Developing Pre-Service Chemistry Teachers’ Understandings of Teaching through Argumentation

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SYNOPSIS

INTRODUCTION

Today, people from all over the world are aware of the importance of evaluating the continuously changing information, data, and arguments critically for making informed decisions. This requires scientific habits of mind that are closely related to argumentation. Hence, many science educators emphasized argumentation both as a scientific thinking skill and as a teaching approach that promote scientific literacy (Klahr & Dunbar 1988; D. Kuhn, 1993; Driver, Newton & Osborne, 2000; Duschl & Osborne, 2002; Erduran & Jiménez-Aleixandre, 2007; Köseoğlu, Tümay & Budak, 2008). Despite the strong support from science educators for argumentation, studies have revealed that argumentation opportunities were given rarely in science classrooms and indicated its necessity in effective pre-service and in-service teacher education (Zeidler, 1997; Newton, Driver & Osborne, 1999; Jiménez-Aleixandre, Rodriguez & Duschl, 2000).

PURPOSE OF THE STUDY

In order to improve chemistry teachers’ pedagogic competence in implementing argumentation we developed an “Argumentation-focused chemistry teaching” course with an explicit-reflective teaching orientation. The purpose of this study is to examine pre-service chemistry teachers’ understandings about argumentation as a result of “Argumentation-focused chemistry teaching” course.
METHODOLOGY

This study was a qualitative case study of a science method course focused on promoting argumentation in chemistry teaching. Participants were 23 pre-service chemistry teachers who attended the argumentation-focused chemistry teaching course. They were in final year of their study at the chemistry teacher education program. Only one participant had limited information about argumentation while other participants did not have any idea about argumentation before the course.

The course lasted for ten weeks with three hours per week. In the course, the characteristics and role of argumentation in science and chemistry teaching was emphasized using an explicit-reflective teaching approach. The course consisted of five sessions: (1) Argumentation in science and science education, (2) Small-group discussions in argumentation, (3) Strategies for implementing argumentation in science education, (4) Modeling and supporting argumentation, (5) Evaluating argumentation. Throughout the course, participants actively engaged in argumentation individually and in small groups through a set of activities focused on argumentation in science and chemistry teaching. In these activities they were encouraged to construct evidence-based arguments and counter-arguments; peer review, evaluate and refine their arguments; and present their arguments as they continuously interacted with their peers.

During the course, we used various strategies to support argumentation such as competing theories, concept cartoons, predict-observe-explain, concept maps and writing frames. Argumentation activities included a range of chemistry topics which students have difficulty with and exhibit alternative conceptions. For example, in such an activity participants were involved in an argumentation about the effect of temperature on forward and reverse reaction rates for a reaction at chemical equilibrium. Additionally, historical science vignettes and role-plays were used to help participants understand the role of argumentation in science. For instance, participants role-played a historical debate around the development of ionic dissociation theory (de Berg, 2006). In this activity, they saw two competing theories to explain the same observations and how this controversy resolved through critical evaluation of arguments. Besides these content-specific activities, pedagogical considerations in implementing argumentation such as managing group discussions and strategies for structuring and encouraging argumentation were also examined through argumentative discourses. Following each activity, participants reflected on their learning experiences and considered the implications of their experiences for the place of argumentation in science and school science. They were also encouraged to make inferences about their roles as teachers when implementing argumentation in chemistry teaching.

Multiple sources of data were collected to examine participants’ understandings about argumentation as a result of the “Argumentation-focused chemistry teaching” course. Primary data sources of the study included interviews with participants; participants’ journals; and written responses to open-ended questions. At the beginning of the study and after the completion of the course, participants answered open-ended questions about the argumentation in science and chemistry teaching. Participants were also asked to keep journals during the course and record their reflections about the argumentation in science and chemistry teaching at regular intervals. Following the completion of the course, semi-structured interviews were conducted with 16 participants to elicit their understandings about the argumentation in-depth. Participants’ worksheets, video records of the course, and the researchers’ observation journals were used as secondary data sources.

Collected qualitative data were analyzed using constant comparison (Strauss & Corbin, 1998) and analytic induction methods to identify and extract common patterns and themes.
Several techniques were employed in order to increase trustworthiness of the data collection and analysis, including data source triangulation, peer debriefing, and searching counterexamples to the assertions.

**FINDINGS**

Analysis of the qualitative data indicated that after participating in the “Argumentation-focused chemistry teaching” course participants’ understandings about argumentation as a teaching approach could be organized into five categories: 1. Skill gains, 2. Conceptual gains, 3. Affective gains, 4. Gains related to nature of science, and 5. Engagement in learning process.

1. Skill gains

After the “Argumentation-focused chemistry teaching” course, participants thought that, as a result of teaching through argumentation, students develop various skills associated with scientific habits of mind such as critical thinking and inquiring and they argued that this skills will also be useful in students’ everyday life. They also stressed students’ social skill gains through argumentation, such as expressing and defending their ideas clearly.

2. Conceptual gains

All of the participants emphasized that teaching through argumentation promotes conceptual change and meaningful learning among students. They supported this idea by stating that in the argumentation process different ideas will be revealed and examined with justifications, and realization of the strengths and weaknesses of each idea stimulate correcting misconceptions and meaningful learning.

3. Affective gains

Participants agreed that teaching through argumentation makes learning more enjoyable, supports active participation of students and their interest in the course. They also noted that argumentation provides more opportunities for students to express their ideas and this will eventually increase students’ self-confidence.

4. Gains related to nature of science

Participants believed that argumentation practices will change students’ perspectives on science. They stated that teaching through argumentation develops more correct understandings about nature of science and students will become more aware of how scientists construct scientific knowledge and tentativeness of scientific knowledge. Some of the participants also stated that as a result of developing understandings about nature of science students will develop more positive attitudes towards science.

5. Engagement in learning process

All of the participants agreed that teaching through argumentation supports active participation to learning for all students. They emphasized that argumentation will increase social interaction in the learning environment and students will communicate their ideas more easily.

**DISCUSSION**

The findings of this study suggest that having prospective teachers actively experience argumentation and then reflect on these experiences can assist them in developing informed understandings of argumentation in science and science education. In general, prospective teachers thought that teaching through argumentation will develop scientific thinking and questioning skills, support conceptual change and meaningful learning, stimulate interest in lesson, develop understanding of nature of science, and encourage active participation of all students. These understandings developed by prospective teachers as a result of explicit-
reflective learning experiences on argumentation consistent with the ideas on the importance and possible benefits of argumentation emphasized in the literature (e.g., Driver, Newton & Osborne, 2000; Duschl & Osborne, 2002; Erduran & Jiménez-Aleixandre, 2007). The findings of this study also support the claim that in order to ensure teachers develop elaborated understandings of argumentation in science education, teachers themselves should engage in the practice of argumentation (Zeidler, 1997; Driver, Newton & Osborne, 2000).

REFERENCES


