Secondary Beginning Teachers’ Views of Scientific Inquiry: With the View of Hands-on, Minds-on, and Hearts-on

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Abstract: The purpose of this study was to investigate beginning teachers’ views of scientific inquiry envisioned in science education reform, which is the main goal of science education at schools. Teachers’ views about scientific inquiry influence their students’ learning in the classroom, so it is significant to investigate teachers’ views about the scientific inquiry. 126 beginning science teachers participated in this study. The survey asking teachers’ view of general scientific inquiry, nature of science (NOS) and the relationship of science, technology, and society (STS), was developed and implemented for 30 minutes. Alternative views of scientific inquiry including NOS and STS were emerged through data analysis with open coding system. The reliability and validity of data collection and data analysis were constructed through the discussion with experts in science education. The results of this study were as follows. Participants defined scientific inquiry as opportunities of ‘Hands-On’ and ‘Minds-On’ or its combination rather than ‘Hearts-On’. However, teachers demonstrated the view of ‘Hands-On’ for the purpose of scientific inquiry and for teachers’ roles in its implementation. The view of ‘Hearts-On’ about scientific inquiry was not identified. The naïve view of NOS were identified more than informative one. More positive attitude about the relationship of STS was released. The implication was made in teacher education, especially structured induction program for beginning teachers.

Keywords: scientific inquiry, beginning teacher, hands-on, minds-on, hearts-on

요약: 과학교육의 목표인 과학탐구에 대해서 초임과학교사들은 어떻게 인식하고 있는지를 조사하였다. 교사의 과학탐구에 대한 인식은 학생들의 과학탐구에 대한 영향을 미치는 것을 고려할 때 연구의 의미가 있다고 할 수 있었 다. 126명의 초임교사들을 대상으로 일반적인 과학탐구에 대한 인식과, 과학의 본성, 그리고 과학-기술-사회의 관계에 대한 인식을 파악할 수 있는 설문지를 개발하였다. 초임과학교사에 의한 과학의 본성과 과학-기술-사회 관계에 대한 인식을 포함하여 전반적인 과학탐구에 대한 인식은 코딩작업을 통해 파악되었으며 이 과정을 통해 자료수집 및 분석의 타당성 및 신뢰성을 과학교육전문가의 토론을 통해 구축되었다. 이 연구의 결과는 다음과 같다. 초임교사들은 과학탐구를 실험적인 절차적 기술과 과학적 사고를 함양하는 기회로 정의하고는 있지만 과학탐구를 하는 이유와 과학탐구를 수행하는 데 있어 교사의 역할은 실험적인 절차적 기술을 함양하는 기회로 파악하고 있었다. 과학탐구에 대한 정의나 목적 또는 교사의 역할에 대해서는 정의적 영역에 해당하는 요소는 거의 파악되지 않았다. 과학의 본성에 대해서는 과 학적 관점보다는 순수한 관점으로 인식하고 있었으며 과학-기술-사회의 관계에 대한 인식은 공정적인 태도를 보여 주었 다. 초임교사를 위한 조직적인 교사교육을 개발할 필요가 있다.

주요어: 과학탐구, 초임교사, 절차적기능, 사고적기능, 정의적기능

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Introduction

The purpose of science education is to achieve scientific literacy (AAAS, 1989; 1993; NRC, 1996; 2000). To meet the needs of scientific literacy at school, students will be able to learn scientific concepts, experience scientific inquiry skills where students understand knowledge’s formation by promoting the understandings about NOS (Nature of Science) and the relationship of STS (Science, Technology, and Society), all of which are possible to be obtained through scientific inquiry teaching.

Scientific inquiry is defined operationally in this study with three Opportunities To Learn (OTL) as follows; students need to have chances to promote procedural inquiry skills from experimentation, which is called as OTL of ‘Hands-On’. Students are reported that they performed significantly better through ‘Hands-On’ approach to science in mastering concepts (McCarthy, 2005). Chung (1998) reported that more physical experience through ‘Hands-On’ activity is pivotal in promoting students’ concept understanding. Yang (2007) also analyzed the types of laboratory instruction in school science to report that there were verification and discovery types with the emphasis of student’s physical experience through ‘Hands-On’ activity is pivotal in promoting students’ concept understanding. Another OTL of ‘Minds-On’ is that students promote scientific thinking skills from argumentation through inquiry teaching. Skills in scientific inquiry tend to be recognized as technical and procedural skills only, however, thinking skills as well as procedural skills are operationally defined as scientific inquiry skills (NRC, 2000; Park, 2006). Bybee (2006) emphasizes the importance of thinking skills in the context of scientific inquiry and suggests that the components of inquiry are at the ‘center of the learner’s mental activity’ (p. 9) and occur within a scientific context, with scientific goals and orientations, such as explanation building. Standards (NRC, 1990) stress students’ opportunity of ‘doing’ during inquiry activity. That is, students promote scientific thinking skill by developing argumentation and procedural skills by carrying out the investigation. Osborne et al. (2003) mentioned the use of creativity in scientific inquiry as a necessary thinking skill. Thinking or reasoning skills seem necessary to understand science and to do science. Kuhn (1986, 1993) added that students should have the capacity to think about their thought by developing the ability to coordinate their existing theories with new evidence they generate in an explicit and conscious way. Overall, students’ thinking skills (‘Minds-On’) as well as procedural skills (‘Hands-On’) should be provided with opportunity for students to ‘do’ explicitly in the authentic environment created by teachers (NRC, 2000).

The last OTL of ‘Hearts-On’ is that students understand the nature of science including STS (NRC, 2000; Park, 2006). Standards (NRC, 2000) added one more definition of ideal scientific inquiry as ‘understanding’ about scientific inquiry besides ‘doing.’ ‘Understanding’ about scientific inquiry is the opportunity of ‘Hearts-On’. Song and Cho (2004) described that Hearts-On can be the next paradigm of science education for the beginning of the 21st century in that students need to be motivated in their science learning by knowing that scientific activities can be joyful. Song and Cho (2004) also released that science has become much important to modern life and society cannot exist at all without science. Students understand science as humanism. The main feature of ‘Hearts-On’ can be illustrated as follows; students need to understand the core of science, to enjoy the joy of science, to feel the beauty of science, to experience the usefulness of science, to be aware of the responsibility of science, and to participate in the development of science (Song and Cho, 2004).

‘Hearts-On’ in science education is regarded as affective domain in science learning objectives, such as attitude about science, the nature of science and scientists as well as scientific knowledge (Lederman, 1992).

In summary, operational definition of envisioned scientific inquiry in this study consists of two categories; one is ‘doing’ and the other ‘understanding’. ‘Doing’ consists of another two skills; one is procedural inquiry skill, ‘Hands-On’, and the other