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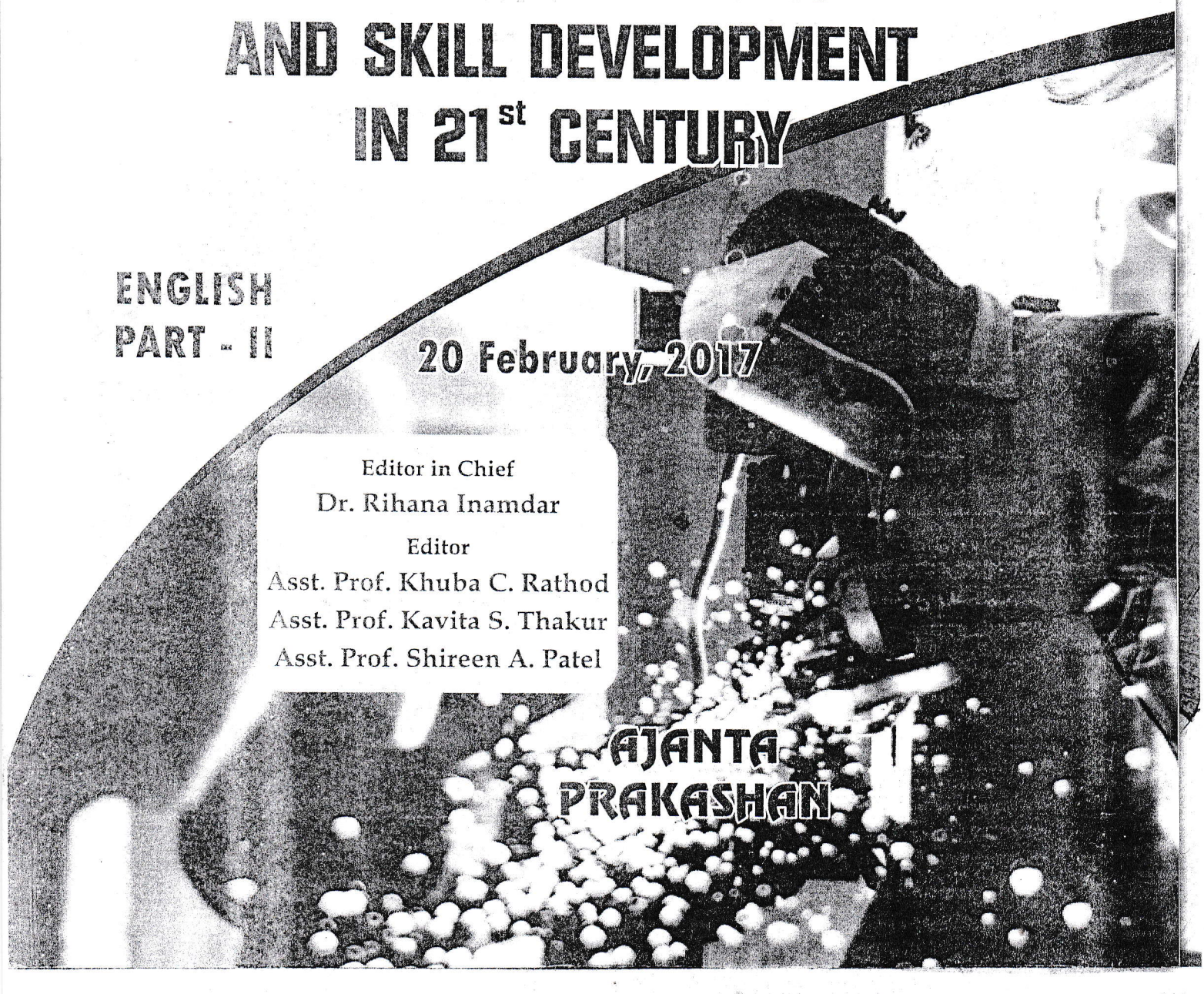

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AJANTA PRAKASHAN

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On Definitions of Creative Processes, Product and Potential

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Introduction

Higher education occupies a special position in the educational system of any nation because it is at the apex of the entire educational structure and thus influences all levels of education. Through ideas and innovations, its influence on the future of the nation is also very considerable. It is higher education firstly, because it constitutes the top most stage of formal education and more importantly because it is concerned with processes in the more advanced phases of human learning. The entrants are about eighteen years of age and therefore they are mentally mature and capable of performing at the abstract level. They can analyze, synthesize and grasp concepts and ideas of all kinds. Their creative faculties are also developed adequately. Consequently the content, methods of interaction and organization of work have to be very different from what they are at the school. If education strives to prepare children for a productive life in society, the educational system must accept responsibility for supporting and developing creativity.

Definition

There have been recent integrative efforts to describe and delineate the field of creativity research (Batey &Furnham,2006; Plucker, Beghetto, & Dow,2004) with regard to definitions, many researchers have adopted the "new and useful" definition of creativity (Mumford,2003); which suggests that a creative product is that which is deemed to be novel or original and useful or adaptive. Another area of agreement has involved the concept that creativity may refer to a person(or persons), processes, products, and also the environmental press (Rhodes, 1961/1987). However, it is important to consider how the term creativity has come to be understood and defined.

The historical background of the term creativity has a significant bearing on attempts to define the construct. The most significant issues that underpin creativity definitions concern Western verses Eastern perspectives, and creativity as divine intervention. Creativity as the original product of an individual is a predominately Western perspective. The earliest perceptions of creativity were dominated by the story or the

creation in Genesis. From here, the concept of creation as originality and utility arose and influenced subsequent interpretations of the properties of creative products. This contrasts with an Eastern view of creativity as the expression of personal growth or as self-growth (Lubart,1999). The paradigmatic approach that has dominated creativity research almost exclusively adopted this Western perspective of creativity as novelty and utility. The earliest, though predominately Western, conceptions of creativity drew mystical interpretations (Stenberg & Lubart, 1999). The ancient Greeks believed that inspiration and creation resulted from divine intervention . from this perspective, creativity was "associated with mystical powers of protection and good fortune" (Albert & Runco, 1999, P.18). The consequence for the concept of creativity was that it was considered beyond measurement and comprehension, a legacy that arguably remains today.

In time, the Greeks began to reduce the emphasis of divine intervention by the highest gods, instead considering creativity to be related to each individual's guardian spirit. By the time of Aristotle, creativity was seen as a natural event that conformed to natural law, even if it did involve "an associated with the madness and frenzied inspiration (Albert & Runco, 1999, P.15). Little by little, creative acts became associated with the abilities and dispositions of the person. As creativity became associated with individuals, so researchers like Galton began investigations of Heredity Genius(Galton, 1869/1962) and the London school or differential movement sought to elucidate the most basic component of creative thought production; fluency (Hargreaves,1927). The grounding of the scientific investigation of creativity in the individual ability differences field led to the construct being considered a predominately intellectual trait. Notable studies include the work of Terman and his associates (e.g., Terman & Oden, 1947,1959), Guilford (e.g.,1950) and Torrance (1974). Further, the intellectual trait background of creativity research may have deflected focus from other important individual differences traits such as personality, motivation, values and interests. A recent review has examined the relationships between creativity, intelligence, and personality (Batey & Furnham, 2006).

How creativity is defined is crucial to how the construct is studied. Yet "what creativity is, and what it is not, hangs as the mythical albatross around the neck of scientific research on creativity" (Pretky, 2000-2001, p. 97). As a psychological concept, creativity has resisted unequivocal definition or clear operationalisztion (Parkhurst,1999; Plucker et al.,2004; Runco,2004). Most researchers agree that creativity may be defined with regard to the terms new and useful (Mumford, 2003). However, recent research has indicated that, in many cases, peer-reviewed creativity studies do not provide a definition of the construct (Plucker et.al., 2004).

Alongside the growing consensus behind the new and useful definition of creativity, there is a also concurrence regarding the areas to which definitions have been attributed. Rhodes (1961/1987) suggested that definitions relate to four areas: the person(s) who creates, the cognitive processes involved in the creation of ideas, the press or environmental influences, and lastly the product that result from creative activity. This 4Ps approach appears to have gained relatively wide consensus (Runco, 2004). How researchers interpret

the new and useful definition o creativity will determine how they assess the construct. For example, if usefulness is taken to mean utility for society as a whole, then how creativity is measured and what populations may be sampled is very different from the researcher who sees usefulness as relating only to the experiment or study at hand. Those researchers who emphasize the importance of social appraisal or ecologically valid appraisals of the novelty and utility of a creative person or product will be inclined to measure the construct using taters or judges.

Those who emphasize a person-centered view of creativity will probably assess creativity with reference to trait attributes, like intelligence or personality (e.g., Eysenck, 1993; Guilford, 1950). Those who emphasize a process-centered view will probably assess creativity with references to problem-solving (e.g., Finke et.al., 1992; Mednick, 1962). Those who emphasize the role of the environment will focus on the climate for creaticity (Amabile, 1996; Dul & Ceylan, 2011). However, the dominant definition of the moment is the new and useful product-oriented approach: "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.107). This indicates that advocates of this approach will look to define creativity in terms of the outputs or products of an individual. Then, by proxy, the person who produced the novel an useful product will be deemed creative.

Theories of Creative Processes and Products

1) Creativity as Analogical Thinking

Many investigators claim that analogies play an important role in the cognitive mechanisms involved in creative thinking [Holyoak and Thagard, 1995; Kreitler, 1990]. Anologies are characterized by two disparate domains – the source domain (often a well-explored domain) and the target domain (about which we use the analogy to learn something new. Analogies connect the target and source domains by creating an awareness of similar aspects. Analogies can be based on the similarity between objects at the lowest; the similarity between relations; and, on a higher order, the similarity of relations between relations. According to Holyoak and Thagard " The most creative use of analogies depends on both noticing higher-order similarities and being able to map isomorphic systems of relations" [Holyoak and Thagard, 1995, p. 34]. The use of analogies typically involves four steps: selecting a source analogy by retrieving information about it from memory; mapping the source analog to the target and generating inferences about the target; evaluating and adopting these inferences to account for the differences between the target and source domains; and finally, learning something more general from the success or failure of the analogy.

2) De Bono's Theory: Creativity as Lateral Thinking

The term 'lateral thinking' was coined by de Bono [de Bono, 1969] to describe a thinking process that progresses outside habitual channels of thinking. These channels are shaped, according to de Bono, by

incoming information, similar to the way water shapes land. As water shapes land, in a like manner incoming information tends to deepen the mind-channels. Like the shape of the water-land system organized only by the internal forces of that system, the mind is also a self organizing system. The mind-channels direct the flow of incoming information so as to associate different contents. Thinking about one thing naturally invokes thinking about another. Routine thinking occurs when one's thoughts are allowed to drift in existing channels. Creative thinking, on the other hand, occurs when thoughts are directed or when they accidentally drift laterally across channels. One of the tools suggested by de Bono for enhancing creative thinking is provocation. The role of provocation is to deflect thinking from current channel to other channels. De Bono's model of creative thinking – crossing between well-established channels- does not necessarily involve the creation or new channels, but rather finding new paths linking existing channels. Creative ideas are thus formed by connecting two or more previously known, but unconnected, pieces of content. De Bono explains this by the fact that every idea must be logical in hindsight, and therefore must be connected to the existing, well-established system of channels.

3) Guilford's Theory: Creativity as Divergent Thinking

Divergent thinking is defined as the ability to produce a diversity of responses to an open-ended problem [Guildford, 1959]. The importance of the concept of divergent thinking lies in the fact that divergent thinking tests have been used in the past 30 years to asses the creative potential of individuals. The responses for these tests are evaluated in terms of four measures: fluency- the raw number of responses; flexibility- the number of different categories of responses; originality- the uniqueness or statistical infrequency of the responses; and elaboration- the richness of the content describing each item. Guildford hypothesized that in the course of problem solving a creative individual is likely to use first divergent thinking, that draws on fluency, flexibility, and originality in order to "diverge" from what is known to original ideas. The individual then uses convergent thinking, the logical mode of thought, to converge on a single solution, or idea.

4) Mednick's Theory: Creativity as Remote Associations

The most famous associative theory of creativity is Mednick's theory outlined in his "Associative Basis of the Creative Process" [Mednick, 1962] and operationalized in the "Remote Association Test" known as the RAT. The basic elements of Mednick's theory are ideas, or other meaningful cognitive elements. Association means activation of one element as a result of an activation of another. Mednick's suggests three mechanisms for associating previously unrelated, elements; serendipity – a chance event stimulates two, previously unrelated, elements; similarity – the two associative elements, or the stimuli that evoked these elements, are similar; and mediation of common elements, typically through the use of symbols. The most important concept of Mednick's story is associative hierarchy: the way an individual's associations are organized. Mednick's developed the Remote Association Test to assess an individual's hierarchy structure. Each item in

the test consists of three words such as "cookies"; "sixteen"; "heart". The task is to find another word that is related to all three (in this case the word is "sweet").

5) Koestler's Theory: Creativity as Bisociations

Bisociation, a term coined by Koestler, 1966], is a thinking process in which one combines two habitually unrelated and incompatible matrices of thought. The term matrix refers to any skill, ability, or any pattern of activity governed by a set of rules – its code. Koestler notes that routine thinking processes operate on a single 'plane', such as when following a single set of rules or playing a single game. The bisociative, creative process, which always operates on more than one plane, is double minded, or involves playing simultaneously more than one game. Koestler cites a number of case studies of bisociation in science: Gutenberg who invented the printing process combined the techniques of the wine press and the seal; Kepler in discovering the form of planetary movement around the sun married physics to astronomy; Darwin connected biological evolution with the struggle to survive. Koestler claims that unconscious thinking plays an important role in the process of Bisociation. In the incubation phase of a problem-solving process, combinations of thought matrices are formed on various levels of consciousness.

6) Newell and Simon's Theory: Creativity as Search

Newell and Simon view the cognitive system as a goal seeking system connected to the outside environment through two kinds of channels: a sensory channel through which it receives information and the motor channel through which it acts on the environment. The system has memory for storing both kinds of information: information on the current and past states of the environment and information of possible acts. Goals are attained by the cognitive system's ability to build associations between particular changes in the state of the world and particular actions that will bring these changes about. The above assumptions about the mechanism of the cognitive system lead Newell and Simon to develop the Means-Ends Analysis model of cognition and to the construction of the GPS computer program that stimulates human problem solving based on the Means-Ends analysis model. GPS is a system that searches selectively through a possibly very large environment in order to discover and assemble sequences of actions that will lead it from a given situation to a desired situation.

7) Lenat's Theory: Creativity as Heuristic Search with criteria for interestingness

According to Lenat, heuristic search can account for many cognitive activities including creative problem solving: " It turns out that we can model a surprising variety of cognitive activities (recognizing, problem solving, inventing) as search in which the performer is gided by a large collection of informal ' rules o thumb' which we shall call heuristics or heuristic rules" [Lenat, 1978, p.262]. Although, according to Lenat, each heuristic has its own domain of applicability outside of which it is meaningless or useless, he claims that many heuristics are identical, or, at least similar across domains. Several computer programs use heuristic search to arrive at innova-

tive solutions or concepts. Lenat describes, DENDRAL, a heuristics-based computer program aimed at enumerating atom-bond graphs of organic molecules developed by Feigenbaum and Buchanan [Feigenbaum, 1997]. DENDRAL produced results in this very specific field that were interesting even for experienced chemists. DENTRAL's success, Lenat argues, lies in the fact that its few dozen heuristics represent a balanced set of both highly domain-specific and more abstract domain-independent heuristics. Lenat's own program AM and its successor, Eurisco, were designed to discover interesting new (at least for the program) mathematical concepts. Both programs were guided by a set of a few hundred heuristic rules of varied generality.

8) Perkins's Theory: Creativity as a Search in a "Klondike space"

Perkins [Perkins, 1995,1995a] views the creative process as search through a space of possibilities to attain end-states called resolutions. Perkins metaphorically likens search in a space of possibilities to searching for gold in the Klondike, where the fundamental principle is: 'Gold is where you find it'. The most obvious heuristic for search in a Klondike space is to start at a certain point, test some points around it, and then move in the direction of the highest payoff. Such strategies are called hill-climbing by Artificial Intelligence researchers. Two fundamental problems are associated with hill-climbing strategies: first, they do not necessarily lead to the best solution; and second, and even more important, in searching for gold (or for a creative solution) hill-climbing leads to where everyone else is going. Perkins identified four distinct regions of a problem space, each posing a unique difficulty to hill-climbing. It is in these regions, he argues, that creative ideas are likely to be found. The four problems are: the rarity problem, the isolation problem arises, the oasis problem, the plateau problem.

9) Hofstandter's Theory: Creativity as Variations on a Theme

Hofstandter's theory of Creativity [Hofstandter, 1985] draws on a "simple but crucial" distinction between an object and a mind's concept of the object. Hofstandter metaphorically views concepts as "a metallic black box with a panel on it, containing a row of plastic knobs with little pointers on them, telling you what each one's setting is". To make the metaphor of a 'knobbed machine' more useful for modeling concepts, the concept of 'knob' should be stretched to allow for new knobs to emerge, depending on the setting of other knobs, or even depending on other concepts currently in the active domain of concepts. Using the knobbed machine metaphor, Hofstandter describes creativity as a mechanism that supports the making of variations on a theme by changing the setting of the knobs or by extending degrees of freedom through recognizing new knobs. Creativity 'enjoys' the fact that concepts have a natural tendency of "slipping" from one into another, following an unpredictable path.

10) Gestalt-School's Theory: Creativity as Breaking Sets

Gestalt is defined as an overall quality of a content of consciousness that transcends its parts. In the context of engineering Gestalt can be said to be "An overall utility of a system which is different than that of its

individual parts". The whole is more than the sum of its parts, and that additional quality can be transposed, which means that the same content can support different Gestalts. This feature of Gestalt is commonly exemplified by the shift in perception often occurring when viewing pictures such as the famous rabbit-duck picture or the Necker cube. Gestalt psychologists use the term insight to refer to the moment the Gestalt changes. Kohler [Kohler.1997], for example, views insight as a process occurring when the problem-solver suddenly re-organizes visual information in a way that satisfies the requirements of the goal. Perception involves building an organized structure (a Gestalt) from visual input while creative thinking involves breaking and reorganizing that structure.

11) Boden's Theory: Creativity as Exploring and Transforming a Conceptual Space

Generative rule systems – structures such as English grammar, mathematical equations, and the like – are fundamental to Boden's theory of creativity. Each generative system can (timelessly) describes a set of possible structures. Sometimes we want to know whether a particular structure could have been produced in principle by a certain generative system. For example, one might ask whether a certain logical formula could have been derived by a generative system composed of a set of logical axioms and derivation laws. Margaret Boden views creative ideas as ones that could not have been generated before by the generative rule system. In contrast, a merely novel idea is one that can be described by the same generative system as other, familiar ideas, but for some reason had not been produced before. A truly creative idea is one that cannot be so described. According to Boden, creativity always involves tacit or explicit reference to some specific generative system. The view of creative ideas as ones that cannot be produced by a certain generative system also highlights the importance of constraints in creativity – they make creativity possible.

12) Finke's Theory: Creativity as a Process of 'Function Follows Form'

Finke's [Finke et al., 1992] distinction between divergent and convergent thinking. Finke's theory deals with divergent insight which is described as a process of 'function follows form'. One begins with a structure and seeks to find novel uses or novel implications for that structure. As Finke notes: "In divergent insight one tries to find meaning in the structure rather than to structure that which is meaningful". The structure one uses as a starting point for divergent insight is defined by Finke as 'pre-inventive form'. To determine the factors that affect divergent insight – in particular role of pre-inventive forms – Finke carried out a set of experiments in which pre-inventive forms were represented by a collection of 15 drawings of mostly three-dimensional geometrical shapes such as a spheres, half-spheres, cubes, cylinders, wires, tubes and wheels. The resulting inventions were rated judges on a 5-point scale for their apparent originality, it was considered a creative invention.

13) Wallas' Theory: Creativity as a Process of Preparation, Incubation, Illumination and Elaboration

Wallas, drawing on poincare's [Poincare, 1913] and other introspective reports formulated a theory of the creative process based on necessary stages. In Wallas theory the act of creation begins in the preparation stage where the existence of a problem, a deficiency or a need is identified; the elements involved in the situation are explored; and some ideas for solving the problem are evaluated but are found inappropriate. After completing the preparation stage, the problem solver enters (often unintentionally) the incubation stage in which the problem is put aside and no conscious thought is devoted to trying to solve it. The problem solving process continues, however, on the subconscious level of the mind where many combinations are tested until one of them suddenly, in a flash of insight, crosses the boundaries to the conscious level – an event that constitutes the illumination stage. Since it is most likely that illumination will not bring with it the solution with all the necessary details or, very possibly, the idea may even be simply wrong, an additional stage, elaboration, is needed to work out the details and verify the idea. Wallas' model of the creative process has been widely accepted in the cognitive science community [Torrance, 1988] and has motivated other researchers to suggest refined models of the events that occur during each of the four stages.

14) Creativity as a Second Order Change

The authors of the book change [Watzlawick et al. 1979] make an interesting distinction between two types of system changes: first order changes in which system components are modified at the logical level of a system's framework; and second order changes which operate on the meta level (i.e., another, higher level system for which the current system is either a sub-component or a sub-category). Although not referring directly to creativity, the examples given in the book suggest a close link between solutions incorporating second order changes and creative solutions.

15) Schank's Theory: Creativity as a Mechanical Process

Schank [Schank, 1988,1995] tries to view creativity as a computational mechanical process. Arguing that behind the creative process an algorithm must exist in principle, he tries to characterize such algorithms using a special construct called explanation patterns (or XPs). Schank deals with a particular kind of creativity: the creation of novel explanations. An XP is a standard explanation for an event that has been used many times before. Creativity, Schank argues, perhaps means no more than the application of technique or a rule where one would not expect to apply it. It is an intentional misapplication of XPs. Construction an explanation is the essence of creativity, because explanations are predictions about how things will happen. The creative explanations starts with a failure, and ends with and explanation of why the previous explanations have failed.

According to Schank, the most important part of the creative process is to notice that something is wrong.

16) Weisberg theory: Creativity as 'Nothing Special'

Creative thinking, according to Weisberg, begins with what we know, but also goes beyond the past, on the basis of new information arising from the situation. Weisberg suggests the following mechanisms as ones that underlie problem-solving processes that may seem (to the problem-solver and possibly to others) as creative processes: near analogies in which target analogy selection is based on salient similar cues that exist in both the target and the source domain; associations-chain triggered by an environmental event and resulting in an unexpected idea (unlike Mednick's theory Weisberg makes no distinctions concerning the structure of the association hierarchy); recisions and modifications- in contrast to some creator's reports describing their creation as conceived whole or brought forth without revision, any large scale work begins with only a glimpsing of the final product and always undergoes revisions and modifications between their initial and final form.

Conclusion

This selection reviews various theories of creativity and creativity enhancement methods suggested by different investigators from fields such as Cognitive Psychology and Artificial Intelligence. These theories reflect the points of view of the investigators and the domain of the content they have selected. The goal of this section is twofold: To provide a comprehensive review of what the scientific community thinks of creativity and related cognitive processes, its testing, its possible mechanization, and how it can be enhanced and To lay the groundwork for a later discussion about the differences and similarities between current theories of creativity and the theory of creativity and the theory presented in this work.

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