of meta-analysis to synthesize the empirical research on the effects of the intervention techniques for fostering creativity. The purposes of this study were as follows: (a) to calculate the effect size of different types of the intervention techniques used in the creativity training process and (b) to identify the variables inherent in the subjects or in the training process, which could influence the training results.

Research Questions

1. What are the effect sizes of different types of training programs?
2. What is the relationship between training time periods and effect size?
3. What is the relationship between measurement tools and effect size?
4. What is the relationship between the subjects' age and effect size?
5. What is the relationship between the subjects' category and effect size?
6. Overall, what are the relationships among these variables with effect size?
7. Can a path-model be established by these variables?

Definition of Terms

1. Creative thinking skills: specific thinking strategies that can be developed through various teaching methods (Rose & Lin, 1984).
2. Creative thinking ability: an innate ability that some individuals have in greater abundance than others (Rose & Lin, 1984).

3. Creative motivation: a commitment to creative tasks primarily by the interest, enjoyment, satisfaction, and challenge of work itself as well as environmental enhancement. In this study, it assumed that creative motivation could have an additive relationship between intrinsic and extrinsic motivation rather than "hydraulic relationship" (Amabile, 1990).
4. Statistical power: it is the ability to detect a true difference when in fact a true difference exists in the population of interest (McNamara, 1994, p. 55).
5. Moderator: It is a qualitative (e.g., gifted or non-gifted) or quantitative (e.g., age) variable that affects the relations between an independent or predictor variable (e.g., types of creativity training programs, training time periods) and dependent or criterion variable, i.e., effect size (Shadish & Sweeney, 1991).
6. Mediator: It is induced by the independent variable, which then causes the outcome, effect size index (Shadish & Sweeney, 1991). For example, motivation is a mediator, which will be induced by the intervention (e.g., types of creativity training programs or training time periods).

Limitations

There would be several limitations in this study:

First, this study did not include and analyze the influences from social culture or environment on individual creative behavior (Feldman, Csikszentmihalyi, & Gardner, 1994).

Second, the studies used in this meta-analysis study were limited in creativity training programs, that is “small c” which was more related to everyday life rather than “big C,” not truly magnificent contributions in human history (Baer, 1997; Cramond, 2001; Feldman, Csikszentmihalyi, & Gardner, 1994; Gilhooly, 1999).

Third, the problems caused by the method of meta-analysis still exist in this study, such as the issues of “oranges and apples” and publication bias (Cook, et al., 1994; Hunt, 1997; Light & Pillemer, 1984). The first issue was related to how different measurement results were combined. For example, different studies used different measurement tools to measure different components of creative thinking, and even in the same measurement tool also had different subscales. The second issue was concerning the data collection bias between published and unpublished studies, which was also called “the file-drawer problem.”

Finally, the results of this study might not be able to apply to individual situations. Because the important intermediate factor, “psychological component” (e.g., personality, motivation, and emotional well-being), would produce different interaction effects during the training process and assessing the progress (Cameron & Pierce, 1994; Cropley, 1990; Eisenberger, & Cameron, 1996).

CHAPTER II

REVIEW OF THE LITERATURE

This chapter will review theoretical concepts about creativity and discuss the issues related to motivation and measurement of how to influence the process. It will also review the results of fostering creativity and investigate the effectiveness of creativity training programs. Finally, it will briefly introduce the method of meta-analysis.

Reviewing creativity theories and research on the issues of assessing and fostering creativity will provide a framework for conducting an evaluation for the effectiveness of creativity training programs (Treffinger, Isaksen, & Firestien, 1983).

Reviewing Creativity Theories

The ubiquitous *four-Ps* approach is quite familiar and popular for studying creativity. The four approaches are (a) the environment for developing creativity, (b) the product of creativity, (c) the process of creativity, and (d) the person who is creative (Scope, 1999). In developing a creativity training program as well as its evaluation, these four domains always need to be included and considered. Since the training program is a whole package, it includes creating a place for people to increasing their creative skills and yielding creative products. Therefore, the viewpoints about creativity behind these training programs are unavoidably associated with their instruction materials for fostering creativity.

Historically, J. P. Guilford, is recognized as the pioneer and major contributor in the field of creativity research (VanTassel-Baska, 1998, chap. 21). His description of creativity was based on the ability to manipulate ideas in fluent, flexible, elaborate, and original ways (Guilford, 1950). And creativity is not an individually specific module, for his viewpoint is primarily embodied in the *Structure of Intellect model* (SOI), so it is a manifestation of basic mental function's manipulation. Guilford's position about creativity has great influence on this area even today (Brown, 1989). For example, first, creativity ability should be stable, which suggested that the function of creativity training program is to free or release the potential rather than create new potential where previously little or none existed. Second, whether an individual with creative abilities actually performs creative behavior will be determined by motivational and temperamental factors. Third, creativity abilities are continuously distributed; therefore, researchers can study creativity in normal people.

Following this line, E. P. Torrance (1974) focused on the process of creativity, and he developed the famous *Torrance Tests of Creative Thinking*. Many creativity training programs are primary focused on the training of these thinking skills and use this test as the measurement of training effect. His definition of creativity is as follows:

> Creativity is a process of becoming sensitive to problems, deficiencies, gaps in knowledge, missing elements, disharmonies, and so on; identifying the difficulty; searching for solution, making guesses, of formulating hypotheses about the deficiencies; testing and retesting these hypotheses

> and possibly modifying and retesting them; and finally communicating the results. (p.8)

However, Amabile (1990) studied creativity from another point of view. She concentrated on the factor of motivation (Amabile, 1983, 1985, 1987). She viewed creativity as composites of three factors: (a) domain-relevant skills, (b) creativity-relevant skills, and (c) task motivation to contribute to a field of knowledge. In this model, creativity requires extensive knowledge preparation in a given field (VanTassel-Baska, 1998). And her original contribution of this area is from her prominent study of the task motivation (Dacey, 1989, chap. 11). While designing or evaluating a creativity training program, the research of Amabile and her colleagues could provide a lot of implications (Amabile, Hennessey, & Grossman, 1986), especially the idea of promoting intrinsic motivation and its impact. They gave three suggestions to create a fertile environment for cultivating creativity (Dacey, 1986): (a) teaching children should rely more on self-evaluation and self-reward systems and not focus on external inducements, (b) teaching children to understand external inducements and not to be overwhelmed by their own intrinsic enjoyment of work, (c) helping children to find ways to really explore their most enjoyable and challenging activities. These suggestions are widely accepted and implemented in the area of gifted education. Besides, the interaction between motivation and creativity is very profound and worth researchers continue studying. "Then, we might run less risk of losing any of the creativity of our young Einsteins" (see Dacey, 1986, p. 214-216).

In the same line, Feldhusen (1995), based on Amabile's model, includes a strong emphasis on metacognitive skills as an aspect of creativity-relevant skills, just like Sternberg's Three-facet model (Sternberg, 1988, chap. 5). The three most relevant factors in Feldhusen's creativity model are:

1. Metacognitive processing: A set of strategies or metacognitive skills for processing new information and for using the knowledge base that one has acquired.
2. The knowledge base: A large and fluent knowledge base and mastery of skills in a particular domain.
3. Personality variables: A set of attitudes, dispositions, motivations etc. acquired from parents, teachers, mentors, peers, and personal experiences that predispose and orient the individual to search for alternatives, new configurations, or uniquely appropriate solutions. (p. 266)

As for the manifestation of creativity, Gardner expressed his viewpoint in his books, e.g., *Frames of Mind* (1983) and *Creating Minds* (1994). The later is based on three factors and their interrelationships: the relationship between the child and the master, the relationship between an individual and the work in which he or she is engaged, and the relationship between an individual and other persons in his or her world (VanTassel-Baska, 1998). Creativity has different expression ways just like his multiple intelligences theory (Gardner, 1983); or from studying these creative people, there might be different domains of intelligences behind these people's achievements.

Those different kinds of intelligences are (a) verbal-linguistic, (b) visual-spatial, (c) logical-mathematical, (d) musical-rhythmic, (e) bodily-kinesthetic, (f) interpersonal, (g) intrapersonal, and (h) naturalistic intelligence. As human history shown, creativity has been vigorously continuing presenting at these areas. This point of view also implies that creativity could have many different kinds of manifestations, some could express as verbal form and some might be not (e.g., arts and music). Therefore, using TTCT as criteria for evaluating a creativity training program might capture only limited aspects of its various presentations.

As a matter of fact, most models of creativity prefer an interaction approach, for most researchers or educators will agree that creativity won't develop by itself. There are still many factors to influence its manifestation. A comprehensive model example is the Multi-dimensional, Interactive Process Model of Human Creativity proposed by Alexander, Parsons, and Nash (1996). Their definition of creativity is as follows:

> Creativity is continuous, pervasive, interactive, and multidimensional process that gives rise to invention, transformation, generation, novelty, and originality. Creativity is an integral part of all human intellectual performance; a higher order of intellectual processing, influenced by biological, psychological, sociological, conceptual knowledge, and general problem-solving knowledge internal to the creator. (p.53)

The model has four assumptions: (a) creativity is continuous, not dichotomous; (b) creativity is a dynamic, interactive, and multidimensional process; (c) creativity may encompass intentionality, but requires awareness; (d) creativity is higher order

intellectual processing. And it has four components: (a) Biological components include genetics, neurology, anatomy and physiology; (b) Psychological components include personality, motivation, and emotional well-being; (c) Sociological components include society, culture, and economy; (d) Knowledge components include conceptual knowledge and general strategic knowledge. This model comprises the *four P*s and contains various controversial views about the nature of creativity as well as the implementation of training creativity. For example, the biological components imply that these factors will not be changed much by a training program, the most successful training effects might come from knowledge components, and the psychological and sociological components often be ignored or "balanced" by the experimental design, random sampling and assignment, which should be considered as a "main effect" rather random error sources.

The Impact from Motivation

Motivation is absolutely a key issue in study creativity (Halpin & Halpin, 1973), especially when conducting a comprehensive assessment of a training program. Feldhusen and Goh (1995) suggested such comprehensive assessment requires multiple measures of the cognitive processes, motivations, interest, attitudes, and styles associated with creativity. However, researchers primary focus only on the assessment of cognitive skills' improvement in a creativity training program. Torrance (1972) had found that "motivating and facilitating conditions" certainly could make a difference in creativity training. Amabile (1983) started the systematic study of how motivation affects creative performance. She explains the function of reward in the creative process

and which reward condition would improve or inhibit creative motivation. She also mentioned the relationship between intrinsic motivation and extrinsic motivation. For nearly all of her studies assumed that as extrinsic motivation increases, intrinsic motivation (and creativity) must decrease. But for some cases, there seems to be an additive relationship: intrinsic motivation remains high, and creativity is still enhanced in the face of extrinsic motivation (Amabile, 1990).

In addition to the ambiguous effect of motivation, another difficulty of studying this topic is that it is hard to be measured or observed directly; most of the studies rely on self-report or final creative product. Moreover, the behavior of creative thinking or a creative attitude is derived from a kind of feeling or emotion, which strongly relates to intrinsic motivation. Most of the time, especially at the initial stage and the "incubation" stage in which no conscious work is done (Gilhooly, 1999), people aren't aware of what happens in their minds and how it works, just as "subliminal perception" (LeDoux, 1996, Zajonc, 1980). Therefore, the self-report or introspection method might not work out very well, for creativity might function as an unconscious process (Brown, 1989); it can only be inferred from the observable behavior.

Further investigation of reward effect on intrinsic motivation was explored by Eisenberger and Cameron (1996), which provides more interaction considerations regarding how motivation works with other factors. For example, when reward is presented "appropriately," it could have incremental effects on intrinsic motivation. In other words, the intrinsic motivation could be triggered by an outside stimulus as long as the stimulus is acceptable by the subjects (Sharples, 1992).

Finally, Feldhusen and Clinkenbeard (1986) concluded that creativity training programs "must be combined with other factors to produce the long-term, transferable effects culminating in the creative person" (p. 178). These factors include (a) applying creative thinking skills in real life situations, not merely exercises and activities (e.g., all areas of school curriculum), (b) creating a non-judgmental environment atmosphere which encourages creativity and risk-taking, and (c) paying attention to the persistence necessary to develop a creative product. Such instruction models for creativity they suggested are Enrichment Triad Model (Renzulli, 1976), the Purdue Three Stage Model (Feldhusen & Kolloff, 1986), and self-directed learning approaches (Treffinger, 1978), which must also comprise with efficient instructional methods. Besides, as Treffinger (1993) proclaimed, we should aware that:

> Stimulating creativity is not a process of homogenization. It is not teaching everyone a fixed set of strategies, …Rather, the power of efforts to nurture creativity arises form our ability to help individuals recognize, develop, and realize their unique strengths ad talents, to learn, and to be creatively productive in their own way, not just in our way. (p. 20)

Just as creativity is a complex concept, creativity training programs also may involve revealing innate potential abilities, improving thinking skills, as well as motivation and attitudes, which should be fostered in an environment with full-time climate of acceptance and encouragement (Amabile, 1983; Feldhusen & Clinkenbeard, 1986).

Assessing Creativity

Feldhusen and Clinkenbeard (1986) stated the problem of using criterion for evaluating the effectiveness of the creativity training programs. First, since the *Torrance Tests of Creative Thinking* is the most frequently used criterion, and creativity training materials often involve divergent thinking activities, evaluating training program with such tests becomes a case of "teaching to the test." Besides, scoring better on a posttest than a pretest may be a result of having learned what is wanted on the test, i.e., the "practice effect," rather than truly increasing creativity (Gallagher, 1985). However, the former "pseudo effect," teaching to criterion, can be clarified by using or comparing with other kinds of tests, e.g., *Stroop Color and Word Test* or the *Raven Progressive Matrices.* And the latter concern, practice effect, can be solved by using control group design.

Nevertheless, there is another major concern about the impact of motivation on the *Torrance Tests of Creative Thinking*. An early study (Halpin & Halpin, 1973) had found that the scores of TTCT could be improved just by facilitating the motivation for taking the test. And a Torrance (1972) study also found 69% of successes by facilitating testing conditions. Moreover, using divergent thinking as an introductory activity tended to increase students' interests or motives in a study topic (Baer, 1997). Therefore, the improving posttest scores might come from the motivation factor, rather than the training materials. Just as Feldhusen and Goh (1995) noted, "good instructional strategies alone do not guarantee successful, real-life creative production. They probably only facilitate creative thinking processes making it easier to access creativity" (p. 241). This indicates

that the actual effects of creativity training programs might come from two sources: the training process works as a stimulus to foster motivation on creative thinking behaviors as well as the content and instructional strategies of the training materials.

Fostering Creativity

According to Guilford's view of creativity, creative ability should be stable (Brown, 1989; Guilford, 1950). And the Multi-dimensional, Interactive Process Model of Human Creativity (Alexander, Parsons, and Nash, 1996) also shows that only some aspects can be influenced by the training efforts. Meanwhile, many researchers affirmatively state that creativity is teachable (e.g., Feldhusen, 1993; Feldhusen & Clinkenbeard, 1986; Treffinger, 1993), and the training effect is robust enough to be able to generalize across many aspects (Scott, Leritz, & Mumford, 2004a).

Torrance (1972) reviewed 142 studies related to creativity training, and the results showed that overall 72 % of the studies were successful. He summarized that "the most successful approaches seem to be those that involve both cognitive and emotional functioning, provide adequate structure and motivation, and give opportunities for involvement, practice, and interaction with teachers and other children" (p. 132-133). And the greatest effect seems from involving deliberate teaching. Even though the findings support the statement "creativity is teachable," since he used the method of "vote counting" to total the number of successful studies which were statistically significant; yet, there are still some questions that remain to be answered, such as which program is more effective and how to compare the effects of different programs.

Rose and Lin (1984) used the method of meta-analysis to synthesize the effects of creative training programs. They divided the programs into six categories: (a) Creative Problem Solving, (b) Productive Thinking Program, (c) Purdue Creative Thinking Program, (d) other creative thinking programs, (e) school programs, and (f) special techniques. Although they figured out the effect size of different types of intervention programs, they did not explore any internal and external validity issues. However, their results present the effectiveness of creativity training program by different types. For example, they found that, overall, the Creative Problem Solving training program obtained more improvement than other programs. And, overall, TTCT's verbal components displayed more improvement than figural components. Feasibly, the findings suggest that these training programs might have more impact on some aspects of creativity like verbal expression but not on figural expression. And this may indicate that the figural form of the TTCT might be measuring an innate aspect of creativity that cannot be affected much by training which is relatively stable, as Guilford (1950) mentioned. Besides, they were additionally surprised by the relatively small effects of both the Purdue Creative Thinking Program and Covington's Productive Thinking Program, which were supposed to be effective programs (Feldhusen & Clinkenbeard, 1986). However, if we compare the effects on figural creativity components, the Purdue Creative Thinking Program had the greatest effect. Such findings suggested that the results might be interpreted from an alternative point of view regarding "ability or skill" changes.

Scope (1999) investigated the relationship between instructional variables and instructional time of the creativity training programs. The goal of his meta-analysis was to determine whether instruction has an impact on creativity in school-age children. He examined following variables: (a) amount of time spent on instruction and (b) the instruction variables: reviewing, structuring, questioning, responding, and independent practice; and did not account for motivational, social, personal, and cognitive variables that could contribute to creativity. He found only independent practice had a small positive relationship with creativity scores. The relationship between time spent on instruction and creativity scores was not supported by the data. Still, at least he had explored two more important variables: instruction time and instructional methods.

Scott, Leritz, and Mumford (2004a) conducted a more comprehensive meta-analysis of 70 prior studies. The goals of their investigation were (a) providing a reasonably compelling assessment of the overall effectiveness of creativity training and (b) identifying key characteristics of training content and delivery methods that influenced the training efforts. They found that "well-designed creativity training programs typically induce gains in performance with these effects generalizing across criteria, settings and target populations" (p. 361). And more successful programs are likely to focus on development of cognitive skills and exercise of their realistic applications. Moreover, the effectiveness of training is not limited to age (below and above 14 years old), setting (academic or occupational), gifted or non-gifted (see Table 3 of Scott, Leritz, & Mumford, 2004a, for complete data). These findings are quite important. For the relationship between age and achievement seems to have a trend

(Lehman, 1953, 1962, 1966; and Dennis, 1956, 1966). In their studies, though, there are some differences among artists, scholars, and scientists; but, overall, the achievement/product index increases from age 20 to the highest around ages 30 to 50, then declines. Dacey's Peak Periods Theory offers a theory that "there are certain peak periods in life during which creative ability can be cultivated most effectively" (Dacey, 1989, p. 164-165). Thus, if the effect of training could work out across age and occupation, then this will be a very important implication for the human resource development area.

Meta-analysis

Although in 1972 the study of Torrance had supported the idea that creativity is teachable, some questions remained to be explored further, e.g., which variables will influence the effect of the training results (e.g., Scope, 1999) and the generalized ability of the training effect (e.g., Scott, Leritz, & Mumford, 2004a). Meta-analysis arose in the 1970's, because it introduces the concept of effect size as a more suitable and reasonable statistical method to synthesize the results of studies. And there have been three papers using meta-analysis to study the effectiveness of creativity training (i.e., Rose & Lin, 1984; Scope, 1999; Scott, Leritz, & Mumford, 2004a&b).

The reasons for this study to choose meta-analysis as the method to synthesize previous studies are (a) vote counting is not powerful, (b) effect size could provide more useful statistical information, and (c) it could lead to higher level of explanation about potential causes-effects relationships.

There are two major drawbacks about vote counting as a method for a quantitative research synthesis (Light & Pillemer, 1984). The first disadvantage is its ability to detect the true difference in a statistical sense, i.e., it is not powerful. Especially when the studies' samples sizes and effect sizes are small, using vote count will often fail to identify a significant overall treatment effect. The second disadvantage is that it won't give any information about the size of a treatment effect.

Statistical power is the probability that a statistical test will lead to a correct rejection of the null hypothesis, and it is strongly influenced by the sample size. Generally, the larger sample size will have larger power. Another condition, given other things being equal, the larger the effect size, the greater the difference between the population means, the greater the power. Since power is determined by (1) effect size, (2) sample size, and (3) choice of α level (power will be greater for a test at α= .05 than α= .01), if we know any three of the values (power, effect size, α and sample size), then we can determine the fourth as indicated in Cohen's power table (1988).

Hunt (1997) notes that "finding the average effects of any form of treatment is the primary goal of meta-analysis, but this reveals nothing about when, where, and how the treatment works" (p. 51). At this secondary level of analysis, we need to find the moderator and mediator variables. A moderator is a qualitative (e.g., gifted or non-gifted) or quantitative (e.g., age) variable that affects the relations between an independent or predictor variable and dependent or criterion variable" (Shadish & Sweeney, 1991, p.883). And "the independent variable causes the mediator, which then causes the outcome" (Shadish & Sweeney, 1991, p.883), i.e., the dependent variable

(e.g., effect size index). Therefore, if researchers could find any moderator and mediator variables associated with creativity training programs, then the findings will provide possible explanation for the causal-effect relationships among the variables.

CHAPTER III

METHODS

This chapter introduces the research procedures of (1) the database for selecting studies, (2) the selection criterion, (3) the coding of the studies, (4) the intercoder reliability, (5) the methods of computing effect size, as well as (6) related statistical analyses used in this meta-analytic study. Finally, this study uses Light and Pillemer's (1984) checklist to review the findings.

Procedures

Database and Criteria for Selecting the Studies

Database used for selecting. The following two databases served as the primary sources to be included in this research synthesis: PsycINFO, and Dissertation Abstracts International. Using the Texas A&M University library through the website search engine and entering appropriate key terms for each source, such as, "creativity" and "training program," a comprehensive search for relevant and appropriate articles were conducted. The research and review process occurred during August and September of 2004.

Criteria of Selection. The following were the criterion used in the selecting of the studies which would be included in this meta-analysis study. First, the study must be related to creativity training and provided creativity measurement information. This study included school programs (e.g., Arts, music, and second foreign language class, etc.), and the purpose was to use them as a reference group or baseline. Second, the

study was required to provide enough information about the statistics needed to calculate the effect size (Appendix A). Third, the study was required to provide information about the research design (pre-post test, experimental and control group), subject's information (e.g., sample size, age, and category), description of the training program, and measurement tool used in the study. Fourth, if several studies were based on the same data set, only one publication was retained to avoid overweighting the same data's effect. For example, if the studies could be identified by being conducted by the same author, then only one of the published journal article rather than dissertation would be included. Citations for these studies are listed in the reference section.

Coding of Studies

After all relevant articles were collected, each study was read and coded. General information about the study included: (a) author; (b) date of publication; (c) subject's demographic information (i.e., age and category); (d) sample size; (e) type of experimental design (e.g., pre-post test, control group present or not); (f) published (journal articles) or unpublished (dissertation); (g) types of training program, e.g., Creative Problem Solving (CPS), any named creativity training programs (NCTPs), other unnamed creativity training programs or workshops (Other CTPs), school programs (School Ps), other creativity training techniques (Other Techs), and other techniques used in the training program which were not directly intended to increase creativity (Other Attitudes); (h) the psychological measurement tools used in the study, e.g., *Torrance Tests of Creative Thinking* or other standard forms of testing; e.g., SOI,

and their measuring types (i.e., verbal, non-verbal, or both, and using judges/raters); and (i) training time period in minutes (codes' definitions as shown in Appendix C).

Intercoder Reliability

From the pool of selected studies, 10 studies were randomly selected by SPSS software and independently coded by the primary investigator and a former Ph. D. student who graduated in May 2004 from the program of gifted and talented in the Department of Educational Psychology at Texas A&M University. A standardized coding form was created (Appendix B) that allowed the second coder to extract information regarding independent variables, i.e., subjects' information including age (Yrcode) and category (GT code), sample sizes (experimental and control group), types of training program (Program code), training time period (in minutes), and measurement tools (M-tool code).

Computations and Analysis of Effect Sizes

The procedures used in the meta-analysis of the group design studies following those of Hedges and Becker's (1986) suggestions. When means or standard deviations were not available from reports, effect size was calculated from *t*-test, and *F* statistics. Formulas for calculating effect size were listed in Appendix A.

In each study, all of the subscales' effect sizes were assessed (e.g., fluency, flexibility, originality, and elaboration in TTCT's verbal or figural form). Then, all of the subscales' effect sizes were averaged into one single effect size index to present the effect of the study. If the study had more than one treatment group, then each treatment group would be calculated separately, and the study would have more than one effect

size index to present each treatment's effect. In this study, the reliability of computing effect size was comparing by the effect size results with other author's results: Rose and Lin (1984), Scope (1999), and Scott, Leritz, and Mumford, (2004a).

Statistical Methods

In addition to assessing effect sizes as the main statistical analysis, this study quantitatively synthesized the results of the former studies along with Pearson correlation, regression and path-analysis methods. The purpose of these analyses is described as follows:

(a) Pearson correlation: to know the relationships among these variables and their relationships with effect size.

(c) Regression analysis: to assess the contribution of each independent variable on the creativity training effect. Thus, the dependant variable was the effect size.

(d) Path-analysis: to figure out the path coefficients among these variables with effect size and to explain their relationships with effect size. Path coefficient is a form of correlation that has been "partialled out" or computed with other variables held constant. Amos and M*puls* statistical software were used in this study.

Evaluating Reviews

Finally, using Light and Pillemer's (1984, p. 160-161) checklists to evaluate this study, the questions are as follows:

1. What is the precise purpose of the review?
2. How were studies selected?
3. Is there publication bias?

4. Are treatments similar enough to combine?
5. Are control groups similar enough to combine?
6. What is the distribution of study outcomes?
7. Are outcomes related to research design?
8. Are outcomes related to characteristics of programs, participants, and settings?
9. Is the unit of analysis similar across studies?
10. What are guidelines for future research?

CHAPTER IV

RESULTS

The purpose of this study was to use the method of meta-analysis to synthesize the empirical research on the effects of intervention techniques for fostering creativity: (a) to calculate the effect size of different types of the intervention techniques used in the creativity training process and (b) to identify variables inherent in the subjects or in the training process, which could influence the training results.

This chapter will include an overview of the descriptive statistics, discussions related to the validity of the meta-analysis, and then conclude by addressing the research questions delineated in Chapter I.

Overview

There were a total of 51 studies and 62 comparisons (47 published and 15 unpublished) included in this meta-analysis study which had already excluded the studies that did not have enough statistics information for assessing the effect size. The total searching results of PsycINFO by using keywords, “creativity” and “training program,” showed 73 related to creativity training papers in the end of September 2004. And, among them there were two articles that also used the meta-analysis regarding creativity training programs. One was Rose and Lin’s (1984) study which used 46 studies (about 64 comparisons), and the other was Scope’s (1999) study, which used 30 studies (40 comparisons) limited only to student groups. Therefore, the sample cases

collected in this study was acceptable, but it was still not good enough for the purpose of computing a structural equation model or doing a path-analysis (Ullman, 2001).

Descriptive Statistics

Table 1 shows the publication date of the articles in this study including published journal articles and unpublished dissertations. If the results of the dissertation had been published, only the data from the journal article was included in this study.

Table 1. *Publication Date*

Year	Number of case	Percent (%)
~1969	1	1.6
1970~1979	8	12.9
1980~1989	28	45.2
1990~1999	23	37.1
2000~2003	2	3.2
Total	62	100.0

Table 2 and Table 3 include the subjects' information in this study. Table 2 presents the distribution of subjects' age. About 84% of the studies were using students as their subjects, and nearly 70% were under the high school level. Only 16% were non-student groups, including teachers, nurses, and employees. Besides, even in student groups, no more than 10% used gifted/talented students as their subjects. In Table 2, three special groups were educable mentally retarded (10~12 year-old), learning disabled

(11~12 year-old), and mentally handicapped (IQ: 50~80). They were not classified by their chronological ages.

Table 2. *Subjects' Age*

Age	Number of case	Percent (%)
Preschool (under 6 yrs)	4	6.5
Elementary (6~12 yrs)	25	40.3
High school (13~18 yrs)	13	21.0
College (19~22 yrs)	7	11.3
Employee (25~60 yrs)	10	16.1
Special group	3	4.8
Total	62	100.0

Note. Special groups are learning disabled, educable mentally retarded, and mentally handicapped.

Table 3 also includes these three, as well as three other groups, who were also classified as a special category: disadvantaged preschool students (5~6 year-old), American Indian (2 and 6 grade), and hearing-impaired (8 and 10 year-old).

Table 3. *Subjects' Category*

	Number of case	Percent (%)
Normal students	41	66.1
Gifted students	5	8.1
Employees	10	16.1
Special group	6	9.7
Total	62	100.0

Note. Special groups are learning disabled, educable mentally retarded, mentally handicapped, as well as disadvantaged preschool students, American Indian, and hearing-impaired students.

Table 4 summarizes the measurement tools which were used for assessing the effect of creativity training programs. About 60% of the studies choose the *Torrance Tests of Creative Thinking* as the evaluation measurement. Other standardized testing was about 20%, and 5 studies used self-established scales. Unfortunately, *Stroop Color and Word Test* or *Raven Progressive Matrices* types of testing which are supposed to measure the general intelligence ability, *g* factor, but also related to creativity, could not be found in any of the studies.

Table 4. *Measurement Tool Categories Used in the Studies*

	Number of case	Percent (%)
TTCT-Verbal	8	12.9
TTCT-Figural	15	24.2
TTCT-V&F	16	25.8
Other scales	14	22.6
Judges	4	6.5
Attitude	5	8.1
Total	62	100.0

The types of training programs in this study are listed in Table 5. The intercoder reliability for other categories was 100% consistence, except “time period” and “types of training program.” For training time period, after using 30 minutes as the estimation for a section whenever there was no exact time period mentioned in the study, then time period coding consistency was also 100%. As for the types of creativity training programs, after discussing the criterion with another coder, the interrater agreement

coefficient changed from .60 to .80. Because some of the training programs had more than one characteristic of the categorized criterion, the programs might be categorized as combining two or more types of training programs. Therefore, the intercoder reliability in this item was lower than others.

Table 5. *Types of Training Program*

Name of program	Number of case	Percent (%)
CPS	5	8.1
NCTPs	11	17.7
Other CTPs	12	19.4
School Ps	12	19.4
Other Techs	15	24.2
Other Attitudes	7	11.3
Total	62	100.0

Figure 1 and Figure 2 depict the 62 effect sizes, range from -0.22 to 3.84; the mean is 0.89 and the standard deviation is 0.77. As the trend shows, there are 3 cases in which effect sizes are higher than 2.5. These could be considered as outliers. The overall effect size results are as shown in the Table 6.

Table 6. *Effect Size Comparison with Scope (1999) and Rose & Lin (1984)*

Author	Mean	SD	CI_{95}	Number of cases
Overall	.894	.772	.62~1.16	62
Overall with outliers removed ($d > 2.5$)	.762	.498	.58~.94	59
Scott, Leritz, Mumford (2004)	.64	.59	CI_{90}: .53~.76	69
Scope (1999)	.90	1.19	.37~1.43	40
Rose & Lin (1984)	.468	.685	.23~ .71	64

Note. CI_{95} is the 95% confidence interval of effect size.

Figure 1. Effect size index in this study (N=62).

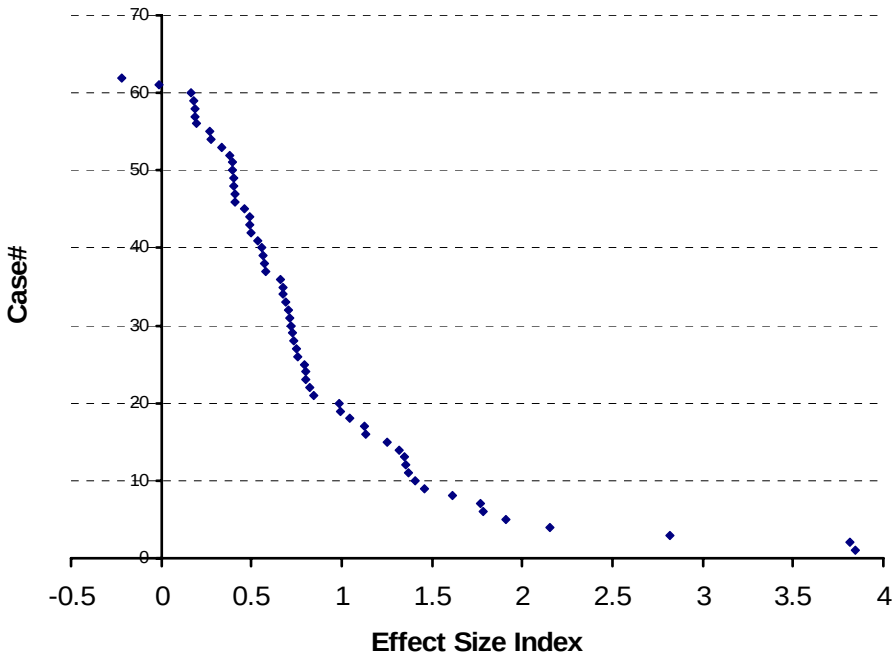
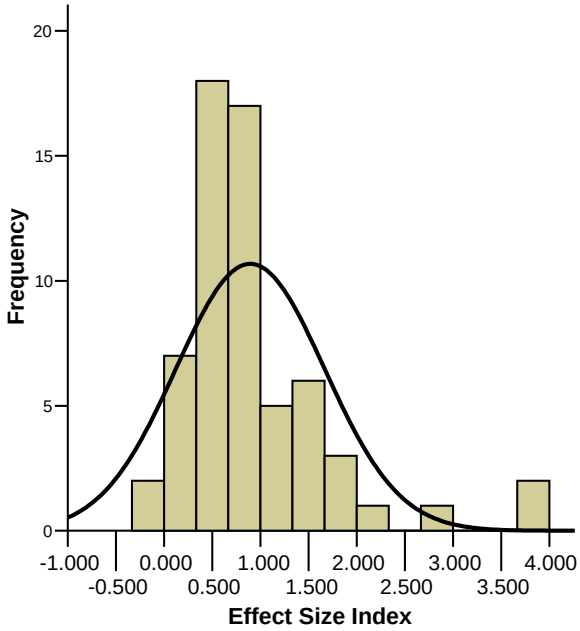


Figure 2. Distribution of effect size index (N=62).



Comparing Effect Size Results with Other Papers

Although the effect size calculating formula used in this study was different from the other two authors, the results were quite similar. Especially, it was very close to Scope's (1999) results. After examining by the CI_{95} with other three papers, the mean effect size was most likely in the range from .62 to .71. The results of Table 6 confirmed the statement of Treffinger (1993), "If you devise and carry out a reasonable treatment, and choose variables carefully to present a realistic operational definition of creativity, yes, you can enhance subjects' performance significantly" (p. 13); and it also could explain the vote counting result of Torrance's (1972) finding. Because the effect sizes of creativity training programs were really sizable, in other words, the statistical power was not small; therefore, these studies had a high probability of detecting statistical significance.

Though this finding might not seem to be very noteworthy, it is important. For this result not only could explain why researchers always could obtain significant results in creativity training programs, but also could give useful information about sample size of a study. While conducting a creativity training program, researchers could know in advance having how many subjects would have enough power to detect the effect of the treatment. For example, if the true effect size of a training program is around 0.8~1.0, and Type I error, $\alpha < .05$, then using the sample size 50 will be good enough to have the power level ($1-\beta$) over 99% (Cohen, 1988, p. 31). Hence, with experimental and control groups of 50 subjects each, the probability of finding a significant training result is over 99%.

Meta-analysis Validity Discussions

Internal Validity

Internal validity is about the quality issues of the studies which would influence the effect size of creativity training programs included in this study. Four variables related to internal validity were examined in this study: (a) sample size, (b) control group, (c) published, and (d) measurement tool. The results are as shown in Table 7.

Table 7. *Internal Validity Influences on the Effect of Creativity Training*

	Mean	SD	n
Sample size			
Below 20	.972 (.869)	.72 (.58)	19 (18)
20~49	.795	.50	29
Over 50	.995 (.522)	1.22 (.22)	14 (12)
Control group			
Absent	.876 (.228)	1.30 (.09)	4 (3)
Present	.896 (.791)	.74 (.49)	58 (56)
Published			
No	.986 (.855)	.85 (.71)	15 (14)
Yes	.865 (.734)	.75 (.42)	47 (45)
Measurement tool			
TTCT	.900 (.741)	.82 (.46)	39 (37)
Non-TTCT	.885 (.798)	.69 (.56)	23 (22)

Note. Numbers in the parentheses are the values after excluding the effect size outliers.

Sample size. Overall, 77% of the studies' sample sizes were less than 50; however, their mean effect sizes were about 0.80. The result showed that the effect size wouldn't be influenced by the smaller sample size. On the contrary, the larger sample sizes, after excluding the outliners, the mean effect size was smaller.

Control group. As for the research design, again after excluding the outliners, there was a significant difference between them. But, if including the outliners, with or without control group, the effect size wouldn't have much difference. However, this should be considered as a threat of internal validity. Besides, this would influence the consequence of being published, since the correlation between these two variables was $r_{(59)} = .415$, $p < .01$.

Published. The published issue seemed not to indicate much difference between published articles and dissertations. However, it had significant relationships with subject's age ($r_{(59)} = -.358$, $p < .01$) and subject category ($r_{(59)} = -.273$, $p < .05$). This observation illustrates that most published articles were likely using student samples.

Measurement tool. The last one was about the measurement issue, the "orange and apple" problem. Overall, fortunately, using TTCT or Non-TTCT did not show much difference, since with both the average of effect sizes were close. But within the TTCT, there was a significant relationship ($r_{(37)} = -.533$, $p < .001$) among using verbal form, figural form, and both. Therefore, this issue should be explored further.

External Validity

External validity is dealing with generalization issues, whether the effect of creativity training could be generalized to other populations or situations. In this study,

three variables were examined: (a) subjects' age, (b) subjects' category, and (c) publication date. As may be seen, Table 8, the overall effect sizes show that crossing these three variables all obtained sizable effects. The implications are very noteworthy.

Table 8. *External Validity Influences on the Effects of Creativity Training*

	Mean	SD	n
Age			
Preschool	.722	.29	4
Elementary	1.016 (.771)	.90 (.32)	25 (23)
High school	.665	.61	13
College	.743	.48	7
Employee	1.102 (.911)	.98 (.82)	10 (9)
Special group	.768	.42	3
Category			
Normal student	.917 (.768)	.80 (.45)	41 (39)
Gifted student	.496	.30	5
Employee	1.102 (.911)	.98 (.82)	10 (9)
Special group	.725	.30	6
Publication date			
Before 1980	.855	.50	9
1980~1989	1.103 (.817)	.99 (.51)	28 (25)
After 1990	.674	.49	25

Note. Numbers in the parentheses are the values after excluding the effect size outliers.

Subjects' age. No matter what's the subject age, each age level could have the effects of creativity training. The training effect would not be only for children, also good for adults. Besides, the relative low effectiveness in the high school group supports Dacey's Peak Periods Theory (Dacey, 1989, chap. 9). And possibly, the training effect might still remain existing even for the elderly people, although there was lack of the studies primary focused on this age level.

Subjects' category. The effects of creativity training were not limited to student groups or in school settings, i.e., everyone in every occupation could all experience potential benefits from creativity training. However, it seemed that the gifted/talented student had less improvement effects. One possible explanation is that of the "ceiling effect." These gifted kids might already have pretty high scores in the pre-test, and post-test would not present as much as improvement as other kinds did.

Publication date. The effectiveness of creativity training was found throughout the years, from 1963 to 2003. Taken as a whole, the results obtained in these analyses did present the effectiveness of creativity training.

Research Questions

1. What are the effect sizes of different types of training programs?
2. What is the relationship between training time periods and effect size?
3. What is the relationship between measurement tools and effect size?
4. What is the relationship between the subjects' age and effect size?
5. What is the relationship between the subjects' category and effect size?
6. Overall, what are the relationships among these variables with effect size?

7. Can a path-model be established by these variables?

Types of Training Program with Training Time Period (Research Question #1& #2)

Table 9 shows the effect size by types of training program and Table 10 presents the Pearson correlation between training time periods and effect size ($r_{(59)}$= .053, p= .69), which is not significant. That means overall the training time periods will not influence the training effects. However, taken training time periods (Table 11 is the training time period across different types of creativity training programs) and types of training programs together, generally speaking, CPS had the highest mean effect size and spent the least training time; school programs, on the other hand, spent much more training or learning time than other programs but had the lowest training effect. Since the school programs in this study served as a reference group, this finding was reasonable. And the Other Attitudes program, which presumed to motivate or facilitate the creativity motivation, also presents sizable effect size, as other types of training program.

Table 9. *Effect Sizes by Types of Training Program*

Types	Mean	SD	Range	Minimum	Maximum	n
CPS	1.127	.60	1.206	.578	1.784	5
NCTPs	.814	.56	1.883	.267	2.150	11
Other CTPs	.851	.77	3.040	-.220	2.82	12
	(.672)	(.48)	(1.630)		(1.140)	(11)
School Ps	.605	.31	1.055	-.009	1.046	12
Other Techs	1.002	.98	3.663	.180	3.843	15
	(.780)	(.53)	(1.731)		(1.911)	(14)
Other Attitudes	1.194	1.28	3.633	.184	3.817	7
	(.757)	(.59)	(1.429)		(1.163)	(6)

Note. Numbers in the parentheses are the values after excluding the effect size outliers.

Table 10. *Variables' Pearson Correlation Coefficient (N=59)*

	Effect Size	Training Program	Time period	Measurement tool	Subjects' Age	Subjects' Category	Control group	Published	Sample size	Publication date
Effect Size	-	- .119	.053	- .080	.082	.022	.251	- .104	- .147	- .126
Training Program		-	- .052	- .065	- .103	- .191	- .162	.075	- .139	.211
Time period			-	- .156	- .090	- .054	.046	- .153	- .047	- .102
Measurement tool				-	.023	- .070	- .326*	- .095	.076	.107
Subjects' Age					-	.624**	- .237	- .385**	- .179	- .037
Subjects' Category						-	- .139	-. 273*	- .105	-.193
Control group							-	.415**	.088	.045
Published								-	.162	.069
Sample size									-	- .120
Publication date										-

**. $p < .01$;*. $p < .05$

Note. The effect size outliers had been excluded in this analysis; *p*: probability level.

Table 11. *Training Time Period by Types of Training Program in Minutes*

Types	Mean	SD	Range	Minimum	Maximum	n
CPS	380	169	380	100	480	5
NCTPS	1342	1771	6000	300	6300	11
Other CTPs	5781	14149	49970	30	50000	12
	(6001)	(14818)	(49970)	(30)	(50000)	(11)
School Ps	5201	8409	29600	400	30000	12
Other Techs	1318	3097	11990	10	12000	15
	(555)	(961)	(3590)	(10)	(3600)	(14)
Other Attitudes	1850	4479	11970	30	12000	7
	(158)	(189)	(410)	(30)	(440)	(6)

Note. Numbers in the parentheses are the values after excluding the effect size outliers.

The other finding is that only in NCTPs (Named Creativity Training Programs) the training time has positive relationship with effect size, $r_{(11)} = .702$, $p < .05$, the longer training time has the higher training effect; other types of training program do not have the same result. Except for this pattern, effect sizes of different types of training programs do not show much difference among the training programs. One possible explanation is that the creativity training program is a whole package which mixes with the other type's features. Another explanation is that during the training process, the instructor's delivery method might have different effects on the results (Scope, 1999). From another viewpoint, the results suggested that the types of training programs alone might not be so important for fostering creativity. In other words, there should be other factors which are far more important than types of training programs.

Creativity Ability vs. Creativity Skills (Research Question #3)

Since Rose and Lin (1984) had found a pattern between TTCT Verbal Form and Figural Form, this issue should be investigated further. Although from Table 7 and Table 10, both have showed that what kinds of measurement tools used in the creativity training program do not have significant difference (Pearson correlation between measurement tool and effect size, $r_{(59)} = .08$, $p = .545$), there is a pattern within the TTCT, verbal and figural forms (Table 12). After excluding the outliners of effect size, the Pearson correlation coefficient between effect size and three types (including combined scores) of the TTCT was significant, $r_{(37)} = -.533$, $p < .001$.

Table 12. *Effect Size by Measurement Tools*

	Mean	SD	Minimum	Maximum	Range	n
TTCT-V	1.215	.47	.487	1.911	1.424	8
TTCT-F	.690	.41	-.220	1.457	1.677	15
TTCT-V&F	.526	.33	-.009	1.250	1.259	14
Other scales	.753	.41	.188	1.765	1.577	14
Judges	.680	.52	.184	1.350	1.166	4
Attitude	1.070	1.05	.166	2.150	1.984	4

Note. The effect size outliers had been excluded in this analysis.

As Rose and Lin (1984) suggested, the "dual nature of creativity," creative thinking skills and innate creative thinking abilities, could be indicated by the pattern. In the meantime, another possible explanation is that just like the concepts of multi-

intelligences, creativity could express itself in different ways; thus, the verbal and figural forms might not be in the same expression domain of "multi-creativity." Therefore, although people have already improved their creative thinking ability, most of them could only express it on the verbal rather than on the figural form.

Thus, if the figural form measures the stable or unchangeable ability aspect of creativity, then TTCT-F should have gained the lowest effect size, and the gain from TTCT-F&V should locate between TTCT-V and TTCT-F. However, the data pattern in this study did not support this hypothesis. Therefore, the results indicate that the view of multi-manifestation of creativity is a more possible explanation.

Generalized Ability across Subpopulations (Research Question #4&#5)

As Table 10 shows, the Pearson correlation of the subject's age and effect size is not significant ($r_{(59)} = .082$, $p = .538$); neither is the subject's category ($r_{(59)} = .022$, $p = .87$). However, from another perspective, that means the effectiveness of training is able to be generalized across age levels and categories, i.e., beyond student group or school setting (Table 8). In other words, the external validity of the effectiveness of creativity training programs is quite robust.

Relationships among These Variables with Effect Size (Research Question #6&#7)

Finally, Table 10 presents the relationships among these variables with effect size. It would not be surprising that there was no any significant relationship with effect size. This might be very bad news, since researchers have been used to finding statistical significance; it also implies that there might not be any significance obtained

by conducting the regression analysis or path-model analysis, the second level of meta-analysis, to find any explainable cause-effect relationships.

In spite of this finding, “non-significant” does not always mean the results are meaningless. This is not the end of the story, but, on the contrary, just the beginning. As a matter of fact, the meanings of these non-significant results had been discussed previously from Table 7 to Table 10. As a whole, “non-significance” revealed that the effectiveness of creativity training results were not limited to sample size, research design, types of measurement, subjects’ age, subjects’ occupations or settings, types of training program, training time period, and could be found all the time.

Regression analysis. As previously discussed, because there was not any significant relationship among these variables with effect size, then, the regression analysis wouldn’t have much significant result either. Table 13 shows the regression analysis results.

All of the Beta coefficients were not significant except the Control group; that means if researchers want to predict the dependent variable, effect size, most of these independent variables except the Control group are not good predictors. In other words, the effectiveness of a training program cannot be known in advance only by these variables individually. This finding also suggests that some other moderators and mediators in the training process had to be identified and investigated which served as the essential factors to influence the creativity training results.

Table 13. *Regression Analysis: Dependent Variable: Effect Size (N=59)*

	Beta	*t*	Sig.
Training program	- .038	- .269	.789
Training time period	- .010	- .077	.939
Sample size	- .165	- 1.210	.232
Control group	.376	2.376	.021
Published	-.201	-1 .278	.207
Measurement tool	.039	.268	.790
Subjects' age	.121	.680	.500
Subjects' category	-.110	-.634	.529
Publication date	- .163	- 1.172	.247

Note. R^2= .168. The effect size outliers had been excluded in this analysis.

Path-model. Though the attempt to find a path-model turn out to be not very successful, it still provides some possible causal relationships among some variables with effect size index. Since there were only 59 effect sizes in this study, which was not enough for conducting complex structural equation model, not all variables were included in this path analysis. The three variables which were excluded in the analysis were subject's category, publication date, and sample size. Subject's category was excluded because it had high correlation with the Subject's age ($r_{(59)}$ = .624, p<.000); thus, retained Subject's age should be enough. Besides, since the publication date and sample size were not of research interest, they also were excluded. The remained variables were (a) types of training program, (b) training time periods, (c) measurement

tools, (d) subjects' age, (e) control group design, and (f) whether published. As Path-Model I shows (Appendix D), only the control group and the published two variables have direct influence on the effect size index; besides, the model fit indexes are not good (Chi-square=37.5, degree of freedom=15, CFI=.065, RMSEA=.161, N=59). The Path-Model II (Appendix E) has better model fit indexes (Chi-square=11, degree of freedom=11, CFI=.998, RMSEA=.008, N=59). However, because the control group and the published two variables are binominal, which violate the assumption of as continuous variables, therefore, the M*plus* statistics software was used to assign these two variables as "categorical" variables. The results were shown in Appendix F. Overall, most of the path coefficients were increased and types of training programs have slight significant indirect effect on effect size by way of training time periods rather than by way of the control group.

Meta-Analytical Issues and Evaluating Reviews

Although, overall, the analyses of internal validity indicated that there were no serious threats to the findings, two issues of the meta-analysis method need to be examined further as follows.

Published bias. Although in Figure 2, the distribution of the effect size index looks normal and the mean between published and unpublished (Table 7) does not show much difference (indicating that there might be no published bias). However, this study did not conduct a thorough search for unpublished papers, only dissertations; besides, as found in examining the internal validity (also in path-model II), being published had significant relationships with subjects' age, category, and control group in this study. As

a result, this study did not cover enough other older age levels (over 22-year-old through 60-year-old or over) or various occupations besides school settings to draw a more comprehensive generality conclusion. In addition, if the analysis used only 47 published journal articles, it would have had statistical significant correlation between training time period and effect size, $r_{(47)}=0.32$, $p< .05$. For these reasons, it is better not to conclude that there is no published bias in this study.

Oranges and apples. In this study, using a non-weighting average method to combine all the subscales of the TTCT (i.e., fluency, flexibility, originality, and elaboration scores for both verbal and figural exercises), and other testing to a single effect size index to represent the effect of the creative training, would have mixed different kinds of effect. Because the creativity training might have affected different aspects of creativity in the person, the test result, ideally, should have reflected each aspect's progress; however, there is only single effect size index which by averaging all subscales, might be a misleading (Light & Pillemer, 1984).

Evaluating reviews. This section attempts to answer the checklist from Light and Pillemer (1984, p. 160-161). Question 1: What is the precise purpose of the review? As a whole, the purpose of this meta-analysis study was really precise, regarding calculating effect sizes of creativity training programs and investigating the relationships among these variables. Question 2 and 3: How were studies selected? Is there publication bias? The studies were mainly collected from the internet PsycINFO database and did not find significant publication bias (Figure 2 and Table7). Question 4: Are treatments similar enough to combine? The treatments, creativity training programs, were similar enough

to be combined except for school programs. Question 5: Are control groups similar enough to combine? Since the control groups were assigned for doing various kinds of activities, there might be some concerns regarding the similarity among these control groups (e.g., Garber, 1981 and Davidson, 1981). Question 6: What is the distribution of study outcomes? The distribution of the effect size index was very good as shown in Figures 1 and 2. Question 7: Are outcomes related to research design? Though only three cases in this study did not have the control group, the results showed that the outcomes (effect sizes) were affirmatively related to the research design, and the control group design was better. Question 8: Are outcomes related to characteristics of programs, participants, and settings? There were no significant differences among these variables with effect size (Table 10), which indicated that outcomes were not related to characteristics of programs, participants, and settings, i.e., the findings can be generalized across subpopulations and settings. Question 9: Is the unit of analysis similar across studies? The unit of analysis of most studies was similar, small group class or workshop and rarely larger than class level; no schools or school districts level was found. Question 10: What are guidelines for future research? The guidelines for future research are focused on the concepts of aptitude-treatment interactions and comprehensive assessment techniques development.

CHAPTER V

SUMMARY, CONCLUSIONS, AND IMPLICATIONS

Summary

Overall, the effectiveness of creativity training programs is robust and the results could be generalized across types of creativity training program, subjects' age, category, and publication date. The estimated average effect size was about .62 to .71. In Scott, Leritz, and Mumford's study (2004a), their result is Mean= .68, CI_{90}: .55~.81 (with outliers removed, Mean= .64, CI_{90}: .53~.76). Generally, the result of average effect size indicates that the creativity training programs can effectively improve the scores of assessing creative thinking behavior. Besides, because of the large statistical power (small d= .20, medium d=.50, large d= .80), it would not be required to use a large sample size to detect the difference between the experimental (treatment) and control group.

To investigate the relationships among related variables: (a) types of training program, (b) instruction time period of training the program, (c) sample size of studies, (d) control group design vs. non-control group design, (e) published status, (f) types of the measurement tools, (g) subjects' age, (h) subjects' category/occupations, and (i) publication date with the dependent variable, effect size index, the Amos statistical software was used once in this study (Appendix D&E). The regression analysis results showed that except for the Control group variable, there's no significant relation between these variables with effect size index. In other words, they are not good

predictors to predict the effect size. Neither did Scope (1999) find a significant relationship between training time period and effect size; he found only that one of the instructional variables, independent practice, had a small positive relationship to creativity scores. However, as path-model II shows, four variables, i.e., measurement tool, control group, subjects' age, and whether published, have influence on the effect size index. This indicates that a research design with a control group and student sample will more likely lead to publishing the result, and publication will influence the effect size index. Besides, the types of measurement tool have indirect influences on the effect size index by way of the control group design, and the types of training programs have indirect influences on the effect size index by way of the training time period. These relationships cannot be found by regression analysis.

Rose and Lin (1984) found that the CPS training program had the highest mean effect size, which could also be identified in this study. In addition, this study found that on average, the CPS training program spent the least amount of training time and could have the highest training effect.

Besides, further investigation about the measurement tool, TTCT, revealed that the TTCT figural form did not have the least gained scores, which implied that the difference among the measuring forms is from the manifestation of creativity rather than measuring the innate creative abilities and plastic aspect of creative skills.

Conclusions

This study used the three domains of creative behaviors: ability, skill, and motivation (Torrance & Safter, 1999), to review the issue of fostering creativity, what

can be changed and what cannot. Overall, assuming some biological based components cannot be changed by the training programs, the effectiveness must be from the skills and motivations domains. In other words, these creative thinking skills and motivations absolutely can be cultivated; and the effectiveness can be found across age levels and occupations. Through training and learning experiences, these creative thinking skills and motivations could help release or reveal the innate creative potential in a person.

Limitations of the Study

Beyond the limitations mentioned in chapter one, this study had another major one, the assessment issue about evaluating creativity training programs. First, to investigate the innate creativity abilities, because none of the *Stroop Color and Word Test* or the *Raven Progressive Matrices* was found in the studies, this issue could not be examined further. Since only the TTCT verbal and figural forms were used, the result suggests that it might not be as Rose and Lin (1984) noted, innate creative abilities vs. creative skills. It is just as likely that there was a different manifestation of types of creativity expression.

Second, basically, in spite of validity and reliability issues (Baer, 1994; Cramond, 1994; Tannenbaum, 1983), measuring creativity is more difficult than measuring intelligence, and even more difficult for assessing the effectiveness of a creativity training program, since it must consider more aspects (e.g., motivation and interaction effects) than just limited domains or particular categories.

According to the Multi-dimensional, Interactive Process Model of Human Creativity proposed by Alexander, Parsons, and Nash (1996), the intervention of a

creativity training program might only access the "general strategic and conceptual knowledge" aspects of creativity. It is hard to cover all of the "psychological" and "sociological" aspects to investigate the integrated effectiveness of a training program, which was suggested by Feldhusen and Goh (1995). That's why some studies' results showed reversed effect by the same training program in their studies (e.g., Garber, 1981; in which the control group was watching films.); even in the same study, while the control group afterward received the same training as did the experimental group, it also found totally reversed effect (e.g., Davidson (1981), and in this case, "history" was a threat to internal validity when the observed effect was due to an event which took place between the pre-post test; this event was not the treatment of research interest (Cook & Campbell, 1979).)

Many environmental factors would have had impact on the subject's motivation just like Davidson's case (1981), and motivation is very essential for expressing a creative behavior on the product or performance on the tests. Unfortunately, from the information provided in the articles included in this study, there were not any quantitative data about motivation or related measurement of the subjects that could be obtained. This is the major problem and provides further limitations of this study for creating a better path-model.

Implications for Future Research

Aptitude Treatment Interactions

A student-centered approach to creativity education is indispensable for fostering creativity (Tan, 2001). Considering the statement of Treffinger (1993) that "stimulating

creativity is not a process of homogenization" (p. 20), researchers should be aware of individual differences and learning styles. Since each individual has his/her own unique strengths and talents, the goals of a training program should help them to recognize, to develop their own creative potential, and finally, to learn to express it in their own way, not just in our way or criteria (Treffinger 1993; Albert, 1990). Therefore, the interaction between psychological components (i.e., personality, motivation, and emotional well-being) and training materials should be included in the development and evaluation of a training program, such as conducting a needs assessment before the training. These efforts will help to understand what works best, for whom and under what conditions.

Comprehensive Assessment

To understand the effectiveness of a training program, a comprehensive assessment is necessary (Feldhusen & Goh, 1995), which including cognitive aspects (e.g., multiple measures of the cognitive processes) and affective aspects (e.g., motivation, interests, attitudes, and styles associated with creativity). Thus, developing motivation measurement tools and collecting related information while conducting or evaluating a creativity training program is quite important in the future. Besides, carefully choosing appropriate criteria for assessing the improvement on each individual is also the essential concept of ATI model (Snow, 1989 and 1992) as well as for a creativity training program, because each individual has his/her own way to express it.

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APPENDIX A

Formulas for calculating effect size, d, and r (Hedges & Becker,1986)

1. $d = \frac{X_E - X_C}{S_P}$ where pre-tests were assumed to provide equivalent groups

X_E = mean of experimental group (post-test)
X_C = mean of control group (post-test)
S_P = pooled standard deviation

$$S_P^2 = \frac{(n_E - 1)S_E^2 + (n_C - 1)S_C^2}{n_E + n_C - 2}$$

where S_P^2 = pooled variance
S_E^2 = variance of experimental group (post-test)
S_C^2 = variance of control group (post-test)
n_E= sample size of experimental group
n_C= sample size of control group

Note. Rose & Lin (1984) and Scope (1999) used $d = \frac{X_E - X_C}{S_C}$, where denominator is *Sc* not *Sp*.

2. $d = t\sqrt{\frac{2}{n}}$ for equal *ns*; *n* = sample size of each group

3. $d = t\sqrt{\frac{1}{n_E} + \frac{1}{n_C}}$ for unequal *ns*

4. $d = \sqrt{F}\sqrt{\frac{n_E + n_C}{n_E n_C}}$

5. $r = \frac{d}{\sqrt{d^2 + 4}}$ when $n_E = n_C$

APPENDIX B

Intercoder coding form

Author	Year	Subjects (descriptions)	Yrcode	GT code

Research design: Pre-Post test	Control group (Yes=1; No=0)	Sample size (experimental)	Sample size (control)

Types of training program (descriptions)	Program code	Time period (min.)

Measurement tool	M-tool code

APPENDIX C

Code definition

Yr code	Subjects' Age
1	Preschool: Under 6 yrs
2	Elementary: 6~12 yrs
3	High School: 13~18 yrs
4	College: 19~22 yrs
5	Senior: over 50 yrs
6	Employee: e.g., workers in business, teachers in school, etc.
7	Special Group: e.g., mental retarded, etc.

GT code	Subjects' Category
0	Normal Students
1	Gifted Students
2	Non-Students: e.g., workers, teachers, nurses, scientists, etc.
3	Special Group: e.g., mental retarded, etc.

Training Time Period	code	Training Time Period	code
< 60 min.	1	1001~2000 min.	5
61~120 min.	2	2001~5000 min.	6
121~400 min.	3	5001~ 10000 min.	7
401~1000 min.	4	10001 min. <	8

Note. This code was used in M*plus* path-model analysis.

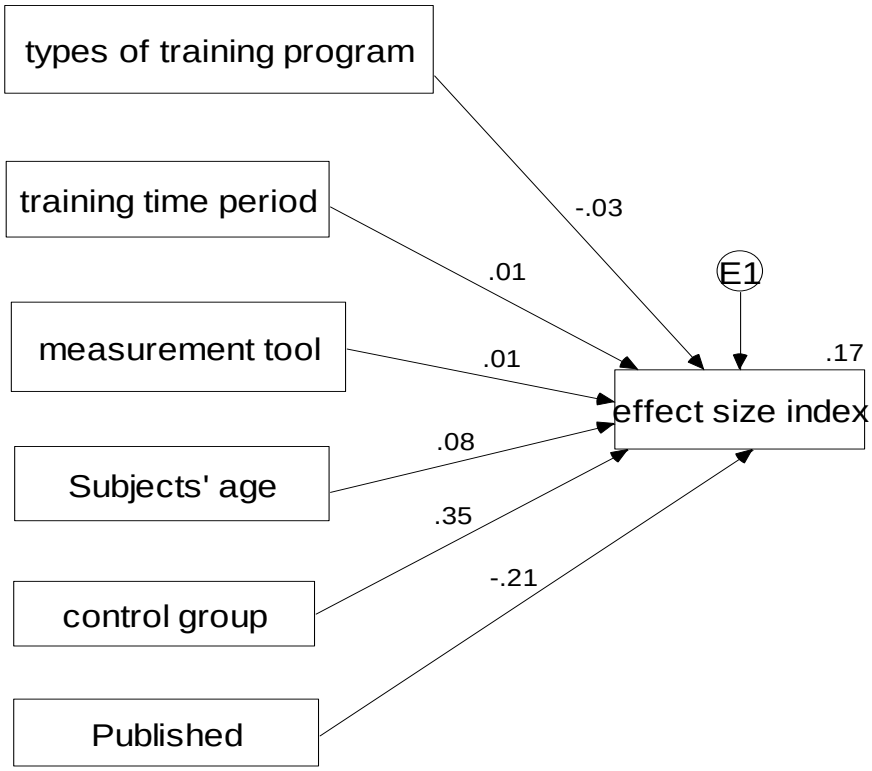
Code definition (continued)

Program code	Types of Training Program
1	Creative Problem Solving (CPS): e.g., Osborn
2	Named Creative Training Programs (NCTPs): e.g., Khatena, Productive Thinking, Purdue, Renzulli, etc.
3	Other Creative Training Programs (Other CTPs): e.g., self-developed, teacher workshop, etc.
4	School programs (School Ps): e.g., second language, computer, music, arts, etc.
5	Other techniques related on creative thinking (Other Techs): incubation, imagery, etc.
6	Other techniques (Other Attitudes) related on humor, cognitive, attitudes, motivation, self-control, etc.

M-tool code	Measurement Tool
1	TTCT-Verbal Form
2	TTCT-Figural Form
3	TTCT-Verbal & Figural Both
4	Other Scales: e.g., SOI, Sounds and Images (SI), etc.
5	Judges' rating
6	Measuring attitudes: "Not primary on creative thinking"

APPENDIX D

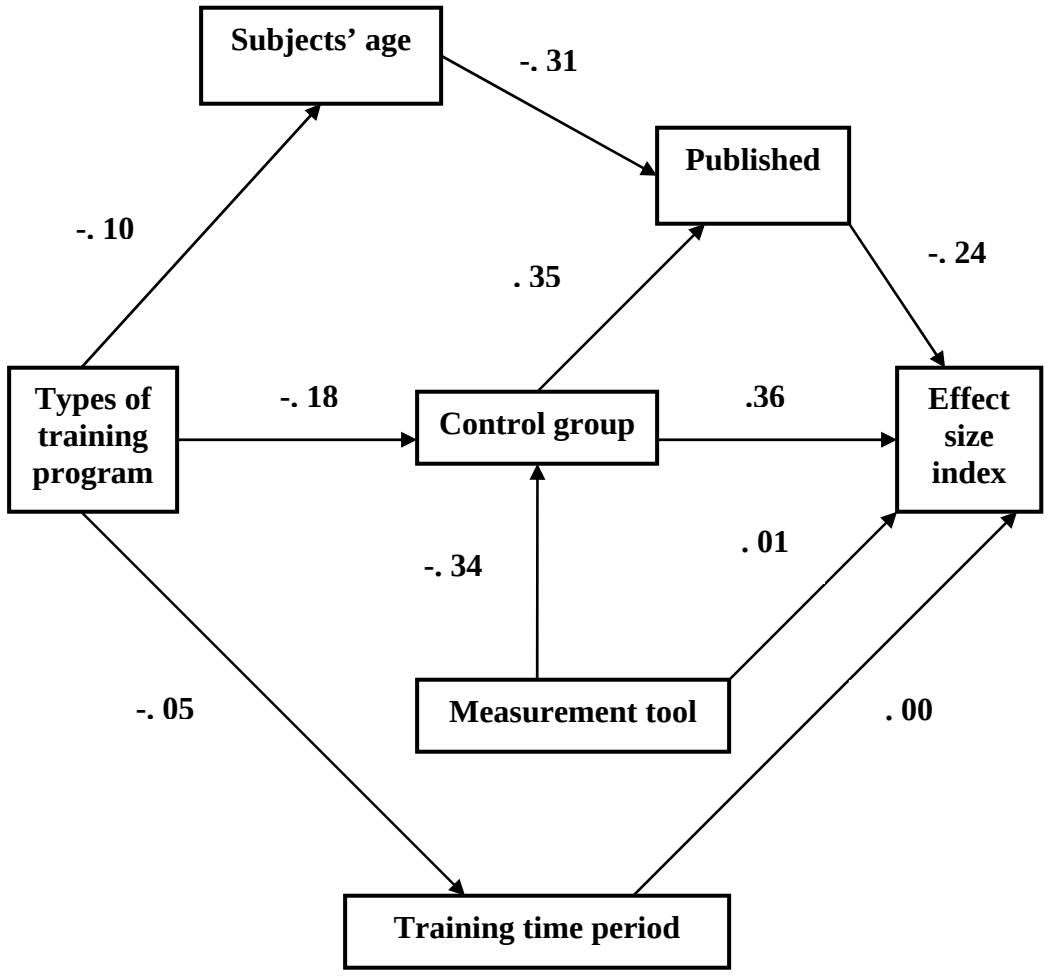
Path-Model I: Chi-square=37.5, degree of freedom=15, CFI=.065, RMSEA=.161,N=59.



Note. Amos statistical software was used in this path-model analysis.

APPENDIX E

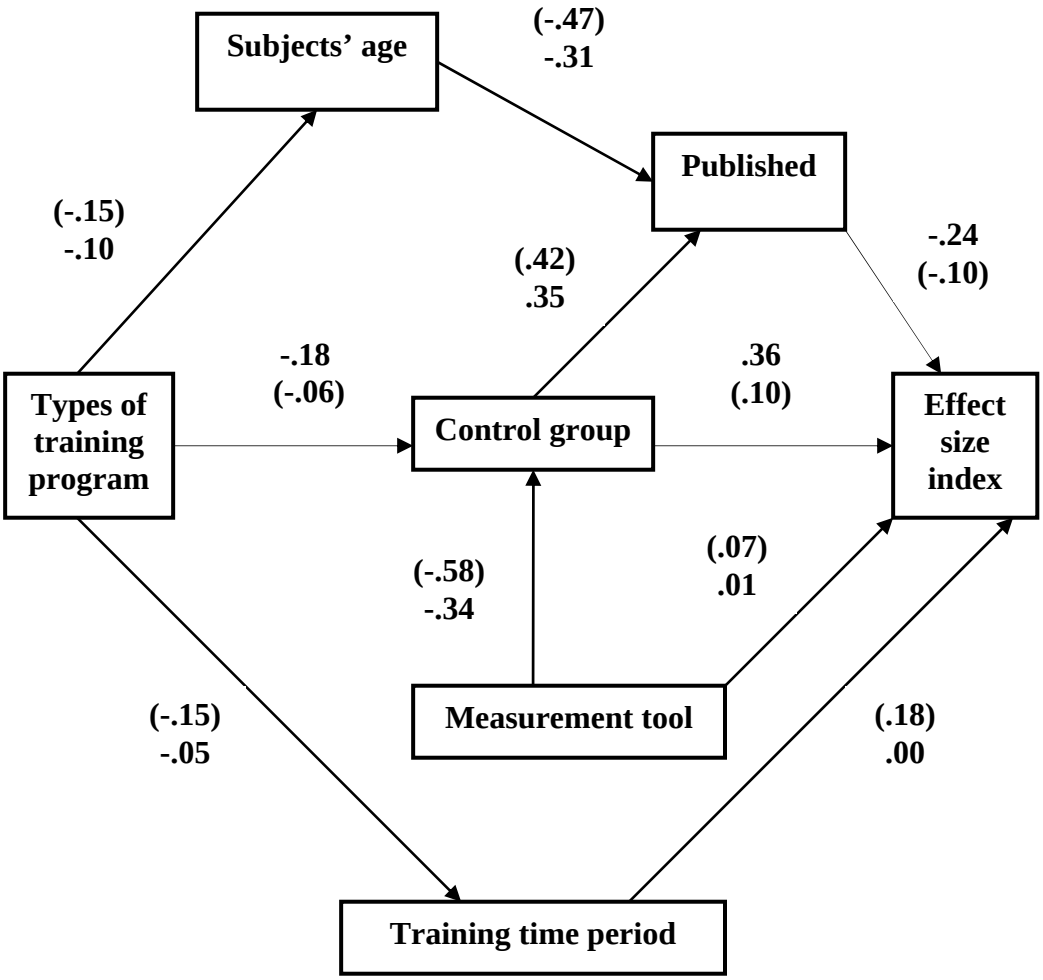
Path-Model II: Chi-square=11, degree of freedom=11, CFI=.998, RMSEA=.008, N=59.



Note. Amos statistical software was used in this path-model analysis.

APPENDIX F

Path-Model II: Comparing results from Amos and Mplus.



Note. Numbers in the parentheses are the results by using M*plus*.

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Working Experience

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2000-01	Graduate Assistant of the Educational Research and Evaluation Laboratory, Department of Educational Psychology, TAMU
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1996-97	Executive Secretary of Chinese Psychological Association (CPA) in Taiwan; conducting annual conference of CPA and research projects
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