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Interpreting "What is Education" from the Perspective of Genes

Ye Lan

Just as the well-known American educator Jonas F. Soltis said, judging a significantly valuable question only through its definition is far from enough.

Our in-depth research on the question "What is education" is directly linked with the rethinking of the foundations of pedagogic principles. We also have studied changes in the understanding of pedagogy as a discipline in the developmental progress and sought the source of educational practice and the historical process of foregoing changes while working on the deep and intrusive research on practices of educational reforms in modern China. Thus, we have gradually formed a new understanding of the education foundation by interactive comparisons and in-depth analyses.

Part I Interpreting Why Genes Are Chosen as a Metaphor for Education Foundation

1. Why "Genes" Are Chosen as the Metaphor for Pedagogic Foundation

In terms of basic understandings, China's pedagogy in the 20th century has been presented in a mechanical manner, which essentially implies education as material processing. It views education and human beings as matter, making the thinking and language expression take on the characteristics of physics. This is because at the beginning of the 20th century, pedagogy was introduced to China together with mathematics, physics, chemistry, etc. The most mature and classical disciplines shown on the scientific development map are mathematics and physics. In making pedagogy scientific, those two hard sciences have been used as the reference frame in the Western world. Physiological mainstream was mostly about intermediate human physiology, so other "soft" sciences were not as popular. Only the "evolutionism"

drew a lot of attention as a methodology of understanding changes of the biological world.

But with the great pattern of China's reform and opening-up policy, as well as changes in understanding of education and in-depth reflections on pedagogy, academic circles have been deeply aware of that human being could not be considered as matter and education could not be seen in the way of physical thinking of classical mechanics. First and foremost, there is no denying that teachers and students are human beings or living organisms. The first necessary step for breaking through tradition is to make the pedagogic scientific reference frame change from physics to biology and life sciences. Meanwhile, it is also necessary to closely watch the latest progress in science, because to researchers it is not only a conclusion, but also a methodological value of breaking through an existing conclusion to form a new one. Pedagogy needs to absorb the wisdom of understanding complex education from all human creative thinking.

The latter half of the 20th century saw ground breaking rapid development of research on biology and human life. In terms of breakthroughs in basic theory, methodology, research methodology and application technology, a great variety of enlightening changes have taken place in macroscopic ecological research, microscopic gene research, and research integrating and focusing on brain science. It occurs to the scientific community that bioscience and life science have reasonable guidance value in understanding the relationship between human beings and natural environment, the meaning of human beings, regulating human beings' behaviors and the meaning of maintaining the existence and development of human beings. For these reasons, the 21st century is regarded as the century of anthropology, biology and life science. This is an inevitable event judging from the trend.

So first, we have paid attention to ecology, life science and brain science in studying the meaning of the way of pedagogical thinking in order to update and supplement scientific foundation of pedagogic theory. We have paid attention to "genes" in seeking for the education foundation, only because genes are the building blocks of human life and the development for generations. This is comparable to education that plays an indispensable role in maintaining the continuous promotion of human spirits and developing individual life.

2. Understanding the Inspirations from "Genes"

A further understanding of what "genes" in themselves mean made me more confident

about the feasibility of using this metaphor.

The word "genes" is derived from biogenetics. According to the simplest description in *Cihai*, a gene is the basic unit carrying and transmitting the genetic information in an organism ... A gene is a segment of nucleotide sequence that encodes protein. That is, structural genes determine the primary structure of a specific protein. Almost all biological characters are a result of the interaction of many genes and the ambient environment. [1]

Additional relevant materials can provide an understanding of some basic properties of genes in biology as well as their meaning to life. [2]

Firstly, a gene is the basic unit for all organisms to realize the transmission of intergenerational genetic information and the internal and basic guarantee for generational life extension and development.

Secondly, the basic material carrier of genetic information is chromosome (DNA), also called chromogen. A chromosome is the major material basis for storing, copying and transmitting genetic information, and its form is generally amphidiploid, helical and crossed. It makes us think of the internal combination and structure of genetic materials.

Thirdly, genes are featured by stability and variability. The material carrier varies, but inside, genetic information remains unchanged. The former exists for a limited period of time, but the latter can be continuously stored, copied and transferred. So, genes present a special relationship between the most fundamental information and material in an organism, as well as the basic characteristics of life.

Fourthly, genes affect a specific organism on the premise of its interaction with ambient environment. That explains why genes vary and are one of characteristics of living organisms.

As illustrated above, genes are the most basic unit interpreting the secret of everlasting life and also the primary foundation of life. Firstly, comparing "genes" to the core of educational theory is to use the meaning of its "primary foundation". Secondly, genes that carry basic genetic information needed for life determine organisms' basic characters, physiological characteristics, metabolic type, instinctive behavior, growth sequence, etc. The transmissibility of the intergenerational information is also one of the basic stipulations of education. The difference lies in the

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1. *Cihai*, Shanghai: Shanghai Lexicographical Publishing House, 1999: 1551.
2. The below arguments and statements are quoted from: Ye Lan, "An Introduction to the 'Life/Practice' Pedagogy", in Ye Lan (ed.), *Gene (About the "Life/Practice" Pedagogy)*, Guilin: Guangxi Normal University Press. 2009: 4. Only individual words and expressions are slightly changed.

"source" and "quality" of educational information, transfer path specific to human social activities. The borrowing of the word "genes" in the aspect of functional intergeneration and mechanism generation shows that choosing and building the core of educational theory requires genetic characters such as function, mechanism, etc. Thirdly, the binary of material carrier enlightens us, that is, the composition of theoretical core is not simple. That explains why the word "genes" is selected and used as an analogy from the perspective of form.

As a matter of fact, using "genes" as the metaphor means our pursuit for the prescriptive quality is the core of pedagogic theory. The primary foundation shall have intergenerational function and generative mechanism. In short, it is linked with life and has the property of life by nature.

After 2009, I have had more new findings in studying pedagogy as my understanding of genes rose further by keeping an eye on the frontier gene research[3]. Major findings are introduced below:

1) Human gene research has become a "famous school" in genetics. So far, more than 90% of human genomes have been determined, and basic theory research, application research and technological research have been vigorously promoted. The application requirement is a great force of driving this research. For instance, the application of DNA fingerprinting and recognition as well as identity confirmation in

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3. My "watch" is amateur and random. Fortunately, on an occasion, I mentioned "genes" when chatting with Professor Mei Bing, Vice President of East China Normal University and Doctor in biogenetics, and then she passionately recommended research on epigenetics to me and send me some resources about such research in Chinese and other languages. I became very excited after really reading those resources. So, here, I would like to express my thanks to Professor Mei Bing. Now, I list papers recommended by Professor Mei Bing by the publication time below (The following statements about epigenetics are summarized by me after reading these articles, so I do not list all of them here. If there is any misreading, I will be responsible for that):
I. Huang Qing, Guo Ying and Fu Weiling, "Human Epigenome Project", *Chemistry of Life*, 2004(2);
II. Dong Yuwei, Hou Jinhui, Zhu Bicai, Li Peiqing and Pang Yonghong, "Concepts on Epigenetics and Research Progress", *Journal of Biology*, 2005(1);
III. Yang Huirong and Zhao Shouyuan, "Formation and Development of Epigenetics", *Chinese Journal of Anatomy*, 2007(4);
IV. Cui Taotao, Li Changqi and Zhang Jianyi, "Epigenetics's Role in the Neuroplasticity", *Chinese Journal of Neuroanatomy*, 2008(6);
V. Li Ting and Zhu Xiongzhao, "Epigenetic Mechanism of Early Experience Influencing the Behavior of Adult Individual", *Advances in Psychological Science*, 2009(6);
VI. Li Guanglei, Yu Shuxun, Fan Shuli, Song Meizhen and Pang Chaoyou, "Research Progress in Epigenetics", *Letters in Biotechnology*, 2011(1);
VII. Stephanie A. Tammen, Simmonetta Friso, et al., 2013, "Epigenetics: The link between nature and nurture", *Molecular Aspects of Medicine* 34, pp. 753 – 764.
VIII. Robert H. Lipsky, 2013. "Epigenetics mechanisms regulating learning and long-term memory", *International Journal of Developmental Neuroscience*, 31, pp. 353 – 358.

the legal science; the wide application of synthetic genes and transgenes, especially in the medical field; researches on the genetic structure of a population and anthropological studies providing material proof for understanding the relation between the East-West differences and genes; and psychological studies on genes, memory, disposition and other aspects at the micro level. Scholars point out that, biology will move from the era of analysis to that of synthesis. So, synthetic biology will lead life science in the future. Besides, it will also exert an effect on research on other sciences, including ethics. It also raises a series of questions about ethnics while benefiting human beings. Today, human beings' wisdom and creation have reached a level of directly taking human life as the model and influencing life development. This is a phenomenon never seen in the previous scientific development and can also be deemed as an important evidence for Anthropocene in the 21st century. Pedagogy cannot neglect this unprecedented change in the research closely linked with human life.

2) We should pay special attention to epigenetics, a new branch of molecular genetics. By studying it, I think there are two main reasons why we need to keep a watchful eye on this field:

First, it reveals double meanings of information contained in genome. In 1987, American scientists said that the property of genes in higher organisms can be researched at two levels. At the first level is the intergenerational transfer rule of genes. This is traditional genetic information, i.e. genetic information provided by DNA sequence or the sequence of human growth and development. At the second level are changes taking place in an organism of gene expression activities from zygote to adult development. Such changes refer to inheritable changes in genes function without any change in DNA sequence — giving an order of how to apply the genetic information at what time and under what circumstances and changing the level of gene expression. That is so-called epigenetics. It changes Mendel's classic understanding of genetics by offering two levels — different ways of presenting genes at the intergenerational level and individual development level, and the hereditability of generated individual epigenetic gene.[4] The differences between intergenerational and individual development genetic expression mechanism change our previous understanding — genes cannot be modified in an individual — and enlighten us to the fact that even the genetic mechanism leaves a space for possibility and uniqueness for individual change. Most likely, in the course of individual development, information

4. Refer to I and II above.

contained in intergenerational genes can be "activated" or "inactivated" or "strengthened" or "mutated". These research findings break our stereotype on the performance of genetic inheritance. From that we can see that almost no factor in a living organism is absolutely unchangeable.

Second, epigenetic genes have a very complex formation mechanism, which is not the focus in this paper, but what we can and must describe is the direct link between changes in the phenotype of genes and those in internal and external environments. The phenotype unique to cells can be changed by the environment of the organism, and forms a complex network to regulate DNA, an important intermediary bridge between life experience and phenotype. With hereditability and transferability, epigenetics becomes an important molecular mechanism of interacting genes and environment.[5] This mechanism reveals the interaction between organisms and environment from the level of molecule. It especially shows that environmental influences play a role in gene expression and can be inherited. This provides a more fundamental scientific basis for understanding the interactive relationship between hereditary and environment and warns educators that attention should be paid to the effect of early experiences on an individual's lifetime as well as the plasticity of human nervous tissue genes so as to improve the endoplasmic level of human beings' body. Thus, we can prevent a certain mental and physiological disease and seek for medications and ways for treating such diseases by consciously changing the surrounding environment.[6] Additionally, this rich and complex formation mechanism of the epigenetic genes brings in a new way of thinking of how to change our understanding.

Even though not knowing well about this branch and its application situation, I have been aware of that research on this branch is important for us to update previous knowledge and change the way of thinking about questions. Also, the knowledge that an individual has an automatic regulation mechanism and ability to respond to environment even at the genetic level. This stunning scientific discovery further confirms the reasonability of comparing "genes" to pedagogic foundation and, accidentally, the study on "genes" themselves is found to be essential to deepen and

5. Refer to III, IV, V, VI and VII above.
6. The article entitled *Environment Affects Gene Expression* by Hu Xuanyi published in "New Knowledge" section on *Guangming Daily* on July 31, 2014 introduces the situation of epigenetics in foreign countries in recent years, vividly and specifically illustrates how social contact and individual mood influence gene expression and get the most possible answer to why epigenetic gene is generated in life that individuals who react to fast changing social environment at the quickest pace will be likely to survive, and they do not — really do not wait for better genes evolved at the level of the species.

enhance the scientific foundation of pedagogic theory.

In short, there is little doubt that disciplinary theory needs to be built on understanding the research object. It is never obtained directly from the object or a summary from experience about the object or direct sketch of the object, even though it covers all these three aspects. As it is about rationally reconstructing the research object, it needs to discuss the object's inner prescription and mechanism, know well about the object's spirit and rich expression, and briefly describe the object's evolutionary path and track. If a theory cannot even give a partial answer to these aspects, then it does not have value for its existence. To complete such a theoretical construction, we must clearly understand the core of the theory to be established. Otherwise, the theoretical system is unlikely to have inner organic connection and become a whole. The "genes" come to me after noticing life questions existing in the pedagogy. It inspires us to think about prescription, richness and complexity of the internal interaction of the theoretical core in depth, making us comprehend meanings beyond the original one of the "genes" but needed by pedagogic theory.

Part II Basic Viewpoints of Representatives of the History of Western Pedagogy on "What is Education"

Undoubtedly, from the perspective of the history of Western pedagogic formation and development, it is of great necessity for us to learn about existing basic viewpoints about "what is education". They are undoubtedly necessary to understand a school from the perspective of the gene. We can get a picture of predecessors' basic views, basic way of thinking, finding the indispensable ingredients by comparison, and the differences in specific concerns and expressions. It is not the first time that I read works written by masters in the history of Western pedagogy, but it is certainly the first time for me to read these works with a purpose to look for the foundation and "genes".[7]

1. Comenius and His Work *The Great Didactic of John Amos Comenius*

The interpretation starts from Comenius historically speaking.

The Great Didactic of John Amos Comenius focuses on what "human being" is and how to teach. According to Comenius, "nature" is the common principle that

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7. For discussions about this regard, see Ye Lan, "An Introduction to the 'Life/Practice' Pedagogy", op. cit., pp. 5 – 33.

must be followed in these two aspects. "Nature" is the prototype of understanding "what education is" and its "soul", so it must be followed and should be embodied in understanding and practicing education. Education against "nature" is deemed as bad practice. "Nature", a component of Comenius' educational theories like gene, contains all foundations of understanding why people receive education and how to educate people.

Comprehending what Comenius's "nature" means is an important link to understand this great educator's educational thoughts in depth. Some people feel that his book is full of religion, while others hold that vividness and freshness of real nature is shown in his work. These two aspects are seemingly contradictory, but they are real in the eye of Comenius. Because in his view, human beings and all creatures in nature are created by God, and the former are the "noblest, perfect and most beautiful" work created to the God's will and "overtop all tangible and intangible creations". The relationship between human beings and nature created by God is that human beings overcome all things and all things serve human beings. According to the Creator, all things will experience growth and change and "all living things exist for a purpose". There is no exception to human beings, "whose ultimate goal is to go beyond the secular life". Therefore, "death" does not mean the ending of the existence but entry into the immortal paradise. The secular life is a road to the immortal paradise. After establishing the goal for the secular life, Comenius associated education with this goal. He pointed out that God has planted the "seed of knowledge, morality and piety" in the heart of human beings, but human beings need to "have their latent abilities developed". What education does is to help human beings to grow their inherent inner seed to form real knowledge, morality and piety. Comenius believed that, "people could be educated ... actually, a man could become a cultivated one."[8] Here, we can see the amazing unification of God and nature, secular life and future life, existence and goal, inherence and education on human beings. This understanding of "human beings" constitutes the core of Comenius' educational theories from the perspective of gene — the specific expression of the unique prescription of "nature" is also a typical example of this core concept that plays a special role in building educational theories.

What should be noted about Comenius is that, even though his educational theories are full of religion, he is not a supra-mundane man. The driving power inside him to study education and create new educational theories comes from his

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8. For the above references, see Chapters 1 – 6, *The Great Didactic of John Amos Comenius*.

strong dissatisfaction about school education in the real world, insight on the defects in theories and practices of actual educational reforms and sincere intention to good education encouraging teenagers to grow. His study centers on school reform and his work entitled *The Great Didactic of John Amos Comenius* becomes the first paradigm of constructing educational theories with the focus on school education. A series of his works, including illustrated readings he has written for infant schools, have been widely adopted and played an important role in influencing school education at that time. Through this, he obtained great vitality by influencing practices with educational theories, making him an iconic figure from the Middle Ages to the modern times in the history of educational research.

2. Rousseau and His Work *Emile*

Jean-Jacques Rousseau was a well-known Enlightenment philosopher and thought leader of the Bourgeois Revolution of the 18th century. He once said that, among all efforts to the benefit of human beings, the most important cause is to educate people[9] . He appeared in the history of educational development with his 1, 762 novel works on education entitled *Emile* and became an important figure that could not be ignored by later generations of educators when talking about educational questions.

Many scholars, including me, have once thought that Rousseau was an educator advocating naturalism, but I feel that it is very important to differentiate the naturalism promoted by him and by Comenius, as we have found from probing into the differences that "freedom", not the pronounced "nature", is the factor that determines Rousseau's fundamental understanding of education. His view on "nature" has two distinctive features below:

First, Rousseau's thoughts on education concentrate on a natural person's educational problems from being born to becoming an adult. This is unlike Comenius, whose focus is placed on the relationship between an individual's growth and education. That is the biggest difference between Rousseau and Comenius in choosing the analysis unit for the research object. That causes important differences in their emphasis on educational problems and specific works. It can be said that Rousseau is the pioneer who has studied the problem relating to the relationship between an individual's growth and education, and had a sustained and strong influence.

Some treatises about problems of educating children come out before

9. Rousseau, *Emile*, Trans. Li Ping'ou, Beijing: The Commercial Press, 1978, p. 2.

Rousseau's, but the most influential and representative work in history is the work *Some Thoughts Concerning Education*[10] written by English philosopher John Locke in 1693, but Locke focused on how to train children born in upper-class family into gentlemen. He is conservative about existing social ethics. His education research emphasizes family education with a view to providing help and support to parents who have no idea about how to train children, and has nothing to do with social problems. His discussions on children and education are built on his own philosophical reflection and observation on the understanding of human beings, in combination with his own experience obtained during contacting children, so they have more limitations. Obviously, Rousseau has read *Some Thoughts Concerning Education*, as he mentions he is the one who has discussed children education once again after Locke. But in his book *Emile*, Rousseau always takes a critical attitude towards Locke's arguments, and until in the last chapter, he clearly says that "I do not feel honored to train children into gentlemen, so I will not follow in Locke's steps". [11] Indeed, Rousseau and Locke differ a lot in education. The biggest difference is that Rousseau's "natural person" means "Emile" created to resist oppression and deprivation by French feudal dynasty at that time. He wants to develop a new person who has not yet appeared but is needed by the ideal "free, equal and philanthropic" society, which is totally different from Locke's orientation of remaining unchanged. With the humanity hypothesis that a person can become kind, Rousseau tables the most basic principle — education must conform to people's natural development as well as the goal of developing "natural persons", thus expressing his objection to constraining children with social norms. In Rousseau's education plans, the most paramount thing is to develop the sensibility and emotional capability as well as rationality-based morality. While Locke is of the opinion that education is to train children into social persons with personality which will inevitably conflict with children's native tendency to pursue happiness and avoid bitterness, so it is a must to impart social norms and beliefs into children and, the earlier, the better. Starting from growth problems and needs of an individual at different ages (Rousseau's unique understanding), Rousseau writes *Emile* according to growth stages of a child in order to introduce and discuss relevant education problems. Also, to stress the decisive significance of children's own life and practices

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10. This is the early translated title of the book by Locke, and has been incorporated into *Cihai*. It was translated by Xiong Chunwen in 2005. The new Chinese translation titled *Jiaoyu Pianlun* to be published by Shanghai People's Publishing House of Shanghai Century Publishing Group is now not distributed, so this paper still uses the original translated title.
11. Rousseau, *Emile*, p. 526.

on their growth, he puts Emile in nature in countryside. While Locke's discussions carry on around the education-related subject terms. They contain suggestions for educating children at different ages in a different way, but they do not become a clue in paper. The aforesaid differences between Rousseau and Locke underline the theoretical characteristics of studying education problems with the focus on children's growth. In addition, we can also see that, the true meaning of Rousseau's "natural person" is actually to develop a new social person for his ideal society. Even though "Emile" is an imaginary character, the critique in his book is very practical. Rousseau claims to get away from "hands of human beings", but actually, "Emile", created by him, is still from "hands of human beings".

In addition, Comenius and Rousseau have different purposes to stress "nature". In order to create pedagogic theories, Comenius turns to nature to mainly obtain the basis for educational order and method by taking nature as educational reference frame. In terms of natural disposition and rights of children — subject of growth, the "nature" mentioned by Rousseau means people's natural instinct. Comenius's nature has methodological significance in building pedagogic theories, while Rousseau's nature has ontological meaning.

The more striking educational thought stated in Rousseau's *Emile* is the strong reality critique and freedom advocating. His critique aims at social and adult damages to children's natural development and growth. He designs a set of educational concepts and methods without practical basis and completely opposite to reality, giving full expression to his strong desire for breaking the bonds of real society system and pursuing for freedom in the aspect of educating children as thinkers. Clearly, that is in line with Rousseau's political pursuit. It also shows that the value of educational thoughts is associated with the understanding of social development during the period of social reform. Throughout the whole book, even though he stresses that educational problems need to be criticized and constructed, the value of *Emile* still mainly lies in the thoroughness of critique not the accuracy and feasibility of the construction.

Specifically, the first essence of education for natural persons proposed by Rousseau means human beings' footloose natural growth — education for both human beings and matters must comply with human needs of natural growth.

Rousseau believes that education is associated with living and life, saying "we begin educating ourselves once we start living; and our education starts with our life."[12] In addition to protecting children, more importantly, education aims to teach

12. Ibid., pp. 13 – 14.

children how to protect themselves and withstand blows in trouble. "Life is not just to breathe but to keep active, that is, we must use our organs, senses, capabilities as well as all parts that can make us feel that we exist. A person who lives the most meaningful life is not the person who has the longest lifespan, but the person who has the most feelings about life."[13] What Rousseau cares about is the significance of education on the freedom of the real life of an individual. Rousseau is dubbed as the most important thinker who brings forward that education must develop an individual's ability to solve problems to be encountered in his life. In a sense, he can be deemed as the founder of "individual pedagogy".

To the knowledge of Rousseau, the nature-oriented education is two-sided, with opposition and advocating complementing each other. Opposition points to tradition, e. g. overprotection and constraints of children's body, impartation of morality for adults, children's forced obedience to others' will, children's minds occupied by a series of courses, etc. The advocating involves a series of new methods, e. g. stressing that the only way to keep limbs robust is being physically active, developing students' sensibility and emotional experience before focusing on the intelligence, and teaching knowledge by contact and relation. "A person who knows well about the whole can get a picture of the location of every part"[14], and a person needs to "acquire the ability of judgment not knowledge"[15], so, children should be taught to know how to acquire knowledge in need, judge the value of knowledge and love truth[16], thus making children actively realize that the power of the world is "real interests", etc. This shows that Rousseau does not oppose all teachings and only advocate all children-centered things, just as everyone believes. What he does not agree with is traditional educational thoughts, methods and systems. He promotes the education that he expects. New persons can become free only by receiving the new education that he promotes.

Through combining these two main features of Rousseau's educational thoughts once again, we can see that one side of the "nature" in Rousseau's educational thought is the surface, while the value orientation of the genes core of Rousseau's thoughts is "freedom". So, the characteristics, historical contribution and the power of Rousseau's educational thoughts all originate from the pursuit for "freedom".

To understand why "freedom" is considered as the genes core of Rousseau's

13. Ibid., p. 15.
14. Ibid., p. 257.
15. Ibid., p. 257.
16. Ibid., p. 283.