Development and Future of Creativity Teaching

Knowledge Economy, Science And Technology, Neurosciences and Creativity

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Abstract—**Nowadays, educational reform is prevailing in developed countries. Although the emphases are different, high level abilities of students like creative thinking and problem-solving ability have attracted attentions. The development and prospect of creativity education are described from three aspects including knowledge economy and creativity, science and technology and creativity, neurosciences and creativity.**

Keywords—*knowledge economy; science and technology; neurosciences; creativity; teaching*

I. INTRODUCTION

Creativity enables human to produce new thoughts, discover and explore new things. It refers to continuous and complicated high level mental activity, consisting of knowledge, intelligence and personality. Creativity teaching trains the ability in discovering and exploring new things and problem solving. With the development of the times, the requirements for individual creativity continuously raise. Core Competencies for Development of Chinese Students was officially released in September 2016. It centers on cultivating "well-rounded person" and explains the connotation of quality-oriented education from three aspects, six core competencies and eighteen nuts and bolts. "Rational thinking", "criticism and questioning", "brave to explore" and "frequent reflection" as well as "problem solving" involve improvement of creativity and cultivation of innovation consciousness.

Previous researches on creativity teaching focus on concrete contents such as classroom environment, teaching methods and teachers' quality. Analysis on the relationship between creativity and knowledge economy, creativity and science and technology, creativity and neurosciences from macroscopic perspective will provide reference for future researches and practice theoretically.

II. KNOWLEDGE ECONOMY AND CREATIVITY

A. Relationship between Knowledge Economy and Creativity

Human is facing "the third productivity revolution", namely "the era of knowledge economy" with competition of "brain". Economist Lester Thurow once said "creativity is the secret for success of knowledge economy, so we must be committed to talent training and reward creativity and provide directions of research and development". Therefore, creativity contributes to rapid development of knowledge economy, which strengthens the importance of creativity cultivation.

In the era of knowledge economy, creativity is not only the power of social development but also the requirement of individual success. When Bill Gates was asked the prerequisites of success, he answered, "Creativity and perseverance of moderns are significant for success". Yahoo CEO Yang Zhiyuan also addresses "originality and ongoing efforts" are the secret of success. Perseverance and ongoing efforts are common characteristics of creative people. The importance of creativity in individual success is obvious.

B. Knowledge Creation, Management and Creativity

In the uncertain economic system, it is certain that "knowledge guarantees continuous competitive advantage". For example, the reason why Japanese enterprises Honda, Panasonic and Canon can succeed is that they have unique methods to create and manage new knowledge. CEOs of these companies know the creation of new knowledge is not to mechanically process objective information but grasp implicit subjective opinions, intuitions and ideals of employees. Methods to use knowledge are reflected through speeches, metaphor and symbolism. [1] Speeches, metaphor and symbolism are important skills to develop creativity. Therefore, knowledge management is inseparable from creativity.

Peter Drucker thinks ideal and thought are of equal importance for enterprises of knowledge creation. [1] The nature of innovation is to create the world according to specific visions or ideals. Therefore, individuals and organizations that create new knowledge must unceasingly update knowledge to thoroughly remold themselves. In knowledge creation, the invention of new knowledge is not restricted to research and development. It is behavior pattern and attitude in which everyone is knowledge worker and inventor. [1]

Knowledge creation in enterprises enlightens us: creativity teaching should have specific visions. Teachers and students should be knowledge workers and inventors. Taiwan scholars have outlined the clear visions: On individual level, individual knowledge and caring for life are emphasized, in order to stimulate people's creativity and potential, improve problem-solving ability and develop skills and self-value. On school level, create innovative and lively learning environment, improve education view and develop characteristics of schools, extend containment and imagination as well as create the

learning environment that respects differences and appreciates creativity. [2] Therefore, the visions will be realized through effective creation and management of knowledge. Then, how to create and manage knowledge effectively?

Knowledge consists of explicit knowledge and implicit knowledge. Explicit knowledge refers to businesslike and systematic knowledge that can be shared easily. Implicit knowledge is highly individualized and abstract which cannot be taught to others. [3] Implicit knowledge comes from experience accumulation including understanding and technical skills that belong to "know-how" skills which cannot be explained in words. Experienced teachers gradually develop fruitful professional knowledge and teaching arts but they fail to express the technical principles and process. Knowledge exchange and sharing convey implicit knowledge and avail knowledge innovation. Knowledge transmission has four possibilities: First, from implicit one to implicit one; second, from implicit one to explicit one; third, from explicit one to explicit one; fourth, from explicit one to implicit one. [3] The establishment of the four kinds of knowledge can promote students' creativity through promoting teaching activities. The building of learning-oriented organization can effectively create atmosphere of creativity and enhance the effects of creativity teaching.

Drucker thinks learning-oriented organizations "obtain and spread knowledge and change behaviors according to new knowledge and understandings". [1] New ideas are of vital importance for learning, but learning-oriented organizations cannot be built only through new ideas. Without the adjustment of working mode, new ideas only create possibilities for changes instead of really changing. In the learning-oriented organization, people ceaselessly improve abilities and learn how to learn.

Therefore, organizational climate in schools, professional knowledge and skills of teachers and individual knowledge and skills of students are of equal importance in effective promotion of creativity teaching. School leaders and teachers should think deeply about how to make schools and teachers as we

III. SCIENCE AND TECHNOLOGY AND CREATIVITY

A. Role of Creativity in the Hi-tech Era

It is an era of knowledge economy as well as science and technology. The rapid development of information technology forms the concept of "Global Village" and changes people's life and thinking styles. Meanwhile, we should get clear understanding of science and technology and their values and establish correct relationships. The analysis needs "high thought".

High thought is an attitude that reserves human science and technology but rejects those infringing human; admits science and technology is an indispensable part for human cultural progress and is the product of human creativity, also thinks art and religion accompany with the progress of science and technology. [1] Furthermore, "high thought" knows how to rationally and consciously use science and technology to improve human life and values. [1]

China holds "National Teenagers' Science and Technology Innovation Contest" annually, encouraging teenagers to innovate and exploit boldly. Courses such as nature, science, and information technology are provided in primary and secondary school education to train students' manipulative and comprehensive ability, in order to make them develop roundly. Therefore, the cultivation of students' creativity, especially creativity of science and technology is one of the most important educational objectives in the new era.

B. Web-based Learning and Creativity Teaching

The popularization of network and the maturity of IT alter the previous teaching model and promote educational development. How to make use of the advantages of science and technology related to network to solve problems in creativity teaching caused by limitation of time and space and to improve effects of creativity teaching has become new topic of creativity education in recent years.

Harbach proposes the application of science and technology as well as internet can promote creativity teaching. [4] Koschmann and Lipponen hold the opinion that online cooperative learning can effectively promote social creativity. Science and technology is regarded as a medium of online cooperative teaching. Attentions are paid to how to carry out cooperative learning under the support of science and technology and to promote peer interaction and group cooperation, and how cooperative learning, science and technology to promote knowledge sharing. [5][6]

Web-based learning especially the cooperative learning in network community can effectively promote students' creativity. [7] Cooperative learning is an effective method to promote creativity and is the core concept of network community. [8] Therefore, cooperative learning will influence the formation of network community and then influence creativity. The following suggestions are provided for the integration of web-based learning in creativity teaching.

1. Data administration system: Course and learning materials can be provided on web-based teaching platform for students.

2. Cooperative tasks: It can be group assignment, special report and case study. The fulfillment of cooperative tasks avails the rapid formation and interaction of learning community.

3. Communication tools: It includes synchronous and asynchronous tools such as online discussion, audio and video interaction and chat platform. In general, asynchronous tools are more widely-used and effectively promote social interaction. [9] It avails students to share documents and review.

4. Diversified problem-solving situation: Modern science and technology encourages students to ask questions and find answers; in order to promote creativity through modern science and technology, diversified scenes must be provided in the educational environment, including conflicts and tension. Besides, creative problem solving must be required, so that students can make choice and feel the strengths of creativity. [10]

5. Online discussion: It provides broader opinions, stimulates more thoughts and exchanges more information as well as enhances skills and knowledge of creative thinking. Besides, online discussion extends time and space of learning and covers the shortage of classroom. Students have more frequent interaction to achieve the best effects of cooperative learning. Topic discussion with diversified problem-solving scenes can effectively enhance students' creativity.

6. Learning community: Activities that promote the formation of online learning community include online discussion, individual or group study, group assignment or special report, cooperative problem solving and case study or discussion. [11]

7. Guided exercise: Experience effectively improves self-efficiency and can be achieved through guided exercise. Teachers must design systematic and progressive exercises or assignments and ask students discuss online to make them grasp the skills of creativity and improve their self-efficiency. [12] Teachers must give proper feedback and guidance in this process.

8. Observation and learning: Online assignments and reports of groups and individuals can be provided for students to browse, in order to achieve the desired effects of observation and learning. It shares achievements of students and students can "solve problems through observing others". Moreover, browsing assignments of other groups online helps students to complete the ongoing tasks because a platform of learning experience exchange is provided for them.

The design of online courses should consider teaching materials and experience in interaction as well as learning flexibility. Web-based learning breaks the limitation of time and space. Learners control their learning progress, time and depth; asynchronous learning can meet this requirement and improve in-depth thinking, which is essential to enhance creativity.

IV. NEUROSCIENCES AND CREATIVITY

A. The Production of Neurosciences and Creativity

Empirical research of brain nerve science can explain why creative thinking can be produced or promoted. For example, many scholars find positive individuals produce more diversified information and association to make them more flexible. [13-18] Positive emotion will increase the activity of dopamine from the perspective of neurophysiology; the release of dopamine promotes the flexibility of cognition and the selection of cognitive views. The theory reveals positive emotion strengthens smell, long-term memory and working memory and influences creative problem solving. [19]

Besides, Dietrich proposes the progress of cognitive neuroscience in recent years has proved specified brain circuits relate to high-level functions of brains, but it hasn't been applied to creativity research. Dietrich observes the insight of creativity influences neural circuit. When the insight of creativity appears, the neural circuit will terminate in prefrontal cortex. [20] When creativity is deliberate control instead of extemporaneous reaction, prefrontal cortex will promote

creation. However, deliberate and extemporaneous creativity will trigger neural computing related to emotional and cognitive analysis.

B. Integration of Neurosciences with Education and Psychology

In the past several decades, neurosciences rapidly integrate with many fields. Schools and institutions for academic research attach more importance to the integration, which will be popular in the academic world.

OECD has launched transnational "learning science and brain research" since 1999. Experts and scholars of research institutions from eighteen countries carry out in-depth cross-disciplinary research on education according to "reading", "mathematics" and "life circle". So far, it has achieved plentiful research results. Introductory workbooks related to research tools of brain and cognitive neurosciences have been compiled to provide foundations for interdisciplinary interaction.

Except for the transnational plan of OECD, research groups integrate neurosciences. For example, Professor Kurt Fischer in Harvard University establishes "International Society for Mind, Brain and Education", in order to promote exchange and cooperation in fields of mind, brain and education as well as discover and provide research resources; main researchers related to integration of mind, brain and education are involved. Besides, Professor Hideaki Koizumi in University of Tokyo hosts "Brain Science and Education Plan" according to different research fields of neurosciences, pedagogy, psychology, linguistics, anthropology, sociology, medical science and information technology. Major research topics in the plan includes: Genetic and environmental factors influencing learning, basic neurophysiological mechanism of learning, critical and sensitive periods of learning, memory, creativity, institutions of sympathy and service heart and development, enhancement of language learning, education of morality and sense of responsibility.

In contrast, although professors Lin Chongde and Dong Qi in Beijing Normal University emphasize the trend and importance of integration, so far, few research institutions or units have implemented, let alone researchers who apply neurosciences to creativity. At present, although a few foreign researchers have combined the researches of neurosciences with creativity and have provided bases in creation process physiologically, it still has large development space. Therefore, researchers should research how to integrate research talents related to neurosciences, psychology and education to carry out in-depth research of creativity and provide more specified methods and suggestions for creativity teaching.

V. CONCLUSION

The development of knowledge economy uses knowledge to create competitive advantages. The development of science and technology does not replace wisdom and creativity of human but help us to give full play to them. In the era of knowledge economy, teachers and students should be knowledge workers and creators. The establishment of learning-oriented organization can effectively promote

knowledge transmission and sharing. Creativity teaching should closely integrate schools and teachers as well as students to create effective learning-oriented organization.

Moreover, creativity teaching should combine science and technology with it. Except for strengthening students' creativity in science and technology, creativity teaching can depend on web-based learning, which provides a different learning model and a space with boundless imagination for educational development and research. Although the effects of web-based learning are continuously tested and corrected, few researches that use web-based learning to promote learning creativity exist. Educators and educationalists can research how to integrate web-based learning in creativity teaching, in order to activate teaching activities and enhance effects of creativity teaching.

Carcia thinks web-based learning consists of three parts: （1）Human: Teachers and students carry out learning activities through cooperation. （2）Educational process: It refers to educational environment, including resources, communication, contents, objectives and activities. （3）Technical support: Support people and educational process. Therefore, the three parts must combine creatively to take significant actions and achieve good effects. [21] In other words, the successful promotion of students' creativity through integrating web-based learning in creativity teaching depends on collaboration of students, teachers, teaching environment and technical support. However, only those with creativity and skills can effectively operate products and tools of web-based learning. That's to say, internet users must be creators. Therefore, teachers for creativity teaching must have knowledge and skills of teaching technology.

The new trend of creativity teaching as well as the objective of creativity researchers include: how to make more in-depth research on creative thinking according to theories and research methods of neurosciences, in order to provide explicit suggestions for educators. Implicit knowledge and the formation of insight are issues in which creativity researchers are most interested and the most difficult questions for them to answer. Researches on neurosciences may provide some clues. Empirical researches of neurosciences indicate neurotransmitter cells will increase and the branches of dendrites of neuron will be more complicated and the synaptic structure will change in the learning process; meanwhile, cranial nerves are plastic. Therefore, creativity teaching can consider how to activate neuron and strengthen the connection of neural network. In conclusion, the development of neurosciences avails the understanding of creativity and promotes researches on creativity.

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