

Creativity

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Creativity refers to the phenomenon whereby a person creates something new (a product, a solution, a work of art etc.) that has some kind of value. What counts as "new" may be in reference to the individual creator, or to the society or domain within which the novelty occurs. What counts as "valuable" is similarly defined in a variety of ways.

Scholarly interest in creativity ranges widely: Topics to which it is relevant include the relationship between creativity and general intelligence; the mental and neurological processes associated with creative activity; the relationship between personality type and creative ability; the relationship between creativity and mental health; the potential for fostering creativity through education and training, especially as augmented by technology; and the application of an individual's existing creative resources to improve the effectiveness of learning processes and of the teaching processes tailored to them.

Creativity and creative acts are therefore studied across several disciplines - psychology, cognitive science, education, philosophy (particularly philosophy of science), technology, theology, sociology, linguistics, business studies, and economics. As a result, there are a multitude of definitions and approaches.

Etymology

The lexeme in the English word creativity comes from the Latin term *creare* "to create, make" and its derivational suffixes also come from Latin. The word "create" appears in English as early as the 14th century, notably in Chaucer (in *The Parson's Tale*). However, its modern meaning as an act of human creation did not emerge until after the Enlightenment.

Definition

In a summary of scientific research into creativity Michael Mumford suggested: "'Over the course of the last decade, however, we seem to have reached a general agreement that creativity involves the production of novel, useful products" (Mumford, 2003, p. 110). Beyond this general commonality, authors have diverged dramatically in their precise definitions, with Peter Meusburger claiming that over a hundred different versions can be found in the literature.

Aspects of creativity

Theories of creativity (in particular investigating why some people are more creative than others) have focused on a variety of aspects. The most dominant are usually identified as the four "Ps" - process, product, person and place. A focus on process is shown in cognitive approaches that try to describe thought mechanisms and techniques for creative thinking. Theories invoking divergent rather than convergent thinking (such as Guilford), or those describing the staging of the creative

process (such as Wallas) are primarily theories of creative process. A focus on creative product usually appears in attempts to measure creativity in people (psychometrics, see below), or in creative ideas framed as successful memes. A focus on the nature of the creative person considers more general intellectual habits, such as openness, levels of ideation, autonomy, expertise, exploratory behaviour and so on. A focus on place considers the best circumstances in which creativity flourishes, including degrees of autonomy, access to resources and the nature of gatekeepers.

Historical and personal creativity

The product of "creativity" has typically been defined in one of two ways: either as something historically new (and relatively rare), such as scientific discoveries or great works of art; or as producing something new in a personal sense - an apparent innovation for the creator, regardless of whether others have made similar innovations, or whether others value the particular act of creation. In the former sense there are writers such as Mihály Csíkszentmihályi have defined creativity in terms of rare individuals who have been judged by others to have made significant creative, often domain-changing contributions (and as such, the level of creativity of an individual can vary over historical time as perceptions change), and Simonton, who has analysed the career trajectories of the creatively eminent in order to map patterns and predictors of creative productivity. In the latter sense, writers such as Ken Robinson, and Anna Craft have focussed on creativity in a general population, particularly with respect to education.

There are a variety of labels for the two sides of this dichotomy. Margaret Boden distinguishes between h-creativity (historical) and p-creativity (personal). Craft makes a similar distinction between "high" and "little c" creativity. while Craft cites Robinson referring to "high" and "democratic" creativity. Common also is the pairing of terms "Big C" and "Little C".

Kozbelt, Beghetto and Runco, use a little-c/Big-C model to review major theories of creativity This approach was first introduced by James C. Kaufman and Beghetto into a four C model: mini-c (transformative learning), which are "personally meaningful interpretations of experiences, actions and insights"; little-c (everyday problem solving and creative expression); Pro-C, exhibited by people who are professionally or vocationally creative but not eminent, and Big-C, reserved for those who are considered truly great in their field. This was to help distinguish more clearly between the amateur unapprenticed in the particular creative domain (e.g. the visual arts, astrophysics etc.), the professional who was domain-competent, and creative genius. The four-c model was also intended to help accommodate models and theories of creativity that stressed domain-competence as an essential component, and domain transformation as the highest mark of creativity; it also, they argued, made a useful framework for analysing creative processes in individuals.

History of the term and the concept

Traditional views in the West and East

It is generally thought that "creativity" in Western culture was originally seen as a matter of divine inspiration. In Greek culture, for instance, Muses were seen as mediating inspiration from the Gods. Romans and Greeks invoked the concept of an external creative "daemon" (Greek) or "genius" (Latin), linked to the sacred or the divine. This probably came closest to describing what the modern age views as creative talent. In the Judaeo-Christian tradition, creativity was the sole province of God; humans were not considered to have the ability to create something new except as an expression of God's work.

The traditional Western view of creativity can be contrasted with the traditional Eastern view. For Hindus, Confucianists, Taoists and Buddhists, creation was at most a kind of discovery or mimicry, and the idea of creation "from nothing" had no place in these philosophies and religions.

The Enlightenment and after

In the West, this view of creativity as divinely inspired was dominant until the time of the renaissance and even later. However, by the 18th century and the Age of Enlightenment, mention of creativity (notably in art theory), linked with the concept of imagination, became more frequent. In the writing of Thomas Hobbes, imagination became a key element of human cognition; William Duff was one of the first to identify imagination as a quality of genius, typifying the separation being made between talent (productive, but breaking no new ground) and genius.

As a direct and independent topic of study, creativity effectively received no attention until the 19th century. Runco and Albert argue that creativity as the subject of proper study began seriously to emerge in the late 19th century with the increased interest in individual differences inspired by the arrival of Darwinism. In particular they refer to the work of Francis Galton, who through his eugenicist outlook took a keen interest in the heritability of intelligence, with creativity taken as an aspect of genius.

In the late 19th and early 20th centuries, leading mathematicians and scientists such as Hermann von Helmholtz (1896) and Henri Poincaré (1908) began to reflect on and publicly discuss their creative processes, and these insights were built on in early accounts of the creative process by pioneering theorists such as Graham Wallas and Max Wertheimer.

In 1927, Alfred North Whitehead gave the Gifford Lectures at the University of Edinburgh, later published as *Process and Reality*. He is credited with having coined the term "creativity" to serve as the ultimate category of his metaphysical scheme: Whitehead actually coined the term - our term, still the preferred currency of exchange among literature, science, and the arts. . . a term that

quickly became so popular, so omnipresent, that its invention within living memory, and by Alfred North Whitehead of all people, quickly became occluded".

The formal psychometric measurement of creativity, from the standpoint of orthodox psychological literature, is usually considered to have begun with J. P. Guilford's 1950 address to the American Psychological Association, which helped popularize the topic and focus attention on a scientific approach to conceptualizing creativity. (It should be noted that the London School of Psychology had instigated psychometric studies of creativity as early as 1927 with the work of H. L. Hargreaves into the Faculty of Imagination, but it did not have the same impact.) Statistical analysis led to the recognition of creativity (as measured) as a separate aspect of human cognition to IQ-type intelligence, into which it had previously been subsumed. Guilford's work suggested that above a threshold level of IQ, the relationship between creativity and classically measured intelligence broke down.

Creativity in psychology and cognitive science

The study of the mental representations and processes underlying creative thought belongs to the domains of psychology and cognitive science.

A psychodynamic approach to understanding creativity was proposed by Sigmund Freud, who suggested that creativity arises as a result of frustrated desires for fame, fortune and love, with the energy that was previously tied up in frustration and emotional tension in the neurosis being sublimated into creative activity. Freud later retracted this view.

Graham Wallas

Graham Wallas, in his work *Art of Thought*, published in 1926, presented one of the first models of the creative process. In the Wallas stage model, creative insights and illuminations may be explained by a process consisting of 5 stages:

preparation (preparatory work on a problem that focuses the individual's mind on the problem and explores the problem's dimensions),

incubation (where the problem is internalized into the unconscious mind and nothing appears externally to be happening),

intimation (the creative person gets a "feeling" that a solution is on its way),

illumination or insight (where the creative idea bursts forth from its preconscious processing into conscious awareness); and

verification (where the idea is consciously verified, elaborated, and then applied

In numerous publications, Wallas' model is just treated as four stages, with "intimation" seen as a

sub-stage. There has been some empirical research looking at whether, as the concept of "incubation" in Wallas' model implies, a period of interruption or rest from a problem may aid creative problem-solving. Ward lists various hypotheses that have been advanced to explain why incubation may aid creative problem-solving, and notes how some empirical evidence is consistent with the hypothesis that incubation aids creative problem-solving in that it enables "forgetting" of misleading clues. Absence of incubation may lead the problem solver to become fixated on inappropriate strategies of solving the problem. This work disputes the earlier hypothesis that creative solutions to problems arise mysteriously from the unconscious mind while the conscious mind is occupied on other tasks.

Wallas considered creativity to be a legacy of the evolutionary process, which allowed humans to quickly adapt to rapidly changing environments. Simonton provides an updated perspective on this view in his book, *Origins of genius: Darwinian perspectives on creativity*.

J. P. Guilford

Guilford performed important work in the field of creativity, drawing a distinction between convergent and divergent production (commonly renamed convergent and divergent thinking). Convergent thinking involves aiming for a single, correct solution to a problem, whereas divergent thinking involves creative generation of multiple answers to a set problem. Divergent thinking is sometimes used as a synonym for creativity in psychology literature. Other researchers have occasionally used the terms flexible thinking or fluid intelligence, which are roughly similar to (but not synonymous with) creativity.

Arthur Koestler

In *The Act of Creation*, Arthur Koestler lists three types of creative individual - the Artist, the Sage and the Jester.

Believers in this trinity hold all three elements necessary in business and can identify them all in "truly creative" companies as well. Koestler introduced the concept of bisociation--that creativity arises as a result of the intersection of two quite different frames of reference.

Geneplore model

In 1992, Finke et al. proposed the "Geneplore" model, in which creativity takes place in two phases: a generative phase, where an individual constructs mental representations called preinventive structures, and an exploratory phase where those structures are used to come up with creative ideas. Weisberg argued, by contrast, that creativity only involves ordinary cognitive processes yielding extraordinary results.

Conceptual blending

In the '90s, various approaches in cognitive science that dealt with metaphor, analogy and structure mapping have been converging, and a new integrative approach to the study of creativity in science, art and humor has emerged under the label conceptual blending.

Creativity is the ability to illustrate what is outside the box from within the box."

--The Ride

Creativity and everyday imaginative thought

In everyday thought, people often spontaneously imagine alternatives to reality when they think "if only...". Their counterfactual thinking is viewed as an example of everyday creative processes. It has been proposed that the creation of counterfactual alternatives to reality depends on similar cognitive processes to rational thought.

Psychological examples from science and mathematics

Jacques Hadamard

Jacques Hadamard, in his book *Psychology of Invention in the Mathematical Field*, uses introspection to describe mathematical thought processes. In contrast to authors who identify language and cognition, he describes his own mathematical thinking as largely wordless, often accompanied by mental images that represent the entire solution to a problem. He surveyed 100 of the leading physicists of his day (ca. 1900), asking them how they did their work. Many of the responses mirrored his own.

Hadamard described the experiences of the mathematicians/theoretical physicists Carl Friedrich Gauss, Hermann von Helmholtz, Henri Poincaré and others as viewing entire solutions with "sudden spontaneity."

The same has been reported in literature by many others, such as Denis Brian, G. H. Hardy, Walter Heitler, B. L. van der Waerden, and Harold Rugg.

To elaborate on one example, Einstein, after years of fruitless calculations, suddenly had the solution to the general theory of relativity revealed in a dream "like a giant die making an indelible impress, a huge map of the universe outlined itself in one clear vision."

Hadamard described the process as having steps (i) preparation, (ii) incubation, (iv) illumination, and (v) verification of the five-step Graham Wallas creative-process model, leaving out (iii) intuition, with the first three cited by Hadamard as also having been put forth by Helmholtz:

Marie-Louise von Franz

Marie-Louise von Franz, a colleague of the eminent psychiatrist Carl Jung, noted that in these unconscious scientific discoveries the "always recurring and important factor ... is the simultaneity with which the complete solution is intuitively perceived and which can be checked later by discursive reasoning." She attributes the solution presented "as an archetypal pattern or image." As cited by von Franz, according to Jung, "Archetypes ... manifest themselves only through their ability to organize images and ideas, and this is always an unconscious process which cannot be detected until afterwards."

Creativity and affect

Some theories suggest that creativity may be particularly susceptible to affective influence.

Creativity and positive affect relations

According to Alice Isen, positive affect has three primary effects on cognitive activity:

Positive affect makes additional cognitive material available for processing, increasing the number of cognitive elements available for association;

Positive affect leads to defocused attention and a more complex cognitive context, increasing the breadth of those elements that are treated as relevant to the problem;

Positive affect increases cognitive flexibility, increasing the probability that diverse cognitive elements will in fact become associated. Together, these processes lead positive affect to have a positive influence on creativity.

Barbara Fredrickson in her broaden-and-build model suggests that positive emotions such as joy and love broaden a person's available repertoire of cognitions and actions, thus enhancing creativity.

According to these researchers, positive emotions increase the number of cognitive elements available for association (attention scope) and the number of elements that are relevant to the problem (cognitive scope).

Various meta-analyses, such as Matthijs et al. (2008) of 66 studies about creativity and affect support the link between creativity and positive affect.

Creativity and negative affect relations

On the other hand, some theorists have suggested that negative affect leads to greater creativity. A cornerstone of this perspective is empirical evidence of a relationship between affective illness and creativity. In a study of 1,005 prominent 20th century individuals from over 45 different professions, the University of Kentucky's Arnold Ludwig found a slight but significant correlation

between depression and level of creative achievement. In addition, several systematic studies of highly creative individuals and their relatives have uncovered a higher incidence of affective disorders (primarily bipolar disorder and depression) than that found in the general population.

Creativity and affect at work

Three patterns may exist between affect and creativity at work: positive (or negative) mood, or change in mood, predictably precedes creativity; creativity predictably precedes mood; and whether affect and creativity occur simultaneously.

It was found that not only might affect precede creativity, but creative outcomes might provoke affect as well. At its simplest level, the experience of creativity is itself a work event, and like other events in the organizational context, it could evoke emotion. Qualitative research and anecdotal accounts of creative achievement in the arts and sciences suggest that creative insight is often followed by feelings of elation. For example, Albert Einstein called his 1907 general theory of relativity "the happiest thought of my life." Empirical evidence on this matter is still very tentative.

In contrast to the possible incubation effects of affective state on subsequent creativity, the affective consequences of creativity are likely to be more direct and immediate. In general, affective events provoke immediate and relatively-fleeting emotional reactions. Thus, if creative performance at work is an affective event for the individual doing the creative work, such an effect would likely be evident only in same-day data.

Another longitudinal research found several insights regarding the relations between creativity and emotion at work. First, a positive relationship between positive affect and creativity, and no evidence of a negative relationship. The more positive a person's affect on a given day, the more creative thinking they evidenced that day and the next day--even controlling for that next day's mood. There was even some evidence of an effect two days later.

In addition, the researchers found no evidence that people were more creative when they experienced both positive and negative affect on the same day. The weight of evidence supports a purely linear form of the affect-creativity relationship, at least over the range of affect and creativity covered in our study: the more positive a person's affect, the higher their creativity in a work setting.

Finally, they found four patterns of affect and creativity affect can operate as an antecedent to creativity; as a direct consequence of creativity; as an indirect consequence of creativity; and affect can occur simultaneously with creative activity. Thus, it appears that people's feelings and creative cognitions are interwoven in several distinct ways within the complex fabric of their daily work lives.

Creativity and intelligence

There has been debate in the psychological literature about whether intelligence and creativity are part of the same process (the conjoint hypothesis) or represent distinct mental processes (the disjoint hypothesis). Evidence from attempts to look at correlations between intelligence and creativity from the 1950s onwards, by authors such as Barron, Guilford or Wallach and Kogan, regularly suggested that correlations between these concepts were low enough to justify treating them as distinct concepts.

Some researchers believe that creativity is the outcome of the same cognitive processes as intelligence, and is only judged as creativity in terms of its consequences, i.e. when the outcome of cognitive processes happens to produce something novel, a view which Perkins has termed the "nothing special" hypothesis.

An often cited model is what has come to be known as "the threshold hypothesis," proposed by Ellis Paul Torrance, which holds that a high degree of intelligence appears to be a necessary but not sufficient condition for high creativity. That is, while there is a positive correlation between creativity and intelligence, this correlation disappears for IQs above a threshold of around 120. Such a model has found acceptance by many researchers, although it has not gone unchallenged. A study in 1962 by Getzels and Jackson among high school students concluded that high IQ and high creativity tend to be mutually exclusive with a majority of the highest scoring students being either highly creative or highly intelligent, but not both. While this explains the threshold, the exact interaction between creativity and IQ remains unexplained.

An alternative perspective, Renzulli's three-rings hypothesis, sees giftedness as based on both intelligence and creativity. More on both the threshold hypothesis and Renzulli's work can be found in O'Hara and Sternberg.

Neurobiology of creativity

The neurobiology of creativity has been addressed in the article Creative Innovation: Possible Brain Mechanisms." The authors write that "creative innovation might require coactivation and communication between regions of the brain that ordinarily are not strongly connected." Highly creative people who excel at creative innovation tend to differ from others in three ways:

they have a high level of specialized knowledge,
they are capable of divergent thinking mediated by the frontal lobe.
and they are able to modulate neurotransmitters such as norepinephrine in their frontal lobe.

Thus, the frontal lobe appears to be the part of the cortex that is most important for creativity.

This article also explored the links between creativity and sleep, mood and addiction disorders, and depression.

In 2005, Alice Flaherty presented a three-factor model of the creative drive. Drawing from evidence in brain imaging, drug studies and lesion analysis, she described the creative drive as resulting from an interaction of the frontal lobes, the temporal lobes, and dopamine from the limbic system. The frontal lobes can be seen as responsible for idea generation, and the temporal lobes for idea editing and evaluation. Abnormalities in the frontal lobe (such as depression or anxiety) generally decrease creativity, while abnormalities in the temporal lobe often increase creativity. High activity in the temporal lobe typically inhibits activity in the frontal lobe, and vice versa. High dopamine levels increase general arousal and goal directed behaviors and reduce latent inhibition, and all three effects increase the drive to generate ideas.

Working memory and the cerebellum

Vandervert described how the brain's frontal lobes and the cognitive functions of the cerebellum collaborate to produce creativity and innovation. Vandervert's explanation rests on considerable evidence that all processes of working memory (responsible for processing all thought) are adaptively modeled by the cerebellum. The cerebellum (consisting of 100 billion neurons, which is more than the entirety of the rest of the brain) is also widely known to adaptively model all bodily movement. The cerebellum's adaptive models of working memory processing are then fed back to especially frontal lobe working memory control processes where creative and innovative thoughts arise. (Apparently, creative insight or the "aha" experience is then triggered in the temporal lobe.)

According to Vandervert, the details of creative adaptation begin in "forward" cerebellar models which are anticipatory/exploratory controls for movement and thought. These cerebellar processing and control architectures have been termed Hierarchical Modular Selection and Identification for Control (HMOSAIC). New, hierarchically arranged levels of the cerebellar control architecture (HMOSAIC) develop as mental mulling in working memory is extended over time. These new levels of the control architecture are fed forward to the frontal lobes. Since the cerebellum adaptively models all movement and all levels of thought and emotion, Vandervert's approach helps explain creativity and innovation in sports, art, music, the design of video games, technology, mathematics, the child prodigy, and thought in general.

REM sleep

Creativity involves the forming of associative elements into new combinations that are useful or meet some requirement. Sleep aids this process. REM rather than NREM sleep appears to be responsible. This has been suggested to be due to changes in cholinergic and noradrenergic neuromodulation that occurs during REM sleep. During this period of sleep, high levels of

acetylcholine in the hippocampus suppress feedback from the hippocampus to the neocortex, and lower levels of acetylcholine and norepinephrine in the neocortex encourage the spread of associational activity within neocortical areas without control from the hippocampus. This is in contrast to waking consciousness, where higher levels of norepinephrine and acetylcholine inhibit recurrent connections in the neocortex. It is proposed that REM sleep would add creativity by allowing "neocortical structures to reorganize associative hierarchies, in which information from the hippocampus would be reinterpreted in relation to previous semantic representations or nodes."

Creativity and mental health

A study by psychologist J. Philippe Rushton found creativity to correlate with intelligence and psychoticism. Another study found creativity to be greater in schizotypal than in either normal or schizophrenic individuals. While divergent thinking was associated with bilateral activation of the prefrontal cortex, schizotypal individuals were found to have much greater activation of their right prefrontal cortex. This study hypothesizes that such individuals are better at accessing both hemispheres, allowing them to make novel associations at a faster rate. In agreement with this hypothesis, ambidexterity is also associated with schizotypal and schizophrenic individuals. Three recent studies by Mark Batey and Adrian Furnham have demonstrated the relationships between schizotypal and hypomanic personality and several different measures of creativity.

Particularly strong links have been identified between creativity and mood disorders, particularly manic-depressive disorder (a.k.a. bipolar disorder) and depressive disorder (a.k.a. unipolar disorder). In *Touched with Fire: Manic-Depressive Illness and the Artistic Temperament*, Kay Redfield Jamison summarizes studies of mood-disorder rates in writers, poets and artists. She also explores research that identifies mood disorders in such famous writers and artists as Ernest Hemingway (who shot himself after electroconvulsive treatment), Virginia Woolf (who drowned herself when she felt a depressive episode coming on), composer Robert Schumann (who died in a mental institution), and even the famed visual artist Michelangelo.

Measuring creativity

Creativity quotient

Several attempts have been made to develop a creativity quotient of an individual similar to the intelligence quotient (IQ), however these have been unsuccessful. Most measures of creativity are dependent on the personal judgement of the tester, so a standardized measure is difficult, if not impossible, to develop.

Psychometric approach

J. P. Guilford's group, which pioneered the modern psychometric study of creativity, constructed several tests to measure creativity in 1967:

Plot Titles, where participants are given the plot of a story and asked to write original titles.

Quick Responses is a word-association test scored for uncommonness.

Figure Concepts, where participants were given simple drawings of objects and individuals and asked to find qualities or features that are common by two or more drawings; these were scored for uncommonness.

Unusual Uses is finding unusual uses for common everyday objects such as bricks.

Remote Associations, where participants are asked to find a word between two given words (e.g. Hand _____ Call)

Remote Consequences, where participants are asked to generate a list of consequences of unexpected events (e.g. loss of gravity)

Building on Guilford's work, Torrance developed the Torrance Tests of Creative Thinking in 1966. They involved simple tests of divergent thinking and other problem-solving skills, which were scored on:

Fluency - The total number of interpretable, meaningful and relevant ideas generated in response to the stimulus.

Originality - The statistical rarity of the responses among the test subjects.

Elaboration - The amount of detail in the responses.

The Creativity Achievement Questionnaire, a self-report test that measures creative achievement across 10 domains, was described in 2005 and shown to be reliable and valid when compared to other measures of creativity and to independent evaluation of creative output. The psychometric approach has been criticized by Robert Sternberg for falling "short of distinguishing imagination from fantasy, relevant from irrelevant material, and contextually valid from rambling associations".

Social-personality approach

Some researchers have taken a social-personality approach to the measurement of creativity. In these studies, personality traits such as independence of judgement, self-confidence, attraction to complexity, aesthetic orientation and risk-taking are used as measures of the creativity of individuals. Other researchers have related creativity to the trait, openness to experience.

As the research into the relationship between personality traits and creativity continues to grow, a more complete picture has developed. Within the framework of the Big Five model of personality some consistent traits have emerged. Openness to experience has been shown to be consistently related to a whole host of different assessments of creativity. Among the other Big Five traits, research has demonstrated subtle differences between different domains of creativity. A meta-

analysis by Gregory Feist showed that artists tend to have higher levels of neuroticism and introversion, while scientists are more conscientious.

Other approaches to measurement

Genrich Altshuller in the 1950s introduced approaching creativity as an exact science with TRIZ and a Level-of-Invention measure.

The creativity of thousands of Japanese, expressed in terms of their problem-solving and problem-recognizing capabilities, has been measured in Japanese firms.

Howard Gruber insisted on a case-study approach that expresses the existential and unique quality of the creator. Creativity to Gruber was the product of purposeful work and this work could be described only as a confluence of forces in the specifics of the case.

Creativity in various contexts

An electric wire reel reused like a center table in a Rio de Janeiro decoration fair. The creativity of this designer in reusing this waste was used with good effects to the environment.

Creativity has been studied from a variety of perspectives and is important in numerous contexts. Most of these approaches are undisciplinary, and it is therefore difficult to form a coherent overall view. The following sections examine some of the areas in which creativity is seen as being important.

Creativity Profiles

Creativity comes in different forms. A number of different theorists have suggested models of the creative person. One model suggests that there are kinds to produce growth, innovation, speed, etc. These are referred to as the four Creativity Profiles" that can help achieve such goals.

Incubate (Long-term Development)

Imagine (Breakthrough Ideas)

Improve (Incremental Adjustments)

Invest (Short-term Goals)

Research by Dr Mark Batey of the Psychometrics at Work Research Group at Manchester Business School has suggested that the creative profile can be explained by four primary creativity traits with narrow facets within each

"Idea Generation" (Fluency, Originality, Incubation and Illumination)

"Personality" (Curiosity and Tolerance for Ambiguity)

"Motivation" (Intrinsic, Extrinsic and Achievement)

Confidence" (Producing, Sharing and Implementing)

This model was developed in a sample of 1000 working adults using the statistical techniques of Exploratory Factor Analysis followed by Confirmatory Factor Analysis by Structural Equation Modelling.

An important aspect of the creativity profiling approach is to account for the tension between predicting the creative profile of an individual, as characterised by the psychometric approach, and the evidence that team creativity is founded on diversity and difference.

Creativity in diverse cultures

Francois Jullien in "Process and Creation, 1989" invites us to look at that concept from a Chinese cultural point of view. Fangqi Xu has reported creativity courses in a range of countries. Todd Lubart has studied extensively the cultural aspects of creativity and innovation.

Creativity in art and literature

Most people associate creativity with the fields of art and literature. In these fields, originality is considered to be a sufficient condition for creativity, unlike other fields where both originality and appropriateness are necessary.

Within the different modes of artistic expression, one can postulate a continuum extending from "interpretation" to "innovation". Established artistic movements and genres pull practitioners to the "interpretation" end of the scale, whereas original thinkers strive towards the "innovation" pole. Note that we conventionally expect some "creative" people (dancers, actors, orchestral members, etc.) to perform (interpret) while allowing others (writers, painters, composers, etc.) more freedom to express the new and the different.

Contrast alternative theories, for example:

artistic inspiration, which provides the transmission of visions from divine sources such as the Muses; a taste of the Divine. Compare with invention.

artistic evolution, which stresses obeying established ("classical") rules and imitating or appropriating to produce subtly different but unshockingly understandable work. Compare with crafts.

artistic conversation, as in Surrealism, which stresses the depth of communication when the creative product is the language.

In the art practice and theory of Davor Dzalto, human creativity is taken as a basic feature of both the personal existence of human being and art production. For this thinker, creativity is a basic cultural and anthropological category, since it enables human manifestation in the world as a "real presence" in contrast to the progressive "virtualization" of the world.

Creative industries and services

Today, creativity forms the core activity of a growing section of the global economy--the so-called "creative industries"--capitalistically generating (generally non-tangible) wealth through the creation and exploitation of intellectual property or through the provision of creative services. The Creative Industries Mapping Document 2001 provides an overview of the creative industries in the UK. The creative professional workforce is becoming a more integral part of industrialized nations' economies.

Creative professions include writing, art, design, theater, television, radio, motion pictures, related crafts, as well as marketing, strategy, some aspects of scientific research and development, product development, some types of teaching and curriculum design, and more. Since many creative professionals (actors and writers, for example) are also employed in secondary professions, estimates of creative professionals are often inaccurate. By some estimates, approximately 10 million US workers are creative professionals; depending upon the depth and breadth of the definition, this estimate may be double.

Creativity in other professions

Isaac Newton's law of gravity is popularly attributed to a creative leap he experienced when observing a falling apple.

Creativity is also seen as being increasingly important in a variety of other professions. Architecture and industrial design are the fields most often associated with creativity, and more generally the fields of design and design research. These fields explicitly value creativity, and journals such as Design Studies have published many studies on creativity and creative problem solving.

Fields such as science and engineering have, by contrast, experienced a less explicit (but arguably no less important) relation to creativity. Simonton shows how some of the major scientific advances of the 20th century can be attributed to the creativity of individuals. This ability will also be seen as increasingly important for engineers in years to come.

Accounting has also been associated with creativity with the popular euphemism creative accounting. Although this term often implies unethical practices, Amabile has suggested that even

this profession can benefit from the (ethical) application of creative thinking.

In a recent global survey of approximately 1600 CEO's, the leadership trait that was considered to be most crucial for success was creativity. This suggests that the world of business is beginning to accept that creativity is of value in a diversity of industries, rather than being simply the preserve of the creative industries.

Creativity in organizations

It has been the topic of various research studies to establish that organizational effectiveness depends on the creativity of the workforce to a large extent. For any given organization, measures of effectiveness vary, depending upon its mission, environmental context, nature of work, the product or service it produces, and customer demands. Thus, the first step in evaluating organizational effectiveness is to understand the organization itself - how it functions, how it is structured, and what it emphasizes.

Amabile argued that to enhance creativity in business, three components were needed:

Expertise (technical, procedural and intellectual knowledge),
Creative thinking skills (how flexibly and imaginatively people approach problems),
and Motivation (especially intrinsic motivation).

There are two types of motivation:

extrinsic motivation - external factors, for example threats of being fired or money as a reward,
intrinsic motivation - comes from inside an individual, satisfaction, enjoyment of work etc.

Six managerial practices to encourage motivation are:

Challenge - matching people with the right assignments;
Freedom - giving people autonomy choosing means to achieve goals;
Resources - such as time, money, space etc. There must be balance fit among resources and people;
Work group features - diverse, supportive teams, where members share the excitement, willingness to help and recognize each other's talents;
Supervisory encouragement - recognitions, cheering, praising;
Organizational support - value emphasis, information sharing, collaboration.

Nonaka, who examined several successful Japanese companies, similarly saw creativity and knowledge creation as being important to the success of organizations. In particular, he emphasized the role that tacit knowledge has to play in the creative process.

In business, originality is not enough. The idea must also be appropriate--useful and actionable.

Economic views of creativity

Economic approaches to creativity have focussed on three aspects - the impact of creativity on economic growth, methods of modelling markets for creativity, and the maximisation of economic creativity (innovation).

In the early 20th century, Joseph Schumpeter introduced the economic theory of creative destruction, to describe the way in which old ways of doing things are endogenously destroyed and replaced by the new. Some economists (such as Paul Romer) view creativity as an important element in the recombination of elements to produce new technologies and products and, consequently, economic growth. Creativity leads to capital, and creative products are protected by intellectual property laws.

Mark A. Runco and Daniel Rubenson have tried to describe a "psychoeconomic" model of creativity. In such a model, creativity is the product of endowments and active investments in creativity; the costs and benefits of bringing creative activity to market determine the supply of creativity. Such an approach has been criticised for its view of creativity consumption as always having positive utility, and for the way it analyses the value of future innovations.

The creative class is seen by some to be an important driver of modern economies. In his 2002 book, *The Rise of the Creative Class*, economist Richard Florida popularized the notion that regions with "3 T's of economic development: Technology, Talent and Tolerance" also have high concentrations of creative professionals and tend to have a higher level of economic development.

Fostering creativity

Daniel Pink, in his 2005 book *A Whole New Mind*, repeating arguments posed throughout the 20th century, argues that we are entering a new age where creativity is becoming increasingly important. In this conceptual age, we will need to foster and encourage right-directed thinking (representing creativity and emotion) over left-directed thinking (representing logical, analytical thought). However, this simplification of 'right' versus 'left' brain thinking is not supported by the research data.

Nickerson provides a summary of the various creativity techniques that have been proposed. These include approaches that have been developed by both academia and industry:

Establishing purpose and intention

Building basic skills

Encouraging acquisitions of domain-specific knowledge

- Stimulating and rewarding curiosity and exploration
- Building motivation, especially internal motivation
- Encouraging confidence and a willingness to take risks
- Focusing on mastery and self-competition
- Promoting supportable beliefs about creativity
- Providing opportunities for choice and discovery
- Developing self-management (metacognitive skills)
- Teaching techniques and strategies for facilitating creative performance
- Providing balance

Some see the conventional system of schooling as "stifling" of creativity and attempt (particularly in the pre-school/kindergarten and early school years) to provide a creativity-friendly, rich, imagination-fostering environment for young children. Researchers have seen this as important because technology is advancing our society at an unprecedented rate and creative problem solving will be needed to cope with these challenges as they arise. In addition to helping with problem solving, creativity can also help students identify problems where others have failed to do so. See the Waldorf School as an example of an education program that promotes creative thought.

Promoting intrinsic motivation and problem solving are two areas where educators can foster creativity in students. Students are more creative when they see a task as intrinsically motivating, valued for its own sake. To promote creative thinking educators need to identify what motivates their students and structure teaching around it. Providing students with a choice of activities to complete allows them to become more intrinsically motivated and therefore creative in completing the tasks.

Teaching students to solve problems that do not have well defined answers is another way to foster their creativity. This is accomplished by allowing students to explore problems and redefine them, possibly drawing on knowledge that at first may seem unrelated to the problem in order to solve it.

Several different researchers have proposed methods of increasing the creativity of an individual. Such ideas range from the psychological-cognitive, such as Osborn-Parnes Creative Problem Solving Process, Synectics, Science-based creative thinking, Purdue Creative Thinking Program, and Edward de Bono's lateral thinking; to the highly-structured, such as TRIZ (the Theory of Inventive Problem-Solving) and its variant Algorithm of Inventive Problem Solving (developed by the Russian scientist Genrich Altshuller), and Computer-Aided Morphological analysis.

Understanding and enhancing the creative process with new technologies

A simple but accurate review on this new Human-Computer Interactions (HCI) angle for promoting creativity has been written by Todd Lubart, an invitation full of creative ideas to develop further this new field.

Groupware and other Computer Supported Collaborative Work (CSCW) platforms are now the stage of Network Creativity on the web or on other private networks. These tools have made more obvious the existence of a more connective, cooperative and collective nature of creativity rather than the prevailing individual one. Creativity Research on Global Virtual Teams is showing that the creative process is affected by the national identities, cognitive and conative profiles, anonymous interactions at times and many other factors affecting the teams members, depending on the early or later stages of the cooperative creative process. They are also showing how NGO's cross-cultural virtual team's innovation in Africa would also benefit from the pooling of best global practices online. Such tools enhancing cooperative creativity may have a great impact on society and as such should be tested while they are built following the Motto: "Build the Camera while shooting the film". Some European FP7 scientific programs like Paradiso are answering a need for advanced experimentally-driven research including large scale experimentation test-beds to discover the technical, societal and economic implications of such groupware and collaborative tools to the Internet.

On the other hand, creativity research may one day be pooled with a computable metalanguage like IEMML from the University of Ottawa Collective Intelligence Chair, Pierre Levy. It might be a good tool to provide an interdisciplinary definition and a rather unified theory of creativity. The creative processes being highly fuzzy, the programming of cooperative tools for creativity and innovation should be adaptive and flexible. Empirical Modelling seems to be a good choice for Humanities Computing.

If all the activity of the universe could be traced with appropriate captors, it is likely that one could see the creative nature of the universe to which humans are active contributors. After the web of documents, the Web of Things might shed some light on such a universal creative phenomenon which should not be restricted to humans. In order to trace and enhance cooperative and collective creativity, Metis Reflexive Global Virtual Team has worked for the last few years on the development of a Trace Composer at the intersection of personal experience and social knowledge.

Metis Reflexive Team has also identified a paradigm for the study of creativity to bridge European theory of "useless" and non-instrumentalized creativity, North American more pragmatic creativity and Chinese culture stressing more creativity as a holistic process of continuity rather than radical change and originality. This paradigm is mostly based on the work of the German philosopher Hans Joas, one that emphasizes the creative character of human action. This model allows also for a more comprehensive theory of action. Joas elaborates some implications of his model for

theories of social movements and social change. The connection between concepts like creation, innovation, production and expression is facilitated by the creativity of action as a metaphor but also as a scientific concept.

The Creativity and Cognition conference series, sponsored by the ACM and running since 1993, has been an important venue for publishing research on the intersection between technology and creativity. The conference now runs biennially, next taking place in 2011.

Social attitudes to creativity

Although the benefits of creativity to society as a whole have been noted, social attitudes about this topic remain divided. The wealth of literature regarding the development of creativity and the profusion of creativity techniques indicate wide acceptance, at least among academics, that creativity is desirable.

There is, however, a dark side to creativity, in that it represents a "quest for a radical autonomy apart from the constraints of social responsibility". In other words, by encouraging creativity we are encouraging a departure from society's existing norms and values. Expectation of conformity runs contrary to the spirit of creativity. Sir Ken Robinson argues that the current education system is "educating people out of their creativity".

Nevertheless, employers are increasingly valuing creative skills. A report by the Business Council of Australia, for example, has called for a higher level of creativity in graduates. The ability to "think outside the box" is highly sought after. However, the above-mentioned paradox may well imply that firms pay lip service to thinking outside the box while maintaining traditional, hierarchical organization structures in which individual creativity is not rewarded.