The Development of Neuroeducation in China and Its Impact on "Learning by Doing" Project

In 2002, a research institute named research center for learning science (RCLS) was founded by Prof. Yu Wei at Southeast University, aiming to conduct translational research on child development and learning science. It was the first research institute of China for doing neuroeducation research. Four years later, a key laboratory of ministry of education was also founded by Prof. Yu Wei at southeast university. This laboratory is committed to the child development and learning science, carrying out multidisciplinary translational research in the area of neuroeducation. Its target is to provide evidence-based studies to support for child development, basic education reformation, and cultivating innovation ability of students in China. After more than ten years of work, a great deal of achievements on the project of "learning by doing (LBD)" inquiry based science education (IBSE) [1][2], the assessment of child social emotion competence [3], and the evaluation of student's key concept scientific learning [4] were obtained in RCLS and the key laboratory of child development and learning science. In what follows, we will briefly review some of these achievements.

The LBD project was co-initiated by ministry of education (MOE) of P.R. China and Chinese association for science and technology (CAST) in August 2001 as a successful result of international collaboration pilot project, which aimed at promoting the children's science education as well as their holistic development and wellbeing. LDB is an IBSE project for 5-12 years old students in kindergartens and primary schools. Over 10 years' practice, LBD reaches out to 22 provinces and benefits over 200,000 students and thousands of teachers. It has become a sound foundation for revising the national standard of science education in primary schools and facilitated the national policy changing on early child development. In 2010, the work of LBD has achieved Purkwa Prize in 2006 and the first class award of education research from MOE, P.R. China [2].

The development of IBSE has faced a lot of new challenges in the pedagogy, including preconception, concept construction, the role of interaction between teachers and students, choosing of key concepts and building learning progressions in science. Conducting scientific research on mind, brain and education can get more reliable and clearer arguments that come from the process of the implementation of LBD. Research findings start to shed lights on how students learn and provide supports to understand the controversial questions in science education. The knowledge of the limited human working memory capacity, as well as the research on behaviors and neural mechanisms showing that the experts use core concepts, models and inquiry skills to solve their problems supports the importance of the key science concept [3-5]. The biology of long-term memory emphasizes the pedagogy based on students' prior knowledge and the assessment of their learning progression. All these pedagogies are emphasized in LBD.

Additionally, we make breakthrough in cultivating children's social emotion competency in LBD [6]. Although it is realized that the social emotional competence is the best predictor for the future success and happiness of our children, the present education curricula focus more on children's academic development than on cultivating children's social emotional competence. Based on our knowledge of emotional influences on learning and development, we have included the social emotional learning standard for the first time in the content standard of LBD science education. Children are expected to improve their social abilities and social skills during science inquiry practice. Considering the special status quo of one-child policy in China, priority is given to children's empathy of emotional competencies and self-esteem of personal characteristics. The requirements and learning stages are also proposed in the standard. Research has shown that IBSE has effectively promoted the social emotion competency of students, particularly the empathy and cooperation behaviors.

Recently, research applying brain imaging techniques to discover the neural activities underlying science learning starts to elucidate the mental processes that happened when a student acquires a new science concept [7-9]. Based on this knowledge, we design and carry out the research of science education in the perspective of neuroeducation [10]. We present the scientific phenomena consistent or inconsistent with the key concept on the computer screen. Students observe the phenomena and perform the relevant tasks according to the experimental instruction, at the same time, their brain signals are recorded. We examine the differences in EEG and ERP parameters related to the students' comprehension of science concept. The pilot experiment results reflect the potential ERP indicators relevant to science concept understanding.

The trans-disciplinary research on neuroeducation can not only support the pedagogy of IBSE and practice of cultivating children's social emotion competency, but also create scientific tools applying to measuring learning outcome in classroom practices. Four series of instruments and software are being developed in RCLS:

(1) Multiuser on-line assessment and record system for inquiry-based education. It can provide the response opportunity for over 40 learners. The teacher can record and analyze the answers from all learners at same time. These results provide for teachers with the learners' cognitive outcomes and learning progression promptly for suitable next step Inquiry-Based Education methods.

(2) Social emotional competence assessment system. The system focuses on empathy and communication assessment. In addition to the traditional questionnaire, this system will also utilize the physiological signal analysis, behavior analysis and the facial expression recognition, such that the assessment of empathy as well as the related social emotional competence becomes more reliable.

(3) Evaluating executive function system. Virtual reality created by computers and presented to the students, their behavior and brain signal data were acquired by the wearable EEG sensors measuring connected to database which forms the major parts of the system.

(4) Estimating key concept proficiency system. Virtual reality were created and presented by computers, the EEG/ERP technology are combined together to assess the students' science concept understanding.

In summary, our research work neuroeducation during the last decade had significantly promoted the development of early education as well as the research strategy of science education in China. Our future work will continue to this research work to promote the further development of neuroeducation in China.

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