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On the Characteristics of Complex Thinking in Teaching Process and Its Enlightenment

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Abstract: *Complexity thinking is a new methodology compared with simplicity thinking, which leads people's thinking to a new field. Looking at the teaching process from the perspective of complex thinking, it is not difficult to find that classroom teaching has been under the control of traditional simple thinking for a long time, which has lost its vitality and suppressed students' creativity and subjectivity. Based on this, this paper starts with explaining the production process, connotation and characteristics of complex thinking, and analyzes the complex characteristics of teaching process, so as to draw enlightenment to the current research of teaching theory.*

Keywords: *Simple thinking, Complex thinking, Teaching process*

1. The emergence of complex thinking

In the long-term scientific creation activities, human beings have bred simple thinking mode, which as a dominant thinking mode controls classroom teaching for a long time. On the basis of the modern mechanical view of nature, human beings have formed a simple thinking mode, born out of the industrial revolution. Simple thinking has made great achievements in modern natural science. Newton's "Three Laws", Leibniz's "Monologue Theory", Kant's "Legislation for Man-made Nature" and Einstein's "Logical Simplicity and so on" [1], so that simple thinking has become a basic scientific belief throughout all aspects, levels and fields of scientific activities. Influenced by natural science, humanities and social sciences have made many achievements by using simple thinking, such as Saint-Simon's empirical human science theory, Comte's empirical philosophy and sociology, Taylor's management principle based on the concept of "economic man", etc. On the teaching principle, the achievements of simple thinking are shown in Rousseau's naturalistic education view, Herbart's four-stage teaching method, Taylor's classic model of curriculum development and so on.

Simple thinking surpasses religious and feudal single hegemony and autocratic knowledge in grasping the relationship between nature, society and people. Newton wrote in his book "Mathematical Principles of Natural Philosophy" that "nature does nothing useless. As long as you do a little less, it's useless to do more. Because nature likes simplification, but doesn't like to boast about itself with any unnecessary reasons "[2]. The simple thinking in the field of natural science has deeply penetrated into many other fields. This kind of thinking is simplified as the mechanical operation of a clock, and all the components interact with each other with an accurate and measurable linear law of causality. Latin America thinks that "human soul is the gear transmission device of automaton" [3]. Since then, this idea has been extended to various fields. In the field of medicine, mainstream medicine always acts according to simplicity. It regards the human body as a mechanical device, and the disease is something that can be eliminated. It doesn't consider that people are complex in spirit and body, and often adopts simple and partial treatment methods.

In the 20th century, simple thinking gradually showed fatal defects. With the development of science, the complexity of the world is gradually revealed, and complexity has become the object of scientific research. In the 1940s and 1950s, Wiener, Shen Nong and others founded the general system theory, cybernetics and information theory, which revealed the overall characteristics of the system. From 1970s to 1980s, Prigaojin, Egan and others founded dissipative structure theory, synergy theory and catastrophe theory. These theories discuss the conditions, dynamic mechanism and ways of complexity. Especially in the last 40 years, the rise and vigorous development of complex science with soliton, chaos and fractal as its main body have greatly changed the scientific picture of the world and the thinking methods and ways of scientists. People begin to realize that complexity and nonlinearity are the prominent features of material, life and human social progress. Highlighting the complexity of the scientific community itself,

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the world is no longer simple, but the unity of simplicity and complexity, order and disorder, certainty and contingency, linearity and nonlinearity, stability and instability, gradual change and mutation.

From the perspective of scientific methodology, complexity should be the first concept of complexity science, and a scientific definition should be given. Different scholars have more than 40 definitions of complexity based on different academic backgrounds. According to the information provided by John Hogan, Seth Lloyd [4] collected 45 definitions of complexity. Up to now, there is still no unified definition, perhaps there is no unified definition of complexity at all. China's research on complexity science began with the open "complex giant system" theory put forward by Qian Xuesen in the early 1990s. Qian Xuesen [5] thinks: "The so-called' complexity' is actually the dynamics of an open complex giant system." Miao Dongsheng believes that complexity is an eternal objective fact for human cognitive ability. So far, complexity is really an empty and vague concept. At present, most of the concepts about complexity have expressed a consensus: complexity is a state where many factors interact, and complexity is "something intertwined"; Complexity expresses an irreducible feature. Complexity thinking is therefore a kind of thinking that combines distinction and association. Complexity thinking is not the thinking that should not be simplified, let alone the thinking that deliberately complicates things. It is a simplified description of external complexity and internal complexity based on new angles, new scientific methods and tools, and it is a simplified thinking that retains the real nonlinear nature of things [6].

As a way of thinking, complex thinking has the following characteristics: First, the scale and structure of the system are complex. The system is composed of various components, and the diversity and difference of the components result in the diversity and difference of the relationships among the components, which is the fundamental source of the complexity of the system. Second, nonlinearity. It is put forward relative to linearity, and "linearity" is to describe an equation in a coordinate system. "Nonlinear" dynamics points out that, in a complex system, any slight change may have an impact on the whole system because the elements are interrelated and influence each other. The third is chaos. Chaos is an orderly phenomenon in disorder, a complex order, and a new organizational concept. The irregular and orderly phenomenon of chaos tells us that the basic feature of the world is the mixture of order and disorder. Fourth, the self-organization of "dissipation". Complex systems dissipate a lot of energy and generate new energy to maintain the existence and balance of the system. Therefore, the idea of attaching importance to complexity has aroused great repercussions in the field of humanities and society, and brought new enlightenment to educational theory, especially to the innovation and reform of modern curriculum teaching theory. Fifth, irreversibility. The irreversibility of a system is also called nonreducibility. This is because the complex system composed of many factors and levels has produced a new behavior which is different from the original factors and levels after the emergence. Six is emergent. Sudden change is the turning point of things from one development stage to another, and it is the key point of things' behavior change. In the process of things development, we need to fully understand, scientifically set up and rationally use the emergent points, which is helpful to keep the continuity of things development.

2. On the characteristics of teaching process from the perspective of complex thinking mode

Looking at our classroom teaching process from the perspective of complex thinking, especially teachers' and students' thinking, emotions and other behaviors, we find that the teaching process not only has the characteristics of the natural material world, but also has more complex characteristics that the natural material world does not have, and has the characteristics of complex thinking.

2.1. Teaching process is a complex system

Under the guidance of long-term simple thinking, classroom teaching is like a flowing production line: teaching input-processing of teaching materials-output of teaching products. The teaching process is that teachers impart knowledge to students, students passively accept knowledge, and classroom teaching becomes a stylized behavior, which decomposes the complete general goal into a single teaching goal, and each part is split into more sub-parts. Pascal said: "I think it is impossible to know the whole without knowing the whole. Similarly, it is impossible to know the whole without specifically understanding each part." [7] Education should exist as a whole, not be simplified into one-sided goals [8]. Teaching activities are much more complex than the single level of cognitive activities.

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2.2. The teaching process is an open system

There is no complexity in a closed system, and complexity must appear in an open system. Teaching is not the only factor that affects students' growth. Students are also social people, not only influenced by schools, but also by various external environments. This makes various factors inside and outside the classroom keep various interactive relationships, forming an open circulation system.

2.3. Chaotic characteristics of teaching process

The teaching object is a living person, and it is impossible to accurately predict its change forever. The teaching process should adjust the teaching strategy according to the needs to make it "mixed" with teaching, so as to produce the best teaching effect.

2.4. Irreversibility of teaching process

Once life comes into being, it is irreversible, and the influence of teachers on students is hard to erase in students' life. At the same time, the teaching process should go through a spontaneous change process from disorder to order, so as to maintain the order of teaching, exert external force on classroom teaching, and discover the order in disorder.

2.5. Uncertainty of teaching process

Deterministic connectivity simplicity, uncertain connectivity complexity [9]. In the past, we always programmed the teaching process, and scientific experiments were carried out in the laboratory according to the pre-designed experimental procedures, excluding accidental factors. This simple paradigm presents procedural characteristics in the teaching process. The teaching design is limited and the teaching process is changeable. The design of teaching process must consider the existence of teaching emergencies.

2.6. Nonlinear characteristics of teaching process

The system can't be fixed. Every student and teacher are interrelated and influence each other, and other factors are also changing. In the past, teachers in the teaching elements were regarded as the representatives of the society and the authority of knowledge, ignoring the independent personality of teachers and students. The relationship between teachers and students was limited to axiology, ontology and epistemology, and students were simply regarded as teaching objects, ignoring the subjective value of students themselves. In fact, in the complicated teaching activities, the teaching life experience of teachers and students is far more complicated than axiology and ontology.

2.7. Emergent thinking in teaching process

Under the complex thinking, the teaching process is no longer a peaceful and stable form, but a process of self-transcendence. This requires that there will be a sudden thinking in the teaching process, which will change the traditional view of knowledge. According to the post-structuralist's view: the structure against knowledge comes from the outside world, and we should look for the rules of composition in the discourse itself. That is, the self-organization of various elements of discourse makes the progress of knowledge not only an increase of knowledge, but also a change, resulting in a new theoretical framework, observation perspective and research methods.

3. Enlightenment

Several characteristics of the teaching process show that it overlaps with the complex system in cognition, indicating that the teaching process is also a complex organizational process. Complexity thinking, a new interdisciplinary methodology, provides a theoretical basis for understanding the essence of teaching, and draws the following enlightenment to our teaching theory research.

3.1. Reconstructing instructional design with complex thinking

Classroom design embodies a certain teaching philosophy and thinking mode, which is the blueprint and plan of classroom teaching and directly affects the effect and quality of classroom teaching.

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Traditional classroom teaching design has the characteristics of reducibility, sequence and predetermination, linear causality, etc. It is the product of simple thinking. It ignores teachers' teaching wisdom and students' creativity, and makes teaching a dull and lifeless standard parts processing factory. Using complex thinking to re-examine and construct our classroom teaching design, looking for higher certainty in the uncertainty, moving from static and predetermined to process and unfinished, and from abstract analysis to organic integrity, can classroom teaching return to a fresh, organic and full of vitality [10].

3.2. Using complex thinking to promote the reform of teaching methods

"The basic task of the teaching process is to enable students to realize the communication and creative transformation between their personal experience world and the' spiritual and cultural world' shared by the society, gradually complete the personalized and creative possession of the spiritual wealth shared by the society by their personal spiritual world, and give full play to the educational value of culture and science created by human beings to students' active and healthy development. "[11] With the help of the emerging complexity science, it is particularly important to study the reform of teaching methods, and carry out the reform of teaching thinking mode and the adjustment of teaching behavior mode according to the thinking mode of complexity science [12].

3.3. Using complex thinking to guide teaching procedures

As a new way of teaching thinking, it is suitable for complex teaching activities, and it has the value of application in complex systems. The complexity of teaching thinking presents the advantages of nonlinearity, generation, integrity, openness and relationship [13]. It is of great practical significance to explore the specific application procedures of teaching starting point, teaching process, teaching mutation and teaching innovation with complex teaching thinking.

3.4. Using complexity thinking to construct "teaching complexity theory"

In the past 20 years, the field of educational research has been deeply influenced by complexity theory, and many achievements have been made in basic educational theory, educational research methodology, curriculum and moral education [14]. We should break through the traditional philosophy's view of essence and law, have a new understanding of the essence and law of teaching, break through the limitations of the teaching research methodology of simple thinking, demonstration and speculative binary opposition, and strive for the development trend of holistic, multi-complementary and harmonious symbiosis teaching research. In the future, we need to strengthen the research of complexity theory itself and construct "teaching complexity theory".

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