A SYSTEMATIC REVIEW AND A META-ANALYSIS OF THE RELATIONSHIP BETWEEN PROBLEM FINDING AND CREATIVITY

By

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(Under the Direction of Bonnie Cramond)

ABSTRACT

This dissertation addresses a very important topic, which is discussed but rarely studied by researchers in the creativity field, *problem finding* (PF). The introductory chapter presents the rationale for conducting a systematic review and a meta-analysis study regarding the relationship between PF and creativity in order to answer four questions: What is the nature of the relationship between PF and creativity? Is the relationship affected by certain variables? How do various terms used in the problem finding (PF) literature differ from one another--if they differ at all? And, is there one term that is the best label for the processes that can be studied empirically? Chapter two is an attempt to address those questions through a systematic review of PF literature. Chapter three examines the nature and the magnitude of the relationship between PF and creativity using the meta-analysis method. Five moderators were used to explain the variance in the mean effect size (*r*). Retrieving and aggregating effect sizes from forty studies employing the random-effects model uncovered an overall moderate significant relationship between PF and creativity, *r*= .22 (95% *CI*= .11 - .32). Moderator analysis showed that three out of the five moderators independently influenced the effect size:

age, DT indices, and PF domain. The results suggest that using different terms in PF research does not affect the research findings. Finally, chapter four offers some implications and suggestions for further studies on PF.

INDEX WORDS: Problem Finding, Creativity, Creative Problem Solving, Four P's of Creativity.

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DEDICATION

To the most significant woman who has guided and influenced my life, AISHA, my grandmother

To the best father and mother, Mohamed & Sameera

To my soul mate and friend, Abhar

To the biggest achievement in my life, my twins, Yousif & Alanood

And to my cherished sisters, Aisha, Ghada, Sara, Fatima, Arwa, & Rhoda

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CHAPTER 1

INTRODUCTION

More than sixty years ago, Guilford (1950) talked about the lack of interest in studying one of the most valuable aspects of human intellectual ability, *creativity*. He called for more effort in order to understand this psychological construct. Since that time, many things have changed in the creativity field, and creativity now has become one of the most studied phenomena in psychology and other disciplines, including economics (e.g. Florida, 2012), medicine (e.g. Devi, 2015; Natrielli, Silva, & Natrielli, 2013), engineering (e.g. Cropley, 2015), and mathematics (e.g. Sriraman & Lee, 2011). In addition, creativity is one of the components of the 21st century's 4C's skills, which also include critical thinking, communication, and collaboration (Trilling & Fadel, 2009). Creativity is viewed as a syndrome or complex (Runco, 2014); however, there is not complete agreement on what creativity is.

Cramond (2016) suggested that creativity can be divided into two types: 1) expressive, which is typical in the arts, is an outlet for the creator's emotions and aesthetics, and the outcome can be judged by the product's originality and value in aesthetic and emotional appeal; and 2) inventive, which addresses a worthwhile problem, and the product, which may be an intangible idea, theorem, or formula, can be judged by its novelty and appropriateness for solving the problem.

Creativity can be studied through different angles such as creative Person, creative Process, creative Product, and creative Press (Rhodes, 1961). In terms of creative process, much emphasis in the last six decades has been on two constructs related to creativity: divergent

thinking (DT) and problem solving (PS). Some researchers define creativity as divergent thinking (Runco, 2014); others define it as problem solving (Guilford, 1956). However, there is much evidence that creativity is more than divergent thinking (Runco, 2008) and problem solving (Runco, 2014). Runco (2014) stated,

> Creativity is by no means just problem solving. Creative thinking can help when solving problems (and finding and defining them), but there is more to it. Creative art (which is surely a tautology) is often self-expressive, explorative, and aesthetic more than problem solving (p. 16)

Regrettably, little attention has been paid in the last fifty years to another construct that is related to creativity and creative problem solving, *problem finding* (PF) (Brugman, 1991; Brugman, 1995; Dillon, 1982; Getzels, 1975b; Getzels, 1979; Getzels & Smilansky, 1983; Hoover, 1994; Hu, Zhen Shi, Han, Wang, & Adey, 2010; Okuda, Runco, & Berger, 1991; Reiter-Palmon & Robinson, 2009). To support this argument, a comparison has been made between the number of studies conducted on each: divergent thinking, problem solving, and problem finding in PsycARTICLES, PsycINFO, Educational Resources Information Center (ERIC), and Psychology & Behavioral Science Collection databases. The search was for publication titles only starting from 1950 to 2015. Table 1 shows the results for such a comparison.

Table 1.1

A Comparison between the number of publications on Divergent Thinking, Problem Solving, and Problem Finding

Source Type	Divergent Thinking	Problem Solving	Problem Finding
Academic Journals	518	11,073	81
Dissertations	126	2,701	20
Reports	34	1,768	9
Magazines	13	396	2
Books	12	863	12
Reviews	1	47	1
Total	704	16,848	125

It is evident that problem finding has received little attention in publications compared with divergent thinking and problem solving publications, especially in academic journals and dissertations. Thus, one key question this study aims to answer: *Is problem finding important for creativity*? Answering this question requires first understanding the nature of the relationship between problem finding and creativity and some possible factor(s) (i.e. moderators) that might explain variability in research findings regarding this relationship. One powerful method that can help explore the relationship between problem finding and creativity is *meta-analysis*. According to Lipsey and Wilson (2001), "Meta-analysis is one of many ways to summarize, integrate, and interpret selected sets of scholarly works in the various disciplines" (p. 2). Borenstein, Hedges, Higgins, and Rothstein (2009) suggested that meta-analysis refers to the statistical synthesis of results from a series of studies. Unlike narrative reviews, in which researchers compare the number of significant with non-significant *p*-values and pick the winner (i.e. vote-counting) (Borenstein et al., 2009), the meta-analysis method can offer us more precise and accurate answers regarding the relationship between two variables or the effectiveness of an intervention.

Rationale

There are both theoretical and practical reasons for studying the relationship between problem finding and creativity. One theoretical reason for studying such a relationship is that very little is known about how problems are found and formulated (Getzels, 1975b; Reiter-Palmon & Robinson, 2009). Most school tasks and even divergent thinking tests assess what is called *presented problems* in which the problem is *well defined* (e.g. "List all the square things you can think of" and "List the similarities between an apple and a pear"). However, these tasks may not reflect *real-world problems* (Runco & Okuda, 1988) in which the problem encountered is *ill defined* and requires defining, redefining, formulating, and even discovering a problem that

does not yet exist (Getzels, 1982). In addition, some scholars suggested that finding a problem is more important than its solution. For example, Wertheimer (1945) stated, "The function of thinking is not just solving an actual problem but discovering, envisaging, going into deeper questions" (p. 123). Torrance (1966) contended that creativity requires individuals to be sensitive to problems, deficiencies, gaps in knowledge, missing elements, disharmonies, and so on.

A number of empirical investigations suggested a strong relationship between problem finding and creativity. In their work *Creativity and the Finding and Solving of Real-world Problems*, Okuda et al. (1991) suggested that problem finding was the best predictor of creative accomplishments. In addition, problem finding is an essential component of the creativity process models such as the Wallas' four-stage model of creativity and the Osborn-Parnes model of Creative Problem Solving (Wallas, 1926; Parnes, 1966). Students need to be taught that real-world problems are not always well defined, and educators need to prepare their students for those situations in which they have to use problem-finding skills and to be active thinkers.

Besides the evidence that very little is known about the relationship between problem finding and creativity, yet another challenge is that previous research offered us some contradictory findings regarding such a relationship. For instance, the teams of Csikszentmihalyi and Getzels (1971) and Bouchard and Drauden (1976) studied the relationship between discovery-oriented behavior and problem solving using a similar method; however, some of their findings were in conflict. Csikszentmihalyi and Getzels (1971) found a positive relationship between problem formulation and problem solving while Bouchard and Drauden (1976) reported a negative relationship between these two variables. In addition, Bouchard and Drauden (1976) reported that males and females differed significantly in some problem formulation variables. Still, another example of the conflicting findings can be found in Crooper, Meck, and Ash

(1977), who replicated Arlin's study (Arlin, 1975b) and concluded that no relationship existed between performance on problem finding and formal operation tasks. However, Arlin (1975a, 1975b, 1977) found a significant relationship between these two variables and stated that subjects who can operate at the problem finding stage have already reached the problem-solving stage of formal operations. She stated,

> The relationship between formal operational thinking in the Piagetian sense (problem-solving stage) and the new stage of problem finding should be such that all subjects who are successful in problem finding should also be characterized as formal operational thinkers in the Piagetian sense. However, not all subjects who are characterized as being in the problem-solving stage (the traditional Piagetian stage) should be characterized as also being in the problem finding stage. (p. 603)

Conflicting results can stem from different factors such as the study design, the sample characteristics (e.g. age and gender), the domain, and the different types of measures employed in studies. However, these factors cannot be studied precisely using narrative reviews. Luckily, a quantitative method for synthesizing research findings, meta-analysis, is available and can offer us more decisive answers regarding the relationship between problem finding and creativity. In addition, meta-analysis can help identify some moderators that may affect such a relationship. Searching the problem finding and creativity literature showed that there is no meta-analysis study that has tried to reveal the nature of such a relationship.

Meta-analytic review is particularly useful to resolve controversies across multiple studies (Lipsey & Wilson, 2001), and has also proven to be useful in creativity research. For example, a number of meta-analysis studies have been conducted in the creativity field and covered some issues such as personality in scientific and artistic creativity (Feist, 1998), the effectiveness of creativity training (Scott, Leritz, & Mumford, 2004), intelligence and creativity

(Kim, 2005), creativity and environment (Hunter, Bedell, & Mumford, 2007), creative achievement, IQ, and divergent thinking (Kim, 2008), creativity and stressors (Byron, Khazanchi, & Nazarian, 2010), creativity and psychoticism (Acar & Runco, 2012), creativity and schizotypy (Acar & Sen, 2013), creativity and intrinsic motivation (de Jesus, Rus, Lens, & Imaginario, 2013), creativity and innovation (Sarooghi, Libaers, & Burkemper, 2015), and creativity and psychopathology (Paek, Abdulla, & Cramond, 2016).

In the current study, in addition to calculating the mean effect size across studies for the relationship between problem finding and creativity, five moderators are suggested to explain possible variability in the studies' results: age, gender, creativity measure, divergent thinking indices, and problem finding domain. The selection of these moderators was based on theoretical and empirical reasons, a comprehensive review of problem finding literature, and consultations with some experts in problem finding and creativity research.

Variables in the Study

Creativity

Reviewing the creativity literature showed that there are dozens of definitions offered for the construct "creativity." However, both theoretical and empirical works on creativity suggest that there are at least two variables that distinguish creativity from other psychological constructs: *originality* and *appropriateness* (e.g. Abdulla & Cramond (in press); Acar & Runco, 2015; Brophy, 1998; Charyton & Snelbecker, 2007; Davidovitch & Milgram, 2006; Milgram & Hong, 1999; Mumford & Simonton, 1997; Pohlman, 1996; Rudowicz, 2003; Runco, Illies, & Eisenman, 2005; Runco et al., 2011; Simonton, 2012). Thus, creativity has been defined in some studies as a kind of divergent thinking (DT), which requires originality in thinking in addition to other DT abilities such as fluency, flexibility, and elaboration (Benedek, Fink, & Neubauer,

2006; Fontenot, 1993; Runco, 1986a; Runco, 1986b; Runco & Albert, 1986; Runco et al., 2011; West, Tateishi, Wright, & Fonoimoana, 2012). In addition, there is a considerable amount of research that has treated creativity as a kind of problem finding and solving (Basadur, Runco, & Vega, 2000; Chand, & Runco, 1993; Csikszentmihalyi & Getzels, 1970; Csikszentmihalyi & Getzels, 1971; Dow & Mayer, 2004; Han, Hu, Liu, Jia, & Adey, 2013).

For instance, Runco and Chand (1995) stated, "Thinking is creative if it leads to original and adaptive ideas, solutions, or insights" (p. 244). Scott et al. (2004) stated, "Creativity ultimately involves the production of original, potentially workable, solutions to novel, ill-defined problems of relatively high complexity" (p. 362). Davidovitch and Milgram (2006) defined creative thinking as "A cognitive process of original problem solving by means of which original products are generated" (p. 385). Zha, Walczyk, Griffith-Ross, Tobacyk, and Walczyk (2006), stated, "Intellectual creativity is the ability to view what is ordinary in a novel or atypical way; the ability to detect problems that others may not recognize; or the ability to generate original, exceptional, adaptive, or effective solutions to problems" (p. 355). Runco (1996) stated, "Creativity is manifested in the intentions and motivation to transform the objective world into original interpretations, coupled with the ability to decide when this is useful and when it is not" (p. 4). Finally, Getzels (1975a) stated,

> Thinking may be called creative if: 1) the product has novelty and value either for the thinker or the culture, 2) the thinking is unconventional, 3) it is highly motivated and persistent or of great intensity, and 4) the problem was initially vague and undefined so that part of the task was to formulate the problem itself. (p. 328)

Regardless of the wording used in different creativity definitions, it is evident that at least, creativity requires both originality and appropriateness. Simonton (2012) suggested a third criterion, *surprise* or nonobviousness, a criterion used by the U.S. Patent Office in order to

evaluate creative products.[1] According to the U.S. Patent Office, in order to judge whether an invention is obvious or not, one must: 1) determine the scope and contents of the prior art, 2) ascertain the differences between the prior art and the claims in issue, 3) determine the level of ordinary skill in the pertinent art, and 4) evaluate any evidence of secondary considerations.[2] Kharkhurin (2014) also suggested another criterion that takes into consideration cultural differences, *authenticity*. He offered an extended definition of creativity, which consists of four criteria: novelty, utility, aesthetics, and authenticity. He defined authenticity as, "The ability to express one's inner self and to relate an individual's own values and beliefs to the world" (p. 346). However, more empirical investigations need to be conducted in order to examine if surprise and authenticity are essential and reliably determined criteria for creativity in addition to originality and appropriateness.

Problem Finding

Several definitions were proposed in the problem finding literature. For example, Mackworth (1965) defined problem finding as "The detection of the need for a new program based on a choice between existing and expected future programs" (p. 57). Torrance (1966) offered a kind of comprehensive definition of creativity that takes into consideration problem finding. Torrance stated,

> Creativity is a process of becoming sensitive to problems, deficiencies, gaps in knowledge, missing elements, disharmonies, and so on; identifying the difficulty; searching for solutions, making guesses, or formulating hypotheses about the deficiencies; testing and retesting these hypotheses and possibly modifying and retesting them; and finally communicating the results. (p. 6)

[1] For more details visit http://www.uspto.gov
[2] https://www.uspto.gov/web/offices/pac/mpep/s2144.html

Arlin (1975a) suggested that problem finding includes three elements: "(a) a problematic situation; (b) an opportunity for subjects to raise questions within that situation; and (c) a way of categorizing the questions once raised" (p. 604), and characterized problem finders as "Consistently employing a complex schema in the organization of several dimensions. Those individuals also can be described as fluent in their thinking and expression, flexible and able to elaborate on the given; as divergent thinkers, and as effectively using formal operations" (1975a, p. 100). Getzels and Csikszentmihalyi (1975) defined problem finding as "The posing and formulating of problems" (p. 90). Cropper et al. (1977) defined problem finding "as a divergent process described as creative thought manifest as the ability to formulate problems" (p. 517). Arlin (1977) suggested, "Problem finding is reflected by the kinds of questions raised by individuals and that it is a critical process that links Piagetian operations to creative production" (p. 297). Barber (1981) asserted, "Problem finding shall mean conceiving, identifying or formulating a problem to be solved" (p. 7). Csikszentmihalyi and Getzels (1988) describe problem finding as "Metacognitive in the sense that they involve unconscious or preconscious affective and motivational elements as well as logic" (p. 92). Dillon (1988) suggested, "Problem finding may be conceived as a process which eventuates in a problem to solve. Problems may be conceived to exist at various levels of completeness, each level entailing a different activity of 'finding' the problem" (p. 105). Runco and Vega (1990) suggested, "Problem finding requires that an individual identify and define worthwhile tasks" (p. 440). Ambrosio (1994) defined problem finding as "the recognition or discovery of a discrepancy between an expected or desired outcome and an existing, possible or probable outcome" (p. 14). Jay (1996) reported that problem finding "Refers to behavior, attitudes, and thought processes directed toward the envisionment, posing, formulation, and creation of problems, as opposed to the processes

involved in solving them" (p. 11). Carson and Runco (1999) proposed that problem finding "Entails the ability to imagine, look for discrepancies and apparent contradictions, and entertain new hypotheses about old problems/ issues or generate entirely novel questions or problems to be solved" (p. 168). Lee and Cho (2007) suggested that problem finding "Is regarded as the behaviors, attitudes, and thoughts directed toward posing, formulating, and creating problems" (p. 113).

As noted above, different terms have been used interchangeably in the problem finding literature such as problem discovery, problem formulation, problem identification, problem construction, and problem posing. Only a few researchers distinguished between some of those terms (e.g. Ambrosio, 1994; Basadur, 1995; Runco & Chand, 1994). Thus, for the purpose of this current study, all studies using any of these terms will be included after examining the definitions offered to make sure that the construct being assessed is under the problem-finding umbrella. Chapter two addresses this dilemma descriptively, and chapter three tries to resolve it using the meta-analysis method.

Assessment of Creativity

A great deal of variety in creativity assessment exists (Kaufman, Plucker, & Baer, 2008). As mentioned earlier, creativity is a complex construct, which can be measured through different indicators. These indicators can be classified according to the four P's of creativity: creative process, person, product, and press (Rhodes, 1961). According to Kozbelt, Beghetto, and Runco (2010), the creative process indicates "The mental mechanisms that occur when a person is engaged in creative thinking or creative activity" (p. 24). The creative person "covers information about personality, intellect, temperament, physique, traits, habits, attitudes, self-concept, value systems, defense mechanisms, and behavior" (Rhodes, 1961, p. 307). The creative

product indicates visible outcomes; in Rhodes' (1961) words, "When an idea becomes embodied into tangible form it is called a product" (p. 309). Finally, the term creative press refers to "The relationship between human beings and their environment. Creative production is the outcome of certain kinds of forces playing upon certain kinds of individuals as they grow up and as they function" (Rhodes, 1961, p. 308). Different indicators represent different aspects of creativity, which might render varying relationships between problem finding and creativity; thus, this was taken into consideration for the moderator's analysis in this study.

Age

There are some theoretical and practical reasons to look at the role age plays in its relationship with creativity and problem finding. For example, Arlin (1975a, 1975b) suggested that problem finding is a post formal stage skill in which adults might perform better than those in younger ages. Similarly, Smith and Carlsson (1983) suggested that children become more creative as they age. In contrast, Simon and Bock (2016) who wrote the study on *The Influence of Divergent and Convergent Thinking on Visuomotor Adaptation in Young and Older Adults*, found that age was not always beneficial and reported that younger participants outperformed older participants in divergent thinking as measured by an Alternative Uses Task. Chi Hang, Yim, Hoi Man, and McBride-Chang (2005), who compared sixth-grade students and university students, reported different results depending on the nature of the task. University students scored higher than sixth-grade students on the Real-World-Problem task, while sixth-grade students were more creative on the TTCT figural task. No significant differences were found between the two groups on the verbal task. Yet, another variable that might explain age differences in creativity is *knowledge*. Individuals gain more knowledge as they age and have greater experience compared to children. Barron (1995) suggested that knowledge inhibits

flexibility because those with more experience might be less inclined to try different ways in solving problems. Thus, it would be valuable to find out whether the relationship between problem finding and creativity differs according to the participants' ages.

Gender

A considerable amount of creativity research was devoted to answering the following question: who is more creative, males or females? According to Abraham (2016), "It is naïve and wrong to suggest either that one gender is more creative than another, or that there are absolutely no differences between the sexes" (p. 615). Some suggest that in terms of creative *achievement*, there is some evidence that males outperform females, especially in specific fields such as science, engineering, and mathematics, while the majority of studies concluded there are no differences between males and females in terms of creative *potential* (Pagnani, 2011). However, Abraham (2016) suggested that *cognitive strategies* and *cognitive styles* might explain gender differences in creativity.

Just as with age, gender is another moderator that is included in the current study to examine whether or not there is a difference between males and females in problem finding ability.

Research Questions

1. What terms are used to describe problem finding?
    a. How do various terms used in the problem finding (PF) literature differ from one another--if they differ at all?
    b. Is there one term that is the best label for the processes that can be studied empirically?
2. What is the nature of the relationship between problem finding and creativity?

a. How strong is the *overall* relationship between creativity and problem finding across all five moderators: 1) *age group* (i.e. children, adolescents, and adults), 2) *gender* (i.e. males versus females), 3) *creativity measures* (i.e. divergent thinking, problem solving, creative person, and creative product), 4) *DT subscales* (i.e. fluency, flexibility, and originality), and 5) *PF domain* (i.e. art, writing, humanities, and science and math)?
b. Do relationships significantly differ by *levels of each moderator* described above?

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CHAPTER 2

DEFINING AND SOLVING THE PROBLEM OF PROBLEM FINDING: A SYSTEMATIC REVIEW[3]

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Abstract

This paper addresses the following questions: 1) How do various terms used in the problem finding (PF) literature differ from one another--if they differ at all? 2) Is the one term that is the best label for the processes that can be studied empirically? A review of nearly 200 papers on PF revealed that at least 13 different terms have been used to describe the process of finding a problem. Most PF research uses the term "problem finding," but there is domain specificity regarding the use of some of the terms, and some terms have been used interchangeably, even within the same work(s). Only a few articles distinguish between the terms. Although no clear distinction has been made among the terms in the PF literature regarding possible differences and which labels could be studied empirically, the present effort suggests that there might be important differences which could be explained by (a) how well- or ill-defined the problem is, and (b) the degree to which ideation and evaluation are required. A rubric, based on (a) and (b), is presented here and should allow distinctions to be made among the terms. This paper concludes by suggesting that one term (i.e., "problem finding") be used to avoid confusion. If this is not possible, for whatever reason, the term used instead should be defined with reference to (a) and (b) and the reasons for the choice of terms clearly stated.

Keywords: Problem Finding; Problem Finding Family; Problem Types; Creativity; Creative Problem Solving; CPF Model.

Introduction

One common problem facing education and psychology is that various terms are sometimes used to describe the same phenomenon. The terms *giftedness* and *talent* are sometimes used interchangeably, for example, as are *divergent thinking* and *creativity*. In the former example, one notable contribution Gagné (2005) made was differentiating between the terms giftedness and talent. In the latter example, Runco (2008) made a clear distinction and was explicit in that divergent thinking is *not* synonymous with creativity.

This kind of confusion has plagued the problem finding (PF) literature since the 1960s. Different terms have been used, including problem discovery, problem formulation, problem identification, problem construction, and problem posing. The two questions this paper aims to answer are: 1) How do those various terms differ from one another--if they differ at all? And, 2) which term is the best label for what can be studied empirically? This chapter is devoted to answer these questions using qualitative method, while chapter three seeks to answer it empirically. Although this systematic review identified 200 relevant articles on the topic of PF, not all of these articles were included in the quantitative analysis because many were excluded according to a number of criteria will be discussed in the next chapter.

In order to answer these two questions it is first necessary to review the problem finding literature to identify the full range of terms that have been used in previous work. In addition, it is important to examine the definitions used in the problem finding literature. If all definitions refer to the same construct, then we may conclude that using different terms is a matter of choice; if not, then a distinction should be made among these different terms and the source(s) of

variation should be investigated. The first part of this paper defines the term "problem" and distinguishes between different kinds of problems and problem situations. The second part explores the different processes underlying the finding a problem. The third part examines the definitions offered in the problem finding literature to determine how similar these definitions are. This is followed by proposed answers for the two questions mentioned above. Finally, suggested guidelines are offered to differentiate between some problem finding processes.

What Is A Problem and are There Different Kinds of Problems?

According to Getzels (1982), "At first glance, it does not seem sensible to raise a question about what is meant by a problem. We have faced problems since our earliest days, and there is no one who does not have a problem" (p. 40). However, problem is a broad term, which has positive and negative meanings, different levels, and varies from one person to another. Getzels (1982, p. 40) differentiated between two definitions of a problem: (a) a problem occurring when a desired action to a given situation is blocked, and (b) a problem as a question raised or to be raised for inquiry. The former definition refers to an undesirable situation and the situation in which the problem is *well defined*, while the latter refers to a desired situation and the problem is *ill defined*. This could be the simplest way to classify problems: well versus ill-defined problems.

Pretz, Naples, and Sternberg (2003) defined well- and ill-defined problems this way: "Well-defined problems are those problems whose goals, path to solution, and obstacles to solution are clearly based on the information given. In contrast, ill-defined problems are characterized by their lack of a clear path to solution" (p. 4). Another classification of the term "problem" was proposed by Getzels (1964, 1975, 1982). He distinguished between *presented* problems and *discovered* problems. In the former "the

problem has a known formulation, a known method of solution, and a known solution; in the latter, the problem does not yet have a known formulation, there is no known method of solution, and no known solution" (Getzels, 1975, p. 13).

Dillon (1988) felt that there were levels of problem finding and problem solving. He compared three levels of problems: (a) recognition of problem/solution, (b) discovery of problem/solution, and (c) invention of problem/solution. Getzels (1982) listed 10 types of problem situation, based on the nature of the problem, the method to solve it, and the solution.

1) The problem is given (is known) and there is a standard method for solving it, known to the would-be problem solver, and to others, guaranteeing a solution in a finite number of steps.
2) The problem is given but no method for solving it is known to the problem solver, although it is known to others.
3) The problem is given but no method for solving it is known to the problem solver or the others.
4) The problem itself exists but remains to be identified (become known) by the problem solver, although it is known to others.
5) The problem exists but remains to be identified by the problem solver and by others.
6) The problem-exists but remains to be identified (as in 4 and 5), and there is a standard method for solving it, once the problem is discovered known to the problem solver and to the others (as in 1).
7) The problem exists but remains to be identified, and no standard method for solving it is known to the problem solver, although known to others (as in 2).
8) The problem exists but remains to be identified, and no method for solving it is known to the problem solver or to others (as in 3).

9) The problem does not yet exist but is invented or conceived, and a method for solving it is known or become known once the problem is formulated.

10) The problem does not yet exist but is invented or conceived, and a method for solving it is not known (Getzels, pp. 40-41).

The wording Getzels used in each of the 10 situations deserves some attention because it could help distinguish between some different terms used in the problem finding literature. I will come back to this point after reviewing the definitions used in the different problem finding studies.

Based upon the work of Getzels, Maker and her colleagues (Maker et al., 2006) created the DISCOVER Model with a continuum that shows different types of problems for students to learn to solve. They range from those with only one solution to those that need to be defined by employing different methods and having more than one solution. Like Getzels (1982), they varied the three qualities of problem, method, and solution, but their continuum is determined by the degree to which the problem, method, and solution are known to the presenter of the problem and the solver (See Table 2.1)

Table 2.1

Problem Types according to the DISCOVER model

	Problem		Method		Solution	
Problem Type	Presenter	Solver	Presenter	Solver	Presenter	Solver
I	K	K	K	K	K	U
II	K	K	K	U	K	U
III	K	K	R	U	R	U
IV	K	K	U	U	U	U
V	U	U	U	U	U	U

K= Known, U= Unknown, R= Range (A variety of methods and solutions are available for a problem and only the problem presenter is aware of them) (Sak & Maker, 2004, p. 3).

The Terms for Problem Finding and Their Frequency

A review of the problem finding literature showed that 13 different terms have been used in order to describe problem finding. This information was obtained through searching the following databases from 1960 to 2015: Academic Search Premier, PsycARTICLES, PsycINFO, Dissertation Abstract, Educational Resources Information Center (ERIC), Psychology & Behavioral Science Collection, and the Google Scholar. The literature search was conducted electronically using the following keywords: problem finding, problem construction, ill-defined problems, creative problem solving (CPS). An advanced search option was selected and the search was for articles' titles and abstracts. This searching process resulted in identifying 199 works. This number of articles on problem finding may not reflect the whole problem finding literature, however, these 199 works can be considered as a representative sample.

The majority of the works (199) utilized the term *problem finding* (50.3%), followed by *problem posing* (12.1%), which was found to be used frequently in the mathematic*s* field, then *problem construction* (9.5%), *problem formulation* (9.1%), *ill-defined problems* (4%), *problem generation* (3.1%), *problem identification* (2.5%), *problem representation* (2.5%), *problem definition* (2.5%), *hypotheses formulation and generation* (2%), *problem discovery* (1%), *open ended problems* (1%), and *problem framing* (.04%) Table 2.2 shows the terms used by different researchers.

It may be that some of the problem finding literature was missed; however, it is reasonable to assume that these results are representative of the PF literature. Some authors used more than one of these terms in the same work. For example, Getzels (1982) used the terms problem formulation, problem finding, problem posing, and problem discovery in the same article. Furthermore, in the *Problem Finding, Problem Solving, and Creativity* book, edited by Runco

(1994), the authors used different terms, such as problem construction, problem representation, problem finding, and problem identification. Some researchers were explicit and mentioned that they have used some of these terms interchangeably (e.g. Arreola, 2012; Barber, 1981), and a few distinguished between some of these terms (e.g. Ambrosio, 1994; Basadur, 1995; Runco & Chand, 1994).

Table 2.2
Different Terms Used in Previous Research/Articles

	Terms	Researchers
1	Problem Finding	Allen & Thomas, 2011; Ambrosio, 1994; Anderson, Hughes, & Sharrock, 1987; Arlin, 1975a; Arlin, 1975b; Arlin, 1977; Artley et al., 1980; Baer, 1988; Barber, 1981; Barbot & Lubart, 2012; Basadur, 1980; Basadur, Graen, & Green, 1982; Basadur, 1995; Bennett, 2002; Blissett & McGrath, 1996; Brinkman, 1994; Brinkman, 1999; Brugman, 1991; Carson & Runco, 1999; Chand & Runco, 1993; Cropper, Meck, & Ash, 1977; Csikszentmihalyi, 1988; Dandan et al., 2013; Davis, 1977; Dillon, 1982; Dillon, 1988; Dudek & Cote, 1994; Dyer & Schiller, 1993; Fontenot, 1988; Fontenot, 1993; Franske, 2009; Getzels, 1975; Getzels, 1979; Getzels, 1982; Getzels, 1985; Gartland, 1978; Haiyan, Weiping, & Jiliang, 2010; Han, Hu, Liu, Jia, & Adey, 2013; Houtz, 1994; Holtz, 2002; Hoover, 1994; Hoover & Feldhusen, 1990; Hu, Shi, Han, Wang, & Adey, 2010; Jay, 1996; Kay, 1991; Kay, 1994; Kousoulas & Mega, 2009a; Kousoulas & Mega, 2009b; LaBanca, 2008; LaBanca, 2012; Lai & Grønhaug, 1994; Laidig, 1995; Liggett, 1991; Lee & Cho, 2007; Magne & Ingrand, 2004; Malhotra, 1974; McWhirt, Reynolds, & Achilles, 1989-1990; Moore, 1982; Moore, 1984; Moore, 1985; Moore, 1989; Moore, 1994; Nickerson, Yen, & Mahoney, 2012; Okuda, Runco, & Berger, 1991; Paletz & Peng, 2009; Patricola, 2005; Porath, 1984; Pryzwansky, 1989; Puccio, 1999; Ramirez, 2002; Reed, 1992; Ritchie, 2009; Rostan, 1992; Rostan, 1994; Rostan, 2005; Rostan, 2010; Runco, 1994a; Runco, 1994b; Runco & Acar, 2012; Runco & Chand, 1994; Runco & Nemiro, 1994; Runco & Vega, 1990; Sapp, 1995; Sapp, 1997; Sayeed & Brightman, 1994; Sheremata, 2002; Siu, 2007; Starko, 1989; Stepich & Ertmer, 2009; Subotnik, 1988; Suwa, 2003; Tegano, Sawyers, & Moran, 1989; Wakefield, 1985; Wakefield, 1989; Wakefield, 1991; Wakefield, 1994; Wakefield, 2003; Weiping & Xingqi, 2010; Weissman, 2007; Yoshioka et al., 2005.
2	Problem Posing	Abramovich & Cho, 2006; Cai, 1998; Cai, 2003; Cai & Hwang, 2002; Chang, Wu, Weng, & Sung, 2012; Chen, Van Dooren, & Verschaffel, 2013; Chen, Van Dooren, Chen, & Verschaffel, 2010; Chen, Van Dooren, & Verschaffel, 2015; Christou, Mousoulides, Pittalis, & Pitta-Pantazi, 2005; Courtney, Caniglia, & Singh, 2014; De Ponte & Henriques, 2013; English, 1998; Kapur, 2015; Kar, Özdemir, İpek, & Albayrak, 2010; Silver & Cai, 1996; Kilic, 2013; Kojima & Miwa, 2008; Kojima, Miwa, & Matsui, 2013; Kontorovich, Koichu, Leikin, & Berman, 2012; Lavy & Shriki, 2010; Şengül & Katranci, 2012; Silver, Mamona-Downs, Leung, & Kenney, 1996; Singer & Voica, 2013; Van Harpen & Sriraman, 2013.
3	Problem Construction	Adeyemo, 2001; Arreola, 2012; Bernardo, 2001; Diakidoy & Constantinou, 2001; Harms, 2014; Illies & Reiter-Palmon, 2008; Klavir & Gorodetsky, 2011; Mumford, Reiter-Palmon, & Redmond, 1994; Mumford, Costanza, Threlfall, Baughman, & Reiter-Palmon, 1993; Mumford, Baughman,

		Threlfall, Supinski, & Costanza, 1996; Reiter-Palmon, 1993; Reiter-Palmon, 2009; Reiter-Palmon, Mumford, & Threlfall, 1998; Reiter-Palmon, Mumford, O'Connor Boes, & Runco, 1997; Reiter-Palmon & Robinson, 2009; Rodionov & Velmisova, 2008; Vernon, & Hocking, 2014; Wigert, 2014; Yurkovich, 2014.
4	Problem Formulation	Auclair, 2007; Brugman, 1991; Conoley, Conoley, & Gumm, 1992; Csikszentmihalyi & Getzels, 1970; Csikszentmihalyi & Getzels, 1971; Davis, 1989; Dumont, 1993; Getzels & Smilansky, 1983; Heylighen, 1988; Lyles, 2014; Massey & Wallace, 1996; Nezu & D'Zurilla, 1981a; Nezu & D'Zurilla, 1981b; Sims, 1979; Smilansky, 1984; Smilansky & Halberstadt, 1986; Stefflre, 1985; Volkema, 1983.
5	Ill-defined Problems	Antonietti, 1991; Bennett, 2002; Butler, Scherer, & Reiter-Palmon, 2003; Jaarsveld, Lachmann, Hamel, & van Leeuwen, 2010; Jausovec, 1989; Jausovec, 1994; Mumford & Connelly, 1991; Schraw, Dunkle, & Bendixen, 1995.
6	Problem Generation	Best, 1977; Czarnik & Hickey, 1997; Guerrera, 1995; Mraz & Runco, 1994; Runco & Acar, 2010; Runco, Illies, & Eisenman, 2005.
7	Problem Identification	Clemmensen, 2012; Clinton & Torrance, 1986; Howson & Westbury, 1980; Kurtzberg & Reale, 1999; Subotnik & Steiner, 1994.
8	Problem Representation	Ching, 2010; Jarman, 2014; Lee, Ng, & Ng, 2009; Mitchell, 1993; Wood, 2013.
9	Problem Definition	Ananda & Pedro, 2001; Büyükdamgacı, 2003; Cleven & Gutkin, 1988; Kohfeldt & Langhout, 2012; Sims, Eden, & Jones, 1981.
10	Hypotheses Formulation	Blackburn, 2013; Frederiksen & Evans, 1974; Frederiksen & Ward, 1978; Hoover & Feldhusen, 1990.
11	Problem Discovery	Baker-Sennett, 1991; Runco & Okuda, 1988.
12	Open Ended Problems	Jausovec, 1997; Lin & Lien, 2013.
13	Problem Framing	Copland, 2003.

The Definitions of a Family of Terms

> *It is no longer sufficient to simply refer to problem finding, and assume that we are talking about one process or skill* (Runco, 1994, p. 281, emphasis added).

I turn now to the different definitions offered in the problem finding literature in order to determine whether or not problem finding, problem formulation, problem identification, problem construction, problem posing, and other problem finding family members refer to the same construct. A number of definitions were proposed in the problem finding literature. For example, Mackworth (1965) defined problem finding as "the detection of the need for a new program based on a choice between existing and expected future programs" (p. 57). Arlin (1975b) suggested that problem finding includes three elements: "(a) a problematic situation; (b) an

opportunity for subjects to raise questions within that situation; and (c) a way of categorizing the questions once raised" (p. 604). She characterized problem finders as "consistently employing a complex schema in the organization of several dimensions. Those individuals also can be described as fluent in their thinking and expression, flexible and able to elaborate on the given; as divergent thinkers, and as effectively using formal operations" (p. 100).

Getzels and Csikszentmihalyi (1975) defined problem finding as "the posing and formulating of problems" (p. 90). Cropper et al. (1977) defined problem finding "as a divergent process described as creative thought manifest as the ability to formulate problems" (p. 517). Arlin (1977) suggested, "Problem finding is reflected by the kinds of questions raised by individuals and that it is a critical process that links Piagetian operations to creative production" (p. 297). Barber (1981) asserted, "Problem finding shall mean conceiving, identifying or formulating a problem to be solved" (p. 7). In addition, Barber (1981) used the terms problem finding and problem formulation interchangeably within the same work.

Csikszentmihalyi and Getzels (1988) described the processes of problem finding as "metacognitive in the sense that they involve unconscious or preconscious affective and motivational elements as well as logic" (p. 92). Dillon (1988) suggested, "Problem finding may be conceived as a process which eventuates in a problem to solve. Problems may be conceived to exist at various levels of completeness, each level entailing a different activity of 'finding' the problem" (p. 105). Runco and Okuda (1988) used the terms problem discovery, problem finding, and problem identification within the same study, and concluded, "Problem discovery is a particularly important component in the creative process because it occurs first, and because the quality of a problem may in part determine the quality of solutions" (p. 212). They also distinguished *presented* and *discovered* problems and suggested that, "divergent thinking tasks

that present problems require primarily ideational productivity, but divergent thinking tasks with discovered problems require both ideational productivity and the ability to define a workable task" (p. 213).

Runco and Vega (1990) suggested that problem finding" requires that an individual identify and define worthwhile tasks" (p. 440). Ambrosio (1991) defined problem finding, "the recognition or discovery of a discrepancy between an expected or desired outcome and an existing, possible or probable outcome" (p. 14). In addition, Ambrosio (1991) suggested that problem finding involves problem identification and problem discovery. Kay (1991) defined creative thinking as "A process in which the individual finds, defines, or discovers an idea or problem not predetermined by the situation or task" (P. 234).

Mumford et al. (1993) and Mumford et al. (1996) used the terms problem finding and problem-construction interchangeably and argued that problem construction is based on problem representation (Mumford et al., 1993). They defined problem representation as "schematic, or categorical, knowledge structures abstracted from prior problem-solving efforts" (p. 367).

Basadur (1995) suggested that problem finding "includes both aspects: discovering problems to solve and formulating them for a subsequent solution" (p. 64). He presented a three-stage model, which consists of problem finding (PF), problem solving (PS), and solution implementation (SI). In his optimal ideation-evaluation theory, he suggested, "ideation might be more important in the PF stage; evaluation might be more important in SI stage; and ideation and evaluation might be equally important in PS stage" (p. 66). Along the same lines, Jay (1996) reported that problem finding "refers to behavior, attitudes, and thought processes directed toward the envisionment, posing, formulation, and creation of problems, as opposed to the processes involved in solving them" (p. 11).

Reiter-Palmon et al. (1997) and Reiter-Palmon et al. (1998) suggested that problem construction is the first step in solving ill-defined problems and defined problem construction as "The process by which individuals structure an ill-defined problem and identify the goals and objectives of the problem-solving effort" (Reiter-Palmon et al., 1998, p. 187). Reiter-Palmon et al. (1997) explicitly mentioned, "Several terms have been used interchangeably, among them problem finding, problem identification, and problem construction" (p. 9). They preferred to use the term problem construction because they believed it implies more activity on the part of the problem solver.

Carson and Runco (1999) proposed that problem finding "entails the ability to imagine, look for discrepancies and apparent contradictions, and entertain new hypotheses about old problems/ issues or generate entirely novel questions or problems to be solved" (p. 168). Cai and Hwang (2002) suggested that problem posing involves generative thinking. Lee and Cho (2007) suggested that problem finding "is regarded as the behaviors, attitudes, and thoughts directed toward posing, formulating, and creating problems. On this account, problem finding is a complex concept embracing numerous terms, such as problem expression, construction, posing, formulation, identification, creative discovery, and definition" (p. 113). Franske (2009) used the terms problem finding, problem posing, and problem formulation interchangeably. Paletz and Peng (2009) suggested, "Problem finding, itself, is not a single process. It can be broken down to four separate, but related, skills: problem identification or detection, problem definition, problem expression, and problem construction" (p. 140). Hu et al. (2010) defined problem finding as "students' ability to generate problems for themselves, either generally or within a particular subject domain (e.g., art, science), and either generally within that domain (e.g., scientific problems) or related to a particular context (e.g., problems related to space travel) (p. 46).

Kar et al. (2010) stated that problem posing "is the forming of a new problem from a given situation or experience" (p. 1577). Runco and Acar (2010) asserted, "Problem generation (PG) allows an individual to think divergently about problems that might arise in particular situations (e.g., at home, at work, in school)." They also asserted, "Problem construction is parallel to the process of PG" (p. 144). Arreola (2012) mentioned, "Problem construction refers to the act of structuring or making sense out of an ill defined or ambiguous problem" (p. 2). He asserted that "the term problem construction is also commonly referred to in the literature as problem finding, problem definition, and problem identification; however, to minimize confusion, I refer to it hereafter only as problem construction" (p. 3). Chang et al. (2012) mentioned, "problem posing is a cognitive and metacognitive strategy, which required students to focus on important concepts in the learning materials in the process of problem-posing improves their comprehension of the materials and allows them to monitor their understanding" (p. 776). Jaarsveld Lachmann, and van Leeuwen (2012) defined creativity as "the ability to identify problematic aspects of a given situation and, in a wider sense, as the ability to define completely new problems emphasized that in defining new problems, the organization of knowledge in memory plays an important role" (p. 173). Finally, Wigert (2014) defined problem construction, "Problem construction entails identifying and structuring a problem" (p. 6).

Using the Definitions to Answer the Key Questions

At this point there is sufficient information to address the first question posed above, namely, how do those various terms differ from one another--if they differ at all? Unfortunately, it seems that there is no clear answer implied by the literature on problem finding and the definitions reviewed above. Still, some clues are suggested by the definitions. As indicated earlier, the majority of researchers used the term "problem finding." In addition, it is apparent

that researchers in some fields, specifically mathematics and science (*N*= 28), prefer to use particular terms to describe problem finding. Almost all researchers studying problem finding in mathematics, for instance, used the term "problem posing" (e.g. Abramovich & Cho, 2006; Cai, 2003; Cai & Hwang, 2002; Chang, et al., 2012; Chen, et al., 2013; De Ponte & Henriques, 2013; English, 1998; Van Harpen & Sriraman, 2013). In addition, researchers concerned with scientific problem finding tended to use the term "hypotheses formulation and generation" (Ayas & Sak, 2014; Frederiksen & Evans, 1974; Frederiksen & Ward, 1978; Hoover, 1994; Hoover & Feldhusen; 1990; Sak & Ayas, 2013). This difference in using specific terms in these domains accounts for approximately 15% of the variability.

Yet another source of variability can be explained by the tendency to use the various terms interchangeably within the same work (e.g., referred to problem finding as problem formulation, construction, or posing, and vice versa) (e.g. Arreola, 2012; Barber, 1981; Getzels & Csikszentmihalyi, 1975; Cropper, et al., 1977; Franske, 2009; Lee & Cho, 2007; Mumford et al., 1993; Mumford et al., 1996; Reiter-Palmon et al., 1997; Runco & Okuda, 1988).

Few researchers explicitly distinguished between some of those terms. Basadur (1995) did suggest that problem finding includes both aspects: *discovering* problems to solve and *formulating* them for subsequent solution. Mumford et al. (1994) considered *problem representation* as one operation in the Problem Construction Operation Model (P. 17). Runco and Chand (1994) distinguished between *problem identification* and *problem definition*. They suggested, "the latter reflects what happens when an individual ascertains that a task is manageable" (p. 44). Runco and Chand (1994) also distinguished between the terms *problem discovery* and *problem definition*. They used the term "problem discovery precisely to show that

it occurs early in the problem solving process. In contrast, problem definition occurs at various points within or during the framing and reframing of the problem" (p. 273)

So again, the existing literature does not suggest a clear answer to the first key question. With few exceptions (e.g. Basadur, 1995; Mumford et al., 1994; Runco & Chand, 1994), problem finding is not defined such that it is clearly distinct from the other terms in the family, and indeed, the terms are sometimes used interchangeably. The term "problem finding" is the most common, and there is domain specificity in the use of some of the terms.

Which of the terms is the best label, or labels, for what can be studied empirically?

The various problem finding behaviors (e.g. problem generation, problem construction) have been correlated with a range of measures of creativity. For example, Ambrosio (1994) used the term problem finding and reported a statistically significant correlation between problem quantity and divergent thinking. Arreola (2012) used the term problem construction (PC) and found a positive significant correlation between PC ability and PC quality, PC originality, solution quality, and solution originality. Carson and Runco (1999), who used the term problem finding, which was assessed through problem generation (PG) tasks, found a significant correlation between some of the PG and problem solving (PS) tasks. Silver and Cai (1996), who studied the relationship between problem posing (PP) and problem solving (PS), reported significant differences in PP between those who scored high and low in PS, favoring the high PS group. Ching (2010), who used the term problem representation (PR), reported high significant correlations between some PR sub-skills and PS sub-skills. Csikszentmihalyi and Getzels (1971) used the term problem formulation and reported a high significant correlation between the total problem formulation and originality scores. Hoover (1990), who used the term scientific problem finding, which was assessed through formulation hypotheses (FH), found a significant

relationship between FH and creativity as measured by the TTCT. These correlations confirm the value of problem finding but do not help us to distinguish among the different terms used.

There is a need for empirical research that could directly compare the various measures of problem finding behaviors and could investigate how strongly each relates to one another and to creativity. This will be addressed in the next chapter.

The Problem Finding Hierarchy: Suggested Guidelines For the Use of the Terms

Although the previous findings suggest that there are no empirical reasons to conclude that the various terms differ in important ways, there might be some as of yet undetected differences. This supposition is mainly based on Getzels' 10 types of problems mentioned earlier (Getzels, 1982), on Basadur's optimal ideation-evaluation theory (Basadur, 1995), and on a few other works, which suggest that there are subtle differences between some of the terms (e.g. Runco & Chand).

The following hierarchy suggests that there might be some important differences between five problem finding processes: problem discovery, problem formulation, problem construction, problem identification, and problem definition based upon two dimensions. These dimensions are: 1) *to what degree the problem is ill-defined*, and 2) *to what degree ideation and evaluation are required in each process*.

I suggest that Problem Discovery (PD) represents the highest level of the ill-defined problems in which the problem does not yet exist; rather, *it needs to be invented* (Getzels, 1982). In the case of Problem Discovery (shortened to PD1 to distinguish it from Problem Definition), only ideation might be required because the evaluation component may hinder or inhibit such a process. Another feature that distinguishes PD1 from other problem finding processes is that PD1 is an *unconscious* process and that no *information* is given about the problem. However,

that is not to say that PD1 arises in a vacuum. Knowledge plays an important role in PD1 and other problem finding processes described below, but as Csikszentmihalyi and Getzels (1988) suggested, problem finding involves unconscious or preconscious affective and motivational elements as well as logic. The unconscious element might be highly related to the PD1 process.

The second process in the hierarchy is Problem Formulation (PF), which represents the case in which the problem also does not yet exist, but *it can be conceived through some given information*. In addition to the amount of information given in the PF process, yet another feature that distinguishes PF from PD1 is that an individual(s) has some kind of awareness or feeling that something needs to be done, although he or she is not sure about the method that should be used or the outcome. Furthermore, it is suggested that both ideation and evaluation are needed in the PF process, *but ideation might be more important in the PF stage than evaluation*.

The third kind of problem finding process is Problem Construction (PC). In the PC case, the problem exists but *needs to be constructed in a new form*. In the PC process, the problem finder is aware of the problem and has some information regarding how the problem might be constructed. Ideation and evaluation might be *equally* important in the PC process.

The Problem Identification (PI) process represents the case in which the problem exists but remains *to be identified by the problem finder*. In the PI case, the problem finder has good information about the problem he or she encounters. Evaluation might be more important in the PI stage than ideation.

Finally, Problem Definition (PD2) refers to the problem that already exists but needs to be defined through using some evaluative skills. In this case, evaluation is more prominent than ideation. Figure 2.1 shows the relationships among the degree of problem definition, ideation, and evaluation in the Problem Finding Hierarchy.

More Creative ----------Less Creative

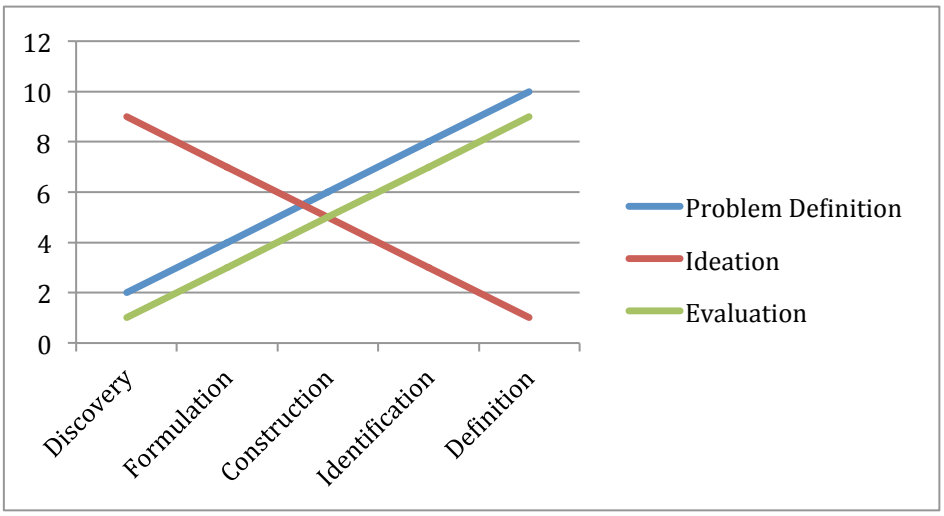

Figure 2.1: Graphic representation of the problem finding hierarchy from more to less creative showing the relationship between the amount of ideation vs. evaluation and problem definition required at each level.

The Creative Problem Finding Hierarchy: Summary and Limitations

As was indicated above, the Creative Problem Finding (CPF) Hierarchy is *not* a new invention; rather, it is a new representation based on previous works, which suggested that:

1. there are different kinds and levels of the problem finding (e.g. Getzles, 1982),
2. evaluative skills must to be considered in studying problem finding (e.g. Runco & Chand, 1994),
3. the ratio of ideation/evaluation may differ in each problem finding process (e.g. Basadur, 1995), and
4. problem finding should not be considered as a single process; instead, there is a family of problem finding processes (Runco, 1994).

This hierarchy distinguishes among five problem-finding processes: problem discovery (PD1), problem formulation (PF), problem construction (PC), problem identification (PI), and problem definition (PD2). The CPF hierarchy suggests that the differences among these five problem-finding processes lies in: 1) the degree in which the problem is ill defined, with problem

discovery (PD1) representing the highest degree of the ill-defined problems and problem definition (PD2) representing the lowest degree of the ill-defined problems, and 2) the degree to which ideation vs. evaluation is required. It is proposed that problem discovery (PD1) relies considerably more on ideation and evaluation plays a lesser role in such a process. This does not mean the absence of evaluation in the problem discovery process. Evaluation and evaluative skills are believed to play a role in all of the problem finding processes.

The opposite case is reflected in problem definition (PD2), in which individuals rely considerably on evaluation and evaluative skills. Problem construction (PC) represents the case in which ideation and evaluation are equally needed. Finally, both ideation and evaluation are needed in problem formulation PF and problem identification PI processes, but ideation might be more important in the PF process and evaluation might be more important in the PI process.

The CPF hierarchy emphasizes that problem finding is a *creative* process; thus, the term creative problem finding is used. This entails that the problem finding processes require different levels of originality and appropriateness. Having said that, it is hypothesized that the less defined the problem is, the more originality is required. Also, the more ideation is required over evaluation, the more creativity is required.

The CPF hierarchy is built on several assumptions about problem solving, especially problem finding. These assumptions are that problem finding:

- is an *active* process, which results from the interaction of metacognitive (e.g. evaluation, monitoring, and planning), cognitive (e.g. attention and perception), affective (e.g. feelings and emotions), motivational (intrinsic and extrinsic), and environmental elements.

- is a *conscious* process, and consciousness plays an important role in all problem-finding processes. It is only in the Problem Discovery Process that subconscious processing may also play an important role.
- and the creative problem solving process are *not* linear processes. Problem finding processes could be found in different creative problem solving steps, not only at the beginning of the creative problem solving process. According to Runco (1994), "A fixed sequential interaction among the various facets of problem finding and problem solving is not well supported, nor it is realistic" (p. 272).

In addition, the CPF hierarchy does *not* assume that problem finding and problem solving are separate processes, they are not, and the interaction between different problem finding processes and problem solving needs to be further studied. However, as Csikszentmihalyi averred, solving a problem is not finding a new one (Csikszentmihalyi, 1988).

Limitations and Future Directions

There are limitations to the proposed CPF hierarchy. First, it aims to differentiate between the different problem finding processes, but unfortunately, there is some uncertainty about the processes. They are, after all, not easily observable and, like most cognitive operations, must be inferred. The same thing can be said about the ideation or evaluation that is involved in problem finding. It can be difficult to determine the involvement of each and their ratio. The CPF hierarchy should thus be viewed as a new guide that needs to be refined as more data are collected. Even so, the hierarchy may serve as a useful conceptualization that could lead in several directions for research.

Most obvious is the study of the relationship between and among each of the five problem finding processes suggested in the CPF hierarchy. For now, what is proposed is that

each of these five processes may differently interact and influence the problem to be solved *and* the originality of the solution or the outcome. Although some research has indicated that problems discovered by individuals themselves result in higher original solutions than problems that are presented or well defined, this relationship should be revisited. Does the amount of problem finding in any given situation always determine the originality of the ideas and alternatives produced?

Additional research on the measurement of problem finding processes would also be useful. If we really want to measure problem finding processes, then we need to devise specific tasks that offer ill-defined and *real-world problems*. Although some work has been done in this regard (e.g., with the Problem Generation Test [Carson & Runco, 1999; Okuda et al., 1991; Runco & Okuda, 1988]), tasks targeting each problem finding process suggested in the CPF hierarchy would represent a step forward. The hierarchy outlined here is offered as a guide and impetus to further research on problem finding and to more refined investigations of the problem finding processes, but there is much work left to be done to refine it, test it, extend it, and apply it.

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CHAPTER 3

A META-ANALYSIS OF THE RELATIONSHIP BETWEEN PROBLEM FINDING AND CREATIVITY[4]

[4] Ahmed Abdulla, Sue Hyeon Paek, Rodney Dishman, Bonnie Cramond, and Mark Runco. To be submitted to *Psychology of Aesthetics, Creativity, and the Arts*.

Abstract

Is problem finding (PF) as a creative process important for creativity? This was one key question this study aimed to answer by examining the relationship between these two constructs. The second key question was how various terms used in the problem finding literature differ from one another. Accordingly, in this meta-analysis, I estimated the population correlations between PF and creativity and examined whether they varied according to the sample characteristics and to other study features. Both published and unpublished studies in English from 1960-2015, which reported appropriate quantified and sufficient statistical information, were included. Applying these criteria to 237 identified works resulted in including 40 studies with a total of 6,649 male and female participants from childhood to adulthood. Using the random-effects model, the results showed that PF and creativity were moderately significantly correlated, r= .22 (95% *CI*= .11 - .32), with high heterogeneity, $Q(195)= 15480.27$, $p < .001$, $I^2 = 98.74\%$. Three out of five moderators significantly explained some of the variability in the mean effect size: DT indices (i.e. fluency, flexibility, and originality), PF domain (i.e. art, writing, science/math, and social/humanities), and age (i.e. children, adolescents, and adults). Regarding whether or not various terms used in the problem finding PF literature differ from one another, the ANOVA analysis showed that using different labels in problem finding and creativity research does not affect the studies' results. The study findings call educators and psychologists to pay more attention to problem finding and not to consider it as a single process. Rather, it should be considered as a family of processes that help individuals to define, identify,

and even discover problems that might or might not yet exist. Finally, this study calls for developing more measures that assess ill-defined problems in addition to most DT measures that assess presented problems.

Keywords: Problem Finding; Creativity; Four P's of Creativity; Meta-analysis; Effect Size.

Introduction and Literature Review

Earlier efforts in creative problem solving (CPS) models were given over to address the question "how to solve the problem creatively." However, before the problem can be solved, it is important to *identify what the problem is in a given situation*. Einstein and Infeld stated,

> The formulation of a problem is often more essential than its solution, which may be merely a matter of mathematical or experimental skill. To raise new questions, new possibilities, to regard old problems from a new angle, requires creative imagination and marks real advance in science (Einstein & Infeld, 1938, p. 92)

It can be said that the systematic study of problem finding began in the 1960s by two psychologists, Mihaly Csikszentmihalyi and Jacob Getzels (Csikszentmihalyi, 1965; Getzels & Csikszentmihalyi, 1965; Csikszentmihalyi & Getzels, 1970; Getzels, 1964). Since the 1960s, the number of studies addressing problem finding has grown, but this growth or interest in studying problem finding does not reflect the importance of this topic.

One valuable resource for problem finding research is the edited handbook *Problem Finding, Problem Solving, and Creativity* (Runco, 1994). This book addressed many topics related to problem finding such as problem finding and cognition (Mumford, Reiter-Palmon, & Redmond, 1994), metacognition (Jausovec, 1994), problem finding and teaching (Moore, 1994), and creative problem solving (Treffinger, Isaksen, & Dorval, 1994). Although this is a good way to classify problem-finding literature, for the purpose of this study, the literature review is organized according to Rhodes' framework of the four P's (Rhodes, 1961). It, thus, addresses three of the four in its three parts: 1) studies that look at the relationship between problem

finding and creative *Process*, 2) studies that look at the relationship between problem finding and creative *Product*, and 3) studies that look at the relationship between problem finding and creative *Person*. Unfortunately, due to the scarcity of studies conducted on problem finding and creative *press*, creative press will not be discussed in this review of literature.

Problem Finding and Creative Process

A number of studies have investigated the relationship between problem finding and other mental processes related to creativity and creative thinking such as problem solving and divergent thinking (e.g. Arlin, 1975a; Artley, Van Horn, Friedrich, & Carroll, 1980; Cai & Hwang, 2002; Fontenot, 1993; Hoover, 1994; Kar, Özdemir, İpek, & Albayrak, 2010; Kurtzberg & Reale, 1999; Nezu & D'Zurilla, 1981; Runco & Okuda, 1988).

Reviewing these studies showed that: 1) creativity was defined either as divergent thinking (e.g. Arlin, 1975a; Artley et al., 1980; Hoover, 1994; Runco & Acar, 2010) or problem solving (e.g. Cai and Hwang, 2002; Kar et al., 2010; Kochen & Badre, 1974; Smilansky, 1984); 2) the majority of studies defined creativity as divergent thinking using the well-known divergent thinking tests, such as the Torrance Test of Creative Thinking (TTCT) and some of Guilford's and Wallach and Kogan's tests to assess creativity; 3) the majority of these studies used mixed samples (i.e. male and female), with few exceptions such as Arlin (1975a), who dealt only with female subjects; 4) these studies were conducted on different age groups: children (e.g. Cai & Hwang, 2002; Hoover, 1994), adolescents (e.g. Kurtzberg & Reale, 1999; Runco & Okuda, 1988), and adults (e.g. Arlin, 1975a; Artley et al., 1980; Fontenot, 1993; Kar et al., 2010; Nezu & D'Zurilla, 1981); and 5) problem finding was assessed in different domains such as science (Hoover, 1994), mathematics (Cai & Hwang, 2002), business (Fontenot, 1993), social and humanities (Nezu & D'Zurilla, 1981), and in general using real-world problems (Arlin, 1975a;

Artley et al., 1980; Kurtzberg & Reale, 1999; Runco-& Okuda, 1988).

Although the majority of these studies reported a positive relationship between problem finding and the creative process, some findings were in conflict. For example, Arlin (1975a) looked at the relationship between problem finding and some cognitive processes, including divergent thinking as measured by the TTCT and Guilford's tests, among sixty female college seniors. According to Arlin (1975a), problem finding requires: 1) a problematic situation; (2) an opportunity for subjects to raise questions; and (3) a way of categorizing the questions once raised (p. 101). Arlin (1975a) found a significant positive correlation between PF quality, defined as "the weighted average of the questions according to intellectual products category" (p. 102), and elaboration (r= .21, p < .05), adaptive flexibility (r= .26, p < .05) and expressional fluency (r= .21, p < .05), while PF quality was negatively (non-significantly) correlated with spontaneous flexibility (r= -.09, p > .05), ideational fluency (r= -.19, p > .05), and associational fluency, (r= -.01, p > .05). Regarding PF quantity, which represented "the total number of questions asked by a subject regardless of type of question" (p. 102), no significant correlations were found between PF quantity and all DT indices; some were positively correlated with PF quantity such as associational fluency (r= .10, p > .05), ideational fluency (r= .12, p > .05), and spontaneous flexibility (r= .11, p > .05), while elaboration, adaptive flexibility, and expressional fluency were negatively correlated with PF quantity (r= -.09, p > .05), (r= -.01, p > .05), and (r= -.09, p > .05) respectively.

However, in a similar study conducted by Artley et al. (1980), which utilized the same instrument to assess creativity (i.e. TTCT) among male (N=19) and female (N= 65) undergraduate students, the findings were in conflict with Arlin's (1975a). Artley et al. (1980) found a significant positive correlation between PF quantity and creativity (r= .47, p < .01), as

defined by Arlin (1975a), although they reported a non-significant negative correlation between PF quality and creativity (r= -.07, p > .05) as defined by Arlin (1975a).

Another interesting issue regarding the relationship between problem finding and creativity that is defined as divergent thinking is to determine which divergent thinking ability is more related to problem finding. For instance, Runco-and Okuda (1988) examined the role of problem discovery in divergent thinking as measured by Wallach's and Kogan's divergent thinking tests (Wallach & Kogan, 1965) and creative performance among twenty-nine adolescents (19 males and 10 females). The results suggested that the scores from the presented problems and the scores from the discovered problems were moderately correlated, but the discovered problems elicited significantly *more ideas* (i.e. fluency) than the presented problems. Hoover (1994), who studied scientific problem finding in fifth grade gifted students (18 males and 22 females), found a similar result, but flexibility was more highly correlated with problem finding than fluency as measured by the TTCT (r= .41) and (r= .34) respectively. Thus, it will be interesting to look at which of the divergent thinking abilities is more related to problem finding.

Finally, as mentioned earlier, in addition to divergent thinking, creativity was defined as problem solving in some studies (e.g. Cai and Hwang, 2002; Kar et al., 2010). For example, Cai and Hwang (2002) compared problem solving and problem posing between U.S. and Chinese students in mathematics. The findings revealed that there was a much stronger link between problem solving and problem posing for the Chinese sample than for the U.S. sample, which opens the door for more cross-cultural studies in problem finding. Similarly, Kar et al. (2010) investigated the relationship between the problem solving and problem posing skills of prospective elementary mathematics teachers. The findings suggested that there was a significant positive relation between problem solving and problem posing skills. Therefore, it is of interest

to find out the potential differences between the studies that defined creativity as divergent thinking and those that defined it as problem solving in its relationship with problem finding.

Problem Finding and Creative Product

Studies using a creative product in order to assess the relationship between creativity and problem finding also differed in how creativity was defined, measured, and the domain in which problem finding was studied. For example, Csikszentmihalyi and Getzels (1971) and Rostan (1994) used a male sample, while Moore (1982) and Brinkman (1999) conducted their studies on mixed samples. Unlike studies that looked at the relationship between problem finding and creative process, studies classified under creative product used a variety of methods to assess creativity and problem finding in different domains.

For example, Csikszentmihalyi and Getzels (1971) who studied problem finding in art asked five well-known artists and art critics to evaluate the craftsmanship (i.e. technical skill of the product regardless of its originality), *originality* regardless of its craftsmanship, and 3) the overall aesthetic value. A positive relationship was found between discovery-oriented behavior defined as concern for discovery at the problem-formulation stage, and the originality of the creative product (r= .54, p < 01). Moore (1982) replicated Csikszentmihalyi's and Getzels' (1971) study and examined the relationship between problem finding and originality, craftsmanship, and the aesthetic value but with *writers*. Like Csikszentmihalyi's and Getzels' (1971) study, Moore (1982) asked five judges to evaluate the written products. The study participants were divided into two groups: a high creative group (N=8) vs. a low creative group (N=8) of adolescent. Results indicated a high relationship between problem finding defined as "The way problems are suggested, posed, formed, envisaged or credited" and the originality of the product (Moore, 1982, p. 24). The creative group scores were higher on originality and

aesthetic value, though not always significantly, perhaps due to the small sample size. The way a student approaches a writing problem greatly affects the originality of the product. The ability to perceive a deeper structure in the relationships between objects appears related to the originality of written or artistic products.

In the music domain, Brinkman (1999) asked three judges to evaluate the creativity of compositions produced by the study participants. He defined creative product as what qualified judges say to determine whether or not melodies produced by the study participants meet the criteria of originality, craftsmanship, and aesthetic value. Unlike Csikszentmihalyi and Getzels (1971) and Moore (1982), Brinkman (1999) reported non-significant differences in problem type (well-defined vs. ill-defined) and creativity style.

Rostan's (1994) study also examined the relationship among problem finding, problem solving, and cognitive controls but used problem solving tasks to assess creativity. Eighty adult male subjects were studied in four groups based on their domain of expertise (art or science) and their professional productivity (critically acclaimed professional producer or professionally competent). The critically acclaimed professional producer, as compared to the professionally competent, manifested a propensity for allocating a greater proportion of time and discovery-oriented behavior to the finding of a problem.

Problem Finding and Creative Person

Different measures of the creative Person, such as personality and behavioral measures, have been used in order to investigate the relationship between problem finding and creative individuals. For instance, Mumford, Costanza, Threlfall, Baughman, and Reiter-Palmon (1993) investigated the relationship between some personality variables such as openness, flexibility, and persistence, and problem construction among 250 undergraduate students (59 male and 191

female). Mumford et al. (1993) sought to identify personality characteristics that can promote or inhibit problem construction. Problem construction was assessed using a modified version of Smilansky's problem construction task (Smilansky, 1984). In this task, the study participants were first asked to complete the Raven test (series D and E), and then they were asked to invent a new item of the Raven test. The results obtained indicated that certain patterns of personality variables such as motivation and self-initiation could be used to account for the quality and *originality* of problem constructions. Reiter-Palmon, Mumford, and Threlfall (1998) looked at the role of problem construction defined as "The process by which individuals structure an ill-defined problem and identify the goals and objectives of the problem solving effort" (p. 187), and personality type between 80 male and 114 female undergraduate students. In order to assess problem construction, participants were presented with a situation and asked to write as many restatements of the problem as they could. Reiter-Palmon et al. (1998) concluded that individuals with high problem construction ability are able to construct an ambiguous or ill-defined problem in a way that they can relate to or understand.

In another study, Carson and Runco (1999) examined the relationship among creative problem solving and problem generation abilities, stress and daily hassles, and coping skills in a sample of college undergraduates (26 males and 48 females). Carson and Runco (1999) defined problem generation as "the ability to generate whole new problems to solve or issues to explore" (p. 168). They reported that problem generation and problem solving abilities were negatively related to such coping processes as confrontation, distancing, escape-avoidance tendencies, and excessive acceptance of responsibility, and positively associated with more general adaptive qualities, such as self-controlling and positive reappraisal. The findings strongly suggest that problem solving and problem generation abilities are important components of an individual's

overall capacity to cope with both the major and minor stresses of life.

Arreola (2012) also studied the influence of some personality variables on problem construction and creative problem solving among 167 undergraduate participants (52 males and 113 females). Arreola (2012) looked at the relationship between problem construction (PC) *quality* and personality variables by having participants restate given social problems. Arreola (2012) defined PC quality as,

> The degree to which the problem restatements were feasible or possible, as well as the extent to which the problem restatements as a whole completely represented the context. Quality also included the level in which detail was provided and the degree to which the problem restatements covered multiple different views of the problem (p. 48)

He reported a significant positive correlation between PC quality and Introversion (r= .32, p < .01), Neuroticism (r= .52, p < .01), and Prevention Focus (r= .74, p < .01), and a significant negative correlation between PC quality and Extraversion (r= -.33, p < .01), Emotional Stability (r= -.62, p < .01), and Promotion Focus (r= -.51, p < .01). The PC *originality* was statistically positively correlated with Neuroticism (r= .47, p < .01), Prevention Focus (r= .41, p < .01), and significantly negatively correlated with Extraversion (r= -.17, p < .05), and Emotional Stability (r= -.47, p < .01).

Summary of the Literature Review on Problem Finding and Creativity

As observed in the problem finding and creativity literature, there is not one single way or method to assess creativity; thus, examining the potential differences between the methods is important in order to find out whether or not the relationship between problem finding and creativity may differ according to the creativity measures (i.e. creative process, product, and person). Even when the researchers used a measure of divergent thinking, there were different outcomes regarding some divergent thinking indices and problem finding (e.g. Arlin 1975a).

Another issue that deserves attention is the domain specificity. Some of the previous studies looked at the relationship between problem finding and creativity in *art* (e.g. Csikszentmihalyi & Getzels, 1971), *science* (e.g. Hoover, 1994), *mathematics* (e.g. Cai & Hwang, 2002) and *writing* (e.g. Moore, 1982). Yet, others looked at the relationship between problem finding and creativity in general (i.e. administered tasks from real-world problems) such as Runco-and Okuda (1988) and Carson and Runco (1999). Therefore, it is important to consider the domain influence of such a relationship.

Finally, other variables deserve attention such as gender and age differences. Some previous studies were conducted only with males, such as Csikszentmihalyi and Getzels (1971); others targeted females, such as Arlin (1975a). In addition, some studies looked at school age students (e.g. Hoover, 1990; Kar et al., 2010); others looked at adults (e.g. Carson & Runco, 1999; Csikszentmihalyi & Getzels, 1971; Rostan, 1994). All these variables were considered as possible moderators for the current meta-analysis. It is important to note that the majority of studies on problem finding and creativity were found to be cross-sectional studies, with few examples of experimental studies.

METHOD

This section aims to address different methodological issues related to the current meta-analysis study. Specifically, this section covers the following topics: 1) locating research results, 2) study time frame, 3) inclusion and exclusion criteria, 4) coding procedures and reliability, 5) methods for calculating and synthesizing effect sizes, 6) heterogeneity and moderator analyses, and 7) assessing publication bias. All of these themes are discussed in detail according to meta-analysis guidelines.

Like any primary social science study, a meta-analysis study should meet a number of criteria for what should be reported in each section of the study, starting from the study title and ending with the study conclusion. Fortunately, a number of guidelines and standards for writing and reporting meta-analysis studies have been developed in the last twenty years such as Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA; Moher, Liberati, Tetzlaff, & Altman, 2010), Meta-Analysis Of Observational Studies in Epidemiology (MOOSE; Stroup et al., 2000), and APA's Meta-Analysis Reporting Standards (MARS; APA, 2008). The MARS standards were adopted in the current study. Appendix (A) shows the MARS standards.

Locating Research Results

Lipsey and Wilson (2001) described in detail the process of identifying and locating research reports. They listed a variety of sources for a comprehensive search of literature, which include review articles, references in studies, computerized bibliographic databases, bibliographic reference volumes, relevant journals, conference programs and proceedings, authors or experts in the area of interest, and government articles (p. 25). Cooper, (2017) provided a more detailed reference that discusses the process of searching literature for meta-analysis studies such as a research-to-research channel (i.e. personal contact, mass solicitation, traditional invisible colleges, and electronic invisible college), quality-controlled channels (i.e. professional conference papers and peer reviewed journals), and secondary channels (i.e. research report reference lists, research bibliography, prospective research registers, Internet, reference database, and citation indexes). The limitations of each of these methods were also discussed in the book (Cooper, 2017).

These techniques for locating and selecting studies to be included in the meta-analysis were considered in the current study. For instance, a number of *computerized databases* were searched including Academic Search Premier, Dissertation Abstract, PsycARTICLES, PsycINFO, Educational Resources Information Center (ERIC), Psychology & Behavioral Science Collection, and the Google Scholar. Three *relevant journals* in creativity were manually searched for articles: *Journal of Creative Behavior*, *Creativity Research Journal*, and *Psychology of Aesthetics, Creativity, and the Arts*. *Research report reference lists* were used when a study cited another study that might be of interest. In addition, I *contacted an expert* in problem finding and creativity asking for studies that he might be aware of, which could be included in the current meta-analysis study.

Study Time Frame and Keywords

The study time frame for articles was from January 1st 1960 to October 30th 2015. The literature search was conducted electronically using the following keywords: creativity, creative thinking, problem finding, problem generation, problem formulation, problem construction, problem identification, problem posing, problem discovery, ill-defined problems, discovery-oriented behavior, creative personality, creative achievement, divergent thinking, creative problem solving, and all possible combinations and permutations of these terms. The studies including the keywords, either in their titles or abstracts were initially selected and individually reviewed to find additional references. This search process of the literature, in addition to other methods of locating research results discussed above, produced 237 works on problem finding including published and unpublished articles, books, book chapters, conference papers, and technical reports. The majority of studies were obtained electronically, but there were a few

cases in which I needed to get a hard copy from the university library or request an interlibrary loan.

Inclusion and Exclusion Criteria

The final inclusion/exclusion decision was based on the following criteria and the study questions mentioned in chapter one:

1. *Publication Type:* Both published and unpublished studies were included to avoid publication bias (Cooper, 2017; Rosenthal, 1991). Therefore, both published works such as peer reviewed journal articles and unpublished research documents such as dissertations and conference proceedings were included, whereas magazine articles were excluded. In addition, in press studies were included.
2. *Appropriately Quantified Measures*: Only quantitative studies were included. Therefore, theoretical reviews and case studies were excluded. Furthermore, experimental studies were included only when the studies reported relationships from a pre-test *before* implementing any interventions.
3. *Sufficient Statistical Information*: Studies were included only when those studies offered sufficient statistical information to calculate effect size estimates for zero-order bivariate relationships between creativity and problem finding: Pearson r, mean, standard deviation, odds ratio, frequency for each group, and various test statistics such as F -value, *t*-value, and chi-square value. Those studies reporting multivariate relationships were excluded because the multivariate relationships were adjusted by different sets of covariates; therefore, those effect measures are not comparable across studies.
4. *Redundancy*: When the same sample was used in more than one study, only the most complete version of the studies was included to rule out redundancy.

5. *Cultural and Linguistic Range*: This study is limited to the studies published in English.
6. *Problem Finding and creativity*: Only studies that investigated the relationship between problem finding and creativity as measured by different creativity assessments were included. Note that researchers have used different terms in order to describe the process of finding a problem such as problem construction, problem generation, and problem posing. The creativity assessments include the creative product, creative person, and creative process measures. Because problem-solving measures vary (i.e. some require using convergent thinking more than divergent thinking), *only* problem solving tasks that require using divergent thinking were included in this study.

In sum, the major ramifications for this study are: 1) the inclusion of all kinds of publications except magazine articles, unlike some meta-analysis studies that include only peer reviewed articles, 2) the time frame, which includes the period between January 1st 1960 to October 30th 2015. This time frame was based on the fact that the systematic study of problem finding in its relationship with creativity began in the late 1960s, more specifically, with Mihaly Csikszentmihalyi, and Jacob Getzels' studies on problem finding with art students (Csikszentmihalyi & Getzels, 1970; Csikszentmihalyi & Getzels, 1971), and 3) the inclusion of studies was limited to those written in English only; thus, some important studies in other languages may be overlooked.

As indicated above, the decisions for inclusion and exclusion of the studies were made based on the six criteria and based on the research questions reported in chapter one. Appendix (B) shows in detail the decision made for each of the 237 works found in the problem finding literature based on those six criteria. *If any study did not meet even one of these six criteria, it was excluded*. For example, the non-empirical articles were excluded because they did not meet

criteria 2 (Appropriately Quantified Measures), and 3, (Sufficient Statistical Information) (e.g. Abramovich & Cho, 2006; Allen & Thomas, 2011; Ananda & Pedro, 2001; Csikszentmihalyi, 1988; Getzels, 1985; Runco & Nemiro, 1994). Only two studies were excluded because they did not meet the language criterion (Haiyan, Weiping, & Jiliang, 2010; Weiping & Xingqi, 2010). Regarding the redundancy criterion, eleven works were excluded. If the same study was found in different kinds of publications such as a thesis, dissertation, book chapter, and journal article, the journal article was included (e.g. Basadur, 1980; Brinkman, 1994). Finally, although some works reported appropriate quantified measures and sufficient statistical information, these works were not considered in the relationship between problem finding and creativity (e.g. Auclair, 2007; Baker- Sennett, 1991; Blissett & McGrath, 1996; Grawitch, Munz, Elliott, & Mathis, 2003; Lin & Lien, 2013). Figure 3.1 summarizes the final inclusion/exclusion results. In addition to journal articles (75%), three book chapters (i.e. Dudek & Cote; Jausovec, 1994; Mumford et al., 1994) and seven theses/dissertations (i.e. Ambrosio, 1994; Arreola, 2012; Barber, 1981; Ching, 2009; Harms, 2014; Holtz, 2002; Yurkovich, 2014) were included in the final analysis.

Note that the number of excluded studies in figure 3.1 adds up to 317 because some studies were listed in more than one category as a reason for exclusion; they did not meet more than one criterion as mentioned above.

The final inclusion/exclusion decision was made by two raters: me, and a graduate students who is knowledgeable about meta-analysis and with whom I worked on a previous meta-analysis project (Paek, Abdulla, & Cramond, 2016). Concerning the inclusion/exclusion decision, the two raters agreed on 228 works (96.2%) and disagreed on 9 works (3.8%). In the case of disagreement, the two raters met and discussed each case individually in order to make a final decision about whether to include or exclude each of these works.

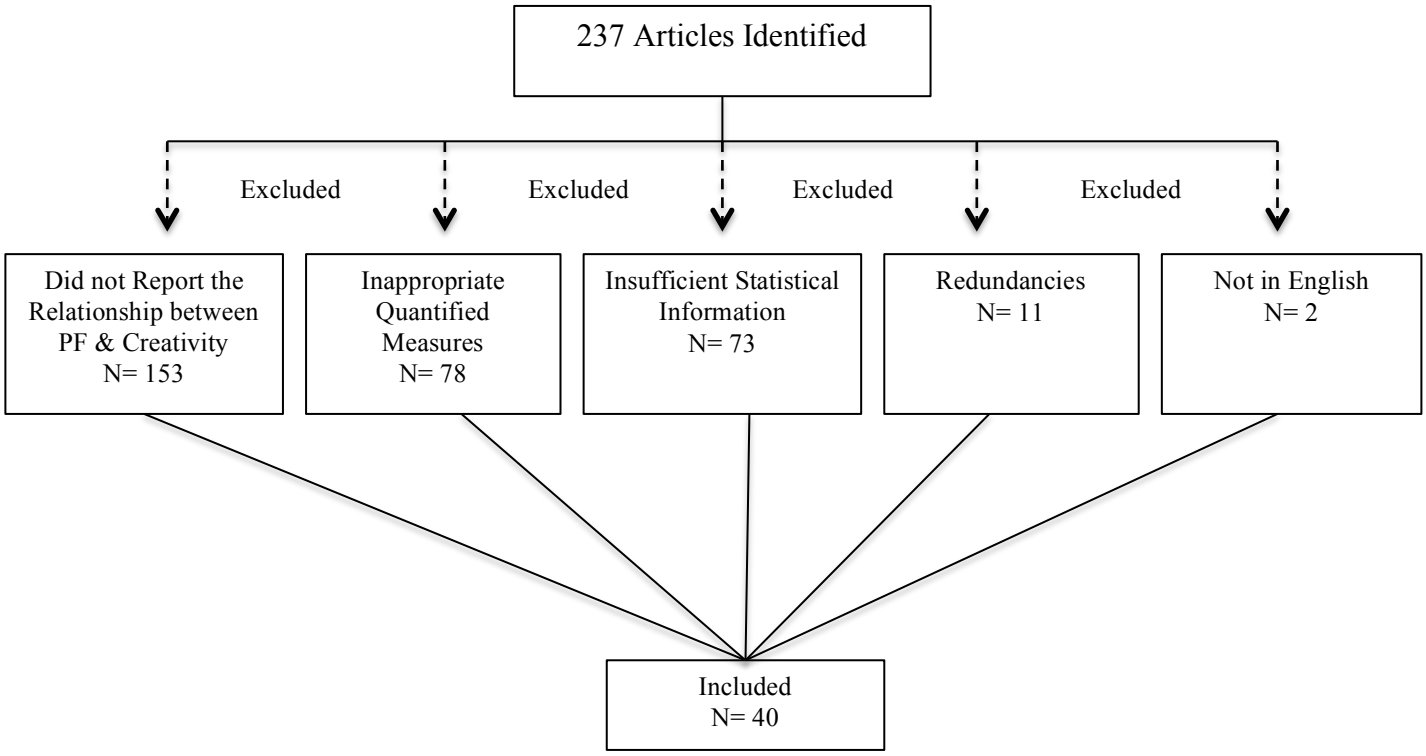


Figure 3.1: Flow chart for selection of studies

Coding Procedure and Reliability

Developing a coding protocol or guide might be the hardest and the most time consuming step in conducting any meta-analysis study, especially when a large number of studies are to be included. One important issue is *what information will be coded*? According to Cooper (2017), the choice of what information to code should be based on a comprehensive reading of the literature or some theoretical and practical reasons. Another issue is *how to assess coding reliability*? These two issues will be briefly discussed before moving to the procedure used in the current study.

What information is to be coded?

There might be no single answer for such a question because the answer depends on the nature, scope, design, objectives, and other factors of the study. However, Lipsey and Wilson (2001), Rosenthal (1991), Cooper (2017), and other meta-analysts (e.g. Card, 2012; Wilson, 2009) listed different types of information that may be desirable to code in any meta-analysis

study. One good classification is offered by Cooper (2017), who classified types of information to be coded into eight categories: 1) the report, 2) the predictor or independent variable, 3) the sittings in which the study took place, 4) the participants and sample characteristics, 5) the dependent or outcome variables and how they were measured, 6) the type of research design, 7) the statistical outcomes and effect sizes, and 8) the coder and coding process characteristics (p. 115).

How to assess coding reliability?

According to Cooper (2017), "The coding of studies for a research synthesis is not a one-person job" (p. 133). Most meta-analysts suggest that there should be at least two coders for examining the coding reliability (Card, 2012; Wilson, 2009). There are several issues related to the coding reliability. First, it is crucial to have a trained coder who is familiar with the process of coding protocol and who has enough knowledge about the topic of the meta-analysis study (Cooper, 2017; Lipsey & Wilson, 2001; Wilson, 2009). In general, the coder(s) should be at least at the level of doctoral study (Lipsey & Wilson, 2001). Recording errors, ambiguous definitions of variables to be coded and predisposition of coders are some sources of unreliability in study coding (Cooper, 2017). Researchers in meta-analysis suggested different kinds of coding methods such as double coding in which all studies are coded independently by more than one coder (Cooper, 2017). All these issues (i.e. what information is to be coded and how to assess coding reliability) were considered in the current study, as shown in detail in the next section.

Coding procedure and reliability for the current study

Based on reading a representative sample of problem finding literature and discussions with two experts in creativity and problem finding, a coding protocol was initiated which includes information about the following: 1) study ID, 2) number of effect sizes per study, 3)

year of publication, 4) age, 5) gender, 6) measure of creativity used in each study, 7) divergent thinking indices, 8) problem finding domain, 9) types of statistics, 10) direction of the effect size, 11) effect size value (*r*), and 12) variance for r_z. In addition, a column was created for the coders' notes. Table 3.1 shows the coding protocol in detail.

The same individuals who made the inclusion/exclusion decision have coded information separately in an excel file. Before beginning the coding process, the second coder and I met two times to discuss and clarify issues related to the coding process. Once everything was clearly defined, I provided the second coder with the following: 1) a copy of the definitions of moderators and their levels, 2) a copy of the coding protocol, 3) a copy of the coding sheet, 4) a CD which contained all included and excluded studies (i.e. 237 studies), and 5) a printed copy of the included studies. The coding was conducted for *all* studies included in this meta-analysis. According to Lipsey and Wilson (2001), "it is desirable for the reliability samples to consist of 20 or more studies, with 50+ being more desirable" (p. 86).

The coding was conducted in two phases. In the first phase, the coders only coded twenty-five studies. The rest of the included studies were coded in the second phase. The intraclass correlation (McGraw & Wong, 1996) coefficient was calculated for phase 1 and both raters met to resolve discrepancies. After the coders completed coding all studies (i.e. phase 2), the two-way mixed absolute agreement intraclass correlation coefficient was calculated for all studies. Some mechanical errors were found in both phases and have been corrected. As mentioned above, in the case of disagreement on any variable (e.g. effect size, moderator level), the discrepancies were resolved by meeting and discussing each case. The intraclass correlation coefficient for all the *effect sizes* (k= 196) was .975 and the reliability coefficient for the *Fisher z variance* (i.e. the variance of r_z) was .970.

Table 3.1

The Coding Protocol Used to Test the Coding Reliability

Variable Name	Variable Label	Type of Coding	Criteria	Code	Test of Criteria
ID	Study ID	Nominal			
E.S	Effect Size ID	Nominal			
Publication Year	Publication Year	Continuous			
Gender	Gender	Nominal	Male	1	Sample with male groups above 75%
			Female	2	Sample with female groups above 75%
			Combined	3	Sample with both males and females
Age Group	Age Group	Ordinal	Grades 1 to 6	1	
			Grades 7 to 12	2	
			Adults	3	
			Combined	4	
Creativity Measure	Creativity Measure	Nominal	DT	1	
			PS	2	
			Creative Person	3	
			Creative Product	4	
DT Index	DT Index	Nominal	Fluency	1	
			Flexibility	2	
			Originality	3	
			Composite	4	
PF Domain	Domain of PF Task	Nominal	Art	1	
			Writing	2	
			Science/Math	3	
			Social/Humanities	4	
			Others	5	
Statistics	Type of Statistic	Nominal	Mean Differences		
			Correlation		
			Other		Please specify
Direction	Effect Size Direction	Nominal	Positive	1	
			Negative	2	
Effect Size	Effect Size Value	Continuous			
Fisher z Variance	Fisher z Variance	Continuous			

Effect size calculation

Because the majority of included studies reported Pearson product-moment correlation coefficients, (*r)* has been chosen as an effect size for the current study. The correlation coefficient *r* ranges from -1, which represents a perfect negative linear relationship, to 1, which represents a perfect positive linear relationship. The correlation coefficient *r* is used to assess the strength and direction of the relationship between two variables (Ellis, 2010). There are two main approaches concerning synthesizing *r*: those who suggest synthesizing the correlation coefficient

itself without any adjustments (e.g. Schmidt & Hunter, 2015), and others who suggest converting *r* to the Fisher's *z* (e.g. Borenstein, Hedges, Higgins, & Rothstein, 2009; Cooper, 2017; Lipsey & Wilson, 2001). In the current study, the latter approach has been employed for several reasons, including the fact that variance strongly depends on the correlation, the Person *r* is not normally distributed, and that the Person correlation coefficient has some unsatisfactory statistical properties such as a problematic standard error formulation (Borenstein et al., 2009; Lipsey & Wilson, 2001). Therefore, all correlation coefficients were transformed to Fisher's *z*. The results of Fisher's *z* then converted back into correlational form. Thus, prior to aggregating effect sizes, the following equation was used to transform *r* to *z*:

$$Z = 0.5 \times 1n\left(\frac{1+r}{1-r}\right)$$

The variance was computed using the following formula:

$$V_z = \frac{1}{n-3}$$

And the standard error was computed as follows:

$$SE_z = \sqrt{V}z$$

After all analyses have been conducted using Fisher's z, the following formula was used to convert r_z to *r*:

$$r = \frac{e^{2z}-1}{e^{2z+1}}$$

For studies that did not report correlations such as *F* and *t* statistics, the mean differences and the standard deviations were used to compute the Cohen's *d*, which was then transformed to *r* using the following formula:

$$r = \frac{d}{\sqrt{d^2+\frac{1}{pq}}}$$

Most of the studies reported more than one effect size. With the exception of one study

(i.e. Mumford et al., 1996), which reported 40 effect sizes, the number of effects ranged from 1 to 10, with a mean of 3.9. These effects were coded for the moderator analysis. For example, when a study reported two effect sizes, one that assessed creative personality and the other assessed creative process, both effect sizes were included and coded separately for the moderator analysis.

Synthesizing Effect Sizes

This study employed a *random-effects model* to aggregate mean correlation between problem finding and creativity using SPSS macros, version 23.0 (i.e. MeanES, MetaF, and MetaReg; IBM, 2016; Wilson, 2006). In addition, the Comprehensive Meta-Analysis, version 3 was used to generate the study's figures. Unlike the fixed-effects model, the random-effects model assumes the there are two sources of variability, the *within-study variance* stemming from sampling error and the *between-study variance*, which is the variance of the effect size across studies. The effect size of each study was weighted by the inverse of its variance to produce the summary effect size. These days, meta-analysts recommend beginning with the random-effects model.

Heterogeneity Analysis

Heterogeneity was examined using Q and I^2 statistics. According to Lipsey and Wilson (2001), "A significant Q rejects the null hypothesis of homogeneity and indicates that the variability among the effect sizes is greater than what is likely to have resulted from subject-level sampling error alone" (p. 117). The Q statistic was computed using the following formula:

$$Q = \sum_{i=1}^{k} \left(\frac{Y_i - M^2}{S_i} \right)$$

Another approach for quantifying heterogeneity is I^2, which "describes the percentage of total variation across studies that is due to heterogeneity rather than chance" (Higgins,

Thompson, Deeks, & Altman, 2003, p. 558). The I^2 statistic and its confidence intervals were calculated using the following formulas:

$$I^2 = 100\% \times \frac{Q - df}{Q}$$

$$LL_I^2 = \left(\frac{L^2 - 1}{L^2}\right) \times 100\%; \; LL_I^2 = \left(\frac{U^2 - 1}{U^2}\right) \times 100\%$$

Higgins et al. (2003) suggested that I^2 values of 25% might be considered low, 50% might be considered moderate, and 75% and above might be considered high.

Moderator Analysis

According to Cooper (2017), "If the effect sizes display significantly greater variability than expected by chance, the meta-analysts then begin to examine whether study characteristics are systematically associated with variance in effect sizes" (p. 241). Based on some theoretical and practical reasons in problem finding and creativity literature, using five moderators was suggested to explain variability in effect sizes: gender, age, creativity measure, divergent thinking indices, and problem finding domain. Table 3.2 shows the descriptions of those moderators in detail. Two methods of moderator analysis were used in the current study, the ANOVA and the meta-regression. The ANOVA was used to assess the relationship between the mean effect size and each moderator separately, and the meta-regression was used to assess the impact of several moderators simultaneously. Planned and post hoc contrasts were used to explore differences in each level of the moderators. Just as with contrasts in ordinary ANOVA, they can be used to explore differences among the levels of each moderator (Hedges & Pigott, 2004).

Table 3.2
Description of the Study Moderators

Moderators	Definitions/Tests
Measures of Creativity	
a. DT	All kinds of DT tests that ask participants to produce many (i.e. fluent), different (i.e. flexible), and unique (i.e. original) ideas.
b. PS	All kinds of problem solving tests used in creativity studies.
c. Creative Product	All kinds of performance tasks (e.g. drawing, composing, doing an experiment, etc.).
d. Creative Person	All kinds of creative personality, creative attitude, creative behavior, and creative styles measures.
DT Indices	
a. Fluency	The total number of ideas given on any one DT exercise.
b. Flexibility	The number of themes or categories within an ideation of an examinee or a respondent.
c. Originality	The unusualness or uniqueness of ideas of an examinee or respondent.
d. Composite	Studies that offer a total score for DT or PS tests.
PF Domain	
a. Art	Includes all artistic domains such as music and drawing.
b. Writing	Includes all tasks that assess problem finding in writing.
c. Science/Math	Include all kinds of hypotheses testing and scientific experiments.
d. Social/Humanities	Includes all tasks from social life.
e. General	Includes everyday problems.
Age Groups	
a. G1-6	Sample with G1-6 or 6-11yr's old group.
b. G7-12	Sample with G7-12 or 12-17yr's old group.
b. Adults	Sample with over 18yrs old and above.
Gender	
a. Male	Sample with male above 75%.
b. Female	Sample with female above 75%.
c. Combined	Sample combined with both males and females.

Assessing Publication Bias

Publication bias was examined through the funnel plot, Rosenthal's Fail-safe *N*, and the Egger test. The Trim and Fill method was not used because according to Stern and Egger (2008), "It is known to perform poorly in the presence of substantial between-study heterogeneity" (p. 321). A funnel plot is a scatterplot of sample size versus estimated effect size for a group of studies (Greenhouse & Iyengar, 2009, p. 428). However, visual inspection of the funnel plot may be largely subjective (Borenstein et al., 2009); therefore, evidence of publication bias was statistically tested using the Egger's test (Egger, Smith, Schneider, & Minder, 1997).

RESULTS

This study was designed to answer three key questions. The first question examined the nature and the magnitude of the relationship between problem finding and creativity across five moderators (DT indices, creativity measure, problem finding domain, age, and gender), and the second looked at whether or not these five moderators could explain some of the variability in the mean effect size. Finally, the third question tried to find out whether or not different terms used in the problem finding literature differ from one another in their relationship with creativity.

Publication Bias

Four methods for assessing publication bias were used: the funnel plot, Rosenthal's Fail-safe *N*, and the Egger test. Figure 3.2 shows the funnel plot. According to Sterne, Backer, and Egger (2005), "Funnel plots should be seen as a generic means of examining small study effects rather than as a tool to diagnose specific types of bias" (p. 75). Sterne et al. (2005) emphasized that the funnel plot asymmetry may not result from bias and listed five potential sources of asymmetry in funnel plots. However, figure 3.2 showed that one effect size was quite far from the mean Fisher *z* (i.e. Frederiksen & Ward, 1978); thus, a sensitivity analysis was conducted to find out whether removing this effect size would change the summary effect size. It was found that the mean effect size dropped off from .220 to .196 because the correlation coefficient of that effect size was very high (r= .99) with a high sample size (N= 2,636).

The Rosenthal Fail-safe *N* is another method to assess publication bias. This method assumes that unpublished studies and those that reported non-significant differences might be omitted (i.e. the file-drawer problem). In the Rosenthal Fail-safe *N*, if the *z* value is significant, then we need to know how many studies with *z* values averaging zero would need to be included to reduce the publication bias (Becker, 2005). In the current study, the Rosenthal Fail-safe *N*

result showed that z= 36.131, p <.001, and the number of missing studies that would bring p-value to alpha= 6,414.

The Egger test has been widely used to test the funnel plot asymmetry. In the current study, regression was computed to test for asymmetry of the effect sizes distribution. The results showed that the regression intercept was significant (t-value= 5.5217, two-tailed p < .001).

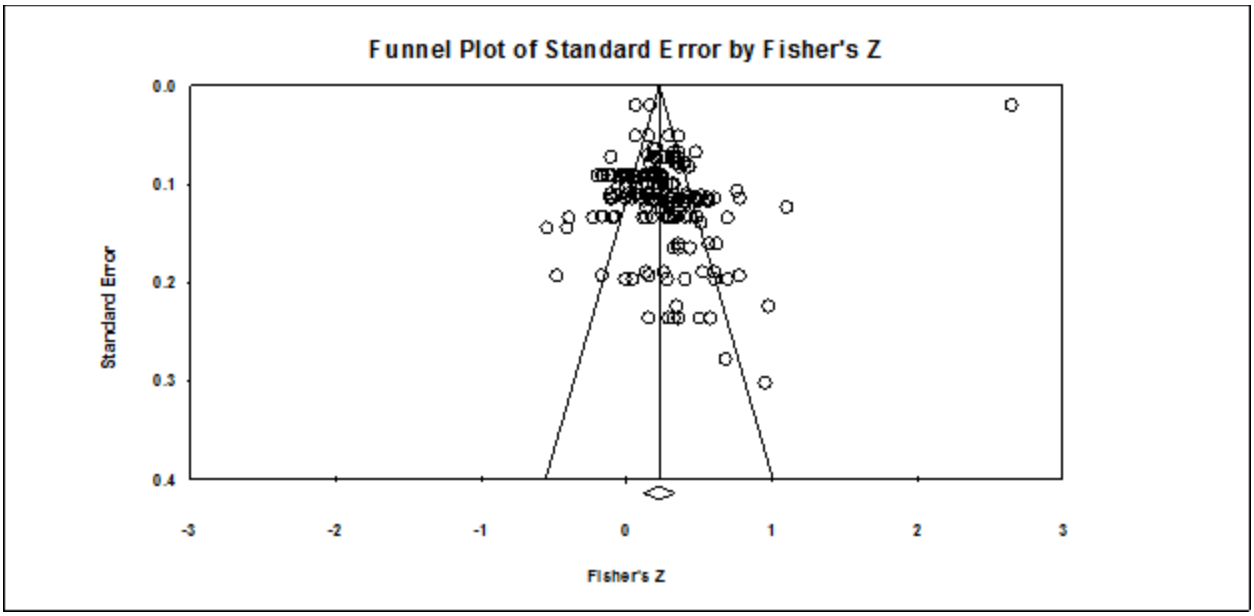
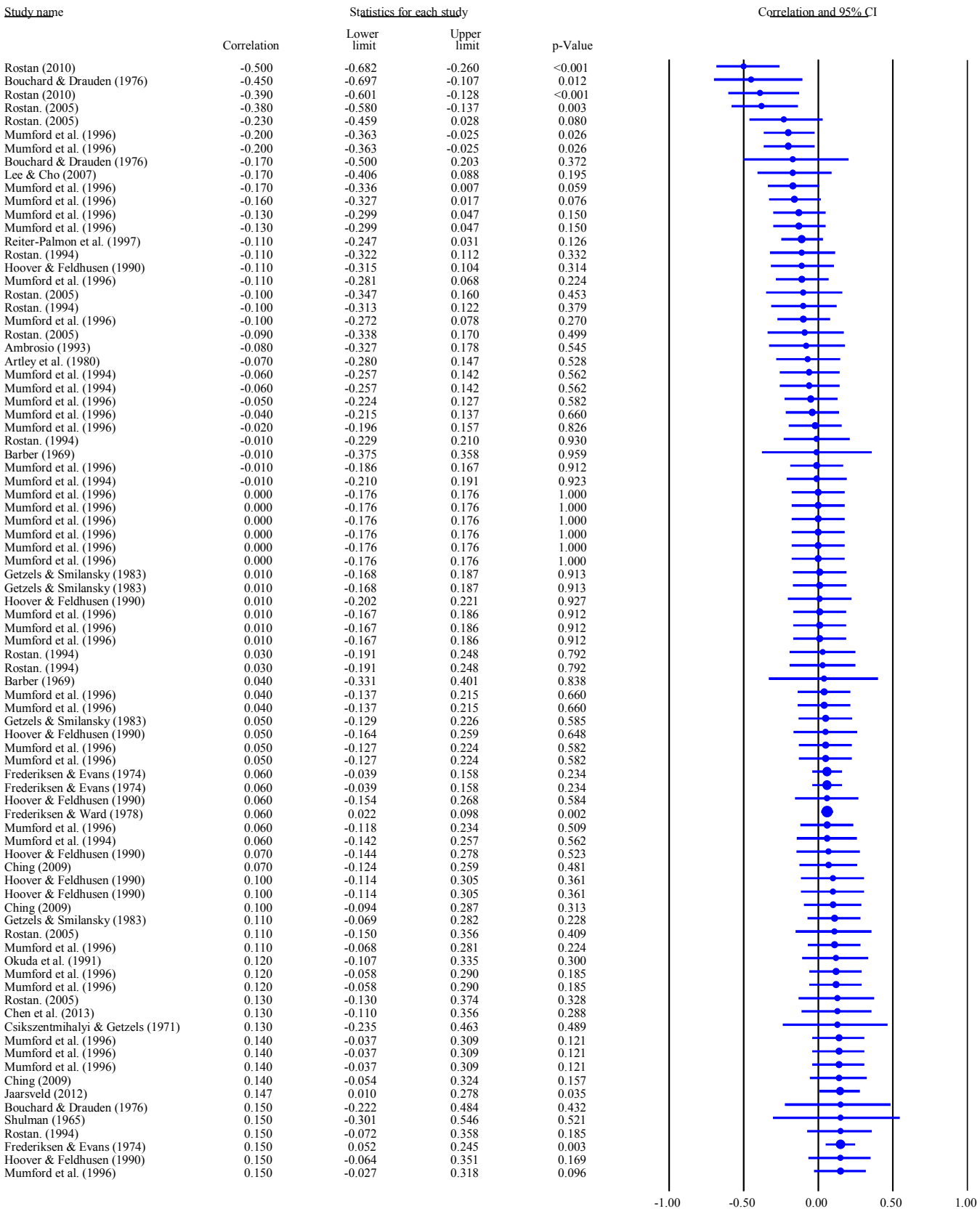


Figure 3.2: Funnel Plot of Standard Error

The Overall Relationship Between Problem Finding and Creativity

Forty studies including a total of 6,649 participants and 196 effect sizes were included and analyzed. Concerning the first question about the overall relationship between problem finding and creativity, both the *random-effects* and *fixed-effects* models showed a significant correlation between problem finding and creativity. However, the fixed-effects model showed a high correlation between problem finding and creativity r= .39 (95% *CI*= .38 - .40), while the random-effects model showed that problem finding and creativity correlated moderately r= .22

(95% *CI*= .11 - .32). As mentioned in the method section, this study employed the random-effects model and assumed that the relationship between problem finding and creativity might be influenced by other factors than sampling error alone. The heterogeneity analysis confirmed this assumption, $Q(195)= 15480.27$, $p < .001$, $I^2 = 98.74\%$ (*CI*= 98.71% – 98.78%). This means that the relationship between these two variables cannot be fully explained using the fixed-effects model; thus, it was crucial to search for possible moderators that may account for the variation in the mean effect size. Figure 3.4 shows the forest plot for the 196 effect sizes and the summary effect size.


Study name
Statistics for each study
Correlation and 95% CI
Correlation
Lower limit
Upper limit
p-Value
Rostan (2010) -0.500 -0.682 -0.260 <0.001
Bouchard & Drauden (1976) -0.450 -0.697 -0.107 0.012
Rostan (2010) -0.390 -0.601 -0.128 <0.001
Rostan. (2005) -0.380 -0.580 -0.137 0.003
Rostan. (2005) -0.230 -0.459 0.028 0.080
Mumford et al. (1996) -0.200 -0.363 -0.025 0.026
Mumford et al. (1996) -0.200 -0.363 -0.025 0.026
Bouchard & Drauden (1976) -0.170 -0.500 0.203 0.372
Lee & Cho (2007) -0.170 -0.406 0.088 0.195
Mumford et al. (1996) -0.170 -0.336 0.007 0.059
Mumford et al. (1996) -0.160 -0.327 0.017 0.076
Mumford et al. (1996) -0.130 -0.299 0.047 0.150
Mumford et al. (1996) -0.130 -0.299 0.047 0.150
Reiter-Palmon et al. (1997) -0.110 -0.247 0.031 0.126
Rostan. (1994) -0.110 -0.322 0.112 0.332
Hoover & Feldhusen (1990) -0.110 -0.315 0.104 0.314
Mumford et al. (1996) -0.110 -0.281 0.068 0.224
Rostan. (2005) -0.100 -0.347 0.160 0.453
Rostan. (1994) -0.100 -0.313 0.122 0.379
Mumford et al. (1996) -0.100 -0.272 0.078 0.270
Rostan. (2005) -0.090 -0.338 0.170 0.499
Ambrosio (1993) -0.080 -0.327 0.178 0.545
Artley et al. (1980) -0.070 -0.280 0.147 0.528
Mumford et al. (1994) -0.060 -0.257 0.142 0.562
Mumford et al. (1994) -0.060 -0.257 0.142 0.562
Mumford et al. (1996) -0.050 -0.224 0.127 0.582
Mumford et al. (1996) -0.040 -0.215 0.137 0.660
Mumford et al. (1996) -0.020 -0.196 0.157 0.826
Rostan. (1994) -0.010 -0.229 0.210 0.930
Barber (1969) -0.010 -0.375 0.358 0.959
Mumford et al. (1996) -0.010 -0.186 0.167 0.912
Mumford et al. (1994) -0.010 -0.210 0.191 0.923
Mumford et al. (1996) 0.000 -0.176 0.176 1.000
Mumford et al. (1996) 0.000 -0.176 0.176 1.000
Mumford et al. (1996) 0.000 -0.176 0.176 1.000
Mumford et al. (1996) 0.000 -0.176 0.176 1.000
Mumford et al. (1996) 0.000 -0.176 0.176 1.000
Mumford et al. (1996) 0.000 -0.176 0.176 1.000
Getzels & Smilansky (1983) 0.010 -0.168 0.187 0.913
Getzels & Smilansky (1983) 0.010 -0.168 0.187 0.913
Hoover & Feldhusen (1990) 0.010 -0.202 0.221 0.927
Mumford et al. (1996) 0.010 -0.167 0.186 0.912
Mumford et al. (1996) 0.010 -0.167 0.186 0.912
Mumford et al. (1996) 0.010 -0.167 0.186 0.912
Rostan. (1994) 0.030 -0.191 0.248 0.792
Rostan. (1994) 0.030 -0.191 0.248 0.792
Barber (1969) 0.040 -0.331 0.401 0.838
Mumford et al. (1996) 0.040 -0.137 0.215 0.660
Mumford et al. (1996) 0.040 -0.137 0.215 0.660
Getzels & Smilansky (1983) 0.050 -0.129 0.226 0.585
Hoover & Feldhusen (1990) 0.050 -0.164 0.259 0.648
Mumford et al. (1996) 0.050 -0.127 0.224 0.582
Mumford et al. (1996) 0.050 -0.127 0.224 0.582
Frederiksen & Evans (1974) 0.060 -0.039 0.158 0.234
Frederiksen & Evans (1974) 0.060 -0.039 0.158 0.234
Hoover & Feldhusen (1990) 0.060 -0.154 0.268 0.584
Frederiksen & Ward (1978) 0.060 0.022 0.098 0.002
Mumford et al. (1996) 0.060 -0.118 0.234 0.509
Mumford et al. (1994) 0.060 -0.142 0.257 0.562
Hoover & Feldhusen (1990) 0.070 -0.144 0.278 0.523
Ching (2009) 0.070 -0.124 0.259 0.481
Hoover & Feldhusen (1990) 0.100 -0.114 0.305 0.361
Hoover & Feldhusen (1990) 0.100 -0.114 0.305 0.361
Ching (2009) 0.100 -0.094 0.287 0.313
Getzels & Smilansky (1983) 0.110 -0.069 0.282 0.228
Rostan. (2005) 0.110 -0.150 0.356 0.409
Mumford et al. (1996) 0.110 -0.068 0.281 0.224
Okuda et al. (1991) 0.120 -0.107 0.335 0.300
Mumford et al. (1996) 0.120 -0.058 0.290 0.185
Mumford et al. (1996) 0.120 -0.058 0.290 0.185
Rostan. (2005) 0.130 -0.130 0.374 0.328
Chen et al. (2013) 0.130 -0.110 0.356 0.288
Csikszentmihalyi & Getzels (1971) 0.130 -0.235 0.463 0.489
Mumford et al. (1996) 0.140 -0.037 0.309 0.121
Mumford et al. (1996) 0.140 -0.037 0.309 0.121
Mumford et al. (1996) 0.140 -0.037 0.309 0.121
Ching (2009) 0.140 -0.054 0.324 0.157
Jaarsveld (2012) 0.147 0.010 0.278 0.035
Bouchard & Drauden (1976) 0.150 -0.222 0.484 0.432
Shulman (1965) 0.150 -0.301 0.546 0.521
Rostan. (1994) 0.150 -0.072 0.358 0.185
Frederiksen & Evans (1974) 0.150 0.052 0.245 0.003
Hoover & Feldhusen (1990) 0.150 -0.064 0.351 0.169
Mumford et al. (1996) 0.150 -0.027 0.318 0.096
-1.00
-0.50
0.00
0.50
1.00

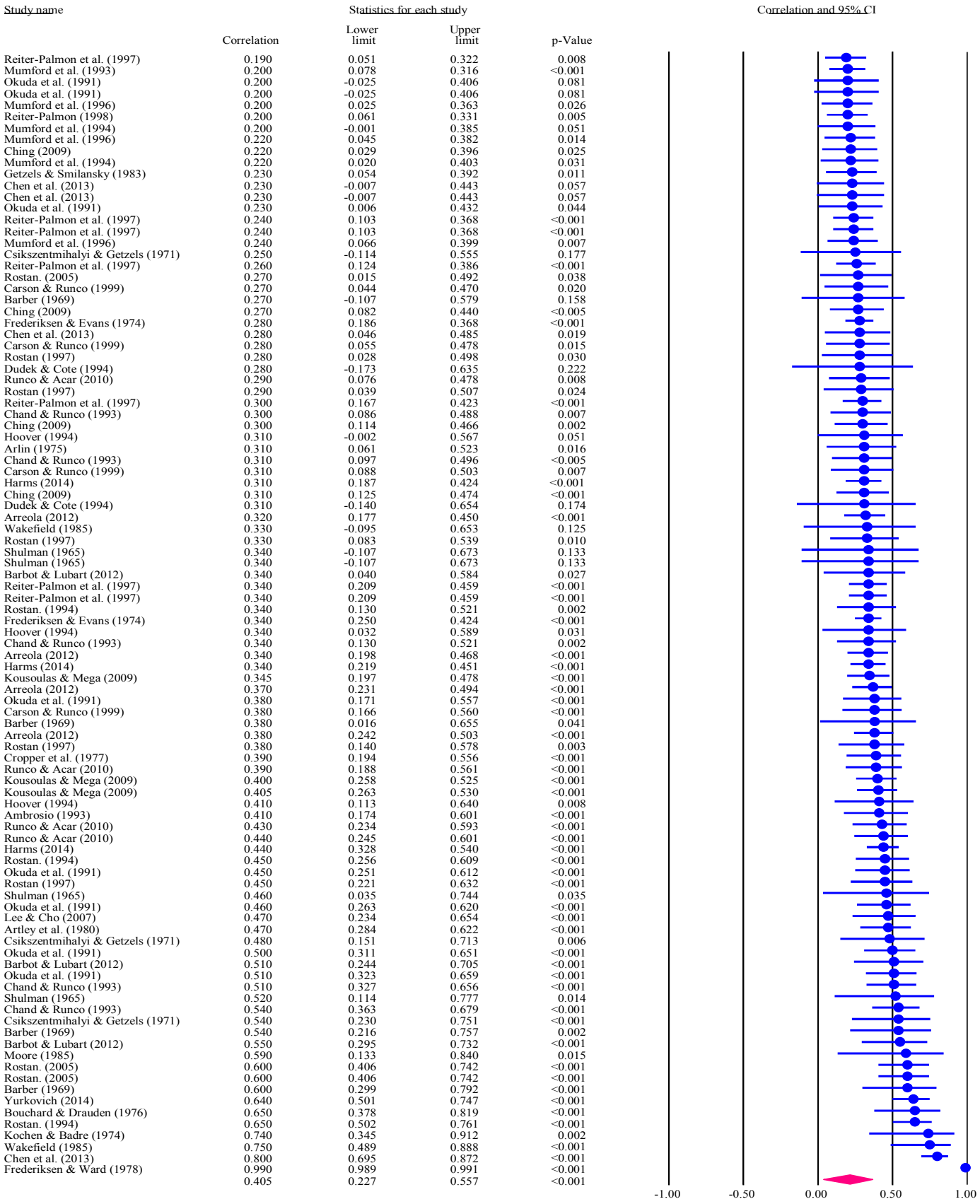


Figure 3.3: The Forest Plot for All Effect Sizes and the Summary Effect Size

Moderator Analyses

The ANOVA analysis was used first in order to test the five study moderators separately. The ANOVA results showed that the following moderators: age (Q[2]= 6.60, p < .03), divergent thinking indices (Q[3]= 10.95, p < .01), and problem finding domain (Q[4]= 18.44, p < .001) significantly explained the variance in the mean effect size, while gender (Q[2]= 1.69, p = .47) and creativity measure (Q[3]= 0.65, p = .88) moderators did not significantly explain the variance in the mean effect size. Table 3.3 shows the contrast weight, the number of effect sizes, the mean effect sizes, the confidence intervals, the p-values, and the Q and I^2 for each level of the five moderators.

For the *measure of creativity* moderator, the results indicated that creativity, as measured by product, was more highly correlated (r= .248; CI= 132 - .348) with the mean effect than creative personality (r= .230; CI= .113 - .341), problem solving (r= .204; CI= .022 - .372), or divergent thinking (r= .196; CI= .140 - .250), which was the least correlated with the summary effect. Regarding the *divergent thinking indices* moderator, both fluency (r= .314; CI= -.084 - .625) and originality (r= .291; CI= .234 - .345) moderators were more highly correlated with the mean effect than flexibility (r= .149; CI= .096 - .201). The highest correlation in the *problem finding domain* moderator was in the writing domain (r= .360; CI= .243 - .466) and the lowest was in the social and humanities domain (r= .091; CI= -.213 - .379).

Surprisingly, contrary to Arlin's (1975a, 1975b) assumption that problem finding is a post formal process in which older students (i.e. adults) might perform or possess higher levels of problem finding skills compared with younger students, the children's group (r= .297; CI= .226 - .365) more significantly correlated with the mean effect size than the adults' group (r= .207; CI= .059 - .345). Finally, concerning the gender moderator, the results showed that females

outperformed males with respect to the mean effect size (*r*= .305; CI= .202 - .379), (*r*= .183; CI= .025 - .332) respectively.

Table 3.3
Effect Sizes Results by Group and Total for the Study Moderators

Moderator	Contrast Weight	*k*	Mean *r*	95% *CI*	*P*	*Q*	I^2
Measures of Creativity							
Divergent Thinking	-.5	45	.196	.140 - .250	<. 00	194.93	77.43
Problem Solving	-.5	97	.204	.022 - .372	.02	14377.99	99.33
Creative Person	.5	19	.230	.113 - .341	<.01	102.50	82.44
Creative Product	.5	35	.248	.132 - .348	<.01	179.53	81.06
DT Indices							
Fluency	.5	38	.314	-.084 - .625	.11	9984.00	99.63
Flexibility	-.5	39	.149	.096 - .201	<. 00	116.14	67.28
Originality	.5	19	.291	.234 - .345	<. 00	33.47	46.22
Composite	-.5	100	.165	.125 - .205	<. 00	450.30	78.01
PF Domain							
Art	-.25	33	.199	.078 - .313	<. 00	170.94	81.28
Writing	1	14	.360	.243 - .466	<. 00	65.25	80.08
Science/Math	-.25	26	.162	.106 - .217	<. 00	65.50	61.83
Social/Humanities	-.25	49	.091	-.213 - .379	.56	14106.42	99.66
Other Domains	-.25	74	.282	.241 - .322	<. 00	258.74	71.79
Age							
G1-6	1	47	.297	.226 - .365	<. 00	196.78	76.62
G7-12	-.5	26	.113	.039 - .185	<. 00	81.91	69.48
Adults	-.5	123	.207	.059 - .345	<. 00	14906.43	99.18
Gender							
Male	1	15	.183	.025 - .332	.02	76.13	81.61
Female	-1	17	.293	.202 - .379	<. 00	36.44	56.09
Mixed	0	164	.213	.094 - .325	<. 00	15295.92	98.93

Meta-Regression Analysis

According to Thompson and Higgins (2002), "Meta-regression aims to relate the size of effect to one or more characteristics of the studies involved" (p. 1559). Multiple regression analyses were conducted to further test the statistically significant moderators: age, DT indices, and PF domain. In addition, 2-way interactions were tested in order to find out if the impact of one variable depends on the magnitude of the second variable and vice versa.

In the first regression model, all five moderators were added together in order to find out whether or not these moderators might explain the variability in the mean effect size. The multiple regression analysis showed that the model significantly explained the variance in effect sizes, $Q_{Model}(5)= 23.27$, $p < .001$; $Q_{Residual}(190)= 188.53$, $p = .516$.

The second multiple regression analysis was conducted between the divergent thinking indices and age moderators (i.e. divergent thinking indices + age). The results indicated that divergent thinking indices *and* age significantly explained some of the variance in effect sizes, $Q_{Model}(2)= 17.94$, $P < .001$; $Q_{Residual}(193)= 189.51$, $P= .55$. The 2-way interaction analysis between divergent thinking indices and age (i.e. DT indices × age) was significant as well, $Q_{Model}(3)= 18.25$, $P < .001$; $Q_{Residual}(192)= 189.65$, $P= .53$.

A third regression analysis was conducted between the divergent thinking indices and creativity measure moderators. The regression analysis showed that (divergent thinking indices + creativity measure) moderators significantly explained some of the variance in the mean effect size, $Q_{Model}(2)= 12.46$, $P < .01$; $Q_{Residual}(193)= 190.02$, $P= .54$. The 2-way interaction between these two moderators was significant as well, $Q_{Model}(3)= 12.86$, $P < .01$; $Q_{Residual}(192)= 189.78$, $P= .53$.

The fourth regression analysis was conducted to examine if (divergent thinking indices + problem finding domain) moderators may explain variance in effect sizes. The regression analysis showed that these two moderators significantly explained some of the variability in the mean effect size, $Q_{Model}(2)= 16.31$, $P < .001$; $Q_{Residual}(193)= 189.49$, $P= .55$. The 2-way interaction between divergent thinking indices and problem finding domain moderators was significant, $Q_{Model}(3)= 16.46$, $P < .001$; $Q_{Residual}(192)= 189.56$, $P= .53$.

The divergent thinking indices *and* gender moderators explained some of the variance in the summary effect, $Q_{Model}(2)= 15.31$, $P < .001$; $Q_{Residual}(193)= 189.67$, $P= .55$, and the 2-way interaction was significant as well, $Q_{Model}(3)= 20.44$, $P < .001$; $Q_{Residual}(192)= 188.76$, $P= .55$.

Concerning the age group moderator, age *and* problem finding domain significantly explained some of the variance in effect sizes, $Q_{Model}(2)= 6.65$, $P < .05$; $Q_{Residual}(193)= 189.07$, $P= .57$. However, the 2-way interaction between age and problem finding domain was not significant.

Finally, regarding the problem finding domain moderator, the multiple regression analyses of: 1) problem finding domain + creativity measure, and 2) PF domain + gender did not significantly explain the variance in the mean effect size.

How Do Various Terms Used in the Problem Finding Literature Differ from One Another?

In order to answer such a question, a new moderator was created and added, *PF labels*. The labels used in the forty studies were coded and entered into the software. Six categories were created: problem finding ($k= 70$), problem construction ($k=66$), formulation hypotheses ($k= 19$), problem formulation ($k= 10$), problem posing ($k= 11$), and other ($k=20$). The ANOVA analysis showed no significant differences between these labels, $Q(5)= 2.22$, $P = .82$, which means that

using different labels in problem finding and creativity research does not affect the studies' results.

DISCUSSION

This quantitative synthesis identified a significant positive relationship between problem finding and creativity. The *direction* of the relationship between problem finding and creativity was not too surprising since a number of studies that previously examined such a relationship reported positive correlations. What is really interesting was the *magnitude* of the relationship between problem finding and creativity, which was medium according to Cohen's guidelines (Cohen, 1988) compared with other mental processes. For example, Kim (2005), who conducted a meta-analysis study of the relationship between creativity and IQ, found a small correlation between these two constructs, r= .174. In another meta-analysis study of the relationship between creative achievement to both IQ and divergent thinking, Kim (2008) reported a significant relationship between creative achievement and divergent thinking, r= .216. This is very close to the mean effect size found in this study between creativity and problem finding; thus, one question that needs some reflection and thinking from those who study creativity is: *why is problem finding receiving little attention compared to divergent thinking and problem solving in the literature?* (See table 1.1). Answering such a question is beyond the scope of this study and requires more empirical investigations and discussions between those who are interested in studying problem finding.

However, the summary effect size of the relationship between problem finding and creativity showed a high heterogeneity, which called for a search for other factors that might explain such heterogeneity. As mentioned in the method section, the decision behind choosing

these five moderators (i.e. creativity measure, divergent thinking indices, problem finding domain, age, and gender) was not arbitrary; rather, it was based on a comprehensive reading of problem finding literature, consulting some experts who have conducted research regarding the relationship between problem finding and creativity, and some theoretical and practical reasons. For instance, choosing creativity measure as a moderator was based on the fact that creativity is a multidimensional construct, which can be assessed through different angles. In a recent review, Abdulla and Cramond (in press) reviewed about 40 different measures that assess creativity including creative person, process, product, and press measures. Thus, it was expected that using different measures for assessing creativity might affect the findings regarding the relationship between problem finding and creativity. Although the meta-regression results showed that this moderator did not significantly explain variability in the mean effect size, creativity as measured by product was more highly correlated (r= .248) with the mean effect size than creative person (r= .230), problem solving (r= .204), and divergent thinking measures (r= .196).

The second moderator, divergent thinking indices, which was significantly independent from the mean effect size, consisted of four components: fluency, flexibility, originality, and composite for those studies that reported the composite score. Fluency(r= .314) and originality (r= .291) indices were found to be highly correlated with the mean effect compared with flexibility (r= .149). This was consistent with Artley et al. (1980), Runco and Okuda (1988), and Kurtzberg and Reale (1999). For example, Artley et al. (1980) found a significant positive correlation between problem finding quantity and creativity (r= .47, $p < .01$), while Runco and Okuda (1988) reported that the discovered problems elicited significantly *more ideas* than the presented problems.

Problem finding research was conducted in different domains such as *art* (e.g. Bouchard & Drauden (1976); Csikszentmihalyi & Getzels, 1971), *music* (e.g. Barbot & Lubart, 2012), *writing* (e.g. Moore, 1985), *science* (e.g. Hoover, 1994), and *math* (e.g. Chen et al., 2013), and different domain-based measures were used in those studies; therefore, it was important to test whether or not employing different problem finding measures in different domains might explain some variability regarding the relationship between problem finding and creativity. The ANOVA and the meta-regression results showed that problem finding domain moderator significantly explained the variance in the effect sizes. More specifically, studies that assessed problem finding in the writing domain (r= .360) showed a higher correlation with the mean effect size compared with art (r= .199), science and math (r= .162), and social and humanities (r= .091) domains. One possible explanation is that writing tasks might elicit more ill defined problems than science and math tasks for some reasons that need to be explored in future research.

The fourth moderator, age group, was considered in this study since there is a solid theoretical reason to expect that age might moderate the problem finding and creativity relationship. Arlin (1975a, 1975b, 1977), for example, suggested that problem finding is a post formal stage in which older students might possess higher levels of problem finding compared with younger students. However, the age group moderator finding was contrary to this argument and the results indicated that in problem finding and creativity relationships, children (r= .297) performed better than adolescents (r= .113) and adults (r= .207). In other words, problem finding in children was more related to creativity than in adolescents and adults. One question that might be interesting and needs more empirical investigation is: *why is there a drop in the relationship between problem finding and creativity in the adolescent age group*?

Concerning gender, although the results showed that females were more highly correlated with the mean effect size than males (r= .293 vs. r= .183), the omnibus test indicated no significant differences between gender and the mean effect size. This may be due to the low number of effect sizes in the male (k= 15) and the female (k= 17) groups. Only a few researchers questioned the possible gender differences in problem finding and creativity relationship (e.g. Bouchard and Drauden, 1976). Most studies consisted of mixed samples. Therefore, it might be interesting to conduct more studies that compare males and females in problem finding skills since there is a scarcity of such research.

Finally, regarding the use of different problem finding labels in the problem finding research, the results showed that there is no significant difference between different problem finding terms used in problem finding and creativity research. One explanation for such a finding is that researchers in different domains have their preference in regard to using a specific term. For instance, it was found that researchers who study problem finding in mathematics prefer using the term problem posing, while those who study problem finding in science prefer to use the term formulating hypotheses. However, although the current finding shows no real differences between those different terms in effect, one suggestion this study offers is that there might be important differences which could be explained by: 1) how well- or ill-defined the problem is, and 2) the degree to which ideation and evaluation are required. Based on these two criteria, the Creative Problem Finding Hierarchy (CPFH) was developed. The CPFH tries to distinguish five problem-finding processes (see chapter 2). However, this is a newly developed hierarchy, which needs to be tested in future studies. It is important to note that this finding (i.e. no differences between different terms) might not be very accurate and it only applies to problem finding and creativity research. In the current analysis, these different terms were coded without

examining the definition offered for each term. As a result, it might be interesting to conduct a study that examines those definitions and comes up with a more accurate answer regarding the possible differences between those terms.

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CHAPTER 4

CONCLUSION

This collection of two studies aimed to answer three research questions. The first two questions were concerned with the relationship between problem finding and creativity and the third was intended to discover whether or not using different terms in problem finding and creativity research might result in different findings. The introductory chapter discussed the rationale behind conducting a meta-analysis study regarding the relationship between problem finding and creativity. The main study variables were discussed and defined. This chapter ended with presenting the research questions.

The second chapter examined one of the dilemmas in the problem finding literature: various terms were used in the previous studies to describe the same construct. The qualitative review showed that at least 13 different terms have been used in order to describe problem finding. First, it was necessary to define the term "problem" before trying to solve such a problem. Different kinds of classifications for the term "problem" were found in the literature such as well-defined problem vs. ill-defined problem and presented problem vs. discovered problem. It is evident that problem finding deals with ill-defined and discovered problems rather than well-defined and presented problems. A comprehensive review of literature showed that the majority of the identified works (N=199) utilized the term problem finding (50.3%), researchers in other domains such as science and mathematics have their preference regarding the label they prefer to use, some researchers used these terms interchangeably in the same work or in different

works, and only a few tried to distinguish between some of those terms. One attempt to solve the problem of using various terms was The Creative Problem Finding Hierarchy (CPFH). This hierarchy was based on Getzels' 10 types of problems, on Basadur's optimal ideation-evaluation theory, and on a few other works, which suggest that there are differences between some of the terms (see chapter 2). The CPFH distinguishes five problem finding processes based on two dimensions: 1) to what degree the problem is ill-defined, and 2) to what degree ideation and evaluation are required in each process. It is suggested that problem discovery (PD1) represents the highest level of the ill-defined problems and it relies considerably on ideation rather than evaluation. The second process is problem formulation (PF) in which both ideation and evaluation are needed, but ideation might still be *more* important in this process than evaluation. Another feature that distinguishes problem formulation is that individuals have *some* information about the problem to be found. The third process in the hierarchy is problem construction (PC). Both, ideation and evaluation might be *equally important* in this process. In the problem construction process, the problem finder has more *awareness and information* regarding how the problem might be constructed. The problem identification (PI), the fourth process, is the opposite of the problem formulation; it requires using more evaluative thinking than ideation. In PI, the problem exists but remains to be identified by the problem finder. Finally, problem definition (PD2) refers to the problem that already exists but needs to be defined through using some evaluative skills. In this case, evaluation is more prominent than ideation. Some limitations for the CPFH are discussed at the end of chapter two.

The third chapter was a meta-analysis study of the relationship between problem finding and creativity. The literature review section shed light on previous research that examined the relationship between problem finding and creativity. The literature review section was divided

into three main parts: 1) problem finding and creative process, 2) problem finding and creative person, and 3) problem finding and creative product. The method section discussed some issues related to meta-analysis studies such as locating research, coding procedure, publication bias, heterogeneity and moderator analyses. This meta-analysis study followed the APA guidelines for reporting meta-analysis studies (see appendix A). Regarding the question raised in the first chapter of whether or not problem finding is important for creativity, the answer was *yes*. It was found that the mean effect size was slightly higher than the mean effect size that Kim (2005) reported regarding the relationship between divergent thinking and creative achievement. Due to the high heterogeneity found in the summary effect, five moderators were analyzed to find out if one or more of those moderators might be independent from the mean effect size. Three out of the five moderators significantly explained the variability in the mean effect size: DT indices, PF domain, and age. One reason to conclude that problem finding is important for creativity is what the "DT indices" moderator analysis revealed: originality was highly correlated with the mean effect size (r= .291). Originality is one essential criterion for creativity in addition to appropriateness.

Regarding the PF domain, it was found that the writing domain was more highly correlated with the mean effect size than any other domain (r= .360). This finding may encourage problem finding researchers to develop measures that are writing-based. Finally, unexpectedly, the age group moderator results showed that the children's group (6 to 11 years) was more highly correlated with the mean effect size than the adults' group (above 18 years). Another interesting finding was the obvious slump with the adolescents' group compared with the children's group. This might need more empirical investigation to find out why the relationship between problem finding and creativity drops at adolescence.

Although the ANOVA results showed that the female group (r= .293) outperformed the male group (r= .183), the omnibus test showed that the gender moderator was not independent from the mean effect size. This was due to the low number of effect sizes in male (N=15) and female groups (N= 17). Most of the studies were conducted on samples consisting of both genders (e.g. Arreola, 2012; Artley, Van Horn, Friedrich, & Carroll, 1980; Carson & Runco; Hoover, 1994; Lee & Cho, 2007; Okuda, Runco, & Berger, 1991; Wakefield, 1985). Only a few studies comparing males and females in problem finding were found and the results were contradictory (e.g. Bouchard & Drauden, 1976; Hoover, 1994; Hoover & Feldhusen, 1990; Frederiksen & Evans, 1974). The rest of the studies used either male or female samples (e.g. Arlin, 1975; Csikszentmihalyi & Getzels, 1971; Rostan, 1994). Another recommendation is to conduct more studies that examine gender differences in problem finding skills.

There are other topics that this study recommends. First, although some studies looked at the relationship between problem finding and some personality characteristics, we need to know more about "problem finders." Who are problem finders and what personality characteristics distinguish them from problem solvers, for example. Second, in terms of the mental process, this study looked at the relationship between problem finding and creativity, which was defined in many studies as divergent thinking. An interesting topic, which is related to the ideation-evaluation theory, is the relationship between problem finding and convergent thinking. The problem finding literature showed that there is a scarcity regarding such a relationship. Finally, the issue of having a low number of studies on problem finding might be due to the lack of measures offered to assess problem finding. Thus, this study recommends and encourages researchers to design measures that can be used to assess problem finding and explore who the problem finders are.

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APPENDIX A

META-ANALYSIS REPORTING STANDARDS (MARS)

Paper Section and topic	Description
Title	Make it clear that the report describes a research synthesis and include "meta-analysis," if applicable
	Footnote funding sources(s)
Abstract	The problem or relation(s) under investigation
	Study eligibility criteria
	Type(s) of participants included in primary studies
	Meta-analysis methods (indicating whether a fixed or random model was used)
	Main results (including the more important effect sizes and any important moderators of these effect sizes)
	Conclusions (including limitations)
	Implications for theory, policy, and/or practice
Introduction	Clear statement of the question or relation(s) under investigation
	Historical background
	Theoretical, policy, and/or practical issues related to the question or relation(s) of interest
	Rationale for the selection and coding of potential moderators and mediators of results
	Types of study designs used in the primary research, their strengths and weaknesses
	Types of predictor and outcome measures used, their psychometric characteristics
	Populations to which the question or relation is relevant
	Hypotheses, if any
Method	**Inclusion and exclusion criteria**
	Operational characteristics of independent (predictor) and dependent (outcome) variable(s)
	Eligible participant populations
	Eligible research design features (e.g., random assignment only, minimal sample size)
	Time period in which studies needed to be conducted
	Geographical and/or cultural restrictions
	Moderator and mediator analyses
	Definition of all coding categories used to test moderators or mediators of the relation(s) of interest
	Search strategies
	Reference and citation databases searched
	Keywords used to enter databases and registries
	Search software used and version
	Time period in which studies needed to be conducted, if applicable
	Listservs queried
	Contacts made with authors (and how authors were chosen)
	Reference lists of reports examined
	Method of addressing reports in languages other than English

	Aspects of reports were examined (i.e., title, abstract, and/or full text)
	Number and qualifications of relevance judges
	Indication of agreement
	How disagreements were resolved
	Treatment of unpublished studies
	Coding procedures
	Number and qualifications of coders (e.g., level of expertise in the area, training)
	Intercoder reliability or agreement
	Whether each report was coded by more than one coder and if so, how disagreements were resolved
	If a quality scale was employed, a description of criteria and the procedures for application
	If study design features were coded, what these were
	How missing data were handled
	Statistical methods
	Effect sizes calculating formulas (e.g., Ms and SDs, use of univariate F to r transform)
	Corrections made to effect sizes (e.g., small sample bias, correction for unequal ns)
	Effect size averaging and/or weighting method(s)
	How effect size confidence intervals (or standard errors) were calculated
	How effect size credibility intervals were calculated, if used
	How studies with more than one effect size were handled
	Whether fixed and/or random effects models were used and the model choice justification
	How heterogeneity in effect sizes was assessed or estimated
	Ms and SDs for measurement artifacts, if construct-level relationships were the focus
	Tests and any adjustments for data censoring (e.g., publication bias, selective reporting)
	Tests for statistical outliers
	Statistical power of the meta-analysis
	Statistical programs or software packages used to conduct statistical analyses
Results	Number of citations examined for relevance
	List of citations included in the synthesis
	Number of citations relevant on many but not all inclusion criteria excluded from the meta-analysis
	Number of exclusions for each exclusion criterion (e.g., effect size could not be calculated), with examples
	Table giving descriptive information for each included study, including effect size and sample size
	Assessment of study quality, if any
	Overall characteristics of the database (e.g., number of studies with different research designs)

	Overall effect size estimates, including measures of uncertainty (e.g., confidence and/or credibility intervals)
	Number of studies and total sample sizes for each moderator analysis
	Assessment of interrelations among variables used for moderator and mediator analyses
	Assessment of bias including possible data censoring
Discussion	Statement of major findings
	Impact of data censoring
	Relevant populations
	Treatment variations
	Dependent (outcome) variables
	Research designs
	General limitations (including assessment of the quality of studies included)
	Implications and interpretation for theory, policy, or practice
	Guidelines for future research

Publication manual of the American Psychological Association (2010). Washington, DC: American Psychological Association

APPENDIX B

THE INCLUSION AND EXCLUSION CRITERIA FOR THE PF AND CREATIVITY META-ANALYSIS

	Author(s)/Year	Study Title	Publication Type	Appropriate Quantified Measures (Y/N)	Sufficient Statistical Information (Y/N)	No Redundancy (Y/N)	Published in English (Y/N)	Problem Finding and creativity measures (Y/N)	Decision (Include/Exclude)
1.	Abramovich & Cho (2006)	Technology as a Medium for Elementary Preteachers' Problem-Posing Experience in Mathematics.	Journal Article	N	N	Y	Y	N	Exclude
2.	Adeyemo (2001)	Mode of representation and instructions in solutions to practical construction problems.	Journal Article	Y	Y	Y	Y	N	Exclude
3.	Allaire & Marsiske (2002)	Well- and ill-defined measures of everyday cognition: relationship to older adults' intellectual ability and functional status.	Journal Article	Y	Y	Y	Y	N	Exclude
4.	Allen & Thomas (2011)	A Dual Process Account of Creative Thinking.	Journal Article	N	N	Y	Y	N	Exclude
5.	Ambrosio (1994)	Social problem finding: A cognitive-developmental perspective.	Dissertation	Y	Y	Y	Y	Y	**Include**
6.	Ananda & Pedro (2001)	Interpreting, categorizing and responding to the environment: the role of culture in strategic problem definition.	Journal Article	N	N	Y	Y	N	Exclude
7.	Anderson, Hughes, & Sharrock (1987)	Executive Problem Finding: Some Material and Initial Observations.	Journal Article	N	N	Y	Y	N	Exclude
8.	Antonietti (1991)	Effects of partial analogies on solving an ill-defined problem.	Journal Article	N	Y	Y	Y	N	Exclude
9.	Arlin (1975a)	A Cognitive Process Model of Problem Finding.	Journal Article	Y	Y	N	Y	Y	Exclude

	Author(s)/Year	Study Title	Publication Type	Appropriate Quantified Measures (Y/N)	Sufficient Statistical Information (Y/N)	No Redundancy (Y/N)	Published in English (Y/N)	Problem Finding and creativity measures (Y/N)	Decision (Include/Exclude)
10.	Arlin (1975b)	Cognitive Development in Adulthood: A Fifth Stage?	Journal Article	Y	Y	Y	Y	Y	**Include**
11.	Arlin (1977)	Piagetian Operations in Problem Finding.	Journal Article	Y	N	Y	Y	Y	Exclude
12.	Arreola (2012)	The Influence of Personality on Problem Construction and Creative Problem Solving.	Thesis	Y	Y	Y	Y	Y	**Include**
13.	Artley, Van Horn, Friedrich, & Carroll (1980)	The relationship between problem finding, creativity and cognitive style.	Journal Article	Y	Y	Y	Y	Y	**Include**
14.	Auclair (2007)	Problem formulation by medical students: an observation study.	Journal Article	Y	Y	Y	Y	N	Exclude
15.	Baer (1988)	Long-term effects of creativity training with middle school students.	Journal Article	Y	N	Y	Y	Y	Exclude
16.	Baker (1991)	Components of Efficient Problem-Solving: A Perspective on Creative Discovery.	Dissertation	Y	Y	Y	Y	N	Exclude
17.	Barber (1981)	Children's problem finding and creative responses in and between reading and art.	Thesis	Y	Y	Y	Y	Y	**Include**
18.	Barbot & Lubart (2012)	Creative thinking in music: Its nature and assessment through musical exploratory behaviors.	Journal Article	Y	Y	Y	Y	Y	**Include**
19.	Basadur (1995)	Optimal Ideation-Evaluation Ratios.	Journal Article	Y	N	Y	Y	Y	Exclude
20.	Basadur (1980)	Training in creative problem solving: Effects on deferred judgment and problem finding and solving in an industrial research organization.	Dissertation	Y	Y	N	Y	Y	Exclude

	Author(s)/Year	Study Title	Publication Type	Appropriate Quantified Measures (Y/N)	Sufficient Statistical Information (Y/N)	No Redundancy (Y/N)	Published in English (Y/N)	Problem Finding and creativity measures (Y/N)	Decision (Include/Exclude)
21.	Basadur, Graen, & Green (1982)	Training in Creative Problem Solving: Effects on Ideation and Problem Finding and Solving in an Industrial Research Organization.	Journal Article	Y	Y	Y	Y	Y	Exclude
22.	Basadur, Runco, & Vega (2000)	Understanding how creative thinking skills, attitudes and behaviors work together: A causal process model.	Journal Article	Y	Y	Y	Y	N	Exclude
23.	Bennett (2002)	Embracing the ill-structured problem in a community economic development clinic.	Journal Article	N	N	Y	Y	N	Exclude
24.	Berg, Meegan, & Klaczynski (1999)	Age and Experiential Differences in Strategy Generation and Information Requests for Solving Everyday Problems.	Journal Article	Y	Y	Y	Y	N	Exclude
25.	Bernardo (2001)	Analogical problem construction and transfer in mathematical problem solving.	Journal Article	N	Y	Y	Y	N	Exclude
26.	Best (1977)	Problem space generation and development in the game of MasterMind.	Dissertation	Y	Y	Y	Y	N	Exclude
27.	Bian, Minhong, Spector, & Yang (2013)	Design of a Dual-Mapping Learning Approach for Problem Solving and Knowledge Construction in Ill-Structured Domains.	Journal Article	Y	Y	Y	Y	N	Exclude
28.	Blackburn (2013)	Assessing the Effects of Cognitive Style, Hypothesis Generation, and Problem Complexity on the Problem Solving Ability of School-Based Agricultural Education Students: An Experimental Study.	Dissertation	Y	Y	Y	Y	N	Exclude
29.	Blissett & McGrath (1996)	The relationship between creativity and interpersonal problem-solving skills in adults.	Journal Article	Y	Y	Y	Y	N	Exclude
30.	Bouchard & Drauden (1976)	Discovery-oriented behavior and problem solving.	Journal Article	Y	Y	Y	Y	Y	**Include**
31.	Brinkman (1994)	The effect of problem finding and creativity style on the musical compositions of high school students.	Dissertation	Y	Y	N	Y	Y	Exclude

	Author(s)/Year	Study Title	Publication Type	Appropriate Quantified Measures (Y/N)	Sufficient Statistical Information (Y/N)	No Redundancy (Y/N)	Published in English (Y/N)	Problem Finding and creativity measures (Y/N)	Decision (Include/Exclude)
32.	Brinkman (1999)	Problem Finding, Creativity Style and the Musical Compositions of High School Students.	Journal Article	Y	N	Y	Y	Y	Exclude
33.	Brooke, Duncan, & Cooper (1980)	Interactive instruction in solving fault-finding problems: An experimental study.	Journal Article	Y	Y	Y	Y	N	Exclude
34.	Brugman (1995)	The discovery and formulation of problems.	Journal Article	N	N	Y	Y	N	Exclude
35.	Brugman (1991)	Problem finding: Discovering and formulating problems.	Journal Article	N	N	Y	Y	N	Exclude
36.	Butler, Scherer, & Reiter-Palmon (2003)	Effects of Solution Elicitation Aids and Need for Cognition on the Generation of Solutions to Ill-Structured Problems.	Journal Article	Y	Y	Y	Y	N	Exclude
37.	Büyükdamgacı (2003)	Process of organizational problem definition: how to evaluate and how to improve.	Journal Article	Y	Y	Y	Y	N	Exclude
38.	Cai (1997)	An Investigation of U.S. and Chinese Students' Mathematical Problem Posing and Problem Solving.	Conference Paper	Y	Y	Y	Y	N	Exclude
39.	Cai (2003)	Singaporean students' mathematical thinking in problem solving and problem posing: an exploratory study.	Journal Article	Y	Y	Y	Y	N	Exclude
40.	Cai & Hwang (2002)	Generalized and generative thinking in US and Chinese students' mathematical problem solving and problem posing.	Journal Article	Y	Y	Y	Y	N	Exclude
41.	Carson & Runco (1999)	Creative problem solving and problem finding in young adults: Interconnections with stress, hassles, and coping abilities.	Journal Article	Y	Y	Y	Y	Y	**Include**
42.	Chand & Runco (1993)	Problem finding skills as components in the creative process.	Journal Article	Y	Y	Y	Y	Y	**Include**

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43.	Chang, Wu, Weng, & Sung (2012)	Embedding game-based problem-solving phase into problem-posing system for mathematics learning.	Journal Article	Y	N	Y	Y	N	Exclude
44.	Chen, Van Dooren, & Verschaffel (2015)	Enhancing the Development of Chinese Fifth-Graders Problem-Posing and Problem-Solving Abilities, Beliefs, and Attitudes: A Design Experiment.	Book Chapter	Y	Y	N	Y	Y	Exclude
45.	Chen, Van Dooren, & Verschaffel (2013)	The Relationship between Students' Problem Posing and Problem Solving Abilities and Beliefs: A Small-Scale Study with Chinese Elementary School Children.	Journal Article	Y	Y	Y	Y	Y	**Include**
46.	Chen, Van Dooren, Chen, & Verschaffel (2010)	An investigation on Chinese teachers' realistic problem posing and problem solving ability and beliefs.	Journal Article	Y	N	Y	Y	Y	Exclude
47.	Ching (2009)	The effects of computer-based video strategy training for problem representation and self-explanation on undergraduate students representing and solving ill-structured problems.	Dissertation	Y	Y	Y	Y	Y	**Include**
48.	Christou, Mousoulides, Pittalis, & Pitta-Pantazi (2005)	Problem solving and problem posing in a dynamic geometry environment.	Journal Article	N	N	Y	Y	N	Exclude
49.	Ciarrochi, Leeson, & Heaven (2009)	A Longitudinal Study into the Interplay between Problem Orientation and Adolescent Well-Being.	Journal Article	Y	Y	Y	Y	N	Exclude
50.	Clemmensen (2012)	Usability problem identification in culturally diverse settings.	Journal Article	N	N	Y	Y	N	Exclude
51.	Cleven & Gutkin (1988)	Cognitive Modeling of Consultation Processes: A Means for Improving Consultees' Problem Definition Skills.	Journal Article	N	Y	Y	Y	N	Exclude

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52.	Clinton & Torrance (1986)	S.E.A.M.: A training program for developing problem identification skills.	Journal Article	N	Y	Y	Y	N	Exclude
53.	Conoley, Conoley, & Gumm (1992)	Effects of Consultee Problem Presentation and Consultant Training on Consultant Problem Definition.	Journal Article	N	Y	Y	Y	N	Exclude
54.	Copland (2003)	Developing the Problem-Framing skills of Prospective Principals.	Conference Paper	N	Y	Y	Y	N	Exclude
55.	Courtney, Caniglia, & Singh (2014)	Investigating the Impact of Field Trips on Teachers' Mathematical Problem Posing.	Journal Article	Y	Y	Y	Y	N	Exclude
56.	Cropper, Meck, & Ash (1977)	The relation between formal operations and a possible fifth stage of cognitive development.	Journal Article	Y	Y	Y	Y	Y	**Include**
57.	Csikszentmihalyi (1988)	Solving a problem is not finding a new one: A reply to Simon.	Journal Article	N	N	Y	Y	N	Exclude
58.	Csikszentmihalyi & Getzels (1970)	Concern for discovery: An attitudinal component of creative production.	Journal Article	Y	Y	Y	Y	Y	**Include**
59.	Csikszentmihalyi & Getzels (1971)	Discovery-oriented behavior and the originality of creative products: a study with artists.	Journal Article	Y	Y	Y	Y	Y	**Include**
60.	Czarnik & Hickey (1997)	Problem Generation in the Mission to Mars Curriculum.	Conference Paper	Y	Y	Y	Y	N	Exclude
61.	Dandan et al. (2013)	Brain mechanisms of valuable scientific problem finding inspired by heuristic knowledge.	Journal Article	Y	Y	Y	Y	N	Exclude
62.	Davis (1989)	Strategic decision making behavior: Aspects of the problem formulation phase.	Journal Article	Y	Y	Y	Y	N	Exclude
63.	Davis (1977)	The Process of problem finding: A production-marketing example.	Journal Article	N	N	Y	Y	N	Exclude

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64.	De Ponte & Henriques (2013)	Problem posing based on investigation activities by university students.	Journal Article	Y	Y	Y	Y	N	Exclude
65.	Diakidoy & Constantinou, (2001)	Creativity in Physics: Response Fluency and Task Specificity.	Journal Article	Y	Y	Y	Y	N	Exclude
66.	Dillon (1982)	Problem Finding and Solving.	Journal Article	N	N	Y	Y	N	Exclude
67.	Dillon (1988)	Level of Problem Finding vs. Problem Solving	Journal Article	Y	Y	Y	Y	N	Exclude
68.	Dixon & Bangert (2004)	On the Spontaneous Discovery of a Mathematical Relation during Problem Solving.	Journal Article	Y	Y	Y	Y	N	Exclude
69.	Dumont (1993)	Inferential heuristics in clinical problem formulation: Selective review of their strengths and weaknesses.	Journal Article	N	N	Y	Y	N	Exclude
70.	Dudek & Cote	Problem Finding Revisited.	Book Chapter	Y	Y	Y	Y	Y	**Include**
71.	Dyer & Schiller (1993)	"Not Wilting Flowers Again!": Problem Finding and Problem Solving in Movement and Performance.	Journal Article	N	N	Y	Y	N	Exclude
72.	English (1998)	Children's Problem Posing within Formal and Informal Contexts.	Journal Article	Y	Y	Y	Y	N	Exclude
73.	Fontenot (1988)	The effects of training in creativity and creative problem-finding upon business people as measured by fluency, flexibility, and quality of the problem statement.	Dissertation	N	Y	N	Y	Y	Exclude
74.	Fontenot (1993)	Effects of Training in Creativity and Creative Problem Finding Upon Business People.	Journal Article	N	Y	Y	Y	Y	Exclude
75.	Franske (2009)	Engineering Problem Finding in High School Students.	Dissertation	Y	N	Y	Y	Y	Exclude

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76.	Frederiksen & Evans (1972)	Effects of Models of Creative Performance on Ability to Formulate Hypotheses	Journal Article	Y	Y	Y	Y	Y	**Include**
77.	Frederiksen & Ward (1978)	Measures for the Study of Creativity in Scientific Problem-Solving	Journal Article	Y	Y	Y	Y	Y	**Include**
78.	Gartland (1978)	The relationship of problem finding to selected formal-operational Piagetian tasks in middle adolescents.	Dissertation	Y	Y	Y	Y	N	Exclude
79.	Getzels (1985)	Problem Finding and the Enhancement of Creativity.	Journal Article	N	N	Y	Y	N	Exclude
80.	Getzels (1975b)	Problem-Finding and the Inventiveness of Solutions.	Journal Article	N	N	Y	Y	N	Exclude
81.	Getzels (1979)	Problem Finding: a Theoretical Note.	Journal Article	N	N	Y	Y	N	Exclude
82.	Getzels (1982)	The Problem of the Problem	Book Chapter	N	N	Y	Y	N	Exclude
83.	Getzels & Csikszentmihalyi (1976)	The Creative Vision: A Longitudinal Study of Problem Finding in Art	Book	Y	Y	N	Y	Y	Exclude
84.	Getzels & Csikszentmihalyi (1975)	From Problem Solving to Problem Finding.	Book Chapter	Y	Y	N	Y	Y	Exclude
85.	Getzels & Smilansky (1983)	Individual differences in pupil perceptions of school problems.	Journal Article	Y	Y	Y	Y	Y	**Include**
86.	Goldsmith & Matherly (1986)	Seeking simpler solutions: Assimilators and explorers, adaptors and innovators.	Journal Article	Y	Y	Y	Y	N	Exclude
87.	Guerrera (1995)	Testing the effectiveness of problem-based learning through problem generation and problem solving with high school biology students.	Thesis	Y	Y	Y	Y	N	Exclude

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88.	Grawitch, Munz, Elliott, & Mathis (2003)	Promoting creativity in temporary problem-solving groups: The effects of positive mood and autonomy in problem definition on idea-generating performance.	Journal Article	Y	Y	Y	Y	N	Exclude
89.	Greeno, Magone, & Chaiklin (1979)	Theory of constructions and set in problem solving.	Journal Article	Y	Y	Y	Y	N	Exclude
90.	Haiyan, Weiping, & Jiliang (2010)	School Environment Effects on the Relations Between Adolescents' Personality and Creative Scientific Problem Finding.	Journal Article	Y	Y	Y	N	Y	Exclude
91.	Harms (2014)	The Effects of Problem Construction and Information on Creative Problem Solving.	Thesis	Y	Y	Y	Y	Y	**Include**
92.	Han, Hu, Liu, Jia, & Adey (2013)	The Influence of Peer Interaction on Students' Creative Problem-Finding Ability.	Journal Article	N	Y	Y	Y	Y	Exclude
93.	Heylighen (1988)	Formulating the Problem of Problem-Formulation.	Book Chapter	N	N	Y	Y	N	Exclude
94.	Holtz (2002)	Effect of graduate medical education on the divergent thinking and problem finding abilities of resident physicians: A pilot study.	Dissertation	Y	N	Y	Y	Y	**Include**
95.	Hoover (1994)	Scientific problem finding in gifted fifth-grade students.	Journal Article	Y	Y	Y	Y	Y	**Include**
96.	Hoover & Feldhusen (1990)	The scientific hypothesis formulation ability of gifted ninth-grade students.	Journal Article	Y	Y	Y	Y	Y	**Include**
97.	Hoover & Feldhusen (1994)	Scientific Problem Solving and Problem Finding: A Theoretical Model.	Book Chapter	Y	Y	N	Y	Y	Exclude
98.	Howson & Westbury (1980)	Creative Activity in Mathematics Education: A First Attempt at Definition and Problem-Identification.	Conference Paper	N	N	Y	Y	N	Exclude

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99.	Hsieh, Nickerson, & Zenger (2007)	Opportunity Discovery, Problem Solving and a Theory of the Entrepreneurial Firm.	Journal Article	N	N	Y	Y	N	Exclude
100.	Hunter, Bedell-Avers, Hunsicker, Mumford, & Ligon (2008)	Applying Multiple Knowledge Structures in Creative Thought_ Effects on Idea Generation and Problem-Solving.	Journal Article	N	Y	Y	Y	Y	Exclude
101.	Hu, Shai, Han, Wang, & Adey (2010)	Creative Scientific Problem Finding and its Developmental Trend.	Journal Article	Y	Y	Y	Y	Y	**Include**
102.	Illies & Reiter-Palmon (2004)	The Effects of Type and Level of Personal Involvement on Information Search and Problem Solving.	Journal Article	Y	Y	Y	Y	N	Exclude
103.	Jaarsveld (2010)	Solving and Creating Raven Progressive Matrices: Reasoning in Well- and Ill-Defined Problem Spaces.	Journal Article	Y	N	Y	Y	Y	Exclude
104.	Jaarsveld, Lachmann, & van Leeuwen (2012)	Creative reasoning across developmental levels: Convergence and divergence in problem creation.	Journal Article	Y	Y	Y	Y	Y	**Include**
105.	Jarman (2014)	Quantifying the qualitative: Measuring the insight experience.	Journal Article	Y	Y	Y	Y	N	Exclude
106.	Jausovec (1994)	Metacognition in Creative Problem Solving.	Book Chapter	Y	Y	Y	Y	Y	**Include**
107.	Jausovec (1997)	Differences in EEG Activity During the Solution of Closed and Open Problems.	Journal Article	Y	Y	Y	Y	N	Exclude
108.	Jay (1996)	The nature of problem finding in students' scientific inquiry.	Thesis	Y	Y	Y	Y	N	Exclude
109.	Kapur (2015)	The preparatory effects of problem solving versus problem posing on learning from instruction.	Journal Article	Y	Y	Y	Y	N	Exclude

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110.	Kar, Özdemir, İpek, & Albayrak (2010)	The relation between the problem posing and problem solving skills of prospective elementary mathematics teachers.	Journal Article	Y	Y	Y	Y	N	Exclude
111.	Kay (1991)	The figural problem solving and problem finding of professional and semiprofessional artists and nonartists.	Journal Article	Y	N	Y	Y	Y	Exclude
112.	Kay (1994)	From theory to practice--Promoting problem-finding behavior in children.	Journal Article	N	N	Y	Y	N	Exclude
113.	Kay (1994)	A Method for Investigating the Creative Thought Process.	Book Chapter	N	N	Y	Y	N	Exclude
114.	Kilic (2013)	Determining the Performances of Pre-Service Primary School Teachers in Problem Posing Situations.	Journal Article	N	N	Y	Y	N	Exclude
115.	Kintsch & Greeno (1985)	Understanding and solving word arithmetic problems.	Journal Article	N	N	Y	Y	N	Exclude
116.	Klavir & Gorodetsky (2011)	Features of Creativity as Expressed in the Construction of New Analogical Problems by Intellectually Gifted Students.	Journal Article	Y	Y	Y	Y	N	Exclude
117.	Kochen & Badre (1974)	Questions and Shifts of Representation in Problem Solving.	Journal Article	Y	Y	Y	Y	Y	**Include**
118.	Kohfeldt & Langhout (2012)	The Five Whys Method: A Tool for Developing Problem Definitions in Collaboration with Children.	Journal Article	N	N	Y	Y	N	Exclude
119.	Kojima & Miwa (2008)	A System that Facilitates Diverse Thinking in Problem Posing.	Journal Article	Y	Y	Y	Y	N	Exclude

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120.	Kojima, Miwa, & Matsui (2013)	Supporting Mathematical Problem Posing with a System for Learning Generation Processes through Examples.	Journal Article	Y	Y	Y	Y	N	Exclude
121.	Kontorovich, Koichu, Leikin, & Berman (2012)	An exploratory framework for handling the complexity of mathematical problem posing in small groups.	Journal Article	N	N	Y	Y	N	Exclude
122.	Kornreich (1969)	Discovery versus programmed instruction in teaching a strategy for solving concept-identification problems.	Journal Article	Y	Y	Y	Y	N	Exclude
123.	Kotovsky, Hayes, & Simon (1985)	Why are some problems hard? Evidence from Tower of Hanoi.	Journal Article	Y	Y	Y	Y	N	Exclude
124.	Kousoulas & Mega (2009a)	Students' Divergent Thinking and Teachers' Ratings of Creativity: Does Gender Play a Role?	Journal Article	Y	Y	Y	Y	N	Exclude
125.	Kousoulas & Mega (2009b)	Creative and critical thinking in the context of problem finding and problem solving: A research among students in primary school.	Journal Article	Y	Y	Y	Y	Y	**Include**
126.	Kurtzberg & Reale (1999)	Using Torrance's problem identification techniques to increase fluency and flexibility in the classroom.	Journal Article	Y	N	Y	Y	Y	Exclude
127.	LaBanca & Ritchie (2010)	Impact of problem finding on the quality of authentic open inquiry science research projects.	Journal Article	N	N	Y	Y	N	Exclude
128.	LaBanca (2008)	Impact of Problem Finding on the Quality of Authentic Open Inquiry Science Research Projects.	Dissertation	N	N	Y	Y	N	Exclude
129.	LaBanca (2012)	The Creative Process of Problem Finding Manifested in Open Inquiry.	Conference Paper	N	N	Y	Y	N	Exclude
130.	Lai & Grønhaug (1994)	Managerial problem finding: Conceptual issues and research findings.	Journal Article	N	N	Y	Y	N	Exclude

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131.	Laidig (1995)	Problem finding, problem defining, and problem solving by novice clinical teachers in nursing.	Dissertation	N	N	Y	Y	N	Exclude
132.	Lavy & Bershadsky (2003)	Problem posing via "what if not?" strategy in solid geometry — a case study.	Journal Article	N	N	Y	Y	N	Exclude
133.	Lavy & Shriki (2010)	Engaging in problem posing activities in a dynamic geometry setting and the development of prospective teachers' mathematical knowledge.	Journal Article	N	N	Y	Y	N	Exclude
134.	Lee, Ng, & Ng (2009)	'The contributions of working memory and executive functioning to problem representation and solution generation in algebraic word problems': Correction.	Journal Article	Y	Y	Y	Y	N	Exclude
135.	Lee & Cho (2007)	Factors Affecting Problem Finding Depending on Degree of Structure of Problem Situation.	Journal Article	Y	Y	Y	Y	Y	**Include**
136.	Liggett (1991)	Creativity and Non-Literary Writing: The Importance of Problem Finding.	Journal Article	N	N	Y	Y	N	Exclude
137.	Lin & Lien (2013)	The Different Role of Working Memory in Open-Ended Versus Closed-Ended Creative Problem Solving: A Dual-Process Theory Account.	Journal Article	Y	Y	Y	Y	N	Exclude
138.	Lin, Hsu, Chen, & Wang (2012)	The relations of gender and personality traits on different creativities: A dual-process theory account.	Journal Article	Y	Y	Y	Y	N	Exclude
139.	Lyles (2014)	Organizational learning, knowledge creation, problem formulation and innovation in messy problems.	Journal Article	N	N	Y	Y	N	Exclude
140.	Magne & Ingrand (2004)	Advising Beef-Cattle Farmers: Problem-Finding Rather than Problem-Solving. Characterization of Advice Practices in Creuse.	Journal Article	N	N	Y	Y	N	Exclude

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141.	Malhotra (1974)	A descriptive model of detailed problem-finding behavior.	Working Paper	N	N	Y	Y	N	Exclude
142.	Massey & Wallace (1996)	Understanding and facilitating group problem structuring and formulation: Mental representations, interaction, and representation aids.	Journal Article	Y	Y	Y	Y	N	Exclude
143.	McDaniel & Schlager (1990)	Discovery Learning and Transfer of Problem-Solving Skills.	Journal Article	Y	Y	Y	Y	N	Exclude
144.	McWhirt, Reynolds, & Achilles (1989-1990)	You can't cure it if you don't know you have it.	Journal Article	N	N	Y	Y	N	Exclude
145.	Mestre (2002)	Probing adults' conceptual understanding and transfer of learning via problem posing.	Journal Article	N	N	Y	Y	N	Exclude
146.	Mingers & Rosenhead (2004)	Invited Review: Problem structuring methods in action.	Journal Article	N	N	Y	Y	N	Exclude
147.	Mitchell (1993)	Relationships between types of problem representations and three human ability factors.	Dissertation	Y	Y	Y	Y	N	Exclude
148.	Moore & Carlson (2012)	Students' images of problem contexts when solving applied problems.	Journal Article	N	N	Y	Y	N	Exclude
149.	Moore (1982)	The Relationship between Problem-Finding and Originality, Craftsmanship and Aesthetic Value of the Written Product in Two Groups of Student Writers.	Dissertation	Y	N	Y	Y	Y	Exclude
150.	Moore (1984)	The relationship between problem-finding and originality, craftsmanship, and aesthetic value of the written product in two groups of student writers.	Report	Y	Y	N	Y	Y	Exclude

	Author(s)/Year	Study Title	Publication Type	Appropriate Quantified Measures (Y/N)	Sufficient Statistical Information (Y/N)	No Redundancy (Y/N)	Published in English (Y/N)	Problem Finding and creativity measures (Y/N)	Decision (Include/Exclude)
151.	Moore (1985)	The Relationship between the Originality of Essays and Variables in the Problem-Discovery Process: A Study of Creative and Noncreative Middle School Students.	Journal Article	Y	Y	Y	Y	Y	**Include**
152.	Moore (1989)	Problem finding and teacher experience.	Conference Paper	Y	Y	Y	Y	N	Exclude
153.	Moore (1994)	The Ecology of Problem Finding and Teaching.	Book Chapter	N	N	Y	Y	N	Exclude
154.	Mraz & Runco (1994)	Suicide ideation and creative problem solving.	Journal Article	Y	Y	Y	Y	Y	**Include**
155.	Mumford & Connelly (1991)	Leaders as creators: Leader performance and problem solving in ill-defined domains.	Journal Article	N	N	Y	Y	N	Exclude
156.	Mumford, Costanza, Threlfall, Baughman, & Reiter-Palmon (1993)	Personality variables and problem-construction activities: An exploratory investigation.	Journal Article	Y	Y	Y	Y	Y	**Include**
157.	Mumford, Reiter-Palmon, & Redmond (1994)	Problem Construction and Cognition: Applying Problem Representations in Ill-Defined Domains.	Book Chapter	Y	Y	Y	Y	Y	**Include**
158.	Mumford,Baughman, Threlfall, Supinski, & Costanza (1996)	Process-Based Measures of Creative Problem-Solving Skills: I. Problem Construction.	Journal Article	Y	Y	Y	Y	Y	**Include**
159.	Newman, Willoughby, & Pruce (2011)	Research Report: The effect of problem structure on problem-solving: An fMRI study of word versus number problems.	Journal Article	Y	Y	Y	Y	N	Exclude
160.	Nezu & D'Zurilla (1981a)	Effects of problem definition and formulation on decision making in the social problem-solving process	Journal Article	N	Y	Y	Y	N	Exclude

	Author(s)/Year	Study Title	Publication Type	Appropriate Quantified Measures (Y/N)	Sufficient Statistical Information (Y/N)	No Redundancy (Y/N)	Published in English (Y/N)	Problem Finding and creativity measures (Y/N)	Decision (Include/Exclude)
161.	Nezu & D'Zurilla (1981b)	Effects of problem definition and formulation on the generation of alternatives in the social problem-solving process.	Journal Article	N	Y	Y	Y	N	Exclude
162.	Nickerson, Yen, & Mahoney (2012)	Exploring the Problem-Finding and Problem-Solving Approach for Designing Organizations.	Journal Article	N	N	Y	Y	N	Exclude
163.	Okuda, Runco, & Berger (1991)	Creativity and the finding and solving of real-world problems.	Journal Article	Y	Y	Y	Y	Y	**Include**
164.	Paletz & Peng (2009)	Problem Finding and Contradiction: Examining the Relationship Between Naive Dialectical Thinking, Ethnicity, and Creativity.	Journal Article	Y	N	Y	Y	Y	Exclude
165.	Patricola (2005)	Impact of teachers' problem finding on their data finding and problem defining.	Dissertation	Y	Y	Y	Y	N	Exclude
166.	Pesta, Sanders, & Murphy (1999)	A beautiful day in the neighborhood: What factors determine the generation effect for simple multiplication problems?	Journal Article	Y	Y	Y	Y	N	Exclude
167.	Pitt (1983)	Development of a general problem-solving schema in adolescence and early adulthood.	Journal Article	Y	Y	Y	Y	N	Exclude
168.	Porath (1984)	IQ, Cognitive Level, and Related Information Processing Variables as Predictors of Problem Finding Ability in Intellectually Gifted Children.	Thesis	Y	Y	Y	Y	N	Exclude
169.	Pretz & Zimmerman (2009)	When the goal gets in the way: The interaction of goal specificity and task difficulty.	Journal Article	Y	Y	Y	Y	N	Exclude
170.	Pryzwansky (1989)	Some further thoughts about the problem-finding challenge of consultation.	Journal Article	N	N	Y	Y	N	Exclude

	Author(s)/Year	Study Title	Publication Type	Appropriate Quantified Measures (Y/N)	Sufficient Statistical Information (Y/N)	No Redundancy (Y/N)	Published in English (Y/N)	Problem Finding and creativity measures (Y/N)	Decision (Include/Exclude)
171.	Puccio (1999)	Creative Problem Solving Preferences: Their Identification and Implications.	Journal Article	Y	Y	Y	Y	N	Exclude
172.	Ramirez (2002)	Finding the Right Problem.	Journal Article	N	N	Y	Y	N	Exclude
173.	Redmond, Mumford, & Teach (1993)	Putting creativity to work: Effects of leader behavior on subordinate creativity.	Journal Article	Y	Y	Y	Y	N	Exclude
174.	Reed (1992)	Problem finding: An empirical investigation of problem finding and personality characteristics of academically talented and intellectually gifted secondary students.	Dissertation	Y	Y	Y	Y	N	Exclude
175.	Reiter-Palmon (1993)	Applying the life template: Problem construction in everyday life.	Dissertation	Y	Y	Y	Y	N	Exclude
176.	Reiter-Palmon (2009)	A Dialectic Perspective on Problem Identification and Construction.	Journal Article	N	N	Y	Y	N	Exclude
177.	Reiter-Palmon & Robinson (2009)	Problem identification and construction: What do we know, what is the future?	Journal Article	N	N	Y	Y	N	Exclude
178.	Reiter-Palmon, Mumford, & Threlfall (1988)	Solving Everyday Problems Creatively: The Role of Problem Construction and Personality Type.	Journal Article	Y	Y	Y	Y	Y	**Include**
179.	Reiter-Palmon, Mumford, O'Connor Boes, & Runco (1997)	Problem Construction and Creativity: The Role of Ability, Cue Consistency, and Active Processing.	Journal Article	Y	Y	Y	Y	Y	**Include**
180.	Ritchie (2009)	The Process of problem finding in inquiry education: a focus on students' experiences.	Thesis	Y	Y	Y	Y	N	Exclude
181.	Rietzschel & Nijstad (2014)	Effects of Problem Scope and Creativity Instructions on Idea Generation and Selection.	Journal Article	Y	Y	Y	Y	N	Exclude
182.	Robichaud & Dugas (2005a)	Negative problem orientation (Part I): psychometric properties of a new measure.	Journal Article	Y	Y	Y	Y	N	Exclude

	Author(s)/Year	Study Title	Publication Type	Appropriate Quantified Measures (Y/N)	Sufficient Statistical Information (Y/N)	No Redundancy (Y/N)	Published in English (Y/N)	Problem Finding and creativity measures (Y/N)	Decision (Include/Exclude)
183.	Robichaud & Dugas (2005b)	Negative problem orientation (Part II): construct validity and specificity to worry.	Journal Article	Y	Y	Y	Y	N	Exclude
184.	Rodionov & Velmisova (2008)	Construction of Mathematical Problems by Students Themselves.	Journal Article	N	N	Y	Y	N	Exclude
185.	Rostan (1992)	The relationship among problem finding, problem solving, cognitive controls, professional productivity, and domain of professional training in adult males.	Dissertation	Y	Y	N	Y	Y	Exclude
186.	Rostan (1994)	Problem finding, problem solving, and cognitive controls: An empirical investigation of critically acclaimed productivity.	Journal Article	Y	Y	Y	Y	Y	**Include**
187.	Rostan (1997)	A study of Young Artists: The Development of Artistic Talent and Creativity.	Journal Article	Y	Y	Y	Y	Y	**Include**
188.	Rostan (2005)	Educational Intervention and the Development of Young Art Students' Talent and Creativity.	Journal Article	Y	Y	Y	Y	Y	**Include**
189.	Rostan (2010)	Studio Learning: Motivation, Competence, and the Development of Young Art Students' Talent and Creativity.	Journal Article	Y	Y	Y	Y	Y	**Include**
190.	Runco (1994)	Conclusions Concerning Problem Finding, Problem Solving, and Creativity.	Book Chapter	N	N	Y	Y	N	Exclude
191.	Runco et al. (2016)	Which Test of Divergent Thinking Is Best?	Journal Article	Y	N	Y	Y	Y	Exclude
192.	Runco & Acar (2010)	Do tests of divergent thinking have an experiential bias?	Journal Article	Y	Y	Y	Y	Y	**Include**
193.	Runco & Acar (2012)	Divergent Thinking as an Indicator of Creative Potential.	Journal Article	N	N	Y	Y	N	Exclude
194.	Runco & Okuda (1988)	Problem Discovery, Divergent Thinking, and the Creative Process.	Journal Article	Y	N	Y	Y	Y	Exclude

	Author(s)/Year	Study Title	Publication Type	Appropriate Quantified Measures (Y/N)	Sufficient Statistical Information (Y/N)	No Redundancy (Y/N)	Published in English (Y/N)	Problem Finding and creativity measures (Y/N)	Decision (Include/Exclude)
195.	Runco & Chand (1994)	Problem Finding, Evaluative Thinking, and Creativity.	Book Chapter	Y	Y	N	Y	Y	Exclude
196.	Runco, Illies, & Eisenman (2005)	Creativity, Originality, and Appropriateness: What do Explicit Instructions Tell Us About Their Relationships?	Journal Article	Y	Y	Y	Y	N	Exclude
197.	Runco & Nemiro (1994)	Problem finding, creativity, and giftedness.	Journal Article	N	N	Y	Y	N	Exclude
198.	Sapp (1995)	Creative problem-solving in art: A model for idea inception and image development.	Journal Article	N	N	Y	Y	N	Exclude
199.	Sapp (1997)	Problem parameters and problem finding in art education.	Journal Article	N	N	Y	Y	N	Exclude
200.	Sayeed & Brightman (1994)	OS: Can information technology improve managerial problem finding?	Journal Article	Y	Y	Y	Y	N	Exclude
201.	Scandura (1964)	An Analysis of Exposition and Discovery Modes of Problem Solving Instruction.	Journal Article	Y	Y	Y	Y	N	Exclude
202.	Schraw, Dunkle, & Bendixen (1995)	Cognitive Processes in Well-Defined and Ill-Defined Problem Solving.	Journal Article	Y	Y	Y	Y	N	Exclude
203.	Şengül & Katranci (2012)	Problem Solving and Problem Posing Skills of Prospective Mathematics Teachers About the 'Sets' Subject.	Journal Article	Y	Y	Y	Y	N	Exclude
204.	Sheremata (2002)	Finding and solving problems in software new product development.	Journal Article	Y	Y	Y	Y	N	Exclude
205.	Shulman (1965)	Seeking Styles and Individual Differences in Patterns of Inquiry.	Journal Article	Y	Y	Y	Y	Y	**Include**

	Author(s)/Year	Study Title	Publication Type	Appropriate Quantified Measures (Y/N)	Sufficient Statistical Information (Y/N)	No Redundancy (Y/N)	Published in English (Y/N)	Problem Finding and creativity measures (Y/N)	Decision (Include/Exclude)
206.	Silver & Cai (1996)	An Analysis of Arithmetic Problem Posing by Middle School Students.	Journal Article	Y	Y	Y	Y	N	Exclude
207.	Silver, Mamona-Downs, Leung, & Kenney (1996)	Posing Mathematical Problems: An Exploratory Study.	Journal Article	Y	Y	Y	Y	N	Exclude
208.	Sims (1979)	A Framework for Understanding the Definition and Formulation of Problems in Teams.	Journal Article	N	N	Y	Y	N	Exclude
209.	Sims, Eden, & Jones (1981)	Facilitating problem definition in teams.	Journal Article	N	N	Y	Y	N	Exclude
210.	Singer & Voica (2013)	A problem-solving conceptual framework and its implications in designing problem-posing tasks.	Journal Article	N	N	Y	Y	N	Exclude
211.	Singer, Pelczer, & Voica (n.d)	Problem Posing and Modification as a criterion of Mathematical Creativity.	Journal Article	Y	Y	Y	Y	N	Exclude
212.	Siu (2007)	Problem finding: a critical and fundamental element in design.	Dissertation	N	N	Y	Y	N	Exclude
213.	Smilansky (1984)	Problem solving and the quality of invention: An empirical investigation.	Journal Article	Y	Y	Y	Y	Y	**Include**
214.	Smilansky & Halberstadt (1986)	Inventors versus problem solvers: An empirical investigation.	Journal Article	Y	N	Y	Y	Y	Exclude
215.	Speedie, Houtz, Ringenbach, & Feldhusen (1973)	Abilities measured by the Purdue Elementary Problem-Solving Inventory.	Journal Article	Y	Y	Y	Y	N	Exclude
216.	Starko (1989)	Problem Finding in Creative Writing: An Exploratory Study.	Journal Article	Y	Y	Y	Y	N	Exclude

	Author(s)/Year	Study Title	Publication Type	Appropriate Quantified Measures (Y/N)	Sufficient Statistical Information (Y/N)	No Redundancy (Y/N)	Published in English (Y/N)	Problem Finding and creativity measures (Y/N)	Decision (Include/Exclude)
217.	Stefflre (1985)	Organizational Obstacles to Innovation: A Formulation of the Problem.	Journal Article	N	N	Y	Y	N	Exclude
218.	Stepich & Ertmer (2009)	Teaching Instructional Design Expertise: Strategies to Support Students' Problem-Finding Skills.	Journal Article	Y	Y	Y	Y	N	Exclude
219.	Subotnik (1988)	Factors from the structure of intellect model associated with gifted adolescents' problem finding in science: Research with Westinghouse Science Talent Search winners.	Journal Article	Y	N	Y	Y	Y	Exclude
220.	Subotnik (1994)	Problem Identification in Academic Research: A Longitudinal Case Study from Adolescence to Early Adulthood.	Book Chapter	Y	Y	N	Y	Y	Exclude
221.	Suwa (2003)	Constructive perception: Coordinating perception and conception toward acts of problem-finding in a creative experience.	Journal Article	Y	Y	Y	Y	N	Exclude
222.	Tegano, Sawyers, & Moran (1989)	Problem-finding and solving in play: The teacher's role.	Journal Article	N	N	Y	Y	N	Exclude
223.	Thevenot, C., & Oakhill (2008)	A generalization of the representational change theory from insight to non-insight problems: The case of arithmetic word problems.	Journal Article	Y	Y	Y	Y	N	Exclude
224.	VanLehn (1991)	Rule acquisition events in the discovery of problem-solving strategies.	Journal Article	N	N	Y	Y	N	Exclude
225.	Van Harpen & Sriraman (2013)	Creativity and mathematical problem posing: an analysis of high school students' mathematical problem posing in China and the USA.	Journal Article	Y	Y	Y	Y	N	Exclude
226.	Vernon & Hocking (2014)	Thinking hats and good men: Structured techniques in a problem construction task.	Journal Article	Y	Y	Y	Y	N	Exclude

	Author(s)/Year	Study Title	Publication Type	Appropriate Quantified Measures (Y/N)	Sufficient Statistical Information (Y/N)	No Redundancy (Y/N)	Published in English (Y/N)	Problem Finding and creativity measures (Y/N)	Decision (Include/Exclude)
227.	Volkema (1983)	Problem formulation in planning and design.	Journal Article	Y	Y	Y	Y	N	Exclude
228.	Wakefield (1985)	Towards creativity: Problem finding in a divergent-thinking exercise.	Journal Article	Y	Y	Y	Y	Y	**Include**
229.	Wakefield (1989)	An Arts Orientation, Cognitive Skills and Creative Behaviors.	Conference Paper	Y	Y	Y	Y	N	Exclude
230.	Wakefield (1994)	Problem Finding and Empathy in Art.	Book Chapter	N	N	Y	Y	N	Exclude
231.	Wakefield (2003)	The development of creative thinking and critical reflection: Lessons from everyday problem finding.	Book Chapter	N	N	Y	Y	N	Exclude
232.	Weiping & Xingqi (2010)	Effects of Different Emotion States on Adolescents' Creative Scientific Problem Finding.	Journal Article	N/A	N/A	N/A	N	N/A	Exclude
233.	Weissman (2007)	Art making and metacognition: How visual artists approach problem finding and problem solving.	Dissertation	N	N	Y	Y	N	Exclude
234.	Wigert (2014)	The influence of divergent and convergent problem construction processes on creative problem solving.	Dissertation	Y	N	Y	Y	Y	Exclude
235.	Wood (2013)	Problem Representation and Team Mental Model Development in Individual and Team Problem Solving Performance.	Dissertation	Y	Y	Y	Y	N	Exclude
236.	Yoshioka et al. (2005)	Facilitation of problem finding among first year medical school students undergoing problem-based learning.	Journal Article	N	N	Y	Y	N	Exclude
237.	Yurkovich (2016)	Problem Construction and the Automatic Pursuit of Creative Goals.	Dissertation	Y	Y	Y	Y	Y	**Include**

Note: *The entire reference list for this table is available upon request. It should be noted that if any study did not meet at least one of these six criteria, it was excluded*.