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Instructional Strategy for Promoting Understanding of Nature of Science

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Abstract

The Nature of science (NOS) has been thought of as an important component of "Science literacy" that the goal of standards-based science education. The aim of this paper try to present NOS for science education. Hereby, we may compile and notice where we promote students' understanding NOS. We find the highlight by using "explicit-reflective-embedded" approach with history of science, inquiry-based and socio-scientific-issue have an effective way of teaching NOS. While the methods of studies on exploring students' understanding NOS consist of interviews, questionnaire and reflective journal and their analysis consist of category, description, interpretation and statistical.

1. Introduction

For the past century, NOS has been evident worldwide in science education as seen in the science education standards and research documents of many countries. Similar to science education in other countries, education in Thailand has had long attempted to promote student understanding NOS. NOS became more strongly emphasized when it was included as part of the educational aims as well as becoming a content sub-strand of the current national curriculum. Furthermore, the Thai National Basic Curriculum and the instruction handbook for teachers recommends that teachers integrate concepts of NOS into every science content area. (IPST). [6]).

Although Science Education have been attempts to foster students' understanding NOS, mostly international research and Thailand research has found for many students' lack of understanding NOS and students' misunderstanding of the NOS along with lack of pedagogical skill in teaching NOS and teachers lack of teaching resource that challenge us to find new instructional strategy more than instructional traditional to help teaching NOS. (Ladachart et.al. [10] ; Wong et.al. [18])

As a result of investigating databases such as EBSCOHOST (Education Research Complete), Springer and ThaiLIS the researcher reached 65 studies related to Understand of NOS, As a result of the first classification, these studies found to concentrate on the subjects of teaching NOS, assessing NOS, developing NOS curriculum and developing NOS instruction Model. Therefore, this paper is restricted only with one research studies that are about 'Developing NOS Instructional Model' in the last decades. Within the framework of the research questions posed to examine the Understanding of NOS and Instructional strategy to teach NOS. All studies were analyzed using the content analysis that consists of understanding of NOS, Instructional strategy to teach NOS, research method, findings, results and implications for teaching and learning.

The aim of this study is to investigate understanding of nature of science in the literature about understanding of NOS. In this context, the following question were asked:

1.What is the Understanding of NOS?

2.What are the Instructional strategies to teach NOS?

3.What are the research methods (data collection and data analysis) of the studies?

4.What are the major findings of the studies?

5.What are the results of the studies?

6.What kinds of implications have been suggested in the studies?

2. Understanding of NOS

The nature of science is a multifaceted concept that defies simple definition. It includes aspects of history, sociology, and philosophy of science, and has variously been defined as science epistemology, the characteristics of scientific knowledge, and science as a way of knowing. (Bell). [15]) The Lederman group has proposed seven aspects of NOS that is very popular reference of published research papers. The seven are

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as follows: 1) The empirical nature of Science 2) Scientific theories and laws 3) The creative and imaginative nature of scientific knowledge 4) The theory-laden nature of scientific knowledge 5) The social and cultural embedded of scientific knowledge 6) The myth of scientific method 7) The tentative nature of scientific knowledge. (Matthews). [11]) On the other hand, AAAS defines that the Nature of Science contains three big ideas: The Scientific World View, Scientific Inquiry, and The Scientific Enterprise. The first section, The Scientific World View is about the mindset scientists have in investigating nature. The section on Scientific Inquiry places heavy emphasis on understanding the nature of scientific investigation. The final section in this chapter, The Scientific Enterprise is about humans doing science for a living, and for the benefit of other humans. This section also includes benchmarks about scientific ethics, the role of scientists in the public sphere, and information about the disciplinary structure of science. (Lawrence). [4]) We found the related between defining of Understanding NOS as Table 1.

Table 1. Related between Seven Aspects of Lederman and Three big idea of AAAS

Seven Aspects	Three big idea
2) Scientific theories and laws 4) The theory-laden nature of scientific knowledge 7) The tentative nature of scientific knowledge.	The Scientific World View
1) The empirical nature of Science 3) The creative and imaginative nature of scientific knowledge 6) The myth of scientific method	Scientific Inquiry
5) The social and cultural embeddedness of scientific knowledge	The Scientific Enterprise

3. Instructional Strategy to teach for understanding NOS

Some of researches proposed some approaches to help teach NOS. The effective ways to enhance understanding NOS but beware of some points are as follow:

1. The explicit-reflective-embedded approach has been actively studied and shown to be effective on NOS teaching in pre-service and in-service teacher education program that approach requires deliberate planning, assessment and explanations. But, the studies have not provided a clear or explicit definition of approach in terms of an instructional design framework (Koksal). [12])

2. History of Science (HOS) was suggested as a rich instructional context embedding NOS aspects in Science Content Knowledge (SCK) if (1) HOS is deeply contextualized into content-specific situations; and (2) students have an opportunity to reflect and discuss both NOS and SCK within specific historical contexts. Several studies have used history of science to develop contemporary views of NOS in various contexts. (Kim & Irving) [19])

3. The activity model of inquiry can be a useful instructional framework to use in the classroom to teach aspects of NOS the model can also be taught as scientific content and used to show how different sciences or scientists approach scientific problem solving. The activities within the activity model of inquiry can also be taught. Within these activities, other aspects of NOS can be included, such as the theory-laden nature of science within the observations activity. (Marchlewicz & Wink). [17]) But, if science lesson almost always takes place in laboratory setting, regardless of the content of the lesson, which may require any specialist teaching facilities. Furthermore, students have a misconception about how science works. (Williams). [7])

4. Socio-scientific Issue typically involves the products or the processes of science and create social debate or controversy, the socio-scientific issue movement arises from a conceptual framework that unifies the development of moral and epistemological orientations of students and considers the role of emotions and character as key components of science education. Socio-scientific issues have become important in science education because they occupy a central role in the promotion of scientific literacy. (Sadler & Zeidler). [20]) Learning of NOS through the use SSI has been some research to determine what approaches are beneficial to promote NOS understanding. (Wong et al. [18]) But, some studies found the incorporation of SSI units without an explicit NOS component did not change NOS understanding greatly over the short term, which would indicate that students‟ beliefs did not change greatly. Integrated SSI may not have been helpful to those students with naïve views at the beginning level. (Callahan). [3])

4. Methodology

The studies examined what are the research methods (data collection and data analysis) of the studies about understanding of NOS.

4.1. The methodologies of studying the Understanding of NOS

The data collection techniques and methods of analysis used in the studies conducted to determine understanding of NOS (Table 2)

Table 2. Research Methods

Research Studies	Research Methods			
	C	E	L	S
Khishfe and Lederman, 2006		X		
Callahan, 2009	X			
Afonso and Gilbert, 2010		X		
Buffler, Lubben and Ibrahim, 2009	X			
Kim and Irving, 2010		X		
Mahalee, 2010	X			
Thaiangchanthathip, 2010	X			
Leblebicioğlu, 2011	X			
Limpanont, 2011		X		
Marchlewicz and Wink, 2011	X			

C = Case study, E=Experimental, L = Longitudinal, S = Survey

4.2.Data collection techniques analysis methods

The data collection techniques and methods of analysis used in the studies conducted to determine understanding of NOS as Table 3 and 4

Table 3. Data Collection Techniques

Research Studies	Data Collection Methods			
	QN	IV	RJ	SV
Khishfe and Lederman, 2007	X	X		
Callahan, 2009	X	X		
Afonso and Gilbert,2010		X		
Buffler, Lubben and Ibrahim, 2009	X			
Kim and Irving, 2010	X	X		
Mahalee, 2010	X	X		
Thaiangchanthathip, 2010			X	X
Leblebicioğlu, 2011	X			
Limpanont, 2011	X	X		
Marchlewicz and Wink, 2011	X		X	

QN= Questionnaire, IV=Interviews,
RJ = Reflective Journal, SV= Survey

Table 4. Analysis Methods

Research Studies	Analysis Methods		
	SA	CG	DI
Kishfe and Lederman, 2007		X	
Callahan, 2009	X	X	
Afonso and Gilbert, 2010	X	X	
Buffler, Lubben and Ibrahim, 2009			X
Kim and Irving, 2010	X	X	
Mahalee, 2010			X
Thaiangchanthathip, 2010	X	X	X
Leblebicioğlu, 2011			X
Limpanont, 2011		X	
Marchlewicz and Wink, 2011		X	

SA = Statistical Analysis, CG = Categories
DI = Descriptive- interpretative analysis

We found the most frequently used research methods were case study and experimental, methods of data collection were questionnaire and interviews.

5. Findings

The most important findings obtained 3 points as follow:

1. A precise description of NOS is often debated among philosophers of science, historians of science, and science educators, for long time. The clearly define of understanding NOS is the most important for teacher who chose instructional for developing and assessing Understanding of NOS.

2. The study investigated the relationship between instructional strategy and students' learning of NOS. The explicit-reflective-embedded approach is based of teaching NOS, history of science fostered students' understanding of NOS especially the scientific world view. Inquiry based learning has more effected to scientific inquiry and SSI has effected the key idea of the scientific enterprise. In addition, we found some disadvantage of instructional then teachers will be integrated approach into suitable context instruction.

3. Although there have been numerous criticisms of the validity of various assessment instruments over the years, students' understandings have consistently been found lacking, in an attempt to gain more in-depth understandings of students' and teachers' thinking, educational researchers have resorted to the use of more open-ended probes and interviews. The same has been true with the more contemporary approaches to assessment related to the nature of science. Lederman ([13]) mentions that students' understandings of NOS are best assessed through observations of behavior during inquiry activities. For instant, supporting the "observation" approach also think that asking students to answer questions.

6. Conclusion

We find the highlight by using "explicit-reflective- embedded" approach with History of science, Inquiry-based and Socio-scientific-issue have

an effective way of teaching NOS. Effectively NOS teaching also depends on their integrated instructional that appropriate understanding of NOS objective. While the methods of studies on exploring students' understanding NOS consist of interviews, questionnaires, reflective journal and observations their analysis consist of description, interpretation and statistical. Collecting and analyzing data in mixed methods research will need to collect adequate data.

7. Future Research

We can say that there are still new ways of examining students' understanding. For example, assessed through observations of behavior during inquiry activities but have a few on research studies. Future Research must be concentrated on how to develop NOS Instructional Model and emphasized on the explicit-reflective-embedded approach, inquiry approach and SSI that made a significant contribution to student's Understanding of NOS.

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