

CREATIVE THINKING IN DIGITAL MEDIA ART DESIGN EDUCATION

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Abstract

The study on the brain mechanism of creativity mainly has two aspects: the creative thinking process and the brain structure and functional connection characteristics of highly creative people. Human's rational thinking mode has a high degree of freedom and transcendence, and such problems cannot be expected to be studied by elaborating on the realization of the nervous system. The rational thinking of the brain is mainly based on the structured thinking mode, and the structured thinking mode shows great scientific power. This paper studies the theoretical model of innovative thinking based on category theory, analyzes the creation process of two scientific theories, landmarks in the history of science, and provides an intuitive, transparent interpretation model and rigorous mathematical argument for creative thinking. The structured thinking method has a great revelation and helps create new scientific theories.

Keywords: category theory, creative thinking mode, structured thinking

I. INTRODUCTION

The discussion of human rational thinking is also at the core of modern philosophy. Philosophers have established various theories of mind in the name of "anthropology" or "human knowledge research", forming two camps "rationalism" and "empiricism. Kant proposed the cognitive model of rationalism and empiricism --- transcendental idealism and rational intuition [1]. Modern philosophy and cognitive research scientists believe or assume that human beings have a specific innate cognitive structure of the brain.

The development of modern technical means has made significant progress in studying the brain's thinking mode [2], allowing people to explore the brain structure and connection with function. Brain imaging technology is used to study unique phenomena such as epiphany and the internal connection of the brain. There are two main aspects of brain mechanism research on creativity: the creative thinking process and the brain structure and functional connection characteristics in highly creative people.

Creativity is the advanced manifestation of human rational thinking, the glory of the human mind, and the source of the progress of human civilization. However, creative thinking itself is complex. As is seen in the above literature, with different experimental conditions and technical means, the research results of the brain mechanism of creative thinking are very different. Therefore, challenging to have a clear and deterministic conclusion about the brain mechanisms of creative thinking (one-to-one explanatory model). No studies have shown that innovative brain functional connectivity can be altered by training and then have practical meaning. [3]

The rational thinking of the brain is mainly based on the structured thinking mode. The structured thinking mode of the brain shows great scientific power, and this thinking mode is the primary mode that had significant scientific discoveries in the whole of humankind's history. This paper studies the structural characteristics of the brain's thinking mode based on the category theory, and the brain's structural thinking mode is clearly explained and understood.

II. LITERATURE

2.1. Creativity

Creativity is the act of turning new and imaginative ideas into reality. Creativity is characterized by the ability to perceive the world in new ways, discover hidden patterns, make connections between seemingly unrelated phenomena, and come up with solutions. Creativity involves two processes, namely thinking, then producing. [4]

Creativity happens when someone produces something new and appropriate, generative, or influential. These criteria are at different levels in the creativity hierarchy with novelty being the lowest qualification for creativity and being influential being the highest level of creativity. According to this definition, new, appropriate, generative, and practical ideas are more creative than new and proper ideas.

Creativity has three levels [5], namely novelty, generative, and influential.

- **novelty** - For something to be creative, it must be new that we have never seen or heard of before
- **generative** - Generative means that this new and precise thing leads to the production of goods, products, ideas and more
- **influential** - Influential means that it will shape the way people think or do such things in the future.

2.2 Principle Design Theory

The visual design of the user-computer interface affects the user in using the computer. The visual design includes the graphic elements used in the interface, including the overall layout, menus, form design, use of color, coding, and the placement of each unit of information. Good visual design strongly influences clarity, consistency, and aesthetics. [6]

Visual clarity

The meaning of the visual display must be clear. To get clarity on the meaning of a visual form, it is necessary to follow the existing guidelines. Some basic rules in organizing visuals to meet needs have been applied by graphic designers since several centuries ago, with the Gestalt rules defined by psychologist Wertheimer in

1930. He argues that personal views determine views in broad terms. Therefore, guidelines for organizing visuals focus on commonality, good approach, closure, and continuity.

Similarity means that two visual forms have properties that they seem to have in common. Likewise, approximation means that two visual forms have properties that are shared. Closure implies that two visual forms can cover the same area. Continuity says that one visual form will connect with the following form as a straight line.

Visual consistency

The principle of consistency is part of the overall user interface discussed previously. The consistency of the visual form makes it easier for users to use commands. For example, the radio button is used to specify only one option, while the checkbox can be used for more than one option. Consistency must be set for a particular image or overall design. The user easily understands information if it has a good flow with few distractions that hinder it. An information flow can be said to be continuous and harmonious if its appearance reflects the continuity from one part to another. Continuity can be created by creating styles, shapes or colors that give the user a sense of continuity.

Aesthetic

User interface design relates to general graphic design principles. Design elements must not only be well designed, but they must also work together. Therefore, it is necessary to pay attention to the guidelines for making a display layout by arranging layout elements such as text, images, animations, and videos. The four basic principles of user interface layout are:

- **Unity.** Design elements should be placed in such a way that they constitute a unity of information.
- **Balance.** Design elements must be placed in such a way that there is an overall balance.
- **Rhythm.** You can create more than one vertical and horizontal cadence line(grid). These lines are used to place design elements.
- **Continuity.** Information is easy for users to understand if it has a good flow and few distractions hinder it. An information flow can be said to be continuous and harmonious if its appearance reflects the continuity from

one part to another. Continuity can be created by having pages have a style, shape or color that gives the user a sense of continuity with other pages.

2.3. Category Theory

As early as in ancient Greece, Aristotle wrote his famous „Categories“, which explored the classification of objects that can be recognized by humans. In the context of modern mathematics, categories have other meanings and precise mathematical definitions. Category theory has expanded into most fields of modern mathematics in a very short period of time, and category theory is the language and thinking way of describing abstract mathematical structures. [7]

With functors as morphisms, all categories form a larger Cat. So naturally, we have the notion of isomorphism between categories: as isomorphisms within other categories, two categories X , Y are isomorphic if and only if there are two functors $F: C \rightarrow D$, $G: D \rightarrow C$, so that both sides are identity functors after they are combined, as shown in Figure 2 below:

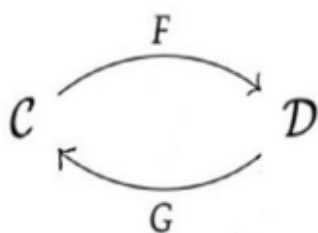


Figure 1. Category isomorphism

The concept of „isomorphism“ is defined by a compositional functor, a thinking way that is consistent with the philosophy of category theory, which defines mathematical structures in terms of morphisms. In other words, the basic ideas of category theory reflect the way we organize the structure of information. The idea that morphism represent category has been widely used in the foundations of mathematics. For example, a subgroup can be equivalently regarded as a single group homomorphism, and the quotient group (or normal subgroup) of a group can be equivalently regarded as a full group homomorphism; thus, a subset can be equivalently defined in terms of injective, a quotient can be equivalently

expressed in terms of surjective. Developing this idea, the concept of homology which measuring the difference between the exact sequence and the surjective of the category can be defined.

Category theory is the study of mathematical structures in a concise, general and abstract way. For example, in topology, a doughnut is the same as a coffee cup. According to category theory, they are isomorphic in a category Top, the object is a topological space, and the arrow is a continuous map (i.e., continuous transformation), so a doughnut and a coffee cup are homeomorphic.

The advantages of category theory is A very obvious trend in the development of modern science is the division between disciplines; knowledge in different fields seems to be divided more and more finely, and it is more and more difficult for us to have an overall understanding of it. At the conceptual level, category theory unifies definitions and concepts from different branches of mathematics. Category theory has partially unified the division of mathematics at the conceptual level, and it has found the same conceptual basis among different branches of mathematics

III. MODEL OF STRUCTURED THINKING

3.1 Break down the problem

In job interviews, you may face a brain teaser like one of these. “What’s the point of guessing the answer to a question when you can just take five seconds and Google it?” you might wonder. The purpose isn’t to make you sweat and scream curse words in your head but to test your capacity for structured thinking and your ability to use logic, practice deduction, and build a great answer by asking many small questions.

With structured thinking, you methodically break down problems and solve them piece by piece rather than worrying, relying on past assumptions, or shrugging in absolute cluelessness. A hypothetical story about asking two job candidates the same question: How tall is the spire on the building they’re in? In this scenario, one candidate happens to know the answer. The other steps outside measure the building’s shadow against her own and gives a rough estimate. “Who are you gonna hire?” Tyson said. “I’m hiring the person who figured it out. ‘Cause that person knows how to use the mind in a way not previously engaged.” [8]

Tools for improving critical thinking

There are 4 ingredients [9] required to make a good an awesome business analyst:

1. Passion for Business Analytics
2. Structured thinking
3. Love for statistics and numbers
4. Business domain knowledge

The tactics and practices mentioned to improve number-crunching abilities and help you apply analytical thinking in day-to-day activities. In addition, there are some exercises to improve structured thinking.

3.2 Rational thinking

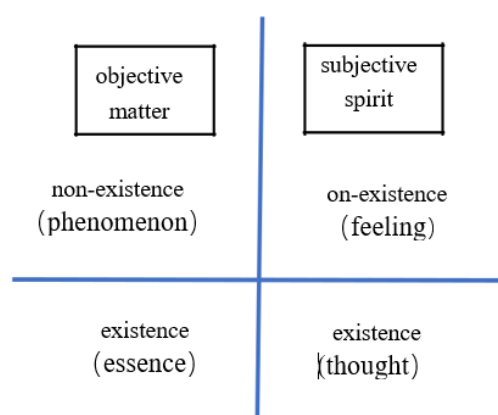


Figure 2. Parmenides' model of rational thinking [10]

After the Renaissance, modern philosophy, physics, mathematics, and neuroscience developed by leaps, the cognition of rational thinking underwent an enormous change, and Descartes put forward the famous slogan "I think, therefore I am" [10], which is logically impossible to refute, that is, all the world of experience, all senses, and all idea are some kinds of illusion. But the existence of this activity itself indicates a being, which is "I", and rational cognition of the world can only proceed from doubt. Only mythical, religious, linguistic, artistic, historical, and scientific symbols can be created and applied in man. Man use symbols to create culture, and the creation and use of symbols is the difference between humans and animals [12].

The various concepts that appear in our thinking and verbal expressions are logically free creations of the mind. They cannot be derived inductively from sensory experience. [13]

3.3 Natural Transformations

To study the structural characteristics of brain thinking, it is necessary to study further the structural aspects of scientific theories, that is, to categorize and axiomatize scientific theories. From the perspective of categorization, the isomorphic characteristics of theoretical models of different disciplines and the categorization characteristics of brain thinking can be shown in Galileo transformation. The transformation is written in matrix T . T connects the two systems and keeps the related physical phenomena consistent in the two systems [14].

Functors and their natural transformations fully demonstrate that the brain has the transcendence of creative thinking, which is manifested everywhere in the process of major scientific discoveries [15]. A scientific theory has its specific mathematical structure, which originates from scientists' free creation. In the process of free products, scientists consciously or unconsciously apply the ideas of category theory. The structured view of category theory simplifies the complex and tentative thinking process, making the thinking process clear and structured. Therefore, category theory is critical in knowledge expression and reasoning. Thinking based on category theory has gradually become a typical paradigm in innovative thinking.

IV. CONCLUSION

Most of the research on innovative thinking is based on neuroscience. This paper analyzes the limitations of existing research methods from the perspective of category theory and proposes a research model on innovative thinking based on category theory. Furthermore, this paper applies the thinking method of categorical equivalence to analyze the creation process of two landmark scientific theories in the history of science, the case is real, and a clear mathematical argument is provide.

Category theory studies structure formed by the relation between objects, so the research focuses on the relationship between objects. Concepts in category theory such as morphism, functor, natural transformation, and isomorphism are the representation of relationships. In a category, the object only needs to satisfy its morphism relation. Category theorists do not need to point out

or care about what constitutes an object; a single object has no significance in a category. The connection between objects is the focus of category theory.

Category theory deals with mathematical concepts abstractly, turning these concepts into sets of morphisms. If we have two theories, each represented as a category whose object is the theoretical model, the morphism preserves the structure of the model in a practical sense. If there is an equivalence relation for these categories, we can say that the two theories are categorically equivalent.

Many scientific theories can be described as a collection of certain mathematical structures. There are two main reasons for applying the equivalence of category theory in studying scientific theories. First, the inherent properties of scientific theories require, for example, the theory has the property of coordinate transformation invariance (isomorphism). Second, the equivalence idea of category theory can simplify theoretical models so that the model can be greatly simplified and the research work can be achieved easily. The structured thinking way has a great revelation and helps to master and create new scientific theories

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