THE INFLUENCE OF SCIENCE TEACHERS´ KNOWLEDGE, BELIEF, AND ATTITUDE IN IMPLEMENTING INQUIRY-BASED LEARNING

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ABSTRACT

This study aimed to investigate (i) the level of teachers´ knowledge about the nature of science (NOS), teachers´ belief and teachers' attitude on inquiry science, and the implementation of inquiry-based learning (IBL), (ii) the difference in the implementation of IBL based on the years of teaching science experience, (iii) the relationship between teachers´ knowledge about NOS, teachers´ belief and teachers' attitude on inquiry science with the implementation of IBL, (iv) the influence of teachers' knowledge about NOS, teachers' belief and teachers' attitude on inquiry science on the implementation of IBL, and (v) the most significant predictor influencing the implementation of IBL. The respondents of this study were the science teachers for primary schools. The quantitative research design was used, therefore, the data had been collected using questionnaires. A total of 728 valid questionnaires were collected and the data were analyzed using SPSS version 17. The results of this study showed the level of teachers´ knowledge about NOS, teachers' belief and teachers' attitude on inquiry science and the implementation of IBL was at the medium level, and there was no significant difference in the implementation of IBL based on the years of teaching science experience. However, this study showed that there was a significant relationship between teachers´ knowledge about NOS, teachers´ belief and teachers' attitude on inquiry science with the implementation of IBL, and there was a significant influence of teachers´ knowledge about NOS, teachers´ belief and attitude on inquiry science on the implementation of IBL. These findings showed that teachers' knowledge about NOS, teachers' belief and teachers' attitude were the predictors of the implementation of IBL. Among the three predictors, teachers´ attitude on inquiry science had the strongest influence on the implementation of IBL. This research found that there is room of improvement in the implementation of IBL and science teachers should improve their knowledge about NOS, belief and attitude on inquiry science.

ABSTRAK

Pengaruh pengetahuan, kepercayaan dan sikap guru-guru sains dalam pelaksanaan pembelajaran berasaskan inkuiri

Kajian ini bertujuan untuk mengkaji (i) tahap pengetahuan guru tentang tabii sains, kepercayaan guru dan sikap guru terhadap inkuiri sains dan pelaksanaan pembelajaran berasaskan inkuiri, (ii) perbezaan pelaksanaan pembelajaran berasaskan inkuiri berdasarkan pengalaman guru mengajar sains, (iii) hubungan antara pengetahuan guru tentang tabii sains, kepercayaan guru dan sikap guru terhadap inkuiri sains dan pelaksanaan pembelajaran berasaskan inkuiri, (iv) pengaruh antara pengetahuan guru tentang tabii sains, kepercayaan guru dan sikap guru terhadap inkuiri sains dan pelaksanaan pembelajaran berasaskan inkuiri, dan (v) peramal yang mempunyai pengaruh yang paling kuat terhadap pelaksanaan pembelajaran berasaskan inkuiri. Responden kajian ini terdiri daripada guru-guru sains yang mengajar di sekolah rendah. Rekabentuk kajian yang digunakan ialah kuantitiatif. Ini bermaksud data kajian dikutip menggunakan soal selidik. Sejumlah 728 soalselidik yang lengkap telah dikutip semula dan data kajian ini dianalisis menggunakan SPSS versi 17. Dapatan kajian ini menunjukkan tahap pengetahuan guru tentang tabii sains, kepercayaan guru dan sikap guru terhadap inkuiri sains dan pelaksanaan pembelajaran berasaskan inkuiri adalah sederhana, dan tidak ada perbezaan yang signifikan dalam pelaksanaan pembelajaran berasaskan inkuiri berdasarkan jumlah pengalaman guru mengajar sains. Walau bagaimanapun, kajian ini menunjukkan terdapat hubungan dan pengaruh yang signifikan antara pengetahuan guru tentang tabii sains, kepercayaan guru dan sikap guru terhadap inkuiri sains dengan pelaksanaan pembelajaran berasaskan inkuiri. Dapatan ini menunjukkan bahawa pengetahuan guru tentang tabii sains, kepercayaan guru dan sikap guru terhadap inkuiri sains adalah peramal pada pelaksanaan pembelajaran berasaskan inkuiri. Antara ketiga-tiga peramal ini, sikap guru terhadap inkuiri sains didapati mempunyai pengaruh yang paling kuat terhadap pelaksanaan pembelajaran berasaskan inkuiri. Kajian ini memberi implikasi bahawa terdapat ruang untuk meningkatkan pelaksanaan pembelajaran berasaskan inkuiri dan guru sains perlu meningkatkan pengetahuan mereka tentang tabii sains, kepercayaan dan sikap mereka terhadap inkuiri sains.

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ABBREVIATIONS

NOS	=	nature of science
IBL	=	Inquiry-based learning
NSTA	=	National Science Teachers Association
NRC	=	National Research Council

CHAPTER 1

INTRODUCTION

1.1 Introduction

In October 1, 1949, the People´s Republic of China (PRC) was formed. At that time, 80% of Chinese people were either illiterate or semi-literate. In 1981, the academic degree system was established. Since 1986, China had implemented the nine-year compulsory education (WORKERCN.CN, 2012). Since China had the reform and opening up policy in 1978, the education development had been recovered and quality-oriented education had been emphasized (Shi & Zhang, 2008). At the end of the 20th century, the Chinese government realized that science and technology had developed speedily and knowledge about economy had become more important in the world, thus, the Chinese government had increased the education development to exploit the advantage of the huge human resources (Hu, 2010). By developing its education system China could be able to meet the challenges of the future.

Although China has had some reforms and effort, China is still a developing country. The Chinese education still has a big development gap with the more developed countries. Hence, China still needs to improve its state of education and keep the pace with the international level.

Throughout the years, the Chinese education system has undergone many changes. In the schools' education level, an academic year is inclusive of two semesters with the first semester starts from September to January and the second one from February to June. There are specific requirements in regards to the admission time. The age for nursery or kindergarten is from 0 to 6 years old. From

the age of 6 to 7, the children move to preschool education whereby it is a transition from kindergarten to primary school. Then, the children go to primary school which include grade 1 to grade 6. In primary school, the age is not limited. Students can choose to stay longer at school than normal years based on their ability. After primary school, the students can go to junior high school that includes grades 7 to 9 if they pass a standardized and centralized exam from the local bureau of education. After completing junior high school, students can proceed to senior high school which consists of grades 10 to 12 if they pass the High School Entrance Exam from the local bureau of education. With an eligible score, students are qualified to enroll to different senior high schools with the enrollment notification under the permission of the local bureau of education. After graduating from senior high school, students can enter colleges (usually 3 years) or universities (usually 4 years) provided that they pass the most stressful centralized exam, known as the National Matriculation Test, which is organized by the Chinese Ministry of Education. Postgraduate education is the final stage in the education system; in which it includes masters (usually 2-3 years) and doctoral studies (usually 3 years).

The subjects taught in primary school in China are Chinese, Mathematics, English, music, sports, art, morality and life, morality and society, science, comprehensive practical activity, and local courses. The subjects taught in junior high school are Chinese, Mathematics, English, History, Politics, Geography, Biology, Physics, Chemistry, Music, Sports, Art, and local courses. In senior high school, except for Information and Application Technology subject, other subjects are the same to the one in junior high school, but the content of all these subjects are more difficult compared to the subjects in junior high school. From these subjects, we can see that junior high school and senior high school are learning science course such as Physics, Chemistry, and Biology separately.

Primary science curriculum has been implemented more than 100 years since China began to carry out primary science curriculum in 1904 (Xie, 2008). Deng (2011) analyzed the situation of science curriculum in secondary school and universities. Since 1949, the science curriculum of the secondary school had included physics, chemistry and biology courses which had been taught separately. In 1980s, the integrated science curriculum was put forward, but the time of the implementation of the integrated science was very short. The main reason was the lack of integrated science teachers. To meet the needs, with the approval of the Ministry of Education, Chong Qing Normal University established the first "science education" undergraduate programs in China, and since then, more than 60 universities set up science education program at undergraduate level.

Before 2001, the original name of science subject was 'nature subject' in primary school in China, in which the main focus was on the knowledge related to the nature and daily life. However, in the new national curriculum standard, the subject was changed to "science" (Jiao, 2012). The contents of the science curriculum are often things and phenomena which students can experience by themselves; hence it is easier to stimulate students' motivation and emotion (Yang, 2012). In 2011, the Chinese Ministry of Education stated that the local bureau of education could make full use of the local curriculum resources with local advantages based on national curriculum management policies, plans and standards (Wu & Meng, 2010). Currently, the science course from 3-6 grades in primary school is an integrated course which includes chemistry, physics, geography and biology. Primary science curriculum had played an important role in cultivating the scientific literacy of the future citizens (Wang & Cheng, 2006).

1.2 Background of the Study

The new curriculum standard in 2001 emphasizes that the fundamental in primary

science reform is teaching using the inquiry-based learning (IBL). It means students are not only required to know the content of the knowledge, but they also need to know the formation process of the knowledge (Pang, 2006). IBL is important as it cultivates students' innovative spirit and improve students` ability in practice and students` scientific literacy. There is internal consistency between IBL and scientific literacy of students in primary school (Zhang, 2005). Therefore, IBL should be implemented through the setting up of different process of teaching in primary school (Xia, 2007).

Some related reports also showed that IBL is necessary and important in science teaching. He (2011) reported that IBL was taken as the main way to cultivate innovative talents in a nationwide seminar "the researches about IBL and innovative talents in elementary and secondary school" which was held in Hangzhou in 2011. Meanwhile, Zhang (2012) reported that the main aim of primary science curriculum was to cultivate students´ scientific literacy. Scientific literacy includes scientific knowledge, scientific methods, scientific attitude and scientific spirit. Obviously, IBL is a way to encourage scientific literacy.

Ding Bang Ping, the director of the research center of science education in Beijing normal university, pointed out that the emphasis of new curriculum reform was to cultivate students´ scientific literacy (Hua, 2012). According to Zhang (2013), learning science should take IBL as a learning method. Under the requirements of the new curriculum standard of science teaching in grade 3 to 6, the IBL is a necessary approach in the teaching of primary science.

From these reports and studies, we can see that IBL is significant and important in primary science ever since the Chinese new curriculum reform was implemented in 2001.

1.3 Statement of Problems

The Ministry of Education of the People´s Republic of China (MEPRC, 2001) published a document called `义务教育课程设置实验方案´(Compulsory education curriculum experiment scheme). The document had specified six objectives and one of the objectives was the implementation of IBL which could help students to develop their information searching skills, critical thinking skills, cooperation skills, communication skills, and creative problem solving skills.

Dai *et al.* (2011) investigated the implementation of the IBL among teachers in the middle and high school in China. These findings from their study showed that the Chinese teachers approved the progressive education agenda and accepted the inquiry pedagogy, though they had some constraints in its implementation. From this research, it can be said that the middle and high school teachers have implemented IBL, but the implementation is not good enough.

Another researcher, Xu (2011), investigated IBL in primary school and found out that primary science teachers had also implemented IBL. However, some teachers did not know how to use the inquiry method flexibly in the practice. Therefore, students did not get the most effective achievement from inquiry-based teaching and learning. In Liu´s (2011) investigation on the current situation of primary science teaching, he also found out that teachers did use inquiry method in the classroom, but in more traditional teaching technique. According to Hu (2013), these teachers preferred the traditional way to get 'the maximal efficiency of teaching'.

The document from the Ministry of Education of the People´s Republic of China (2001) stated that IBL must be done in primary, middle and high school, but it had not been implemented very well. The situation was due to the lack of teachers'

years of teaching experience, knowledge, belief, and attitude. In China, some teachers have less years of teaching experience (Song, 2010; Li, 2013), therefore they could not perform well in teaching (Yang, 2013). Some science teachers did not have a strong basic knowledge and academic skills in primary science teaching (Wang, 2014). As a result, they could not learn, as well as embarking research and exchange information among themselves like the Mathematics and Chinese teachers do (Li & Li, 2011), could not understand the content of the textbooks clearly, and did not know how to organize students to collaborate in group learning (Liu, 2007). Some science teachers did not have strong belief and positive attitude on inquiry science teaching, which make them feel the subject is difficult to teach and do not have the confidence to teach science (Wang, 2011).

Based on the issues mentioned above, teachers' years of teaching experience, knowledge, belief, and attitude may be related to the implementation of IBL in the teaching of primary science. Hence, this study will identify whether these predictors would influence the implementation of IBL.

1.4 Aim of the Study

The aim of this study is to investigate the level of science teachers' knowledge about NOS, teachers' belief and teachers' attitude on inquiry science, and the implementation of inquiry-based learning, whether there is a difference in the implementation of IBL based on the years of teaching experience, and whether science teachers´ knowledge, belief and attitude are contributing to the implementation of IBL in the teaching of primary science.

1.5 Objectives of the Study

The objectives of the study are as follows:

i. To determine the level of teachers´ knowledge about NOS, teachers´ belief and

teachers' attitude on inquiry science, and the implementation of IBL in the teaching of primary science.

ii. To determine the difference in the implementation of IBL based on the years of teaching experience in teaching of primary science.

iii. To determine the relationships between teachers´ knowledge about NOS, teachers´belief, and teachers' attitude on inquiry science with the implementation of IBL in the teaching of primary science.

iv. To determine the influence of teachers´ knowledge about NOS, teachers´ belief, and teachers' attitude on inquiry science on the implementation of IBL in the teaching of primary science.

v. To determine which of the predictors has the most significant influence on the implementation of IBL in the teaching of primary science.

1.6 Research Questions

There are five research questions in this study.

i. What is the level of teachers´ knowledge about NOS, teachers´ belief and teachers' attitude on inquiry science, and the implementation of IBL in the teaching of primary science?

ii. Is there a significant difference in the implementation of IBL based on the years of teaching experience in the teaching of primary science?

iii. Are there significant relationships between teachers´knowledge about NOS, teachers´ belief, and teachers' attitude on inquiry science with the implementation of IBL in the teaching of primary science?

iv. Is there a significant influence of teachers´ knowledge about NOS, teachers' belief, and teachers' attitude on inquiry science on the implementation of IBL in the teaching of primary science?

v. Which of the predictor has the most significant influence on the implementation of IBL in the teaching of primary science?

1.7 Research Hypotheses

Based on the objectives above, this research will test on eight null hypotheses:

Ho1: There is no significant difference in the implementation of IBL based on the years of teaching experience in the teaching of primary science.

Ho2: There is no significant relationship between teachers´ knowledge about NOS with the implementation of IBL in the teaching of primary science.

Ho3: There is no significant relationship between teachers´ belief on inquiry science with the implementation of IBL in the teaching of primary science.

Ho4: There is no significant relationship between teachers´ attitude on inquiry science with the implementation of IBL in the teaching of primary science.

Ho5: There is no significant influence of teachers´ knowledge about NOS on the implementation of IBL in the teaching of primary science.

Ho6: There is no significant influence of teachers´ belief on inquiry science on the implementation of IBL in the teaching of primary science.

Ho7: There is no significant influence of teachers´ attitude on inquiry science on the implementation of IBL in the teaching of primary science.

Ho8: There is no significant predictor that influence the implementation of IBL in the teaching of primary science.

1.8 Significance of the Study

The aim of this study is to investigate the level of science teachers' knowledge about NOS, teachers' belief and teachers' attitude on inquiry science, and the implementation of inquiry-based learning, whether there is a difference in the implementation of IBL based on the years of teaching experience, and whether teachers´ knowledge, belief and attitude are contributing to the implementation of IBL in primary science. This research hopes that from the results and information of this study, teachers will be able to realize the importance of years of teaching experience, knowledge, belief and attitude in implementing IBL in the teaching of

primary science, and try to improve their understanding of NOS, enhance their belief, and have more positive attitude, thus, students can be helped to study effectively by using inquiry instruction.

With the development and progress in the society, comprehensive and innovative people are required. At present, IBL has been emphasized as a way of cultivating comprehensive, innovative and skilled people. As the basic subject in the education, primary science is very important in cultivating comprehensive, innovative and skilled people (Tang, 2012).

In this study, the researcher hopes that from the results and information, the schools can see the situation of IBL in the teaching of primary science. On the school management side, they can send science teachers to attend science courses on how to practice inquiry instruction in classroom so that teachers can improve themselves and help students to learn science by implementing IBL. The education department should also pay more attention on primary science teachers and provide them with more training opportunities to improve their knowledge, belief and attitude to support these teachers' growths. The education department can also see that whether teachers' teaching experience is enough in implementing IBL and whether teachers' knowledge about NOS, belief and attitude on inquiry science have a room of improvement with higher level. In other words, the findings from this study can be used as a guide to improve the implementation of IBL in the teaching of primary science.

1.9 Operational Definitions

The following definitions will be used throughout the study.

i. **Teachers' knowledge about Nature of Science** (NOS): According to Grossman (1990), teachers' knowledge has four components: subject matter

Knowledge (SMK), knowledge of context, general pedagogical knowledge and pedagogical content knowledge (PCK). Teachers' knowledge of NOS is related with their SMK when refers to teachers' comments on NOS and is also related to their PCK when refers to the content that teachers taught (Hanuscin *et al.,* 2010). In this study, Fazio' s (2005) definition of teachers' knowledge about NOS is applicable. According to Fazio, teachers' knowledge about NOS refers to the understanding about what is science, science facts, science objects, scientific theories, scientific method and scientific knowledge. Thus, to measure the teachers' knowledge about NOS in this study, the "Nature of Science Profile Questionnaire" taken from Fazio' s research is used.

ii. **Teachers' Belief** : Pajaras (1992) defines belief as existential presumptions that can be seen from what people say and do. In this study, teachers' belief is referring to the extent of teachers' confidence they can become facilitators of students, focus on students ´ interest, encourage students to construct their own research questions, hypothesis and experiments, seek their own answer, interpret their data, and communicate with other students (Sumrall, 2008). To measure teachers' belief, Sumrall's questionnaire on inquiry belief and practice is used.

iii. **Teachers' Attitude** : Attitudes are defined as a mental state in which a person want or reject a certain object (Zimbardo & Leippe, 1991) or the tendency to react favorably or unfavorably to persons, situations, or events (Munck, 2007). In this study, teachers ´ attitude is referring to the extent of their feeling for inquiry approach whether science teachers feel comfortable, enjoyable, interesting or afraid, whether science teachers feel inquiry science is important, and whether inquiry science takes too much time and effort (Sumrall, 2008).

To measure teachers' attitude, Sumrall's questionnaire on the revised science attitude scale is used.

iv. **Inquiry Science:** inquiry science refers to an instructional approach in the teaching of science. This instructional approach emphasizes student-centered approach and helps students to discuss and discover the nature of science through laboratory activities (NRC, 1996).

v. **Inquiry-based learning (IBL):** IBL is defined as "learners´ minds in puzzling out things, examining assumptions, carrying out mental experiments or real ones, developing well-reasoned arguments by gathering and evaluating evidence, fashioning solutions to problems meaningful to the learners, and envisioning alternative possibilities" (Dai *et al.,* 2011). IBL in this study is defined as a method of teaching, which referred whether students should be dominant in the process of teaching, and whether teachers should allow students to share, discuss and explain ideas, issues and concepts in their word, offer opportunities for students to achieve learning goals, purse topic of their interest, apply the knowledge and solve problems. To measure the implementation of IBL, Practicing Inquiry Pedagogy Questionnaire from Dai *et al.* (2011) is used.

1.10 Limitation of the Study

This research is done in Zhengzhou city where it involves 728 science teachers from 286 primary schools.

The scopes of the study are teachers´ knowledge about NOS, belief and attitude on inquiry science and the implementation of IBL. The variables used in this study may be limited. It is quite possible that there are other variables that are not