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Study on the mechanism of improving creative thinking capability based on Extenics

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Abstract

Creative thinking is the core of Creativity. The current psychological researches on creative thinking mainly focus on cognitive mechanism and brain mechanism, but the studies on how to improve creative thinking ability are rare. Develpoed by Cai Wen, a Chinese scholar, Extenics is a subject that uses formalized models to study the possibility of expansion and the rules and methods of innovation, so as to solve contradictory problems.This article explores the mechanism that affects creative thinking. Based on tbasic-element theory, extension analysis, extension transformation and conversion bridge, the paper systematically discovers the function of extenics on breaking the mindset, developing divergent thinking and promoting remote association capacity, and proposes the approach to promote creative thinking by combing "Extenics + creatology + TRIZ " so as to help the cultivation of innovative talents.

Keywords: creative, thinking, capability,Extenics, mechanism,undergraduate;

1. Introduction

   Creative thinking is the core of Creativity. The current psychological researches on creative thinking mainly focus on cognitive mechanism and brain mechanism, but rarely on how to improve creative thinking ability. Since Extenics sets the groundbreaking study on dynamic things and change processes essentially, utilizing extensive analysis, conjugate analysis method and Conversion bridge method to understand things' divergence,

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conjugation, relevance and entailment. That operatively leads to mindset breakthrough, divergent thinking, remote association and insight generation. This paper aims to develop the educational function of Extenics, study its mechanism influencing human creativity, and construct "Extenics + Creative Studies + TRIZ" model to enhance creative thinking by combining widely applied creatology and TRIZ, which will be helpful to the cultivation of creative talents.

2. Overview of Extenics

Extenics is a subject that uses a formal model to discover the extensibility of matters, and develops rules and methods of innovation, so as to solve the contradictory problems[1]. The basic theory includes three parts: a basic-element theory, extension set theory and extension logic[2]. Basic-element theory utilizes matter-element, affair-element and relationships-element (collectively referred to as basic-elemts) and other formalized languages to express the information and build discriptive models of contradictions. On that basis, it uses Extension Set and Correlation Function to quantitatively express the progresses of quantitative and qualitative changes as well as the critical state, and makes use of Extenics analysis, conjugate analysis, conversion bridge method, extension transformation matrix and other forms of expression policy to create the process. In recent years, the researches and application of Extenics in some intelligence fields, such as recognition, search, diagnostics, data mining, knowledge management, innovation, strategy generation have shown a good prospect of Extenics as methodology[3-4].
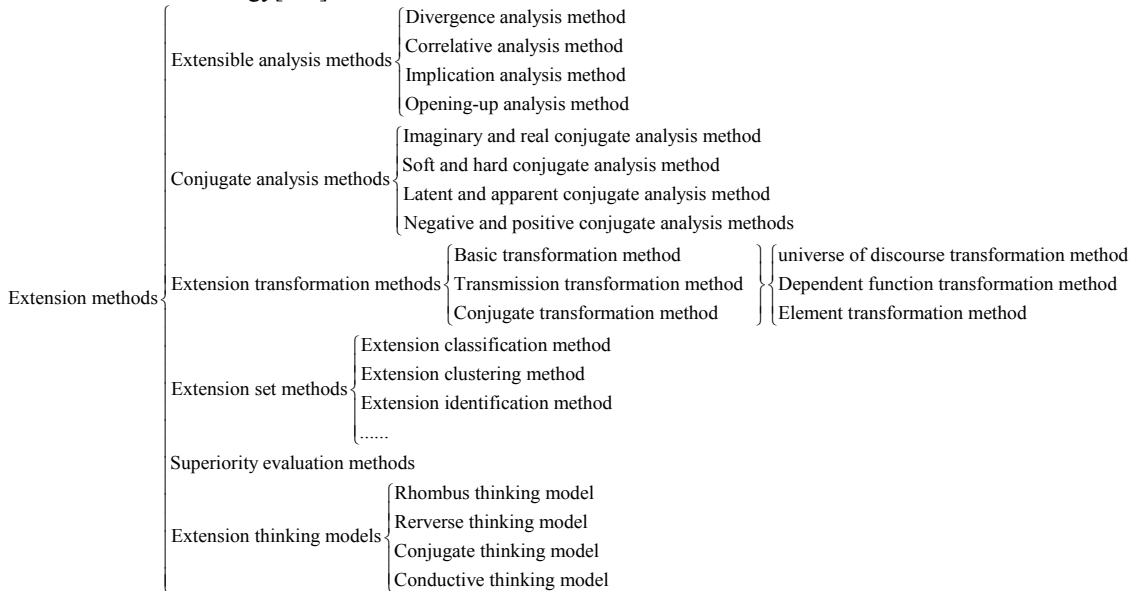

Fig. 1. Extension methods

Extenics study on the process of how to build process-oriented thinking to help people gain innovative products and achievements, ignoring the influence of creation on human consciousness, thinking and other mental and physical state.

3. The Mechanism of Using Extenics to Promote Creative Thinking

By making use of Extenics analysis, conjugate analysis, conversion bridge method, extension transformation matrix and other forms, Extenics generates a series of innovative strategies in ways of formalization and streamline. Then it chooses the best one through Advantageous Degree and some other assessments. That allows creative thinking formalized formal, streamlined and popular[4].

3.1. Mindset Breakthrough mechanism Based on Basic-element Theory

Mental set refers that when one encounters a problem, one tends to use the repeatedly use program and search along the habitual direction and thus psychological fixation comes into being, which hinders the solving of problems. Mental set presents itself in such forms as thinking fixation, method fixation, concept fixation, function fixation and structural rigidities[6].

For instance, psychologist Keane holds that function fixation is the consequence of failure to fully characterize the object properties and functions[7], which showed incomplete information. Without external interferences, individuals usually try to break the shackles of mental fixation by relaxing nerve, stopping to rest or forgetting the previous problem-solving programs. That cannot help people think out of the box, and therefore the automatic elimination of mental fixation becomes unpredictable.

According to Extenics, all matters are extensible. One matter can have many characteristics and one characteristic can be possessed by many matters[2]. One quantitative value can be held by many characteristics of the same objects or by the same characteristic of many objects. Take the matter element at a specific time as an example, its information can be systematically expressed as dimensional form of objects, features and values.

$$M(t) = \begin{bmatrix} O_m(t), & c_{m1}, & v_{m1}(t) \\ & c_{m2}, & v_{m2}(t) \\ & \vdots & \vdots \\ & c_{mn}, & v_{mn}(t) \end{bmatrix} = (O_m(t), \ C_m, \ V_m(t)) \tag{1}$$

Basic-element theory of Extenics prepare an adequate information base to break the mindset, and extension transformation provides thinking strategies to induce mindset breakthrough. Based on the extensibility of matters, by transforming the objective, condition, channel, time and space of a problem, one can do the following to the condition goal and possible solutions: replacement, decomposition, increasing or decreasing, expansion or contraction, and duplication in the hope that one can break the constraints of mental fixation and achieve the goal.

3.2. Divergent Thinking Promotion Mechanism Based on Extensive Analysis and Transformation

Divergent thinking means to think along different directions, reorganize immediate information as well as the information in memory system, and finally create quantity of prototypeal ideas. It is a kind of thinking form that follows no routines, seek variation, and explore the answer from many aspects. Divergent thinking must be of more perspectives, that is, must be multidimensional. The perspectives of thinking stem from brain cognition on research objects, depend on whether jumping out of the previous ideas or not, and are able to control the thinking to spread along different perspectives and directions. Divergent thinking capacity depends on the openness of thinking border, as well as the variability and comprehensiveness of thinking directions.

Extensive analysis and transformation of Extenics links the primitive classification and conversion (including time and space transformation) to ponder. By transforming the elements in the extension collection, the associated guidelines and field, Extenics offers a wide choice of ways for people to resolve contradictions through divergent thinking, because the transformations are able to promote changes in thinking perspective, promote multi-directional and multi-angle thinking, and improve thinking flexibility

The extensive paths of divergent thinking by analysing and transforming target and conditions are as follows[9]:

- 1. Use primitives to express unresolved issues and basic information of objectives. Take conditions and aim as the starting point of divergent thinking.
- 2. Aim divergence: When you think, the following questions concerning aim can be asked: is this the aim you really want? If not, adjust aim from the perspective of object, attribute and value and consider whether it can be decreased or increased and whether it can be combined with other aims or changed into a totally different one.
- 3. Condition divergence: consider whether the present condition can be adjusted from the perspective of object, attribute and value and similar question as with aim divergence: whether it can be enlarged, updated, canceled, or combined with other contents and whether it can be changed into a different content or try the opposite one.
- 4. Creating conditions: consider from the view point of the eight conjugate parts, namely, imaginary part, real part, soft part, hard part, latent part, apparent part, negative part and positive part and provide more materials and establish a complete information system[10].
- 5. Action divergence: to realize the aim, what actions should be taken? Is it possible to make such transformations as replacement, decomposition, increasing or decreasing, expansion or contraction with regards objects, the time, the places, the level, the method and the tool?
- 6. Straighten out the relationships: what are the relations between the condition and the aim such as the relation type, means to maintain the relation, degree, time, location, medium? What is the criterion to check whether the aim is realized? Can the criterion undergo such transformation as replacement, decomposition, increasing or decreasing, expansion or contraction? What will happen after the transformation?
- 7. System divergence: systematically diverge from three aspects, namely, matter, coherence principle and field and always keep in mind that we can get different divergent matter element sets from a given matter element, that is, one matter many characteristics, one characteristic many matters, one characteristic many values and one value many characteristics.
- 8. Solution combination and evaluation: the last step is to make such transformations as replacement, decomposition, increasing or decreasing, expansion or contraction on the result of divergent thinking and work out a practical strategy.

Using the above path to divergent thinking can effectively lead the direction changes and break mindset. And with the extra-cerebral information supplement of the Internet, it is more helpful to get prototypeal and practical strategy.

3.3. Remote Association Generation Based on Basic-element Analysis

American psychologist Dmitry Nick deems individual prototypeality as remote association capability. He holds that the creative process is a combination of interrelated elements, making it a new link to meet the new requirements, and human creativity is a kind of ability to generate that new link between distant unrelated objects from some sense and appearance. "Thinking" in the expression "associative thinking" represents extracting information from memory "warehouse", and "associative" represents discover relationships. Associative thinking can establish extensive connections between things.

The creative feature of associative thinking is that it can create links between unrelated things, and find out consistency with other things in some feature and magnitude[5], such as similar phenomena, similar principle, similar structure or similar materials, etc. The similarity of these things could be mutual leads to similar associative thinking. After analogical transplant, reference information is available to solve problems.

The foregoing Extenics baic-element analysis enables people to look through numerous external appearance of things and see the properties and values on the essence of things. It is easier for people to find certain aspects of consistency between different things with the help of a primitive fundamental transformation and consequent conduction transformation, and have a dynamic view of the studied object. It can help people step over the "gap" of knowledge class storage, and even explore analogical things from a transformed property or value. The construction of Extenics primitives can make further use of the Internet to gather materials and knowledge for associative thinking, broaden horizons, lengthen information measure, and increased the space of association, so as to enhance the depth, breadth and accuracy of association[11]..

3.4. Strategy to Promote the Occurrence of Epiphany

Epiphany is a process in which people suddenly, intuitively and clearly get the solution of a problem. Epiphany consists of 3 elements: (1)giving up of old and invalid thinking(mindset breakthrough);(2)realization of new valid problem solving path(form of new different association);(3)having a feeling of sudden understanding with a kind of strong "Aha" experience[12]. The corresponded capability to break mindset and the ability to activate prototypes and gain key motivate information are important standards to measure individual epiphany ability [13].

Information master levels directly affect the speed of activating prototypes. With the help of Extenics primitive analysis and its library, knowledge effect libraries of TRIZ, and the Internet dynamic emerging mass information, the individuals who master knowledge mining skills can broaden the searching area for prototypes, from an aimless expectation for automatic flashes of prototypes to an orderly and controllable prototype search

The main strategy is as follows: Classify problems; try basic-element analysis; use Keyword search and clustering and other technologies to search on the internet for properties and values of objects and relations[14]; build basic-element base to offer materials for Epiphany; constantly build up the base by collecting information from both the Internet and mobile network[15]. Massive and orderly abstract information can help individuals stave off the limitation of human brain and broaden the search area of prototypes. The reasonably abstracted information in library can show the nature of objects and omit a lot of useless information. Quickly find the similarity in some property of objects; be able to find the motivated prototype; further utilize the mature TRIZ knowledge effect library; 40 innovation methods of TRIZ; the rules of technology advancement. So we can conclude that prototype activation is no longer uncontrollable and unpredictable.

4. " Extenics + Creatology + TRIZ" Model Construction to Enhance Creative Thinking Capability

From the above-mentioned, it can be seen that creative thinking can be accelerated with the help of methods, strategies and tools. Centering around the critical steps in the process of creative thinking — breaking the mindset, expanding creative thinking perspective, and establishing remote association relationship, the paper, based on basic-element theory and extenic transformation method, utilizes the relevant findings of creatology, extenics and TRIZ and develops a model that can facilitates the enhancement of creative thinking ability.

- (1) Use formalized language. One can make basic-element analysis to those problems at hand, extract the matter-elements, affair-elements and relation-elements to describe matters, affairs, relations and problems, and further make functional analysis and sub-field analysis to the problem. With the help of basic-element base to complete the cognition on the problem, try to acquire information from all aspects and think out of the box.

- (2) Try to find the solution by using the 48 engineering parameters of TRIZ and the conflict matrix formed by 40 innovation methods.
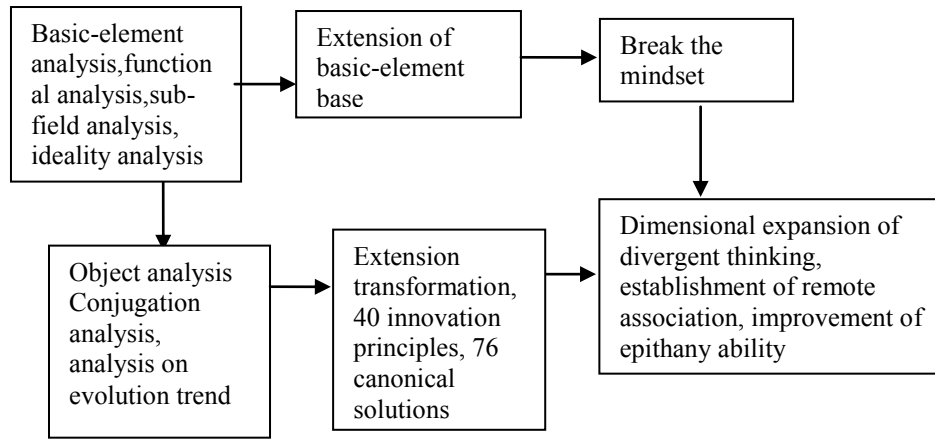

Fig. 2. Model to Enhance Creative Thinking Capability

- (3) If no solution is worked out, one can turn to conjugate analysis of extenics for help by analyzing material parts and nonmaterial parts, soft parts and hard parts, positive parts and negative parts, and potential parts and obvious parts. Thus one can think divergently and comprehensively and get information from the given problem from many perspectives, which can certainly help to think out of the box.
- (4) With condition and goal as the starting point, one can conduct route analysis to basic-elements, appraisal standards and domain (the limitation in time and space) to expand association thinking.
- (5) One can use the extension set theory and substance-field analysis to build a model and locate the heuristic information in the prototype by resorting to the 76 standard techniques, basic-element base and effect base.

If one can follow the above procedures step by step, the mental fixation will be broken, the perspective of divergent thinking opened, remote association established, , key information of epiphany obtained and as a result the problem solved.

This solution has been used in the training of innovation ability among students in many classes, the data have been analyzed and significance test has been made. It has been proved to be effective and helpful to enhance innovation capability.

5. Conclusion and Further Research Directions

In conclusion, the methodology provided by extenics can effectively break the mindset, expand the perspective of divergent thinking and connect those formerly irrelevant things. The validity and effect of the model constructed by combining creatology, TRIZ and exntenics to improve creative thinking ability should be subject to further test in practice. In the future, more exhaustive and refined training strategies should be designed and tested by applying it to a larger variety of subjects. The critical breakthrough to improve creative thinking should be further specified.

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