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The Creative Problem Finding Hierarchy: A Suggested Model for Understanding Problem Finding*

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ABSTRACT

This paper proposes a model, which hopefully will allow researchers in the psychology of creativity to confirm that the different levels and different labels for problem finding can be unified under one construct - problem finding (PF). Although no clear distinctions are made among the levels and terms used in the PF literature, the current efforts suggest that there are important differences that can be explained by (a) how well- or ill-defined a problem is, and (b) the degree to which ideation and evaluation are required. Based on these two criteria, a rubric is presented that allows distinctions to be made among five the PF processes: (a) problem discovery, (b) problem formulation, (c) problem construction, (d) problem identification, and (e) problem definition. The authors examined the literature on PF in English from 1960 to 2015 using the following databases: (a) Academic Search Premier, (b) PsycARTICLES, (c) PsycINFO, (d) Dissertation Abstract, (e) Educational Resources Information Center (ERIC), (f) Psychology & Behavioral Science Collection, and (g) the Google Scholar. This search resulted in 199 articles in which at least 13 different terms were used to describe the process of finding a problem. Only a few articles endeavored to distinguish among the terms used in the literature. This paper concludes by suggesting that one term (i.e., problem finding) is to be used to avoid confusion. If this is not possible, for whatever reason, the term used instead should be defined and the reasons for the choice of terms clearly stated.

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The significance of the process of finding new problems was recognized and emphasized decades ago by a number of well-known figures (e.g., Csikszentmihalyi, 1965; Dewey, 1910; Einstein & Infeld, 1938; Getzels & Csikszentmihalyi, 1965; Mackworth, 1965), who claimed that problem finding (PF) is different and more important than problem solving.! Mackworth (1965), for example, devoted a great deal of his article, *Originality*, tackling the importance of this creative process. Indeed the greatest social contributions that can be made nowadays are to formulate new and testable ideas; *the scientist who does not speculate is no scientist at all* (Mackworth 1965, p.52). Einstein and Infeld (1938) emphasized the significant role of PF over problem solving by stating that *The formulation of a problem is often more essential than its solution, which may be merely a matter of mathematical or experimental skill* (p. 92).

PF is a core process in almost all models of the creative process (See Table 1). Furthermore, PF is considered to be the first step in any problem solving effort, or to be more precise, creative problem solving. Mumford, Mobley, Reiter-Palmon, Uhlman, and Doares (1991) suggested that creative problem solving differs from standard problem solving in four ways:

> *(a) creative problem solving occurs in ill-defined situations in which a greater burden is placed on the individual with respect to defining the nature of the problem and identifying the information and rules used to solve the problem, (b) the need for both divergent and convergent thought, (c) the need to balance convergent and divergent thinking, and (d) the application of existing knowledge through category combination and reorganization.* (pp. 94-95)

Table 1

Selected Models of the Creative Process

	Phases of Creative Process		
Authors	**Problem Finding**	**Ideation/Evaluation**	**Implementation**
Dewey (1910)	• Perceiving a difficulty • Locating or defining the problem	• Suggesting possible solutions • Elaborating implications of these solutions	• Testing the validity of the solutions
Wallas (1926)	• Preparation	• Illumination	• Verification
Osborn (1953)	• Orientation • Preparation	• Analysis • Hypothesis generation • Synthesis	• Verification
Merrifield, Guilford, Christensen, and Frick (1962)	• Preparation, or problem recognition	• Analysis, or developing familiarity with situational potentialities and goal requirements • Production, or generating a tentative solution bridging the gap to goal states	• Verification and Reapplication

	Phases of Creative Process		
Authors	**Problem Finding**	**Ideation/Evaluation**	**Implementation**
Parnes (1967)	• Fact finding • Problem finding • Idea finding	• Solution finding	• Acceptance finding
Newell and Simon (1972)	• Translation of the input, or generation of a problem statement	• Internal representation, or the encoding of stimuli in memory • Selection of a problem-solving method	• Application of the problem-solving method
Mansfield (1980)	• Selection of the problem	• Setting constraints or using conscious and unconscious mental sets to put bounds on the nature of the problem • Changing constraints or altering original constraints that later prove incorrect	• Verification and elaboration of the problem solution
Bransford and Stein (1984)	• Identify problem and opportunities	• Define alternative goals • Explore possible strategies	• Anticipate and act • Look and learn
Silverman (1985)	• Problem identification	• Acquisition of information concerning similar problem structures • Acquisition of information concerning similar problem solutions • Analog knowledge transfer • Analog knowledge transformation	• Application of the problem solution
Van Gundy (1987)	• Objective-finding • Fact finding • Problem-finding	• Idea-finding • Solution-finding	• Acceptance-finding
Mumford, Mobley, Uhlman, Reiter-Palmon, and Doares (1991)	• Problem definition	• Information gathering • Concept selection • Conceptual combination • Idea generation • Idea evaluation	• Implementation planning
Amabile (1996)	• Problem or task identification	• Response generation • Response validation	• Outcome
Isaksen, Dorval and Treffinger (2000)	• Objective-finding • Fact finding • Problem-finding	• Generate ideas • Preparation for action	• Acceptance finding
Basadur and Basadur (2011)	• Problem finding and Fact finding • Problem definition and Idea finding	• Conceptualization • Optimization	• Implementation

Despite its theoretical and practical importance, it is surprising that PF has received little attention in the creativity literature compared with other constructs related to the creative process. In their meta-analytic review, Abdulla, Paek, Cramond, and Runco (2018) reported that problem solving and divergent thinking have been studied 6 to 100 times more than PF. There are a number of possible explanations for this including the challenge of defining PF precisely, the difficulty of assessing PF operationally, and the wide range of labels used in the literature referring to PF. The author's purpose is to determine whether different labels such as problem finding, problem identification, problem generation, and other labels refer to one or a number of processes. Clarifying their distinction or unity would contribute to our understanding of the larger creative process.

Different Labels for Problem Finding

Since the 1960s, different terms have been used to refer to the process of finding a problem including problem discovery, problem formulation, problem identification, problem construction, and problem posing. Thus, it is first necessary to review the PF literature to identify the full range of terms that have been used in previous works. In addition, it is important to examine the definitions used in the PF 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 of a problem. The third part examines the definitions offered in the PF literature and determines how similar these definitions are. The fourth part presents guidelines to differentiate the five PF processes.

Part I: Defining *Problem*

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 (Jay & Perkins, 1997), different levels (Dillon, 1988), and which varies from one person to another. Getzels (1982) differentiated between two definitions (or categories) for a problem: (a) a problem occurring when a desired action to a given situation is blocked, and (b) a problem as a question raised for inquiry (p. 40). 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*. For instance, someone missing his or her flight might be an example of a well-defined problem. In this example, the desired action (that is traveling) is blocked for a number of reasons (e.g., a traffic jam, a problem in the car, not setting the

alarm on time, etc.), resulting in a very few, if not only one solution, which is to book the next available flight! Well-defined problems are also characterized by what Briggs and Reinig (2010) call *scarcity of the solution space,* meaning that the nature of the problem itself does not allow for ideation or multiple solutions. Now consider an example of a gifted third-grade student who heard about *climate change* in the news. She persistently asked her teacher about different causes for the climate change. In this example, the problem is ill-defined, at least for a third-grade student, which led her to ask her teacher (i.e., inquire) about the problem, and maybe led her to stay for hours on her computer searching for *causes of climate change.* Since the problem of climate change is ill-defined (i.e., there are many sub-problems constituting the problem as a whole), there will be a large number of solutions depending on how this student will formulate and define it. Thus, the simplest way to classifying problems could be *well-defined* 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). In addition to the lack of clarity to solution, ill-defined situations *do not clearly specify the goals, information, and resources to be used in problem solving* (Mumford et al., 1991, p. 94).

Getzels (1975, 1982) proposed another classification for the term *problem*. 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) believed that there are levels of PF and problem solving: (a) recognition of problem/solution, (b) discovery of problem/solution, and (c) invention of problem/solution. On the other hand, Getzels (1982) listed 10 types of problem situations ranging *from 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, to The problem does not yet exist but is invented or conceived, and a method for solving it is not known.* (for the full description of the 10 problem situations see Getzels, 1982, pp. 40-41)

To summarize, it is crucial to distinguish between well- and ill-defined problems and to emphasize that PF is about finding and solving ill-defined problems. Moreover, it is important to recognize that there are different levels of ill-defined problems, which call for different levels of PF.

The Terms for PF and Their Frequency

A review of the PF literature showed that during the 55 - year period 1960 to 2015, 13 different terms have been used to describe PF. This information was obtained from searching the following databases: (a) Academic Search Premier, (b) PsycARTICLES, (c) PsycINFO, (d) Dissertation Abstract, (e) Educational Resources Information Center (ERIC), (f) Psychology & Behavioral Science Collection, and (g) the Google Scholar. This literature search was conducted electronically using the following keywords: (a) problem finding, (b) problem construction, (c) ill-defined problems, and (d) creative problem solving (CPS). The search was restricted to articles' titles. This searching process resulted in identifying 199 works. This collection of articles on PF may not reflect the whole PF literature, since not all possible databases were searched. In addition, the search was limited to studies in English; however, these 199 works can be considered substantial, since they include seminal works on PF (e.g., Arlin, 1975a, 1975b, 1977; Basadur, 1995; Csikszentmihalyi & Getzels, 1970, 1971; Dillon, 1988; Frederiksen & Evans, 1974; Frederiksen & Ward, 1978; Hoover & Feldhusen, 1990; Mumford, Reiter-Palmon, & Redmond, 1994; Runco, 1994a).

Within the articles themselves (199), Figure 1 shows that the majority of the works utilized the term PF (50.3%), followed by problem posing (12.1%), 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 shows in detail the terms used by different researchers since the 1960s.

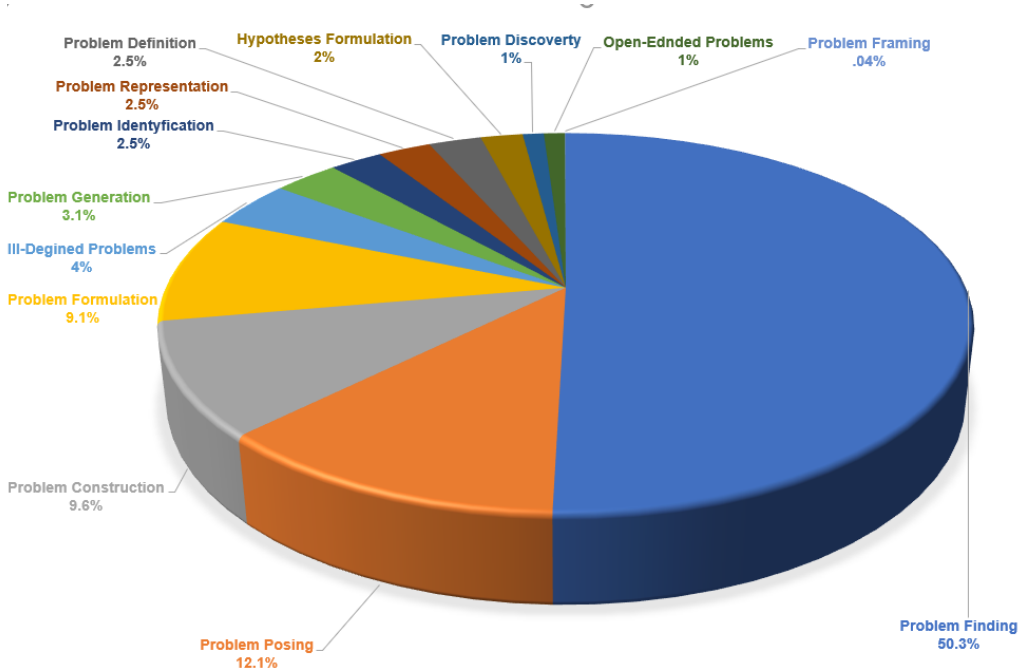

Figure 1. The percentage of the 199 works utilized different terms of PF

Table 2
Different Terms Used in Previous Research/Articles[i]

	Terms	Researchers
1	Problem Finding	Allen & Thomas (2011); Ambrosio (1993); Anderson, Hughes, & Sharrock (1987); Arlin (1975a); Arlin (1975b); Arlin (1977); Artley, Van Horn, Friedrich, & Carroll (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 et al. (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 (1990); 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 et al. (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 et al. (1994); Mumford et al. (1993); Mumford et al. (1996); Reiter-Palmon (1993); Reiter-Palmon (2009); Reiter-Palmon, Mumford, & Threlfall (1998); Reiter-Palmon et al.(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).

Some authors used more than one of these terms in the same work. For example, Getzels (1982) used the terms problem formulation, PF, problem posing, and problem discovery in the same article. Furthermore, in the *Problem Finding, Problem Solving, and Creativity* book, edited by Runco (1994a), the authors used different terms, such as problem construction, problem representation, PF, and problem identification. In summary our search of the literature presents a broad array of perspectives, labels, and definitions.

Part II: Using the Definitions to Distinguish Between Different PF Processes

Unfortunately, it seems that there is no clear answer implied by the literature on PF and the definitions reviewed regarding possible differences between different PF processes. Still, some clues are suggested by the definitions. As indicated, the majority of researchers used the term *problem finding*. In addition, it is apparent that researchers in some fields specifically mathematics and science prefer to use particular terms to describe PF. Almost all researchers studying PF in mathematics, for instance, used the term *problem posing* (e.g. Abramovich & Cho, 2006; Cai, 2003; Cai & Hwang, 2002; Chen, Van Dooren, & Lieven, 2013; De Ponte & Henriques, 2013; English, 1998; Van Harpen & Sriraman, 2013). In addition, researchers concerned with scientific PF 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). The other terms mentioned in Figure 1 were used interchangeably in the literature of the psychology of creativity (e.g., Getzels & Csikszentmihalyi, 1975; Cropper, Meck, & Ash, 1977; Lee & Cho, 2007; Mumford Costanza, Threlfall, Baughman, & Reiter-Palmon, 1993; Reiter-Palmon, Mumford, O'Connor, Boes, & Runco, 1997; Runco & Okuda, 1988).

In fact, few researchers explicitly distinguished between some of those terms. Basadur (1995) did suggest that PF includes both aspects: *discovering* problems to solve them and *formulating* them for subsequent solution. Mumford et al. (1994) considered problem representation as one operation in the Problem Construction Operation Model. On the other hand, Runco and Chand (1994) distinguished between *problem identification* and *problem definition*. They suggested that *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). Finally, in their four stages model (see Table 1) Basadur and Basadur (2011) distinguished between problem generation (the first stage) and problem conceptualization (the second stage):

> *Problem generation begins before the problem is available to be formulated. This process begins with the deliberately seeking out (generating) of new problems and opportunities from scratch as an everyday activity as the first stage. The second phase which occurs after the problem has been generated is called problem formulation. (*p. 31)

To summarize, with few exceptions (e.g. Basadur, 1995; Basadur & Basadur, 2011; Mumford et al., 1994; Runco & Chand, 1994), PF is not defined in a way that it is clearly distinct from the other terms in the family.

Revisiting Empirical Findings of Different PF Processes

The various PF behaviors (e.g. problem generation, problem construction) have been correlated with a range of measures of creativity. For example, Ambrosio (1993) used the term PF and reported a statistically significant correlation between problem quantity and divergent thinking. Arreola (2012) used the term problem construction and found a positive significant correlation between problem construction ability and problem construction quality, problem construction originality, solution quality, and solution originality. Moreover, Carson, and Runco (1999), who used the term PF, which was assessed through problem generation tasks, found a significant correlation between some of the problem generation and problem solving tasks.

Silver and Cai (1996), on the other hand, who studied the relationship between problem posing and problem solving, reported significant differences in problem posing between those who scored high and low in problem solving, favoring the high problem solving group. Importantly too, Ching (2010), who used the term problem representation, reported high significant correlations between some problem representation sub-skills and problem solving sub-skills. Additionally, Csikszentmihalyi and Getzels (1971) used the term problem formulation and reported a high significant correlation between the total problem formulation and originality scores. Hoover (1994), who used the term scientific PF, which was assessed through formulation hypotheses, found a significant relationship between formulation hypotheses and creativity as measured by the Torrance Test of Creative Thinking. Finally, Abdulla et al. (2018) used meta-analytical methods and reported a significant correlation between PF and creativity (r = .22). The relationship between PF and creativity significantly differed by divergent thinking indices, PF domain, and age. Among divergent thinking indices, fluency and originality were more highly correlated with PF than flexibility. Regarding domain, PF in writing was more highly correlated with PF than arts, science and math, and humanities. Finally, concerning age, the relationship between PF and creativity was higher in children compared to adolescents and adults. Abdulla et al. (2018) also examined whether using various labels in PF and creativity litera-

ture would affect the studies' findings and concluded that using different labels in PF and creativity research did not significantly alter studies' results, which indicated a positive relationship between the two constructs. However, these correlations confirm the value of PF but do not help us to distinguish among the different possible levels of PF. There is a need for empirical research that could directly compare the various measures of PF behaviors and could investigate how strongly each relates to one another and to creativity.

Part III: Comparison of Definitions

We turn now to the different definitions offered in the PF literature in order to determine whether or not PF, problem formulation, problem identification, problem construction, problem posing, and other PF family members refer to the same construct. As Table 3 shows, a number of definitions were proposed in the PF literature since the 1960s.

Table 3

Examples of Problem Finding Definitions and Terms Used

Author(s)	Term Used	Definition
Mackworth (1965)	PF	Problem finding is the detection of the need for a new program based on a choice between existing and expected future programs (p. 57).
Arlin (1975b)	PF	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).
Getzels & Csikszentmihalyi (1975)	PF	Problem finding is the posing and formulating of problems (P. 90).
Cropper et al. (1977)	PF	Problem finding is a divergent process described as creative thought manifest as the ability to formulate problems (p. 517).
Arlin (1977)	PF	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)	PF & PF[1]	Problem finding shall mean conceiving, identifying or formulating a problem to be solved (p. 7).
Csikszentmihalyi & Getzels (1988)	PF	Problem finding is metacognitive in the sense that they involve unconscious or preconscious affective and motivational elements as well as logic (p. 92).
Dillon (1988)	PF	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 & Okuda (1988)	PF, PD, & PI	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). Problem finding is a 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 & Vega (1990)	PF	Problem finding requires that an individual identify and define worthwhile tasks (p. 440).
Ambrosio (1993)	PF	Problem finding is the recognition or discovery of a discrepancy between an expected or desired outcome and an existing, possible or probable outcome (p. 14).

Author(s)	Term Used	Definition
Kay (1991)	PF	Problem finding is 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)	PF, PC, & PR	Problem representation is schematic, or categorical, knowledge structures abstracted from prior problem-solving efforts (p. 367).
Basadur (1995)	PF	Problem finding includes both aspects: discovering problems to solve and formulating them for a subsequent solution (p. 64).
Jay (1996)	PF	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. (1998)	PC	Problem construction is the process by which individuals structure an ill-defined problem and identify the goals and objectives of the problem-solving effort (p. 187).
Carson & Runco (1999)	PC	Problem construction 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 & Cho (2007)	PF & PC	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).
Paletz & Peng (2009)	PF	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)	PF	Problem finding is 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)	PP	Problem posing is the forming of a new problem from a given situation or experience (p. 1577).
Runco & Acar (2010)	PG & PC	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) (p. 144).
Arreola (2012)	PC	Problem construction refers to the act of structuring or making sense out of an ill-defined or ambiguous problem (p. 2).
Chang et al. (2012)	PP	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 et al. (2012)	PI	Problem identification is 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).
Wigert (2014)	PC	Problem construction entails identifying and structuring a problem (p. 6).

Note. PF = problem finding; PF^1 = problem formulation; PC = problem construction; PD = problem discovery; PR = problem representation; PG = problem generation

A closer look into these definitions shows that researchers in this field agree on four main issues. First is that PF is different than problem solving. Mackworth (1965) put it this way: *Most people are quite clear by now that there are real differences between scientists who*

are largely solving problems and those who are mainly raising questions (p. 51). De Bono (1993) also differentiated between problem solving and PF describing the former as reactive thinking and the latter as projective thinking. According to De Bono (1993), *In reactive thinking we analyze and sort the information that is presented to us. However, in projective thinking we, ourselves, have to generate information and even create the context as we try to bring something about* (p. 23). A more detailed discussion about the difference between PF and problem solving can be found in Csikszentmihalyi (1988).

Second, a number of definitions emphasized that PF is not a single process and that there are different levels of PF (e.g., Dillon, 1988; Paletz & Peng, 2009). For example, 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). Moreover, Runco (1994b) mentioned that *It is no longer sufficient to simply refer to problem finding, and assume that we are talking about one process or skill* (p. 281). Third, unlike problem solving, PF deals with ill-defined problems in which an individual discovers a novel problem that needs to be solved (e.g., Arreola, 2012; Mumford et al, 1991; Paletz & Peng, 2009; Reiter-Palmon, Mumford, & Threlfall, 1998). What is important to highlight here is that ill-defined problems are not on the same scale or level of complexity (Getzels, 1982).

Finally, although divergent thinking plays an essential role in PF (e.g., Cropper et al., 1977; Runco & Acar, 2010), PF also requires using some evaluative skills (Basadur, 1995; Mumford et al., 1991; Runco & Okuda, 1988). Basadur (1995) presented a three-stage model, which consists of problem finding (PF), problem solving (PS), and solution implementation (SI). Basadur (1995) in his ideation-evaluation theory suggested that *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).

However, as shown in Table 3, definitions of PF differ based on the label used to describe PF, moreover, some of these definitions contain two or more terms that are elaborated within the same study (e.g., Barber, 1981; Lee & Cho, 2007; Mumford et al., 1993; Runco & Acar, 2010; Runco & Okuda, 1988).

Part IV: The Creative Problem-Finding Hierarchy and Guidelines for its Use

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 undetected differences. This supposition is based on: (a) Getzels' (1982) 10 types of problems, (b) Basadur's (1995) optimal ideation-evaluation theory, and (c) a few other works, which suggest that there are subtle differences between some of the terms (e.g., Basadur & Basadur, 2011; Runco & Chand, 1994).

The following Creative Problem-Finding Hierarchy assumes that there are important differences between the five PF processes: problem discovery, problem formulation, problem construction, problem identification, and problem definition. The differences can be discerned by considering two dimensions. These dimensions are as follows: (a) to what degree the problem is ill-defined, and (b) to what degree ideation and evaluation are required in each of the five process.

We suggest that Problem Discovery represents the highest level (or the initial level) of an ill-defined problem. The problem does not yet exist; rather, it needs to be invented (Getzels, 1982). In the case of Problem Discovery, only ideation is required. In fact, the absence of evaluation in Problem Discovery is because the problem has not yet been formulated. Another feature that distinguishes Problem Discovery from other PF processes is that Problem Discovery originates as an *unconscious* process and that no *information* is given about the problem. However, that is not to say that Problem Discovery arises in a vacuum. Knowledge plays an important role in Problem Discovery and other PF processes described below, but Csikszentmihalyi and Getzels (1988) suggested that PF involves unconscious or preconscious affective and motivational elements as well as logic (Hu & Wang, 2010; Mumford et al., 1993; Reiter-Palmon, et al., 1998; Rusu, 2018; Wakefield, 1994). The unconscious element might be related to the Problem Discovery process. An example of how Problem Discovery might be unconscious can be found in Henry Moore writings:

> *I sometimes begin drawing with no preconceived problem to solve, with only a desire to use pencil on paper and only to make lines, tones and styles with no conscious aim. But as my mind takes in what is so produced a point arrives where some idea becomes conscious and crystallizes, and then control and ordering begin to take place.* (Cited in Getzels, 1979, p. 168)

The second process in the hierarchy is Problem Formulation where the problem does not yet exist, but it can be conceived through given information. Breaking the Enigma machine by Alan Turing is a good example of Problem Formulation. Although Turing solved the secret code problem - only a machine can beat a machine - he had some information about the Enigma settings as well as a real example of it. The main feature that distinguishes Problem Formulation from Problem Discovery is that an individual has some basic information and an awareness that something needs to be done. He or she is not sure about the method that should be used or the outcome. Furthermore, both ideation and evaluation are needed in the Problem Formulation process, but ideation might be more important in the Problem Formulation stage than evaluation.

The third kind (or level) of PF process is Problem Construction where the problem exists but needs to be constructed in a new form. In the Problem Construction process, the problem finder is aware of the problem and has some information regarding how the problem might be constructed. Ideation and evaluation are *equally* important in the Problem Construction process. The discovery of the periodic table is an example of Problem Construction. All the scientists involved in the discovery of the periodic table (at least six; Scerri, 2015) were aware that each of elements such as carbon and oxygen consisted of atoms with different weights. However, it was Mendeleev who *went beyond his competitors because he made successful predictions of new elements as well as correcting the atomic weights of already known elements* (Scerri, 2015, p. 10).

The fourth process (or level), Problem Identification, represents the case in which the problem exists but remains to be identified by the problem finder. In the Problem Identification, the problem finder has good information about the problem. However, evaluation is more important than ideation in the Problem Identification stage. For example, when a number of patients begin showing up with similar symptoms an unidentified virus may be the pathogen.

Finally the fifth process (or lowest level), Problem Definition, refers to a problem that already exists but needs to be defined through extensive evaluative skills. In this case, evaluation is more prominent than ideation. Figure 1 shows the relationships between evaluation and ideation for problem definition in the Problem Finding Hierarchy.

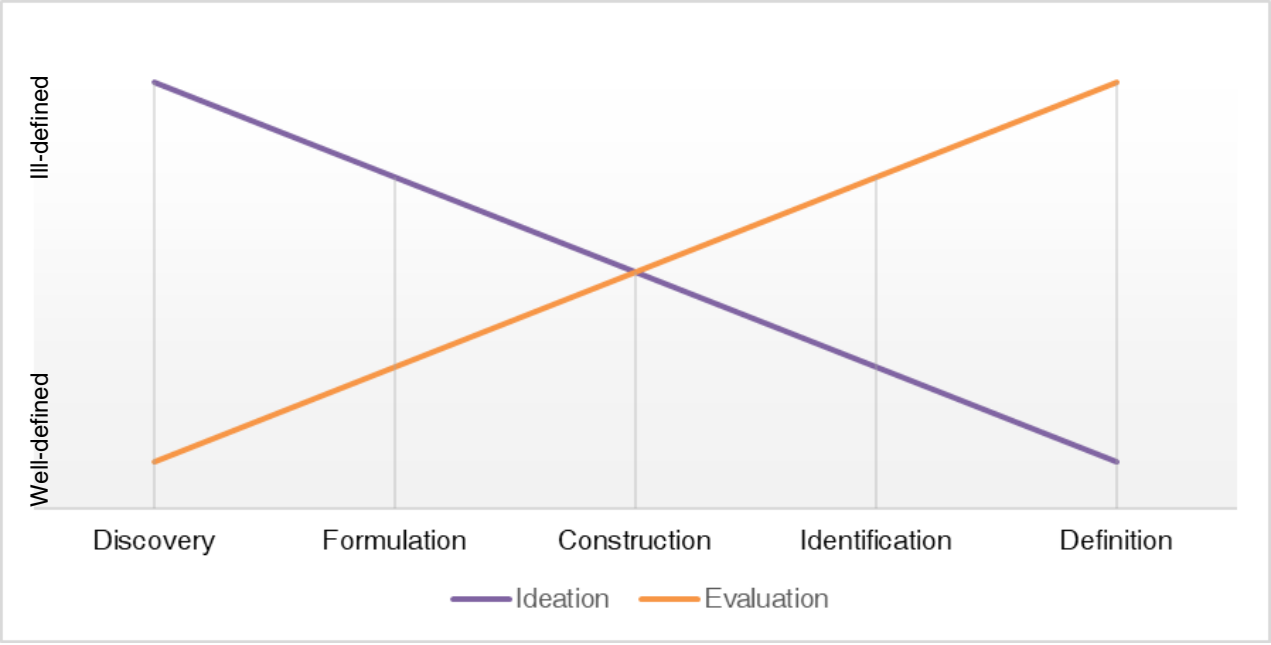

Figure 2. Graphic representation of the Problem Finding Hierarchy from more to less creative showing the relationship between the amount of ideation vs. evaluation required at each level.

The Creative Problem Finding Hierarchy: Summary and Limitations

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

- There are different kinds and levels of the PF (e.g. Getzles, 1982)
- Evaluative skills must to be considered in studying PF (e.g. Runco & Chand, 1994)
- The ratio of ideation/evaluation may differ in each PF process (e.g. Basadur, 1995), and
- PF should not be considered as a single process; instead, there is a family of PF processes (Runco, 1994b).

This hierarchy distinguishes among five problem-finding processes: (a) problem discovery, (b) problem formulation, (c) problem construction, (d) problem identification, and (e) problem definition. The differences among these five problem-finding processes becomes apparent by (a) the degree in which the problem is ill defined, and (b) the ratio crated by the need for ideation or evaluation. Problem discovery representing the highest degree or level for ill-defined problems with problem definition representing the lowest degree or level for ill-defined problems. Moreover, the degree to which ideation vs. evaluation is applied can distinguish the processes or levels. At the top of the hierarchy problem discovery relies considerably on ideation with evaluation playing a lesser role. At the bottom of the hierarchy the opposite is true, evaluation dwarfs ideation. In middle of the hierarchy, problem construction represents the case where ideation and evaluation are equally needed. Finally, both ideation and evaluation are needed in problem formulation and problem identification processes, but ideation is more important in the problem formulation process, whereas evaluation is more important in the problem identification process.

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

The CPF hierarchy shares several assumptions with problem solving. 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 is *not* a linear process. PF processes could be found in different creative problem solving steps, not only at the beginning of the creative problem solving process. According to Runco (1994b), *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 PF and problem solving are separate processes; they are not, and the interaction between different PF processes and problem solving needs to be further studied. However, as Csikszentmihalyi noted, 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 PF 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 PF. It can be difficult to determine the involvement of each and their ratio. The CPF hierarchy should be viewed as a 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 PF processes suggested by the CPF hierarchy. Our claim is that each of these five processes can 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 PF in any given situation always determine the originality of the ideas and alternatives produced?

Additional research on the measurement of PF processes would also be useful. If we really want to measure PF 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 Runco, & Berger 1991; Runco & Okuda, 1988]), tasks targeting each PF process would represent a step forward. The hierarchy outlined here is offered as a guide and impetus to further research on PF. There is much work left to be done to refine it, test it, extend it, and apply it.

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