

# An Elementary School Teacher's Reflection on Implementing Constructivist Instruction in Science Classroom\*

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The main purpose of this paper was to describe how the author, Kuo-Chung Hsu, changed his teaching beliefs and science instruction through participating in a cooperative action research, which is conducted by the author, Jing-Ru Wang. Self-study was adopted to explain and interpret Kuo-Chung Hsu's experience of teaching science in Taiwan island. The current research report involved three parts: firstly, how Kuo-Chung Hsu developed his teaching belief; secondly, the process of transferring Kuo-Chung Hsu teaching belief into practical teaching was provided; thirdly, Kuo-Chung Hsu constructivist instruction was illustrated with a unit of science teaching instruction. In the conclusion of this paper, Kuo-Chung Hsu retrospectively to his personal experiences in constructivist instruction, which reflected the process of how a novice teacher became an expert teacher. This research has significant implications for the design of science teacher professional development.

*Keywords:* science teaching, constructivist instruction, teacher professional development

Mentor A: What are you doing?

Student Teacher B: Typing this assignment (in front of the computer desk)

Mentor A: (looking at the computer) Why must this be done?

Student Teacher B: The professor told me to finish it by...

Mentor A: What does the professor know? The professor has no idea of the real situation (voice up with a bit of anger).

This is the conversation Kuo-Chung Hsu happened to overhear in the library of a school in 2004. This conversation showed that the mentor might believe that the theories taught by professors were useless in real classrooms. Such kind of phenomenon reveals the disconnection between theory and practice. In this article, self-study (Pinnegar & Hamilton, 2009) was adopted to explain and interpret Kuo-Chung Hsu's experience, while implementing the theory of constructivist teaching in his science classroom from 1999 to 2004.

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### **Formation of Constructivism Teaching Belief**

What is constructivism? Constructivism has the ascendancy among learning theories in 1990s (Duit & Treagust, 1998). Kuo-Chung Hsu's first contact with constructivism is primarily presented as a proposition, like knowledge is not passively accepted by the cognitive subject, but built up by individual. The cognitive function is adaptive to organize his/her experienced world rather than discover the objective ontological world (Von Glasersfeld, 1995). Such kind of description is different from most of Kuo-Chung Hsu's learning experience. In his personal experiences, learning science was to learn the knowledge or correct answer that was discovered by scientists instead of learning the process of inquiry. To Kuo-Chung Hsu, it was not through an active building process. Although the constructivist description sometimes conformed as a part of his learning experience, he did not know how to transfer it in his science classroom. So, knowing the proposition of a theory could not change teaching behaviors. This situation meets what Windschitl (2002, p. 151) said, "If teachers are willing to re-culture these kinds of classrooms, their first obstacle is the influence of their own personal history as learners". This is because most teachers are the products of traditional school education and are growing up in the teacher-centered learning environment. Teachers are more likely guided by their imagines of past learning experiences instead of instructional theories. Hence, it was not easy to switch his belief about teaching science and even embedded into teaching practices:

In 1999, I participated in a cooperative action research conducted by the three university professors. One day, a professor provided us a lesson in which we were requested to explore a mystery of a black box. I was astonished while watching a lot of blue water coming out from the black box, while a cup of clear water adding into the box. I was curious and eager to explore this unexpected situation. We were thinking and discussing a lot of possibilities and explanations based on our observation and prior knowledge. Following this vivid activity, the professor provided us lecture about the 5E (Engagement, Exploration, Explanation, Elaboration and Evaluation) instructional model that is consistent with constructivist instruction. The 5E instructional model was presented as a practical way for science teachers to incorporate scientific inquiry and apply our understanding of student learning (Bybee, 2002). I was moved by this learning experience that was so wonderful and useful. I finally understood it was possible to have a connection between the theory and practice. This feeling was contrast to my previous belief. At this moment, I had an ambition to apply 5E teaching model in my science classroom to make my students understand that learning science is a vivid and interesting thing. This scenario revealed that a teacher's learning experience plays an importance role in changing his or her belief of teaching.

During that period, Kuo-Chung Hsu had another experience of playing the role as a student taught by an expert teacher Lu who taught us how to identify and sort four kinds of white powder using the 5E instructional model. When playing as a student, he was impressed and believes that students will be fond of this kind of learning activity.

Taken together, the above two different kinds of learning experiences intensified his belief about the feasibility of embedding the constructivist theory into science curriculum to help students develop understanding of science.

### **Transforming Constructivist Instruction Theory Into Teaching Practices**

#### **Initial Trial of Constructivist Instruction: Working With a Co-worker**

In 2000, Kuo-Chung Hsu was requested to design and teach a science unit using the 5E instructional model. He decided to teach the unit and titled rust. The research team members watched how Kuo-Chung Hsu taught the unit using the 5E instructional model and debriefed right after the lessons. During the debrief discussion, we discussed the success and difficulties of implementing the 5E instructional model. The group discussion often created some tips correspondent to the difficulties that we encountered.

After that, Kuo-Chung Hsu continued to design his science lesson using the 5E instructional model with a co-worker Zu, who taught grade six. It was really a wonderful experience to work with a teacher who was

intelligent and enthusiastic in teaching science. Kuo-Chung Hsu and Zu had one year cooperation and designed 14 units of science lesson using the 5E instructional model. This year, his students enjoyed learning in his science lesson. They always wanted to stay in his science classroom and did some interesting science activities. One of his students provided her response of the learning in an assignment as following:

The science course is interesting and funny. I love to operate the tools and do some experiments. I hope our science teacher continue using this teaching method. (Tze-Ching, 2000/11/24)

The students' positive response was an award that motivated Kuo-Chung Hsu's continuous intention to use the 5E instructional model in his science classroom.

### **Reflective Thinking of Constructivist Instructional: Stimulated Recall by Jing-Ru Wang**

As a teacher enacting the 5E instructional model, Jing-Ru Wang focused on the students' positive attitude toward learning science. One day, after Kuo-Chung Hsu taught the unit, Air Mass and Weather, she interviewed Kuo-Chung Hsu with a sheet of students' responses about their learning in Kuo-Chung Hsu class and his teaching VCD (video compact disc). Jing-Ru Wang showed Kuo-Chung Hsu the evidence that all the low-, middle- and high-level students liked the unit; however, middle- and low- level students did not develop understandings about the concept of the wind and air mass. These results made Kuo-Chung Hsu recognize that he did not give students authority over their learning in most of their learning activities. As Kuo-Chung Hsu was watching his teaching VCD, he found that he used whole class discussion to help students understand the air mass and their impacts on the weather. Kuo-Chung Hsu was the center of discussion and most of his students were not involved in the discussion. Kuo-Chung Hsu would like to change his teaching strategy to either ask students to discuss or present their ideas in groups, preceding the whole class discussion, or he might have them design the experiment to test their ideas.

### **Reading of Science History and Discussion of Natural of Science**

In 2002, we decided to write a book to tell teachers how to teach the nature of science at the level of elementary school. Jing-Ru Wang led Kuo-Chung Hsu and other science teachers read a list of books relating to the history of science and designing science lesson using the 5E instructional model. During this period, Kuo-Chung Hsu gradually understood the consistency between the nature of science and constructivism and through the study of nature of science. Constructivism is a theory of knowing. It is the theory for explaining how people acquire knowledge. So, it is necessary to explore "What is knowledge?" and "How is knowledge formed?". Similarly, the nature of science is to explore what is science and how scientific knowledge is formed.

These regular reading activities lasted for one year. It was very interesting while reading the stories about science. We understood how the scientific knowledge that we taught in school was developed. From "Which is the center of the solar system: the earth or the sun?" and "Phlogiston theory and Oxidation theory", Kuo-Chung Hsu understood that scientific knowledge was the results of arguments of different science communities on the same phenomenon and whoever had powerful explanations based on the evidence, he/she would win the supports by the community. During the period of studying the history of science and exploring the nature of science, Kuo-Chung Hsu further understood the correspondent relationships between the constructivist theory and the formation of knowledge in science classroom. In classroom, students are like scientists who investigate the nature world. The formers construct their knowledge in classroom community, while scientists develop their knowledge in a science community.

Briefly summarized, comparison of Kuo-Chung Hsu's early and current teaching practices, the former teaching was to teach knowledge that was developed by scientists and the latter one was to help students

develop their understanding about science. But, how such kind of change was happening? This is mainly caused by the stimulated recall interview by Jing-Ru Wang. Kuo-Chung Hsu found that teachers may have designed good teaching materials. However, if students lack authority of independent exploration, they may not have a clear understanding of scientific concepts. This idea made Kuo-Chung Hsu understand what it means in the reformed slogan "less is more".

### Conclusions

Kuo-Chung Hsu's implementation of constructivist instruction began with cooperative action research and support from university professors. He had dialogued with his co-workers on the debates between theory and practices. Before joining in the cooperative action research, his teaching approach was mostly following the textbooks and had his students conduct experiments in groups following the instruction. After experiencing the constructivist instruction taught by the university professor and an expert teacher, he had intention to learn constructivist instruction, and furthermore, change his teaching approach. Later, his initial trial of teaching with the 5E instruction model won the supports from his students that consolidated his belief of teaching. However, at this stage, the 5E instruction was still teacher-centered, which may be referred to as weak constructivist instruction. Later, with the stimulated recall interview by Jing-Ru Wang, Kuo-Chung Hsu understood that students did not understand the intended concept. After reading the history of science and the exploration of the nature of science, Kuo-Chung Hsu came to the idea that he should provide students with more opportunities of thinking as well as to presenting their own thoughts. So, he was thinking of the arguments of scientists, and invited students to present their thinking with different statements. Now, his teaching was mostly student-centered. This may be referred to as strong constructivist instruction. This is how Kuo-Chung Hsu's constructivist instruction was built up.

The process of constructing understanding of constructivist instruction is shown in Table 1. In this process, he started teaching science that was following the content in the textbooks and finally turned out to be a strong constructivist teacher, from a novice science teacher to an expert science teacher. This research has significant implications for the design of science teacher professional development. Based on his experience of science teacher professional development, he provided the following strategies for designing science teacher professional development: (1) learning constructivist theory through the 5E instructional model; (2) learning how to teach elementary science through the 5E instructional model; (3) teaching demonstration and debriefing discussion; (4) designing science lesson with co-workers; (5) reading the history of science and discussing how to teach the nature of science; and (6) stimulating recall interviews with teaching VCD and students' responses to the instruction.

Table 1

#### *The Process of Constructing Understanding of Constructivist Instruction*

Period (Time)	Belief and practice (through... practical experiences)
I (1999)	The textbook-centered belief (Learning constructivist theory through the 5E instructional model) (Learning how to teach elementary science through the 5E instructional model)
II (2000)	Constructivist instruction belief (Teaching demonstration and debriefing discussion) (Designing science lesson with co-workers)
III-1 (2002)	Weak constructivist instruction (Reading the history of science and discussing how to teach the nature of science) (Stimulated recall interviews with teaching VCD and students' responses to the instruction)
III-2 (2004)	Strong constructivist instruction

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