Asian Social Science; Vol. 10, No. 13; 2014
ISSN 1911-2017 E-ISSN 1911-2025
Published by Canadian Center of Science and Education

Inquiry-based Learning in China: Lesson learned for School Science Practices

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Received: March 6, 2014 Accepted: May 9, 2014 Online Published: June 25, 2014

doi:10.5539/ass.v10n13p64 URL: http://dx.doi.org/10.5539/ass.v10n13p64

Abstract

Inquiry-based learning is widely considered for science education in this era. This study aims to explore inquiry-based learning in teacher preparation program and the findings will help us to understanding what inquiry-based classroom is and how inquiry-based learning are. Data were collected by qualitative methods; classroom observation, videotape recording, photography, and interview were employed during time of visiting Guangxi Normal University, China. The results can be explained in terms of lesson learned for school science practice of inquiry-based learning and pedagogical strategies. It can be understandable, simply to incorporate for general science classroom, and also be implied to inquiry-based instructional practices.

Keywords: inquiry-based learning, pedagogy, instruction, science teaching, inquiry, scientific inquiry, China

1. Introduction

The current pedagogical approaches in which we need to introduce for 21st century should make a suitable response in both teacher and student roles. It has to gain students to have much more critical thinking and necessary skills to survive in the world of information technology richness and in the world of rapidly changing (Holbrook & Rannikmäe, 2009). Teachers should pay attention of what teaching and learning works in terms of students involvement as well as they should understanding natural world through constructivist views, rather than emphasize on contents or theories for examination (Prawat, 1992; Blumenfeld *et al*., 1994; Nuangchalerm, 2011; Nuangchalerm, 2012). Students should have learning inquiry of what fruitful knowledge for daily life and also necessary skills in which they employ as a learning tools (van Driel *et al*., 1998; Anderson, 2002). Students are learning constructor; teacher is facilitator in science teaching. The pedagogical approach should provide students to have space for accommodating scientific concepts that will help them to have strongly faced with social and cultural involvements (Aikenhead, 2001; Nuangchalerm, 2009a; Ferriera & Gendron, 2011; Yang & Chen, 2013).

The science teaching is growing with the terms of inquiry-based learning, the constructivist view is recognized. Inquiry-based learning is should not be limited in only school science by content emphasized, but also the process of science should be conducted by means of engaging students to understand nature of science (Abd-El-Khalick *et al*., 1998; Aikenhead, 2001; Bell & Lederman, 2003; Nuangchalerm, 2010; Lederman *et al*., 2012; Tytler, 2012). Science teaching should be allowed the ways that modern science operates, use the laboratory to assist students learn science concepts in terms of inquiry format (Schwab, 1966). Students will be developed concepts, thinking abilities, science process skills, argumentation, habit of mind, and understandings in nature of science. That is, the goal of science education and characters of learning person in the 21st century. Teachers should bring beliefs that teaching is process to stimulate learning behaviors; it is not just the process of knowledge transmitter. The changing world is more complex, more situations in which no solution to solve it (Vieira *et al*., 2011). We have to integrate scientific knowledge and science process skills that inquiry-based learning is the answer for science school practices as well.

This instructional approach can be considered teachers as a key person to engage students meet scientific knowledge and understanding about nature of science through inquiry-based instruction. The starting point cannot be denied the process of teacher preparation program because if pre-service teachers did not understand or imply it to classroom, the effective instruction will be failed (Lederman, 1992; Lederman, 1996; Southerland *et al*., 2006; Nuangchalerm, 2009b; Opara & Oguzor, 2011). Teachers anchor their understanding in science

classroom and more than theories and propositional knowledge (Krajcik *et al*., 1994; Anderson, 2002). They should have only more than scientific knowledge and science process skills, but also beliefs, values, and understandings in and about inquiry-based learning are of critical importance to teach science (Demir & Abell, 2010; Minner *et al*., 2010; Opara & Oguzor, 2011).

Students should have experience with "real world" classroom by attending to theoretical and practical activities (Bybee, 2000). Science teaching will be effective in which teacher preparation embedded scientific inquiry and teaching inquiry for preservice science teacher programs both science and methods courses (Sato *et al*., 2008). The program should incorporate inquiring mind and conduct classroom has true course goals of content and inquiry (McIntosh, 2001; Barman, 2002). It will help us to make teacher as scientist, and then it can influence to do inquiry science classroom. This study occurs during of valuable time to visit Guangxi Normal University. The purpose of study is aims to explore inquiry-based learning in teacher preparation program. The findings will help us to understanding what inquiry-based classroom is and how inquiry-based learning are. Not only understand by empirical study, but also pedagogical strategies are useful for science teaching implication.

2. Methodology

2.1 Context of Study

The study is appeared during my visit the Research Institute of Science Education (RISE), Guangxi Normal University. The classroom is very friendly to me for duration time of gathering data. The author let the classroom know the purpose of study and method of collecting data. Videotape recording, photography, and attend classroom were told teachers and students during time of study.

This study selected only two courses that related to inquiry-based learning and time allowed for participating of inquiry-based classroom. Two courses were studied; (i) Research on difficulties in physics experiments for middle school textbook, this course was elective course for bachelor and master degree students. Students attend class on every Wednesday during 08.00 am. and 10.00 am. Students were divided into group of work for studying the difficulties in physics experiments, and then they have to give clearly explanation with demonstration that relevant to theoretical given for 90 minutes. The method of presentation included powerpoint presentation, questioning, discussing, and demonstration experiments in which introduced by textbooks. Thirty minutes left, teachers will discuss with students about and in demonstration, followed by what others teacher should know. Students can feel free to discuss with teachers and peers, (ii) Inquiry science, this course was elective course for bachelor and master degree students. Students attend class on every Friday during 02.30 pm and 04.30 am. Students were divided into six groups for designing some experiments, each group have to design some experiments and they have to instruct other groups to conduct an experiment under determined materials. Ten minutes for giving directions and defined rule of creative experiment. One hour for each group works freely based creative problem-solving. Fifteen minutes for group presentation and discussion, and last fifteen minutes will be summarized by teacher.

2.2 Procedural Study

The study employed qualitative method to gather data; classroom observation, videotape recording, and interviewing were necessary tools to study what inquiry-based classroom is and how inquiry-based learning are. The study was observed and explained through the empirical data by making observation 2 course in preservice teacher preparation program. The author attend science classroom as one student, during the observation I make a recording some activities in which students did, and how they behaved. The science courses consisted of both passive and active learning. , but this first is less, students conducted their science experiments and did reflective practices. The experiments were prepared and practiced by themselves. Some interesting phenomena, interview method employed as it possible. All of data were collected and analyzed by descriptive explanation. The synthesized data were useful for guiding school science practice; especially the role of teachers and students in inquiry-based science classroom should be appeared as well as the 21st century skills and science education reform.

3. Results

3.1 Prior Knowledge and Questioning Engage Students into Science

The inquiry-based classroom is emerged from teacher's beliefs and values about education development. Teachers recognize to "student-centered education", how to manipulate classroom serving this approach. Teacher is a key person to facilitate their students meet requirement of student-centered education as I observed in China. Teacher, who had too much theory and skills in scientific inquiry employ a little bit of passive learning. They just elicit prior knowledge to the new learning situation by using questioning strategies. They open space

of answering by keeping a waiting time 15-20 seconds for all students to share concepts. When some students raise their ideas or concepts, other students can discuss still problem is clearly explained. Questioning strategies are employed during the time of course, students can open book if they cannot find some answer and questions are continuously released by teachers as much as time allowed.

Some contents are not clear or it is difficult to understand, teacher let students bring materials to set simply experiment for testing scientific concepts. The experiment engages students to have much more observation, sensory perception, and critical thinking. They raise suddenly question from directly observation. Then, students' response appears to distinguished answer based on theoretical background and experimental study. Teacher just acts his role as facilitator by giving explanation and engages students to science with questioning. Students have to think and share their experiences between teacher and peers. These phenomena seem to scientists do after found knowledge, share their ideas through public understanding, and reinforce social awareness in science.

Questioning is important thing that teachers should do in science classroom. It can make connection between prior knowledge to accommodate with new knowledge. Teacher is facilitator, who can lead their students to create question, engage students in science lesson, and stimulate higher-ordered thinking skills for all students. If some contents are abstract, experiment can help students to have observation, let them to develop question of what they observe. The process of developing questioning skills can be made by both individual and group of peers as well as them eager to learn science. These are important skills for students in terms of engaging to process of science as well as they should know nature of science.

3.2 Observation as Key Component of Science Learning

Every time of classroom observation, I found that teacher allow students to develop observation skill in which relevant to demonstration and experiments. As observation is the heart of science, basic science process skills, it is explain phenomenon through empirical study, and explain through directly individual perception. Output of observation can be communicated to public as it happens. Some physics contents are difficult to learn and make it be concrete. The demonstration and experiment can help students to participate by whole class observation and argue or dispute by sensory perception, but based on the differences or limitation of sensory perception maybe make some students develop question to ask peers.

Students designed experiment and made observation by themselves. They were participated in all instructional activities, so they can learn science and observe science through way of science or nature of science was incorporated by the process of teaching and learning. Observation is the heart of science and also important skills for science; it leads them to meet real science, not science in the paper or in the blackboard. Students express their behavior eager to learn and also learn by naturally participated activities. They smile, laugh, fun, discuss, and communicate seems as scientist. It can be said that all students had to use sensory organ to perceive materials and use scientific skills for solving the problem. They have to observe, discuss, and evaluate through process of science.

3.3 Transmitting Knowledge through Design Technology

All of course that I studied employed design technology into science or let say teacher design course for leading science and technology into classroom, embedding into students' mind. Teacher acts as facilitator by directing what science hour should be and then mostly of class activities will be conducted by students. Teachers have just make orientation for course, student design of what they should learn through design technology based on scientific concepts. The classroom activities allowed good learning atmosphere, students talk and share their ideas with peers during design technology, prior scientific knowledge will be used, creative problem solving will be employed, and communicate with others will be done. The solution of result will be argued and considered by group process.

The materials for inquiry-based classroom can be found in general i.e. paper glass, candle, sticky paper, pen, plastic bottle, and scissor. It is easy to find and prepare, but good start for creating big ideas. Students can accommodate cognition structures by adapting prior knowledge or experiences based on designed-based classroom. It means that students have to understand scientific concept and also construct new knowledge through creative problem-solving. It should be worked and understandable with clearly explanation. Students learn science with friendly environments, free of thinking but understandable for others. They learn how others think and do base on cooperative learning.

3.4 Nature of Science Incorporated

It is very surprise that students have learned nature of science in every minutes of designed classroom. The classroom activities engage students to meet the philosophy and nature of science in terms of scientific

worldview-students learn to think and do about science through designed-based learning, scientific inquiry-students have to employ science process skills in that process of science included, and scientific enterprise-students have learned science through cooperative learning and they make a judgment by means of argumentation between public awareness, leading them to scientific literacy as well.

As inquiry-based learning considered, designed-based learning integrated into sciences classroom. It develops students to understand about natural world as it should be by prediction, exploration, and communication. Students learn real science, it is not virtual science in which learn through paper or imagination. They use hands-on and mind-on experiences because it is science in which scientific knowledge should be reliable, evidences-based study, and empirical study. Also, they perceive that science tends to be change if it has more explanation with empirical evidences. Classroom atmosphere allowed them to discuss what they think and what they should do, and the how to solve this problem based on theoretical explainable.

The classroom in which I observed emphasized on students think and does by them. Teacher never abandoned valuable students' question or answer. He will express their interesting behavior to all students. It is important thing that make science classroom free for thinking and sharing of what students know. Students also are engaged to familiar with science process skills every hour that school science practice should incorporated into classroom. The process of science is emerged when they use hands-on and mind-on activities within group. It practices them to have analytical and critical thinking.

Additionally, students have habit of mind in science due to classroom atmosphere. They feel safe with all questions and answers because everyone will learn from one to the next one. These developed them to have scientist attributes that help them to reach the goals of science education. Students can think individually, but work with others that help them to verify answer about natural world. Chinese science classroom didn't miss this attributes because the nature of science and role of science affected by social requirement. In sum, what they think and what they do should be accepted by possibility of social direction. Science, society, and technology cannot be separated because among it can push to move forward together. That is, students should be implemented attitude towards science, and embedded positive thinking in science and society practices.

3.5 Learning as a Cycle

During time of gathering data, I can summarize the inquiry-based learning as a cycle. The process of teaching and learning employ, *teach less learn more*, teacher spent time for giving direction of day-course and summarize in what students have learned. Mostly, students act a classroom moderator and actor as well as time allows. Two hours-classroom activity will be started by teacher giving some directions of teaching and learning process. No more than 10 minutes will be determined and then group of assigned students will lead other students to do activities and conducting discussion within committed 90 minutes. Finally, teacher will summarize classroom activities and also scientific concepts in which students have learned no more than 15 minutes. The teaching and learning process can be explained in Figure 1.

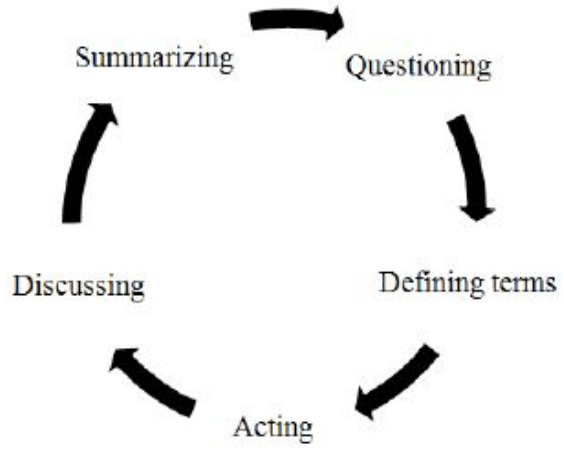

Figure 1. Summarizing inquiry-based learning cycle

- *Questioning*: The first teaching and learning process will lead by the questioning. The question will be raised by teacher in terms of students' assigned work. Question will be solved and represented by classroom engagement. Group of assigned students will raise question or problem in which related to difficult theory or abstract or difficult to understand. They started to discuss and make connection between prior knowledge and problem-solving in which creative thinking is employed. The answer will be found and judged through cooperative learning.
- *Defining terms*: The classroom activities were set by commitment between teacher and students. The second stage of teaching and learning can be described in terms of defining terms or rules, which is meet the terms or rules requirement. Answer must solve the problem that relevant to defined rule. If it is not, the result of innovate or solve the problem will be rejected. It seems to them that learning science should work as scientists, if it works, the result will be accepted by the rules and a group of scholars.
- *Acting*: The process of this stage allow student to do freely with their ideas and that is, make them to do with others same as in the real life situation, no one can work alone or can solve the problem alone. Students have a chance to perceive materials and assimilate learning environment through sensory organs. It helps them to familiar with process of science and nature of science. Students participate experiment, share ideas, discuss with possibly works, and communicate science as much as they can. It can be concluded that this stage make students understanding about nature of science, let them to access real science, and science process skills employed in every classroom movement. Then, it leads them to have positive attitude towards science, they also will behave learning same as scientist to inquire knowledge.
- *Discussing*: This teaching and learning process engaged students to recognized theory in which support the result of the experiment, students learn how scientist works and share their knowledge or exploration with public by effective communication. Teacher acts his role to stimulate students make discussion, engages students with other ideas and answers, helps to generate question, and leads them to discuss with a group of friends. It seems to me observed classroom is naturally questioning and discussing classroom. Teacher is no need to pay attention about students because they are familiar with roles of scientific discussion and argumentation.
- *Summarizing*: The final stage of teaching and learning process, teachers will take his action for summarizing of what student learned and what students should be known. Last fifteen minutes, teacher was key person for leading students to conclude their knowledge and learn how accept others ideas and social rules. He smiles and talks by friendly learning atmosphere. Students pay their attention in what teacher say because it will accommodate their concept understandings and also character in teacher profession.

3.6 Videotape and Classroom Research

Every classroom that I observed and participated instructional activity, I was found that ICT and multimedia were integrated to classroom. They employed these materials as a tool for collecting data about pedagogical strategies. Graduate students will make recording during classroom activities by videotape recording, photography, and live video. After that they will restore these file into electronics version and return to see and giving feedback about the classroom activities. That means, they are conduct classroom research and develop teaching and learning activities through lesson study and engage them to ICT practices.

Students had learned how to make multimedia and also participate in classroom activity that teacher give them by hidden activity. They have to learn how to record and use tools for multimedia. They learn to cut and manipulate video or picture for making professional presentation. Not only pedagogical practice and content knowledge, but also ICT which is necessary for teacher profession are included to teacher preparation program. These processes can be concluded that students had learned a lot about scientific inquiry, science process skills, nature of science, and also professional teachers.

4. Conclusion

The study employed observation, videotape recording, photography, and interview that are empirical study. Data are explained through classroom phenomena in which best practice about inquiry-based learning occurred. As it is concluded, the inquiry-based learning at RISE, Guangxi Normal University will be summarized that *R*: research in inquiry-based classroom, *I*: ICT integrated through classroom activities, *S*: scientific inquiry embedded and nature of science implemented, and *E*: education for developing professional teachers. These are engaged students to character as science educators, they will assimilate scientific inquiry, and scientific literacy as well (Holbrook & Rannikmäe, 2009; Foster, 2011; Soobard & Rannikmäe, 2011).

The learning atmosphere and teaching strategies in RISE, Guangxi Normal University develop their students to engage science. Designed-based technology, cooperative learning, questioning method, authentic learning, and nature of science are the key elements that help students to success scientific inquiry. Roles in inquiry-based

classroom are importance; teacher should teach less, learn more by facilitating students to meet science by themselves. Teacher raises a question or problem into classroom, engage students to think and generate question about natural world, and reinforce students' learning in science classroom. Students have naturally curiosity, eager to learn, and need some inspiration from teacher to thinking about of what and how they learn (Vieira *et.al*, 2011). The pedagogical strategies should response to how question works and engages students to find out answer about science. Teacher can stimulate students' learning based on understanding about nature of science and practical science. Students have space learn science as social and cultural involvements (Aikenhead, 2001; Ferriera & Gendron, 2011; Yang & Chen, 2013).

The inquiry-based learning from China can be implied to school science. The empirical study showed that inquiry-based classroom can help students to meet the goal of science education. It can understandable for science teachers to engage their students to scientific inquiry, nature of science, and scientific literacy (Nuangchalerm, 2009c; Nuangchalerm, 2013). Finally, we will prepare not only preservice teacher, but also students who can solve the problem and faced with the future society in happily. Inquiry-based learning should not be found only in the school science, but it can be embedded for all. That is, develop our society members into scientific literacy, and knowledge-based society.

Acknowledgements

This study has been supported by Faculty of Education, Mahasarakham University, Thailand. The author indebted thanks to Professor Dr.Xingkai LUO, Research Institute for Science Education, Guangxi Normal University, China for classroom study permission. I also thank to Wang Peng for his assistance during time in China.

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