A Modified H-R Diagram Activity to Introduce the Nature of Science

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Abstract: The purpose of this study is to suggest the modification of activities to introduce the nature of science in earth science classrooms. A small modification can turn ordinary textbook activities into the nature of science activities. Since earth science could provide a good basis for the tentative, creative, and socially and culturally embedded nature of science, as well as appropriate understanding about scientific methods, careful modification of earth science activities could be effective for students to understand the nature of science. Considering which aspects of the nature of science are appropriate, along with the possible change in the activity, teachers will be able to modify textbook activities effectively. An example modification of H-R diagram activity was also suggested.

Keywords: the nature of science, earth science activities, nature of science activities, modification of earth science activities.

Introduction

Today, the importance of understanding the nature of science is highly regarded in science education. In fact, many of science education standards from various countries explicitly state the importance of understanding the nature of science (McComas and Olson, 1998). In spite of such emphases, however, students' inadequate understanding of the nature of science has been repeatedly reported by researchers (Lederman, 1992; Lederman et al., 2002). This discrepancy between the goal and the achievement suggests that we need to invest more efforts on how to teach the nature of science to students in science classrooms.

The nature of science should be taught explicitly, because 'just doing science' does not help much in understanding the nature of science (Bell et al., 2003). Moreover, learning science without clear understanding of the nature of science often leads students to mistaken notions (Clough and Olson, 2004). Fortunately, many strategies to help teachers to deliver accurate notion of the nature of science are already available. For example, pictorial gestalt switches such as old/young lady and rabbit/duck images are engaging way to help students to understand that observations are not strictly objective (Michaels and Bell, 2003). Card-exchange activity (Cobern and Loving, 1998) can help both students and teachers to explore their previous understanding and to introduce accurate notions of the nature of science. Black-box activity (Lederman and Abd-El-Khalick, 1998) can provide students an understanding about how science works.

Nevertheless, difficulties of teaching the nature of science are still present in today's science classrooms. Although these activities are excellent to teach the nature of science, they are not woven into science contents and cannot be used repeatedly in teaching various science subjects. For instance, earth science teachers could use these activities to introduce the nature of science once, but they cannot use them repeatedly in earth science classroom. If the nature of science is introduced to students once or twice, with specially designed activities, then not mentioned for the rest of the science course, students might not fully understand the nature of science. While the mistaken notion of the nature of science can be easily given in teaching any science subject, introducing accurate notion of it in teach-

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ing each science subject seems difficult. Thus we need different strategies which are simple for applying but subtle for affecting in the science classrooms.

A few alternative strategies were provided by some researchers. The core idea was ‘modification in activities’. Colburn (2004) suggested that typical cookbook lab can be changed by making small modification. He gave students more choice and stopped the procedure at certain points to bring up the discussions. By this modification, students could learn about the nature of science as well as the chromatography. Lederman and Lederman (2004) also demonstrated how the notion of the nature of science can be introduced in the typical biology activity. They placed some reflective questions regarding the nature of science in several crucial points of the procedure. By this simple modification, the typical cell cycle activity turned into the nature of science/biology activity.

The modification in activities could be a good strategy to introduce the nature of science in earth science, too. Therefore, this study will focus on suggesting the way to introduce the nature of science in high school earth science class through modified activities. With this strategy, the nature of science could be explicitly taught in earth science classroom without making a big change.

The Aspects of the Nature of Science

The nature of science typically refers to the values and assumptions inherent scientific knowledge and the development of scientific knowledge (Lederman and Lederman, 2004). Naturally, the specific aspects and issues about the nature of science are not unanimously agreed among historians and philosophers in science, because the nature of science itself is tentative (Lederman et al., 2002). But a consensus of key ideas of the nature of science appropriate for K-12 students has been agreed in some degree. Lederman and Lederman (2004) suggested seven key aspects of the nature of science as follows.

First, students should understand that there is the crucial distinction between observation and inference (Lederman and Lederman, 2004). Second, students should understand the distinction between scientific laws and scientific theories (Lederman and Lederman, 2004; McComas, 2004). Scientific laws are descriptive statements about the patterns or relationships among the natural phenomena, while scientific theories are inferred explanation about the natural phenomena (Lederman et al., 2002). Thus it is closely related to understanding the distinction between observation and inference. Third, students should understand the empirical nature of science. Science demands and relies on empirical evidence (McComas, 2004). Fourth, students should understand that scientific knowledge involves creativity and imagination (Chiappetta and Koballa, 2004; Lederman and Lederman, 2004; McComas, 2004). Fifth, scientific knowledge is at least partially subjective. It refers the influence of accepted theories in the scientific community as well as the individual backgrounds of researchers (Lederman and Lederman, 2004). Sixth, students should understand that science is socially and culturally embedded (Lederman and Lederman, 2004; McComas, 2004). In other words, there are historical, cultural and social influences on science and science is neither independent nor objective from human social system. Seventh, students should know that scientific knowledge is subject to change. It is called the tentative nature of science (Lederman and Lederman, 2004; McComas, 2004).

In addition to these seven aspects of the nature of science, a few more important aspects have been repeatedly pointed. The myth of the scientific method is one of them (Chiappetta and Koballa, 2004; Lederman et al., 2002; McComas, 1998, 2004). Students should know that controlled experiments are not the only and the most credible scientific method, and there is no single, standard scientific procedure that every scientific investigation should follow. In fact, various methods are, and have been, available for scientific investigations.