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PRE-SERVICE TEACHERS' BELIEFS ABOUT THE IMAGE OF A SCIENCE TEACHER AND SCIENCE TEACHING

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Abstract. *This study examines pre-service teachers' beliefs about the images of a science teacher and the science teaching. Besides, how their beliefs are affected from inquiry-based teaching is investigated. Case study method was used. Pre-service teachers had learned science with inquiry and how they teach science with inquiry in the science laboratory. Data were collected through the drawings and semi-structured interviews. Results indicate that most participants had teacher-centered and conceptual belief about the images of a science teacher and the science teaching at the beginning of the study. However, they had student-centered belief at the end of the study. It was remarked that three pre-service teachers who held different beliefs about student/teacher roles and the teaching of science before the study, had some common beliefs after the inquiry-based science laboratory. Based on the results, it can be said that inquiry-based science teaching positively affects pre-service teachers' beliefs about the images of a science teacher and the science teaching.*

Key words: *belief about teaching, inquiry-based teaching, mental image, pre-service teachers' education.*

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Introduction

Bandura (1986) has stated that beliefs represent the best indicator of why a person behaves, acts and makes decisions in a certain way. Researchers who want to understand teachers' instructional judgments and behaviors have explored teachers' beliefs (Pajares, 1992; Haney & McArthur, 2002; Tanase & Wang, 2010). According to Calderhead (1996), who argues that belief has an influence on behaviors, differentiates between five interrelated areas of teachers' beliefs: beliefs about learners and learning, beliefs about teaching, beliefs about learning to teach, beliefs about one's self and one's role, but also beliefs about the subject matter. These beliefs in five main categories are related to each other and they play an important role in teacher-student interaction.

Pre-service teachers arrive at a teacher education program with their own prior experiences, thoughts, values and beliefs which have an impact on their professional development (Chan, 1999). Teacher education programs play an important role in the development of teachers' beliefs about teaching and learning (Pajares, 1992; Hancock & Gallard, 2004). Their belief about teaching and learning can be formed through the observations they make and the practices they perform over a long time period that begins the day a pre-service teacher starts his/her undergraduate education and it also involves vocational training (Harwood et al., 2006).

Teaching Science with Inquiry

Science education standards documents (AAAS, 1989, 1993; NRC, 1996, 2000) outline specific guidelines for science education (Lee et al., 2004). The standards relate that students in K-12 science classrooms develop abilities to

perform scientific inquiry, gain an understanding of scientific inquiry, and that teachers enable students to acquire a deep understanding of scientific concepts through inquiry-based teaching (NRC, 1996). Teacher preparation programs have the same goal: to provide pre-service and/or in-service teachers with authentic, inquiry-based scientific and constructivist experiences. From these experiences, teacher educators hope that the teachers' beliefs concerning the scientific inquiry, and their skills in experimentation process will help teachers incorporate more inquiry-based teaching methods that focus on students' thinking in their classrooms (Brown & Melear, 2006).

Minogue (2010) explained that educators and educational researchers tend to agree that teacher's beliefs regarding the teaching/learning of science and the ultimate success of science education reform efforts are interrelated. Also, Marshall et al. (2009) have stated that teachers' beliefs for teaching inquiry have affected their use of inquiry in classroom. However, Haney and McArthur (2002) claimed that pre-service teachers often lack sufficient professional classroom experience to "play out" developing their beliefs concerning inquiry-based teaching. To comply with standards in preparing our teachers, preparatory institutions must provide pre-service teachers with experience in conducting inquiry (Brown & Melear, 2007). Pre-service teachers should make explicit connections between an inquiry process, their understanding of how people learn science, and their teaching practice (Crawford, 2007). One space generally considered to offer opportunities for pre-service teachers to learn about inquiry is in the laboratory or practical work (Trumbull, Bonney & Grudens-Schuck, 2005). Pre-service teachers can be provided with the opportunities to gain experience related to "relative" science laboratory practices (Brown & Melear, 2007).

Mental Images

Weber, Mitchell and Nicolai (1995) stated that mental images always maintain some connection to people, places, things, or events, their generative potential in a sense gives them a life of their own, so that we not only create images, but are also shaped by them. According to Elmas, Demirdöğen & Geban (2011) mental images are a representation of a person's experience that involves the knowledge and beliefs. Norman (1983) stated that images provide (1) a belief system, his or her beliefs about the physical system, acquired either through observation, instruction, or inference; (2) observability, providing correspondence between the mental model and the physical system; and (3) predictive power, allowing a person to understand and anticipate the behavior of a physical system.

Drawings offer a different kind of glimpse into human sense-making than written or spoken texts do, because they can express that which is not easily put into words: the ineffable, the elusive, the not yet thought through, the sub-conscious (Weber, Mitchell & Nicolai, 1995). They do not just represent situations; they represent a narrative (van Oers, 1997; cited in MacDonald, 2009). They are helpful instruments for evaluating teaching identities, which are often hidden, influenced by past and present stereotypes, and, in some cases, may contradict the teacher's identity and practice (Weber, Mitchell & Nicolai, 1995).

The Purpose of the Study

Teachers are thought to be central to the process of educational change (Bybee, 1993), and they play an effective role in making educational reforms successful. Unfortunately, most of teachers in Turkey are not ready to use inquiry-based teaching in their class. Many researchers have stated that in-service and pre-service teachers have lack of knowledge, skills, and low self-efficacy belief about inquiry-based teaching, and they have difficulties to teach science with inquiry (Macaroğlu-Akgül, 2006; Akınoğlu, 2008; Ogan-Bekiroğlu & Akkoç, 2009). This situation has become one of the main concerns of science teacher educators in Turkey.

The purpose of this study is to examine pre-service teachers' beliefs about the images of a science teacher and the science teaching. Additionally, it is investigated how their beliefs are affected from inquiry-based teaching. The specific questions that guided this study were:

1. What initial beliefs do pre-service teachers' have about the image of a science teacher and the teaching of science?
2. How is the impact of the inquiry-based science teaching on pre-service teachers' beliefs about the image of a science teacher and the teaching of science?

Methodology of Research

In this study, case study method was used. This method involves the collection and recording of data about a case or cases, and the preparation of a report or a presentation of the case. The collection of data on the site is called as 'fieldwork' and it involves: a) observation and interviewing, b) collection of documentary evidence and descriptive statistics, and c) use of photography, pictures or video tape recordings (Stenhouse, 1988).

Participants

Forty-one pre-service teachers participated in this study. Twenty-six participants were female (63%) and fifteen of them were male (37%). All of them were sophomores at a state university in Turkey. Their images of a science teacher were determined at the beginning and the end of the course. In order to an in-depth analysis of their beliefs about science teaching, three participants were selected among 41 pre-service teachers. The maximum variation sampling technique was used for the determination of three pre-service teachers. The objective of maximum variation sampling technique was to form a relatively small sample and to reflect the diversity of participants that can be parties to the problem to be taken into account in this sample to the maximum degree (Patton, 2002). DASTT-C was used while three participants were selected. Firstly, DASTT-C was applied 41 pre-service teachers and their scores were categorized into three groups (teacher-centered, conceptual, and student-centered). Then, one volunteer pre-service teacher was selected from each group. With three pre-service teachers, semi-structure interviews were made at the beginning and the end of the study.

Research Design

The research was conducted over two semesters in the "Science and Technology Laboratory" course in the 2007-2008 academic years. The goal of the course was to assist the pre-service teachers' understanding of science concepts through scientific inquiry and to teach them how to teach science to their students with inquiry. All research process can explain three stages.

Stage one: In this stage the pre-service teachers were informed about the aims and significance of the science laboratory, the preparation of and use of worksheets, scientific inquiry methods, open-inquiry experiments, science process skills, laboratory equipment, and safety rules. This stage lasted for six weeks. This stage lasted for 12 weeks.

Stage two: The second stage included the implementation of 12 science experiments. The pre-service teachers engaged open-ended science experiments and worked cooperatively in order to learn science content with inquiry. At the same time, they learned scientific inquiry process, they defined research questions, stated hypothesis, identified the variables, planned experiments to collect data. Then, they interpreted findings by discussing them with their group-mates. They gained experience about inquiry-based learning.

Stage three: In this stage, the pre-service teachers were given the opportunity to plan and teach inquiry-based lessons and reflect on their teaching experiences as a teacher. The researcher determined the science subjects in science curriculum. The pre-service teachers planned their teaching activities and designed worksheets with their group-mates. During the course, pre-service teachers taught the subjects. After the lesson, whole class discussions were made about the effectiveness of their teaching. This stage lasted for eight weeks. They gained experience about inquiry-based teaching.

Data Collection Tools

DASTT-C

In this study, beliefs about the image of a science teacher and science teaching/learning were determined Draw-A-Science-Teacher-Test-Checklist (DASTT-C). The instrument was prepared by Thomas, Pedersen and Finson (2001). Stimulus response and constructivist theory were drawn on in preparing the DASTT-C. Based on these theories, instruction models (teacher-centered, conceptual and student-centered) which explain teacher/student roles and the teaching/learning process were defined (Thomas, Pedersen & Finson, 2001).

Teacher-centered model: The teacher is at the center. The planning of classes is mainly based on the sequence of

content by teachers who give secondary emphasis on the beliefs about how students learn the required resources (Hoban, 2003). Students are expected to remember and repeat the information given by the teacher (Billings, 2001). The learning environment is organized in a way which facilitates the transfer of the information by the teacher (Thomas, Pedersen & Finson, 2001).

Conceptual model: The subject and/or the concept to be taught are at the center. Teachers use both didactic methods and such student-centered methods as inquiry, discovery and problem solving in order to teach the subject (Whyte & Ellis, 2003). The teacher chooses the subject; introduces the unit to his/her students and presents them with the necessary basis for the inquiry (Martin, 1997). The teacher guides, while the students conduct activities related to the subject in small groups.

Student-centered model: The teacher guides or facilitates activities and investigations (Thomas, Pedersen & Finson, 2001). Since, the way students learn is the central point, the teachers are structured, taking into account the students' prior knowledge and their social interactions with peers (Hoban, 2003). In this model, where students are cognitively active, discovery is the basic concept (Martin, 1997). Discussions concerning the subject and individual or group projects are noticeable activities in these classrooms (Whyte & Ellis, 2003). The classroom environment is open and encourages student inquiry and exploration (Thomas, Pedersen & Finson, 2001).

DASTT-C was used in order to determine how the pre-service teachers think themselves as science teachers in the future. The pre-service teachers were asked to "Draw a picture of yourself as a science teacher at work. They were also asked the questions, "What is the teacher doing?" and "What are the students doing?" so that they would write some explanations to their drawings.

Interview form

Two semi-structured interviews were conducted with each participant. The interview form was used in order to determine the three pre-service teachers' beliefs about student/teacher roles and the teaching of science. Interview form was prepared by the researcher by using some interview protocols (Salish I Research Collaborative, 1997; Eick & Reed, 2002; Makang, 2003). The interview questions are shown in Table 1.

Table 1. Interview questions.

In the science course;
1. What is the role of a teacher?
2. What is the role of students?
3. What kind of teaching methods are effective to teach science?
4. How do you decide what to teach?
5. How do your students learn best?
6. How do you know when students understand a subject?

Data Analysis

The drawings of the pre-service teachers were graded by using the rubric improved by Thomas, Pedersen and Finson (2001). There are three main dimensions in the rubric: "Teacher", "Student" and "Environment". These main dimensions have five categories (teacher a) activity b) position, student c) activity d) position, e) inside). Drawings were assessed existence (1) or non-existence (0) status into categories. In the test, a 0-4 score interval reflects student-centered image; a 5-9 score interval reflects a conceptual image; a 10-13 score interval reflects teacher-centered image. The drawings were independently analyzed by the researcher and an expert in the science education in order to provide reliability. According to these analyses, the goodness of fit coefficient was calculated as 0.93. This goodness of fit percentage is accepted as reliable (Miles & Huberman, 1994).

The interview data were analyzed through descriptive analysis. Teacher Pedagogical Philosophy Interview (TPPI) coding system was used to categorize data (Salish I Research Collaborative, 1997). The beliefs of pre-service teachers were collected under three categories, teacher-centered, conceptual and student-centered, by considering the teacher action (TA) and student action (SA) sections in the TPPI. To reduce investigator bias, the author

and an expert in the science education independently coded interview data. The agreement was 0.90, and any disagreements were discussed until agreement was reached.

Results of Research

The results of the research are presented into two headings; (a) the mental images of pre-service teachers, (b) the beliefs of pre-service teachers.

The Mental Images of Pre-service Teachers

All pre-service teachers' DASTT-C scores at the beginning and the end of the course are presented in Table 2.

Table 2. DASTT-C scores of pre-service teachers.

	Pre-drawing		Post-drawing	
Categories	n	%	n	%
Teacher-centered	19	46.3	8	19.5
Conceptual	17	41.4	15	36.5
Student-centered	5	12.1	18	43.9

At the beginning of the study, the participants were determined to have high teacher-centered and conceptual teaching images. However, at the end of the study, it was seen that the number of pre-service teachers who had such images decreased; and their images changed into student-centered teaching. Pre-service teachers emphasized the guiding role of the teacher and the active participant role of students in their expressions. Traditional classroom environment in the pre-drawings turned into a laboratory environment in their post-drawings. Three participants' drawings and their explanations help to understand their mental images about teacher/ student role and environment (Figure 1).

Pre-drawings	Post-drawings
	
(a) Teacher demonstrates experiments. Students listen and watch their teachers.	(b) Students do experiments. Teacher observes and guides students' research.

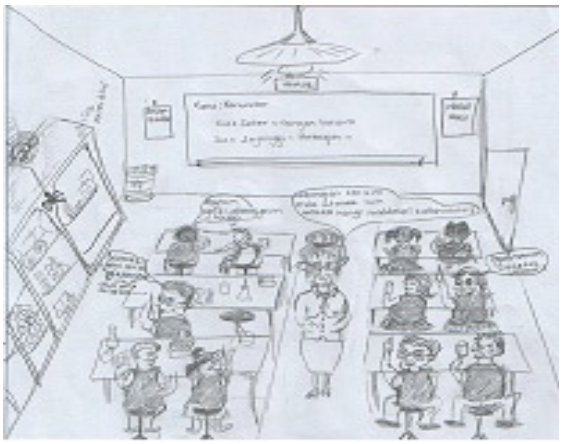
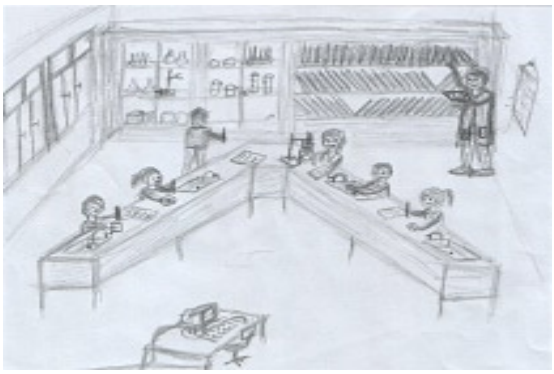
Pre-drawings	Post-drawings
	
(c) After teacher explains the concepts of the subject, students do experiments for reinforcing what they have learned.	(d) Students investigate their research problems. They work in a group. Teacher assesses their performance by using observation form.
	
(e) Students investigate the questions by using books and experiment tools in the classroom. Teacher guides them.	(f) Students learn science at the nature. They investigate their questions. Teacher observes them and listens their explanations.

Figure 1: (a) Ümit's pre-drawing, (b) Ümit's post-drawing, (c) Özge's pre-drawing, (d) Özge's post-drawing, (e) Çınar's pre-drawing, (f) Çınar's post-drawing.

Ümit held a teacher-centered, Özge held a conceptual, and Çınar held a student-centered images beginning of the course. In Ümit's pre-drawing, the teacher was making demonstration experiment for his students. While he was explaining experiment at his desk, students were watching and listening their teachers (Figure 1a). In Özge's pre-drawing, firstly, the teacher was explaining key concepts. After that, students were performing an experiment that is planned by their teacher (Figure 1c). Ümit and Özge believed that teacher should transport knowledge to his/her students. Their students had mostly a passive role (listener, observer) in class. The traditional classroom organization was determined. However, in Çınar's pre-drawing, students were doing research in class. They were making observation and measurement by using experimental tools. Also, they were using books for doing research and checking their results. Students were active learners. The teacher was observing and guiding them. He was not at the center of the class. In his pre-drawing it was seen that student-centered classroom organization (Figure 1e).

Their post-drawings were almost completely different of their pre-drawings, especially for Ümit and Özge. In their post-drawings, Ümit's and Özge's students were doing the experiment with their group-mates. The teacher was not explaining science concepts or experimental process. The teacher had the observer, evaluative and guide roles. Besides, desks were not arranged in rows (Figure 1b-d). In Çınar's post-drawing, he planned his teaching at the out-of school. While students were making an observation of the nature, the teacher was guiding them (Figure 1f). The interactive, student-centered, and inquiry-based learning environment is remarkable in all participants'

post-drawings. Changes were determined in all categories of Ümit's and Özge's images while Çınar's images changed only in the "environment category". Çınar continued his student-centered belief in the "teacher" and the "student" categories.

The Beliefs of Pre-service Teachers

Three of pre-service teachers' beliefs about teacher/student roles and teaching science are presented in Table 3.

Table 3. The beliefs of three pre-service teachers about TA and SA.

	Ümit		Özge		Çınar	
	Pre-interview	**Post interview**	**Pre-interview**	**Post interview**	**Pre-interview**	**Post interview**
Role of a teacher	Explain concepts, ask questions, make demonstrations, assess students' knowledge, organize learning environment	Guide the students, encourage students to ask questions and activate student participation	Explain concepts, observe students' activities, ask questions, check students' knowledge	Determine students' preconception and interest, listen to students' ideas, guide students' research	Encourage students to explain their ideas, guide students' research, direct students' collaboration	Guide the students' questions being investigated, observe students' activities
Role of students	Listen and observe to the teacher, ask questions, answer to the teacher questions	Ask questions, do experiments, present their ideas	Listen to the teacher, answer the teacher's questions, do hands-on activities	Ask questions, do experiments, express their ideas, work collaboratively	Ask questions, do research, make observations, prepare a project, make a presentation	Explain the concepts associated with real life, make self-assessment
Teaching methods	Lecturing, questioning and demonstration	Questioning, hands-on activities, group work	Lecturing, questioning, hands-on activities	Open-ended experiments, cooperative learning, discussion, concept mapping	Field trip, projects, experiments, group work	5E learning model, predict-observe-explain the method, open-ended experiments, concept mapping
Decision about what to teach	Curriculum, textbooks	Curriculum, students' interest	What students need to know for the future (for next class, for national exams)	Student' enthusiasm, interest, relevancy	Student' enthusiasm, interest, relevancy	Student' pre-knowledge, enthusiasm, interest
Learning science best	By reading and seeing	By doing, by explaining	By having an interest, by doing	Not all learn the same way, by group work	By asking questions, by doing	By doing, by discussing, by cooperative learning
Assessing of the students' knowledge	Students can answer teachers' questions	Students can make connections	Students can be successful in exams (written test)	Students can share ideas with others	Students can make applications (address real-life problems)	Students can create something new, students can make self-assessment

Ümit had a teacher-centered belief at the pre-interview. He believed that science can be taught by explaining and demonstrating. He thought that teacher-centered methods such as lecturing, questioning were effective to teach science. According to him, curriculum and textbooks were enough, while determining what to teach. Besides, teacher questions were indicators to assess students' learning. His belief about teacher/student roles and teaching of science changed at the end of the course. He had a student-centered belief about teacher role. He believed that teachers should guide students, encourage them to work together. According to him students' interest was important while determining what to teach. However, his belief about student role was conceptual. Because he still believed that the teacher's instructions were important for students' learning. The teacher should direct students

when they learn concepts, ask questions, or do experiments. Content was important for him because he thought that making connections between concepts is important to understand what students learned.

Özge had a teacher-centered belief about TA and a conceptual belief about SA in the pre-interview. She believed that firstly teacher should teach key concepts by explaining/demonstrating. After that students should confirm these concepts by doing experiments. According to her, the teacher should give directions step-by-step for students; otherwise students could not do experiments. She preferred teacher-centered methods to teach science. Besides, students' need about future (national exams and next class) was important to her. The grades that students obtain from exams were the indicators of science learning. Even though she believed that students learned best by doing and having an interest in the subject, she thought that teacher should be more active than students in class. Özge's belief about TA and SA changed into a student-centered at the end of the course. Özge stated that the teacher should know his/her students' interest and prior knowledge. The teacher should guide students' research and encourage them work together. She preferred student-centered methods. She believed that each of the students has a different learning style. If they work together, they can learn science best. According to her, if students share their ideas with others (explaining, discussing) it is an indicator of learning. She believed that students should be more active than the teacher.

Çınar held a similar belief about TA in the pre and post-interviews. He stated that teacher should interest his/her students' knowledge, interest and enthusiasm. Student questions were a focus, of course. Teacher-student and student-student interactions were important to him. He explained that science should teach student-centered methods such as field trip, projects, group work. According to him, students should plan their learning. He stated that students should figure out real life science problems. At the post-interview, his belief about TA is similar. He stated that students have an important role in planning the teaching and teacher should guide them. He stated that 5E learning model, predict-observe-explain, concept mapping, and open-ended experiments are effective methods to teach science. At the post-interview he indicated the importance of students' self-assessment. According to him, students should be creative and have self-assessment skills. It was an indicator to understand about their learning.

Table 4. The category of the beliefs of the pre-service teachers about TA and SA.

Participants	Pre-interview		Post-interview	
	TA	SA	TA	SA
Ümit	Teacher-centered	Teacher-centered	Student-centered	Conceptual
Özge	Teacher-centered	Conceptual	Student-centered	Student-centered
Çınar	Student-centered	Student-centered	Student-centered	Student-centered

Pre-service beliefs category is presented in Table 4. According to pre-interview results, Ümit held teacher-centered, Özge held conceptual-teacher centered and Çınar held student-centered beliefs with regard to TA and SA. It was seen that the pre-service teachers held similar beliefs in their teacher category (TC) and student category (SC) in their pre-drawings. It was determined that the participants' beliefs concerning the teacher/student role and the teaching of science were student-centered at the end of the inquiry-based science laboratory course.

Discussion

The present study examines pre-service teachers' beliefs about the image of a science teacher and science teaching and how their beliefs change with inquiry-based teaching. Pre-service teachers had different images of the roles of teacher/learner when they first came to the science laboratory course. They had a high rate of teacher-centered and conceptual teaching images. Similarly, Northfield, Gunstone & Erickson (1996) and Minor et al. (2002) have claimed that pre-service teachers mostly held traditional views on student learning when they had recently started their teacher training programs. Researchers have argued that their previous experiences have an effect on the shaping of their beliefs (Ornstein & Lasley, 2004; Duru, 2006; Liaw, 2009) and teacher training programs play an important role in changing these beliefs and developing their experiences (Ogan-Bekiroğlu & Akkoç, 2009; Seung, Park & Narayan, 2010; Otto et al., 2012; Minkee et al., 2013).

The mental images of most pre-service teachers changed at the end of the course. A decrease in the number of pre-service teachers who have teacher-centered and conceptual images and an increase in the number of pre-service teachers who have student-centered images were determined. It was seen that there were still students with teacher-centered images at the end of the course. According to Allamong (1976), the reasons why some students still insisted on teacher-centered pedagogies might be twofold. Firstly, they were resistant to change because of their previous experiences and ideas that envisioned the teacher as the center of the learning environment. The second reason might be a preference; they thought that most of the students might be much more successful in more structured learning environments (cited in Elmas, Demirdöğen & Geban, 2011). It is known that beliefs have deep roots and applications made in one course or in one year may not be sufficient to change them. When it is taken into consideration that these beliefs are not generated over a short period of time, it is believed that it would take time to change them. It is thought that student-centered methods in teacher training program should have features enabling them to be applied for long terms (Tanase & Wang, 2010).

Three pre-service teachers' belief reflects better the effects of the inquiry-based teaching. Before the course, Ümit had a teacher-centered belief. He believed that the teacher's role was to transfer knowledge and the student had the role of receiving the knowledge. Özge had a conceptual belief. She stated that student-centered teaching is effective; however, she believed that content-based teaching is more important than student-centered teaching. Teachers who believe in conceptual teaching apply traditional and constructivist approaches together in the learning and teaching process (Llewellyn, 2007). Ogan-Bekiroğlu and Akkoç (2009) defined the conceptual teaching category, which they called "transitional" in their studies, as applying to beliefs and practices to imply a movement from a traditional to a constructivist approach. Özge's statements that the teacher has the role of guiding and she/he should devise hands-on activities in the courses reflect her student-centered beliefs. On the other hand, her thoughts about the content-based teaching and traditional exam-based achievement reflect her teacher-centered beliefs. Çınar had a student-centered belief. He believed that students should learn subjects associating to their daily life and that they should have an active role in class. His belief about teacher/student roles and teaching/learning science was improved with inquiry-based course.

At the end of the course, it was seen that the beliefs of pre-service teachers teaching of science, the role of the student/teacher, and on the learning environment changed. All activities contributed to their student-centered beliefs about the learning and teaching. Similarly, Varma (2007) aimed to improve pre-service teachers' perceptions about inquiry-based teaching. It was seen that the pre-service teachers developed an understanding of scientific inquiry and inquiry-based science teaching. Moreover, they could appreciate the benefits of teaching and learning science in a constructivist environment.

Conclusions and Implications

It was determined that most of pre-service teachers have teacher-centered or conceptual beliefs about the images of a science teacher and the science teaching at the start of the study. As it is known, pre-service teachers who have traditional or conceptual teaching beliefs will have difficulties to apply constructivist science curriculum. Their traditional beliefs about science teaching should be changed in undergraduate education. Inquiry-based teaching is one approach to improving the quality of undergraduate education by moving toward more student-directed, interactive methods of learning while focusing on learning how to learn (Justice et al., 2009). In this study, pre-service teachers learned how to teach science with inquiry. They gained experience about inquiry-based teaching. At the end of the study, their beliefs about the images of a science teacher changed. Most of the participants have had student-centered belief about the images of a science teacher. According to post-interview results, pre-service teachers believed that students should learn science with inquiry. They stated that teachers should be guides for students' learning and should use inquiry teaching methods to teach science. It can be said that inquiry-based science teaching affected pre-service teachers' beliefs as a student-centered.

Teacher educators should help pre-service teachers uncover their beliefs and actions and any inconsistencies in them. Therefore, some suggestions may be put forward concerning teacher educators and researchers. Pre-service teachers gained experience and knowledge in this course concerning scientific inquiry, and the learning and teaching of science with inquiry. Inquiry-based teaching methods should be used in science laboratory courses in order to enhance pre-service teachers' understanding, experiences, and beliefs in relation to inquiry-based science teaching. In this study, pre-service teachers' mental images and beliefs improved with inquiry-based teaching. However, it could not be followed whether the pre-service teachers would use these practices in their classes

when they become teachers. The effectiveness of the teaching that is provided could be researched in prospective long-term studies by examining whether the opinions of pre-service teachers persist when they become teachers and how they use the acquired knowledge and skills in the class. DASTT-C and the interview form were used in the present study in order to determine the mental images and beliefs of pre-service teachers. In future studies, pre-service teachers' beliefs about the learning and teaching could be analyzed in a different dimension by using different assessment instruments (the metaphor, the observation form, etc.)

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