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The Relationship between Teachers' Knowledge, Attitude and Belief with the Implementation of Inquiry-Based Learning in Zhengzhou, China

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Abstract. This study investigates the level of teachers' knowledge towards the nature of science (NOS), attitude and belief towards inquiry teaching, and the implementation of inquiry-based learning (IBL); the difference of the implementation of IBL based on teachers' years of experience; and the relationship between teachers' knowledge on NOS, attitude and belief towards inquiry teaching with the implementation of IBL. The quantitative research methodology has been used to complete this study. The sample involved is 728 in-service primary science teachers in China. They are asked to answer a questionnaire which consists of four sections. The items measuring teachers' knowledge on NOS, teachers' attitude towards inquiry teaching and the implementation of IBL are adopted from previous studies with the permission of the respective author; whereas, the items measuring teachers' belief towards inquiry teaching has been adapted from another study to meet with the research objectives. The descriptive and inferential statistics have been used to analyses the data. The findings show that the level of teachers' knowledge on NOS, teachers´ attitude and belief towards inquiry teaching, and the implementation of IBL are at the medium level; there is no significant difference in the implementation of IBL according to the teachers' years of experience; and, there are significant relationship between teachers' knowledge on NOS, attitude and belief towards inquiry teaching with the implementation of IBL. These findings implicate that teachers' knowledge, attitude and belief are the three main predictors for the implementation of IBL in the teaching of science in primary schools in China.

Keywords: Teachers Knowledge; Teachers Attitude; Teachers Belief; Inquiry-Based Learning

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Introduction

Since 1978, China has emphasized on quality-oriented education (Shi & Zhang, 2008). However, only in 2001, the Chinese government has initiated an education reform. This reform has brought to the change of the Nature subject which is taught in primary school to a new subject calls Science. This new Science subject is an integrated course which combined the knowledge from chemistry, physics, geography and biology. It is taught to students in grade 3 up to grade 6. The change is due to the development of science and technology which has influenced the Chinese education authorities to realize the importance of science education (Hu, 2010, Jiao, 2012).

In the same year, the Ministry of Education of the People´s Republic of China (MEPRC) (2001) releases a document called 义务教育课程设置实验方案 (A Compulsory Education Curriculum Experimental Scheme). The document has specified six objectives for the Chinese education reforms. One of the objectives is the implementation of inquiry and problem-based learning in science teaching. Such implementation is required to develop students' information searching and processing skills, communication and cooperation skills, as well as critical thinking and creative problem solving skills.

The main problem occurs as a result of the introduction of the new Science subject is the human resource. To solve the problem any teachers can teach the subject. Therefore, according to Li and Li (2011) there are teachers who are teaching science but their training background is not in teaching science. These teachers do not have the professional knowledge about science and the teaching of science, thus, they could not comprehend the content of science in the textbook, have lacked of imagination on how to organize students to collaborate in group learning, and unable to use proper science investigation as required in the inquiry teaching(Liu, 2007). With this problem, the activities for the content delivery, therefore, are dry.

Since the introduction of the new Science, most teachers are haunted to teach science because it is difficult to teach the subject without proper training in science content and pedagogy (Wang, 2011). The teachers have no choice but to teach because the subject is already in the education system. Based on this situation, many teachers refuse to do inquiry teaching. They prefer the traditional way of teaching to achieve 'the maximal efficiency of teaching' (Hu, 2013). But then it is against the requirement stated in the document mentioned earlier. So this study is carried out to identify the predictors that might have related to the implementation of IBL in the teaching of science in primary schools.

There are three main questions to be addressed in this study (a) what is the level of teachers´ knowledge on nature of science (NOS), attitude and belief towards inquiry teaching, and the implementation of inquiry-based learning (IBL) in teaching primary science. (b) Is there a significant difference in the implementation of IBL according to teachers' years of experience in teaching primary science? (c) Is there a significant relationship between teachers´

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knowledge on NOS, attitude and belief towards inquiry science with the implementation of IBL in teaching primary science?. The last question is divided to three small questions to manage the data later on (i) Is there a significant relationship between teachers´ knowledge on NOS and the implementation of IBL in teaching primary science? (ii) Is there a significant relationship between teachers´ attitude towards inquiry teaching and the implementation of IBL in teaching primary science? (iii) Is there a significant relationship between teachers´ belief towards inquiry teaching and the implementation of IBL in teaching primary science?

Literature Review

IBL is a project-oriented pedagogic strategy derives from constructivist theory of learning. Dewey (1938) defines it as "…the controlled or directed transformation of an indeterminate situation into one that so determinate in its constituents distinctions and relations as to convert the elements of the original situation into a unified whole". IBL approach can help students improve their achievement and attitude towards the subject, and improve students' interest towards learning (Kim, 2006; Dimichino, 2007). IBL can also help students to master inquiry skills (Apedoe *et al*., 2006). Students can keep more active attention on learning and get more excellent achievement in the process of inquiry approach (Jin &Bierma, 2011). Based on this statement, for teaching to be effective inquiry method should be acquired and adopted by teachers.

According to Meijer *et al,* (1999), it is a necessary prerequisite for every teacher to have rich content knowledge of the subject they are teaching. In the teaching of science, the study of NOS has become as one of the keys in science education research since 1970s (Abd-El-Khalick & Lederman, 2000). Studies have shown that every science teacher needs to acquire the NOS concept. McComas *et al*., (2000) defined NOS as a fertile hybrid arena, blending various studies of science including its history, sociology, philosophy, and combined with cognitive sciences and even ethics into a rich description of what science is, how it works, how scientists operate as a social group, and how society both directs and influences scientific endeavors.

Besides knowledge, teachers follow their thoughts and act as providers of information and directness to the students, accommodating the changes and modifications in the curriculum with their own personal implicit theories derive from their belief. Bandura (1986) believes behavior can be more effectively predicted by belief regarding capabilities than what they are actually able to accomplish. Nespor (1987) thinks belief is an independent aspect of the cognition associate with knowledge and has stronger affective and evaluative components.

Ajzen and Fishbein (1969) add individuals' attitude as another major determinant of one's behavior. Wilkins (2008) put forward a theoretical model (see Figure 1) relating teacher knowledge, attitude, and belief to instructional practices. This theoretical model is based on Ernest' (1989) model regarding the knowledge, belief and attitudes of the mathematics teachers. It shows that teachers' knowledge, attitude and belief are influenced by their background

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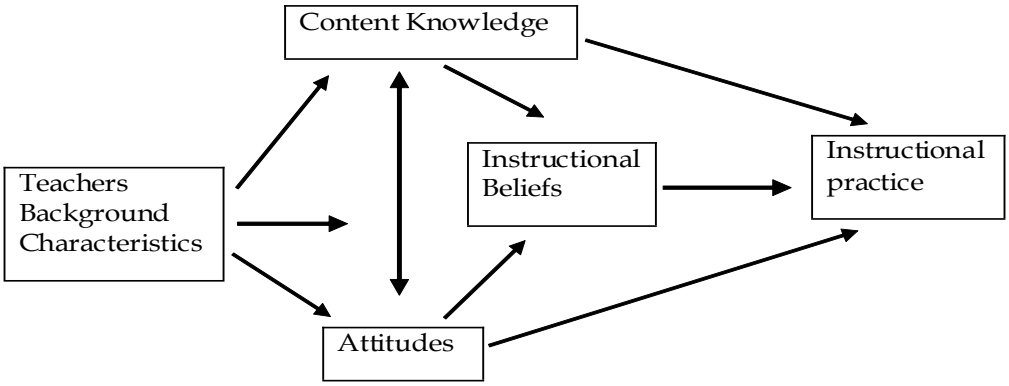
characteristics. Background characteristics involve teachers' experience, education, training and environment (Wilkins, 2008). Teachers' knowledge is representing the cognitive component and teachers´ attitude and belief are representing the affective components (Ernest, 1989). As suggested by the model, teachers´ knowledge, attitude and belief have a direct relationship with the teachers' behavior in the instructional practices. In this study, teachers´ knowledge on NOS, teachers´ attitude and belief towards inquiry teaching are hypothesized as having no relationship with the implementation of IBL in the teaching of primary science, and teachers' experience brings no difference in the implementation of IBL.



Source: Wilkins (2008)

Figure 1: Theoretical model relating teachers´ knowledge, attitudes, beliefs, and instructional practice

Several studies have supported the model drawn by Earnest. These studies show there are connections between teachers' knowledge, attitude and beliefs towards their behavior, which is portrayed in their instructional practice. Abd-El-Khalick (2012) argues that the understanding of NOS can help science teachers to structure good inquiry learning environments. Rivas' research (2003) involving pre-service teachers find that there is a direct connection between pre-service teachers´ understandings of the NOS and their classroom practice. Several studies done in Hong kong, and Norway on teachers' belief reveal teachers´ belief and their practice knowledge have significant impact on the implementation of IBL (Choi, 2007; Chan, 2010; Sikko *et al.,* 2012). Hutchins (2009) finds out that teachers´ attitude has also some significant influence on students´ attitude towards inquiry learning. Another study from Hutchins & Friedrichsen (2012) find out teachers with positive attitude towards inquiry instruction can use inquiry practice better. Sumrall's (2008) study in Mississippi which involves 814 K-5 elementary teachers show teachers' attitude towards inquiry science is found to be related to the use of IBL. Thomas (2008) also finds that teachers´ attitude towards reform has a significant influence on inquiry instructional practice through surveying 6 ninth-grade science teachers. Based on these previous studies, teachers' knowledge, attitude and belief do have some significant relationship with the teachers' behavior. This has encouraged the researcher to look whether these variables can be the predictors of the implementation of IBL in the teaching of primary science in China.

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Research design

The main objectives of this study is to answer the "what" questions regarding the level of teachers´ knowledge about NOS, attitude and belief towards inquiry science, and the implementation of IBL; the difference in the implementation of IBL based on the teachers' years of teaching experience; and the relationship between teachers´ knowledge about NOS, attitude and belief towards inquiry science with the implementation of IBL. This study does not try to answer questions about "why" and "how". As mentioned by Shields and Rangarajan (2013) that quantitative research is used to address the "what" questions rather than the "how/when/why" questions, therefore, this study adopts the quantitative research methodology.

Sampling and Data Collection

This study is carried out in Zhengzhou city in China and its population is the science teachers teaching in primary schools. The sample of this study is selected using the two-stage cluster sampling. This sampling method starts by listing all the clusters in the location. In the first stage the researcher select the clusters using simple random sampling technique. The selected clusters are then sampled in the second-stage using the same technique (Ahmed, 2009). In this study, two districts have been selected from five similar education districts in Zhengzhou City. For each district, 143 primary schools have been chosen, therefore, a total of 286 schools have been selected as the location for the study to take place. In these schools a total of 732 science teachers have been identified and they have been invited to fill in the questionnaire.

For ensuring high response rate, the questionnaires have been filled and collected in front of the researcher. So the response rate is 100%. All questionnaires have been examined. It has been found that 4 questionnaires (0.55%) are incomplete. To ensure the validity of the survey, these 4 questionnaires have been removed, resulting in only 728 (99.5%) valid completed questionnaires to be analyzed.

Instrument

The researchers have adopted three questionnaires to measure teachers' knowledge on NOS, attitude towards inquiry teaching, and to measure the implementation of IBL. Those questionnaires are The Nature of Science Profile Questionnaire (Fazio, 2005), The Revised Science Attitude Scale Questionnaire (Sumrall, 2008) and The Practicing Inquiry Pedagogy Questionnaire (Dai *et al*., 2011). The questionnaire to measure teachers' belief, The Inquiry Belief and Practice Questionnaires, is adapted from Sumrall (2008).

A rating scale is the most useful way when an attitude, behavior, or interest needs to be evaluated on a continuum (Leedy & Ormrod, 2010). The first part of the questionnaire includes the question containing the teachers' years of experience in teaching science in primary school. The second part includes a grading scale, consisting of Likert-type questions, where the teachers state their views on their knowledge on NOS, attitude and belief towards inquiry teaching and the implementation of IBL.

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Data Analysis

The data of this study has been analyzed using the Statistical Package for Social Science (SPSS) version 21. The descriptive analysis is used to test the level of teachers' knowledge on NOS, attitude and belief towards inquiry teaching and the implementation of IBL. The one-way ANOVA has been used to test the difference in the implementation of IBL according to the teachers´ years of experience. Meanwhile, the Pearson correlation has been used to test the relationship between teachers´ knowledge on NOS, teachers' attitude and belief towards inquiry teaching with the implementation of IBL.

The Results

The first objective of this study is to identify the level of teachers´ knowledge on NOS, attitude and belief towards inquiry teaching, and the implementation of IBL. Bluman (1998: 31) gives the solution about the procedure for constructing a grouped frequency distribution for numerical data. He states the class width by dividing the range by the number of classes. Width= R/number of classes (R=highest value- lowest value).

Likert scale has 5 points for teachers' knowledge, attitude and belief, width=5-1/3=1.33 means that the level is divided into three classes: [1-2.33) (low); [2.33-3.66] (medium); (3.66-5] (high). Likert scale has 4 points for the implementation of inquiry-based learning, width=4-1/3=1 means that the level is divided into three classes: [1-2) (low); [2-3] (medium);(3-4] (high).

Table 1: the level of variables

Variables	N	Mean	SD	Level
teachers´ knowledge about NOS	728	2.95	.37	Medium
teachers´ attitude towards inquiry teaching	728	2.96	.38	Medium
teachers´ belief towards inquiry teaching	728	3.00	.38	Medium
the implementation of IBL	728	2.50	.54	Medium

Based on Table 1, the range of mean from teachers´ knowledge on NOS, teachers' attitude and belief towards inquiry teaching is within 2.33-3.66, which is at the medium level. For the implementation of IBL the range of mean is within 2-3, which is also at the medium level. This analysis shows the level of teachers' knowledge on NOS, attitude and belief towards inquiry teaching and the implementation of IBL is at the medium level. The second objective of this study is to identify whether there is a difference in the implementation of IBL based on the teachers' years of experience in teaching science.

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Table 2: The implementation of IBL based on the years of teaching science

Years of teaching science	The implementation of IBL		
	N	Mean	Standard Deviation
1-3 years	380	2.47	.53
4-6 years	300	2.51	.55
7-9 years	49	2.56	.51
Total	728	2.50	.54

The implementation of IBL	Sum of Square	df	Mean Square	F	Sig.
Between Groups	.526	2	.263	.911	.403
With Groups	209.445	725	.289		
Total	209.971	727			

Table 2 shows that the result of the one-way ANOVA indicates there is no difference [F (2, 725)=.911; p>.05] in the implementation of IBL based on the teachers' years of experience in teaching science. This finding shows that the implementation of IBL by all science teachers in this study is equal regardless of their experience. The third objective of this study is to identify whether there are significant relationships between teachers' knowledge on NOS, attitude and belief towards inquiry teaching with the implementation of IBL.

Table 3: Relationship between teachers´ knowledge, attitude, belief and the implementation of IBL

Dimension	1	2	3	4
Teachers´ knowledge about NOS	-			
Teachers´ attitude towards inquiry teaching		-		
Teachers´ belief towards inquiry teaching			-	
The implementation of IBL	.721**	.811**	.786**	-
**. Correlation is significant at the 0.01 level (2-tailed).				

Table 3 shows that the result of Pearson correlation indicates the relationship between teachers' knowledge on NOS and the implementation of IBL is beyond .05 and the Pearson 'r' correlation is .721. For the relationship between teachers' attitude towards inquiry teaching and the implementation of IBL is also beyond .05 and the Pearson 'r' correlation is .811. Meanwhile the relationship between teachers' belief towards inquiry science and the implementation of IBL state beyond .05 and the Pearson 'r' correlation is .786. The findings show that the relationship of these three variables is positive and large (Cohen, 1988), which mean there are significant relationships between teachers' knowledge about NOS, attitude and belief towards inquiry teaching with the implementation of IBL.

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Discussion and Recommendation

The finding of this study shows the respondents have moderate knowledge on NOS, thus, their attitude and belief towards inquiry teaching are also moderate. It is portrayed in their instructional practice, the implementation of IBL, which is also found to be at the moderate level. The results are consistent with some of the previous related studies. Sangsa-ard & Thathong (2014) find more than half of the teachers in their study have medial level of understanding of NOS. Meanwhile, Sikko*et al.*, (2012) study find more than half of their teachers are disagree or strongly disagree to implement inquiry approach in classroom practice. Other studies show that the IBL approach is not popularly implemented in the classroom teaching (Kraus, 2008; Reaume, 2011). In term of the level connection between the variables, there are also studies to confirm the finding of this study. Samuel *et al.*, (2013) find teachers´ beliefs is barely moderately favorable to their practice of IBL, therefore, the level of the implementation of IBL is at the unsatisfactory developing level. Bishaw (2010) also show that the level of teachers' beliefs is related to the implementation of the problem-solving teaching approach.

This study also shows although there is no significant difference in the implementation of IBL according to teachers' years of experience in teaching science, but the descriptive analysis shows that the scores of the implementation of IBL is higher when teachers´ years of experience in teaching is longer. This finding is concurrence with Ladd's (2008) finding which shows teachers with longer years of experience in teaching are more effective compare to teachers with less experience. Another researcher, Wilkin (2008), finds that years of experience in teaching has significant relationship with teachers' instructional practice. Though these studies show that experience does have relationship with the instructional practice, but, its effect on classroom practice as a whole is still seen as a controversial issue. More studies should be done to address this issue.

Another finding of this study show the result of teachers´ knowledge about NOS has significant and positive relationship with inquiry teaching. According to Shim *et al.* (2010), there is a relationship between teachers´ views about NOS and the use of inquiry approach. Abd-El-Khalick (2005, 2012) also argues through the understanding of NOS, teachers could not only convey to students' imagination of science, but also structure a good environment of inquiry learning. Teachers' understanding of NOS has important relation with teachers' promotion of open-ended scientific inquiry and to improve their ability to implement inquiry teaching (Rutherford, 1964; Bencze & Bowen, 2006). However, there are few studies have the opposite findings. Atar (2007) shows that there is no relationship between teachers´ understanding of NOS and practices was far from being simple and linear. Andersen (2011) also states that knowledge cannot be used to predict the implementation of a student-centered approach. These opposite findings require further study in the future.

The result of the teachers´ attitude towards inquiry teaching also shows that it has a significant and positive relationship with inquiry teaching. Teachers´ positive attitudes towards inquiry teaching have important relationship with

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inquiry practice (Sumrall, 2008; Thomas, 2008; Molen & Adlderen-Smeets, 2013; Tenaw, 2014). Haney *et al.* (1996) argues if teachers have positive attitudes towards inquiry teaching, then it might be possible that these positive attitude can be linked to teachers' behaviors in classroom practice. Teachers' attitude affects their degree of commitment to their duties, the way they taught and treated their students, and how they perceive their professional growth (Chen &Rovegno, 2000).

This study also shows teachers' belief towards inquiry science has significant relationship with inquiry teaching. It is important to consider that teachers´ belief can be used to predict the implementation of inquiry teaching in classrooms practice (Nespor, 1987; Trumbull & Slack, 1991; Chan, 2010). Pajares (1992: 307) summarizes findings from many researchers about the relationship between belief and classroom practice: "Few would argue that the belief teachers hold influence their perceptions and judgments, which, in turn, affect their behavior in the classroom, or that understanding the belief structures of teachers and teacher candidates is essential to improving their professional preparation and teaching practices". Munby (1982) explores educational belief literature and suggests when studies show there is no relationship between belief and teachers' behaviors; it may be due to the poor choice of the instrument or the model.

As a whole, the result of this study show consistency with Ernest´ model (1989). Teachers' knowledge, attitude and belief are all found to have significant relationship with these teachers' practice of teaching, in the case of this study is the IBL. The findings from this study suggest the relationship between teachers' knowledge about NOS, attitude and belief towards inquiry teaching with the implementation of IBL is positive and strong, therefore, the hypothesis of this study is failed to be accepted. Consequently, the three variables of this study can be used as the predictors of the implementation of IBL in the teaching of science in primary schools in Zhengzhou, China.

For future research there are few issues need to be tackled. Firstly, it is recommended that the research location should be widened. This study is done in Zhengzhou city only. Other cities or areas in China should be involved to understand the level of the implementation of IBL in primary schools in China. Secondly, a study should be carried out in other level of schools, such as the secondary school level. This study is only involved the science teachers in primary schools. It is ethically wrong to say the findings are also the same in secondary schools without a proper study. Thirdly, this study focuses on the relationship among teachers´ knowledge on NOS, teachers' attitude and belief towards inquiry teaching and the implementation of IBL. It is quite possible that there are other variables that are not included in this study. Further research could find other variables that may have relationship with the implementation of IBL such as teachers' content knowledge and teachers´ qualification. Finally, for further study the use of different tools to collect more accurate data, such as teachers' notes, and teachers' reflections on their teaching of science, are needed.

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Conclusion

Overall, this study has involved 728 teachers from primary schools in Zhengzhou city, which have filled the questionnaire. The questionnaires have been analyzed using descriptive and inference statistics. The results show that the teachers' knowledge on NOS, teachers' attitude and belief towards inquiry teaching and the implementation of IBL is at the medium level. There is no significant difference in the implementation of IBL based on teachers' years of experience in teaching science. But, significant relationship has been found between teachers´ knowledge on NOS, attitude and belief towards inquiry teaching with the implementation of IBL. This finding conforms to Ernest's theory. Lastly, these findings show the three variables, the teachers' knowledge of NOS, attitude and belief, are the main predictors of the implementation of IBL in the teaching of science in primary schools in Zhengzhou, China.

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