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Creative Problem Solving

Creative problem solving that characterizes great accomplishment is based upon "regular" problem-solving skills. Problem solvers need to have extensive detailed knowledge of a subject matter before they begin to solve a problem, because problem solving relies upon application of prior knowledge and expertise. Creative problem solvers do more, however: They apply that extra something that allows them to transcend the past and the ordinary to produce something extraordinary. This is exemplified by NASA's evaluation of problem solving by its employees in Calvin Taylor's study: NASA's lowest evaluation of problem solving was applying existing and prior technologies to find an immediate solution to a problem. Conversely, NASA's highest evaluation of problem solving was producing ideas that lead to major research projects.

Both regular problem solving and creative problem solving involve prior knowledge, but creative problem solving requires a higher degree of expertise and motivation than does regular problem solving. Further, an individual's prior knowledge in regular problem solving and the ability to transcend personal experience and knowledge is essential in producing something truly new in the creative problem-solving process.

Continuity and Discontinuity

The role of expertise in problem solving is critical because problem solving requires detailed knowledge in the domain of the current question. Regular problem solving is based on continuity with the past by matching a problem and the problem solver's prior knowledge. This continuity can result in the retrieval of a possible solution. Failure results in feedback that initiates a new memory search that produces a new solution. The transfer of prior knowledge to a new problem depends on the problems having elements in common so that a new situation reminds the person of a previous experience.

Robert Weisberg explained that in the process of invention, creative thinking begins with what is already known based on an analogy to the current problem. However, the process requires going beyond the already known. A discontinuity in thought occurs when a change is made to a new direction of work. When the new information triggers a switch to the direction of a solution, discontinuities are produced. These discontinuities can be classified into different types: those caused by an external stimulus, and those caused by critical analysis of one's own work. Thus, regular problem solving can be changed into creative problem solving on the basis of the development of deep expertise in a particular domain combined with a critical analysis of one's own work. History is rife with such examples of major advances based upon prior inventions: for instance, James Watt's steam engine, which was based upon the work of Thomas Newcomen; and Thomas Edison's kinetoscope, which was based upon his phonograph. When there is no prior human knowledge to build upon, nature is often used as a source of ideas, such as when the Wright Brothers used birds' wings in flight as the basis for wing-warping.

Stages

The creative process is a special case of problem solving in that the creative process has been identified as a typical sequence of stages that people go through while solving a problem. In 1926, Graham Wallas formulated an often-cited four-stage model of the process of creative problem solving based on the reports of Henri Poincaré. Those stages are (1) preparation, (2) incubation, (3) illumination, and (4) verification. These four stages, though distinguishable, possess considerable overlap.

Wallas's first stage, preparation, is where the facts necessary for achieving a solution to a problem are gathered. Preparation includes searching for relevant facts, exploring, experimenting, and, if necessary, reformulating the problem. Preparation often involves long periods of intense conscious work with little success, yet this is the stage in which potentially useful ideas are evaluated.

Wallas's second stage, incubation, is when the problem is set aside and no longer given conscious attention. Without active attention, potentially useful ideas from the preparation stage may be combined in new ways without the active interference of prior solutions. Thus, incubation involves unconscious processing that may result in a sudden illumination. Many creative achievers have reported that they were not actually working on the problem when a solution came to them. R. Ochse explained that the role of incubation may be to dispel fatigue or to help problem solvers disperse the effects of prior directions that set them on a rigid path. Individuals have a tendency to perceive problems in a particular way and to persist in using a particular strategy for solving a problem even if the strategy does not work. Therefore external, or even internal, stimuli to which problem solvers are exposed during the incubation period may cause a change in mind-set or provide a hint to the problem solver.

Wallas's third stage, illumination, is the sudden experience of insight into the solution of the problem. If the incubation stage is successful, the problem solver experiences a sudden illumination that produces a new method for solving the problem. The illumination or "Aha!" stage is generally regarded as a critical incident of creative thinking. Once this insight has been achieved, the person can then begin verifying the solution that has been revealed.

Wallas's last and fourth stage, verification, involves checking, editing, and generally making the solution fit for public presentation. The illumination stage usually produces only a glimmer of the ultimate solution, yet verification of that glimmer evolves into the ultimate solution and tests the accuracy of the insight.

Problem Finding

Recently, problem finding, a preliminary stage not included in Wallas's problem-solving model, has become the subject of special psychological interest. Many researchers believe that finding the problem is the most crucial aspect of creative problem solving. Albert Einstein stated that the formulation of a problem is often more important than its solution. Ochse explained that problem finding has been defined in terms of discovering some gaps or inconsistencies in existing knowledge. Patterns, orders, and structures based on existing knowledge enable individuals to build mental models of reality. Problem finding occurs when a current perception does not match this model. The more complete a mental model, the better basis it provides for finding problems. Discovering important problems is a field of creative endeavor that necessarily depends on prior knowledge and experience to build elaborate models of reality to be tested. Problem-finding abilities develop through the desire to excel by improving upon existing knowledge.

David Carson and Mark Runco explained that creative problem finding and creative problem solving are related. Problem finding entails the ability to imagine, construct models, compare reality against such models to identify discrepancies and contradictions, entertain new hypotheses about old problems, and finally to generate entirely novel questions or problems to be solved. Creative problem solving is essential to the resolution of tension or disequilibrium and for successful adaptation. Thus, creative problem solving relies on originality but does not exclude fit or appropriateness. Truly creative problem solving is original and adaptive.

Models

The creator of brainstorming, Alex Osborn, formulated a strategy to help people solve or find

ideas for problems using models of creative problem solving. Sidney Parnes followed Osborn when he developed the *creative problem solving (CPS) model.* The Osborn-Parnes's CPS model is a widely used method of creative problem solving. It is easily taught and requires both creative and critical thinking, though Osborn maintained that higher success was attained when these two kinds of thinking were separated. Teachers routinely use creative problem-solving methods in regular and gifted programs. Teachers and trainers use the CPS model for curriculum, instruction, and organizational interventions for solving pre-identified problems and capitalizing on opportunities.

Donald Treffinger and Roger Firestien explained that the CPS model consists of six steps that form a dynamic and flexible system for solving programs. The process calls for great divergence to occur at all stages, followed by a convergent phase during which insightful elements are selected and synthesized. The original problem-solving process of the CPS model consists of five steps of divergent (creative) and convergent (critical) action: (1) Fact Finding, (2) Problem Finding, (3) Idea Finding, (4) Solution Finding, and (5) Acceptance Finding. The first stage, Fact Finding, was later divided into Mess Finding and Data Finding so that the CPS model now consists of a total of six steps: (1) Fact Finding focuses on examining many facts or data about the situation to form the basis for the next step and is usually separated into Mess Finding and Data Finding. (2) Problem Finding helps generate many possible restatements of the problem. (3) Idea Finding helps generate promising ideas and possible solutions for the problem. (4) Solution Finding develops criteria to evaluate those ideas and solutions. (5) Acceptance Finding helps generate ideas for facilitating implementation of the most promising alternatives and building these ideas into a plan of action. Brainstorming is an essential component of each step: (1) to avoid dead ends later in Fact Finding; (2) to explore all aspects of the problem and to discover the essence of the situation in Problem Finding; (3) to find ideas in Idea Finding; (4) to generate criteria and to evaluate ideas generated in Solution Finding; and (5) to determine ways to implement the solution in Acceptance Finding. Each of these steps involves divergent thinking to generate new ideas and possibilities and convergent thinking to select insightful elements, synthesize, or refine. The CPS model emphasizes harmony and balance between divergent or creative and convergent or critical thinking.

Characteristics of Creative Achievers

Ochse concluded that creative thinking skills are not sufficient to predict life performance or to choose exceptional problem solvers. Persistent motivation is the most salient characteristic of creative achievers. Creative ability does not emerge spontaneously from inherent qualities, it is not a special intellectual process, and it is not a gift. Instead, creative ability is a hard-earned prize. Creative problem solvers have a strong desire to succeed and are highly committed to their chosen field. They are willing to work and possess creative ability. Thus, the creative ability and motivation are necessary, but not individually sufficient, for the production of creative work.

Creative problem solving that characterizes great accomplishments is based on common problem-solving skills. Problem solving requires a detailed knowledge of the problem and the application of prior art. It is the application of something extra to the process that makes the solution creative, that something extra that makes the solution original. Creative problem solving involves the reformulation of, and sometimes even ignoring, prior art to provide unique solutions. The CPS model indicates that it is in the "illumination" or the "Aha!" stage where something uniquely creative happens. Creative problem solving is also highly dependent upon the motivation of the problem solver to solve a particular problem.

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See also "Aha!" Experience; Creativity, Definition; Creativity Training

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Creative Process

The creative process (also referred to as creative processes) can be broadly defined as the set of cognitive or mental processes that determine the production of ideas that are both novel and useful. Philosophers have long speculated about the possibility that such processes result from irrational rather than rational ideas, and the belief that creative processes arise in trancelike experiences where individuals have little control over their thoughts and behaviors has been widely endorsed for centuries. However, scientific explanations of the creative process have attempted to explain the exact psychological mechanisms by which people create, and have included more than irrational processes.

Creative processes have constituted an area of psychological research for more than a century. Although the literature is scattered, there is no doubt that the processes underlying creativity are complex and multidetermined. Joy P. Guilford, a leading figure in creativity research for most of the past century, argued that the creative processes comprise a wide range of elements, including fluency, flexibility of thought, originality, sensitivity to problems, the capacity to transform the known, cognition, memory, and personality traits.

In an attempt to account for all these components, the creative process has sometimes been explained as the result of the convergence of three major factors, namely:

1. Attentional factors: higher openness or receptivity to both the environment and one's inner world (thoughts and ideas)
2. Motivational factors: higher willingness to defy the status quo and produce original products
3. Ability factors: higher levels of cognitive ability and the capacity to express complex and unusual ideas

Rather than examining these factors simultaneously, however, psychologists have tended to focus on one or the other. Indeed, psychological investigations into the creative process can by and large be classified according to their focus on either attentional, motivational, or ability factors. This entry is structured accordingly.

Attentional Factors

The idea that creative processes are triggered by differential patterns of attention, specifically perceptual anomalies, most certainly predates psychology. In psychiatry, this idea was first formalized in the 1850s by Bénédict Morel, who conceptualized the creative process in terms of a "degeneration" of the mind and closely related to mental illness. In fact, Morel saw degeneration as the very cause of what would later be defined as schizophrenia. Decades later, Giacomo Lombroso, a Darwinian criminologist who understood genius as a form of hereditary insanity, described degeneration as a morbid vanity that causes mystical interpretations of simple facts and exacerbated self-focus.

Although Morel's concept of degeneration had a short life in creativity research, there has been longstanding support for the link between creativity and psychopathological tendencies. Most notably, Hans Eysenck, a personality psychologist of the past century, postulated that creativity and being prone to psychosis share the same underlying cognitive style of "overinclusiveness," characterized by a failure to inhibit irrelevant information. Likewise, it has been suggested that creative processes are caused by an attentional shift from external sensory stimuli to internal ideational stimuli. Thus, creative processes differ from normal thinking processes in that they are produced by free association rather than logical reasoning, at least initially.

Although evidence for Eysenck's theory has been mixed, the idea that creative processes can be induced by altered states of consciousness has also