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Primary Pre-Service Teachers' Epistemological Beliefs and their Teaching and Learning Experiences

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The epistemological beliefs of pre-service teachers influence both their teaching experiences and their students' content understanding. Little research has been devoted to the interaction between teachers' epistemological beliefs and teaching practices (Schraw & Olafson, 2002). To address this gap, this study investigated primary pre-service teachers' epistemological beliefs and their teaching and learning experiences, as well as how these relate to one another. The participants were 22 (13 females, 9 males) volunteer primary pre-service teachers. Data were collected from science learning histories, open-ended questionnaire on epistemological beliefs, classroom observation reports, lesson plans, and reflective diaries. The result showed that epistemological beliefs can be promoted by using teaching methods that focus on such beliefs.

Keywords: Epistemological beliefs, pre-service teachers, science, teaching/learning experiences.

INTRODUCTION

Given the importance of epistemological beliefs for science education, curricula are designed to promote epistemologically related skills among students; such skills include the development of perceptions about knowledge and the justification of knowledge (National Academy of Science, 1996). Conley (2004) stated that science classrooms should include opportunities for investigating the development of students' epistemological beliefs. An important requirement in teacher education, therefore, is training on how they can foster environments that advance the formation of epistemological beliefs among students. Pre-service teachers' epistemological beliefs influence not only their teaching experiences, but also their students' content understanding. Lemberger, Hewson, and Park (1999) indicated that when pre-service science teachers participate in teacher education programs, they generally hold traditional views regarding knowledge and knowing in science. This situation highlights the need to examine pre-service teachers' epistemological beliefs and how such perceptions are promoted in the classroom.

Several models and theories on epistemological beliefs have been discussed. Early studies (e.g., King & Kitchner, 1994; Kuhn, 1991; Magolda, 1992; Perry, 1970) assumed that epistemological beliefs are unidimensional and develop in stages. More recent studies have revealed that epistemological beliefs have more than one dimension (e.g., Hofer & Pintrich, 1997; Schommer, 1990); some researchers (e.g., Hammer & Elby, 2002) argue that epistemological beliefs are characterized by many dimensions, which are referred to as epistemological resources. Chinn, Buckland and Samarapungavan (2011) called epistemological beliefs as epistemic cognition and they proposed the following five components: epistemic aims (goals related to finding things out) and epistemic value (whether resulting achievements have value); the structure of knowledge (multidimensional) and other epistemic achievements (includes mechanism and causal

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State of the literature

- Epistemological beliefs are defined as beliefs about knowledge and knowing.
- Epistemological beliefs are important for the development of students' learning and so pre-service teacher programs should be designed for promoting their epistemological beliefs.
- Pre-service teachers' epistemological beliefs influence not only their teaching experiences, but also their students' content understanding.

Contribution of this paper to the literature

- This paper contributes to the literature about primary pre-service teachers' epistemological beliefs
- This paper contributes to the literature about primary pre-service teachers' teaching and learning experiences, as well as how these relate to one another.
- This paper contributes to the literature about how primary pre-service teachers' epistemological beliefs and their teaching and learning experiences are related to each other.

frameworks); the sources and justification of knowledge and other epistemic achievements, and the related epistemic stances (includes perception, reasoning and the testimony of other people); epistemic virtues (supporting the development of desired epistemic aims) and vices (not supporting the development of desired epistemic aims); reliable and unreliable processes for achieving epistemic aims.

Also regarding epistemological beliefs as multidimensional, Schommer (1990) defined such beliefs as systems of personal and implicit views or students' assumptions about the nature of knowledge and learning. The author characterized the dimensions as follows: Simple knowledge includes the views that "knowledge is organized as isolated bits and pieces" and "as highly interwoven concepts." Certain knowledge covers such beliefs as "knowledge is absolute" and "knowledge is tentative." Fixed ability refers to views such as "the ability to learn is fixed at birth" and "the ability to learn can be changed." The quick learning dimension includes perceptions such as "knowledge is acquired quickly or not at all" and "knowledge is acquired gradually." Each dimension is independent, and the beliefs that fall under one dimension do not need to develop simultaneously. For example, a student can regard knowledge as wisdom gradually acquired but at the same time perceive it as organized into isolated bits and pieces (Schommer, 1990). Each dimension measures a distinct belief dimension and exerts different effects on learning. The present study examined pre-service teachers' epistemological beliefs on the basis of Schommer's (1990) views.

Although several studies have indicated that students' epistemological beliefs are related to their learning and content understanding (Hammer, 1994; Hofer & Pintrich, 1997), little effort has been directed toward examining the interaction between teachers' epistemological beliefs and their teaching practices (Schraw & Olafson, 2002). Some studies looked into the effects of epistemological beliefs on teaching and found that in general, teachers with constructivist epistemological beliefs use constructivist teaching methods in class, whereas teachers with empiricist beliefs use traditional instruction methods (Hashweh, 1996; Schoenfeld, 1998). Hashweh (1996) stated that constructivist teachers observe students' development of knowledge and are therefore sensitive to students' alternative conceptions. Given this backdrop, in order to get constructivist teachers, an essential task is to determine pre-service teachers' epistemological beliefs and their effects on teachers' teaching and learning experiences.

According to reform documents (National Science Education Standards, 1996), teachers should have sophisticated epistemological beliefs for them to effectively teach scientific inquiry skills and concepts to students. Cheng, Chan, Tang, and Cheng (2009) revealed that teachers' beliefs affect the use of instructional strategies and their performance in the classroom. The authors also indicated that because teacher education programs do not focus on epistemological beliefs, changing pre-service teachers' existing epistemological beliefs is a difficult goal. Cheng et al. (2009) proposed that pre-service teachers' classroom practices are affected by their epistemological beliefs and advocated teacher education that emphasizes how pre-service teachers' epistemological beliefs can be influenced by teacher education programs. The authors found that the relationship between epistemological beliefs and conceptions of teaching differ across teachers. However, they found no linear relationship among these constructs. In line with their study results, Cheng et al. (2009) recommended that in addition to questionnaire surveys and interviews, observations should be conducted in investigating this interaction. Although there are some studies, like Cheng et al. (2009), that have explored the relationship between pre-service teachers' epistemological beliefs and their teaching practices; in the present study pre-service teachers' teaching practices were investigated more than one instruments such as open ended questionnaire, reflective diaries, learning histories, classroom observations. In the current work, therefore, pre-service teachers' classroom practices were observed.

In the present study, there are several reasons for studying pre-service teachers' epistemological beliefs

and their teaching practices. First, Mansour (2013) found inconsistencies related to teachers' epistemological beliefs and their teaching practices, thus driving the author to suggest that science education programs be characterized not only by new teaching methods, but also by learning environments that are conducive to the expression and construction of beliefs. Accordingly, in the present study, pre-service teachers were provided opportunities to express their epistemological views in their courses. Second, several studies explored the relationship between teachers and pre-service teachers' epistemological beliefs and teaching practices (Chan, 2004; Cheng et al., 2009; Hashweh, 1996; Mansour, 2013; Pajares, 1992), but Chan (2004) and Mansour (2013) argue that further research is required for a more in-depth examination of this relationship. Third, Poulson, Avramidis, Fox, Medwell, and Wary (2001) stated that the manner by which teachers' epistemological beliefs affect their teaching practices is complex and that teachers do not need to apply constructivist teaching practices when they are already equipped with sophisticated epistemological beliefs.

Therefore, the present study's investigation of primary pre-service teachers' epistemological beliefs and teaching experiences was conducted in accordance with the insights provided by the aforementioned literature. In the present study, the other purpose of the study is to find out the effects of teaching method that promote epistemological beliefs and how primary pre-service teachers' teaching approaches are changed by such beliefs. The results of this kind of research can facilitate the design of constructivist teaching practices and the development of teacher education programs. Therefore, the main purpose of the current work was to examine the primary pre-service teachers' epistemological beliefs and their teaching and learning experiences in relation to such beliefs.

METHODOLOGY OF RESEARCH

Research Design

To investigate the interaction between pre-service teachers' epistemological beliefs and their teaching and learning experiences, qualitative research was conducted. Data were gathered from primary pre-service teachers' science learning histories, open-ended questionnaire on epistemological beliefs, classroom observation reports, lesson plans, and reflective diaries. Qualitative techniques are important for an objective and thorough examination of the case.

Participants

The participants of the study were 22 (13 females, 9 males) volunteer primary pre-service teachers studying at the Faculty of Education in the Department of Elementary Education of a public university. The participants were in their sophomore year for the 2013–2014 academic year. Their mean age was 22 and their average GPA was 2.4. They expressed willingness to participate in the study but requested to remain anonymous. The study was conducted the Teaching Science and Technology course in a public rural university. The primary pre-service teachers taught two separate sections supervised by the same instructor. The sampling method used was the purposive sampling because the aim of the present study is to examine primary preservice teachers' epistemological beliefs and their teaching practices. Due to the characteristics of qualitative research, the results do not need to be generalized to the entire university; we would like to examine deeply their epistemological beliefs. The primary pre-service teachers attended classroom observations once a week in a public primary school. These observations were conducted in Teaching Science and Technology course. When these primary pre-service teachers graduate from the primary education program, they will teach science, social studies, arts, and mathematics courses to primary students. Given that they are required to master these subjects, the primary teacher education program includes training on these courses and the instructional strategies applied in teaching these classes. Some courses primary pre-service teachers took were as follow: General Chemistry, General Physics, General Biology, Mathematics, Educational Psychology, Language, Foreign Language, Geography, History, Teaching Principles and Methods, Teaching Techniques and Material Design, Science Technology Laboratory Applications. These courses include basic science, mathematics, social science.

Procedure and Data Collection Instruments

As previously stated, data were collected from science learning histories, open-ended questionnaires on epistemological beliefs, classroom observation reports, lesson plans, and reflective diaries. On the basis of such data, the primary pre-service teachers' epistemological beliefs were determined and the relationship between such views and teaching experiences was investigated.

Science Learning Histories

The science learning histories were used to determine the primary pre-service teachers' epistemological beliefs. Kang (2008) developed questions regarding the history of science learning in

classrooms. It includes 9 open ended questions. These questions were translated and adapted by the author of the current study and two other researchers. They were also examined in terms of content and language, after which a pilot study was conducted, wherein questionnaires were administered to the participants at the beginning of the Teaching Science and Technology course. The purpose of these questions was to determine how learning histories influence the teachers' ideas about science instruction. Kang (2008) determined pre-service teachers' learning histories by conducting interviews and providing participants with written questions. The author stated that in the interviews, the pre-service teachers repeatedly described events but in the written question forms, the participants exhibited this behavior to a lesser extent. Thus, in order to get in depth answers, in the present study, the pre-service teachers were required to write about their learning histories. The questions that were provided to the teachers were those presented by Kang (2008).

Classroom Observation Reports

As mentioned earlier, the pre-service teachers attended classroom observations in a public primary school. They observed the classes for four hours each week during the semester. At the end of the semester, they were required to write one classroom observation report that describes their experiences during this activity. The components that the teachers were required to describe in their reports were the teaching and learning environment; teachers' roles; students' roles; and how they would have planned their lessons had they been the instructors of the classes. The classroom observations were intended to enable the teachers to compare science teaching and learning in actual public primary school classrooms and their ideas and the insights that they learned in their education courses at the university.

Open-ended Questionnaires on Epistemological Beliefs

Güven, Sülün, and Çam (2014) formulated open-ended questionnaires on epistemological beliefs with reference to Schommer's (1990) views. These questions cover five aforementioned dimensions of epistemological beliefs: certain knowledge, simple knowledge, quick learning, source of knowledge, and innate ability. Validity and reliability studies for the questions were conducted by Güven et al. (2014). On the basis of the pre-service teachers' responses to the questions, the current work classified the respondents as having naïve, moderate, and sophisticated perceptions. The pre-service teachers' answers were also evaluated by using a rubric developed by Güven et al. (2014).

Lesson Plans

The pre-service teachers were required to teach one science topic in one class-hour during the Teaching Science and Technology course. They were asked to prepare lesson plans that cover lesson objectives, materials used for the lesson, and presentation procedures for the one-hour session, with specific examples of teaching and assessment techniques. These requirements were intended to enable the teachers to compare written lesson plans with their presentations in micro teaching (Note: The activity cannot, however, be classified as micro teaching because each session lasted for about an hour.).

Reflective Writing

The pre-service teachers were also required to write reflective diaries for each class of the Teaching Science and Technology course. For this activity, the teachers were asked to answer the following questions: "What are my questions on today's lesson?"; "What did I learn in today's lesson?"; and "What are the challenging issues in today's class?" These questions were taken from Towndrow, Ling, and Venthan (2008). The purpose of the diaries was to enhance the teachers' awareness of the objective of the course, the application of scientific knowledge and language, scientific process skills, and the relationship between the course topic and daily life. The reflective diaries were then examined in accordance with the rubric developed by Güven et al. (2014).

Implementation of Teaching Methods for the Teaching Science and Technology Course

The Teaching Science and Technology course was taught with constructivist approaches. The course covers scientific knowledge, scientific literacy, teaching methods, assessment techniques, and curricula used in primary schools. It was a three-hour (about 150 minutes) course, with the first two hours devoted to a discussion between the instructor and pre-service teachers regarding the topics covered in the course and activities related to the course objective. For example, the pre-service teachers were required to read research articles related to each topic before class. During class, the articles were discussed while focusing on the topic-related epistemological beliefs of the pre-service teachers. For instance, when an argumentation method was discussed in the class, the pre-service teachers were asked whether this method promotes students' epistemological beliefs and why. For each topic, therefore, the pre-service teachers linked their knowledge with their epistemological beliefs. In the class, the teachers were allowed to work with and discuss ideas with one another. During the last lesson,

the pre-service teachers presented a science topic delineated in the primary school's curriculum. This course lasted for two semesters (about 28 weeks).

Data Analysis

The data were examined by content analysis, and open coding was conducted (Punch, 2005) on the basis of related literature (Kang, 2008; Cheng et al., 2009; Buehl & Fives, 2009) and the pre-service teachers' responses. Moreover, the pre-service teachers' original responses were referred to for understanding of the given constructs.

Validity and Reliability

According to Lincoln and Guba (1985), the trustworthiness of the qualitative study was achieved by credibility, transferability, dependability, and confirmability. In order to ensure the credibility, analyst triangulation and data triangulation was conducted. As previously mentioned, pre-service teachers' epistemological beliefs were determined through the open-ended questionnaires and learning histories, whereas their teaching practices were identified from the learning histories, lesson plans, classroom observation reports, and reflective diaries. Three pre-service teachers' learning histories, lesson plans, open-ended questions, reflective diaries, classroom observations were coded firstly by three researchers. Then, three researchers come to consensus on each code. The remaining coding was conducted by the author. Thus, analyst triangulation was achieved. Data diversity was achieved because more than one data source was used to investigate the constructs. This diversity necessitated data triangulation. The pre-service teachers' responses were also analyzed for consistency of views. In order to ensure the transferability, the implementation of one typical course (related to argumentation) was presented. In order to ensure dependability and confirmability, a researcher other than the author observed the class for whether the instruction was implemented as it is suggested. These procedures ensured internal validity and reliability in the study. Other than the researcher, two others carried out coding, thereby endowing the study with external reliability.

RESULTS OF RESEARCH

Science Learning Histories

The pre-service teachers' science learning histories were examined in relation to their epistemological beliefs. All the teachers' views (except those of three participants) regarding teaching practices were underlain by constructivism. The three exceptions held mixed views on teaching practices. Excerpts of the responses are provided as follows:

> Good and effective science teaching should include application of science; students should be active in the learning process. Students sit U shape in the classroom or in the laboratory. In the laboratory, students participate the discussions and they did application in the teaching and learning environments. These increases students' learning. (Ceyda, constructivism)
>
> In the primary school, my science grade was good because my science teacher explained very well. Since science topics were simple, I was listening carefully. However, in the secondary school, my science grade was awful. However, when I went to the training center, my secondary school grade was increased. Good and effective science teaching should include discipline, content knowledge and teachers should transfer their knowledge to the students. Students should learn by experience. Since young students wonder daily life events and they should start to learn at young age. (Meltem, mixed)

As indicated in the excerpts above, Ceyda highlighted certain constructivist characteristics, such as the active involvement of students. By contrast, Meltem identified the characteristics of both traditional teaching (i.e., transfer of content knowledge) and constructivism (i.e., learning by experience). Thus, Ceyda and Meltem can be evaluated as espousing constructivist and mixed views, respectively.

After the pre-service teachers' instructional practices were described, codes for the responses were developed. These codes are the characteristics of teaching methods, personalities of teachers, motivations of students and teachers, and content knowledge of teachers. Table 1 shows the frequencies (in percentage) with which the codes were referred to in relation to teaching practices.

The table shows that all the pre-service teachers identified one characteristic of a given teaching method. Half of the pre-service teachers deemed the personalities of teachers and motivations of students and teachers as important factors in teaching and learning. By contrast, only a few highlighted the importance of teachers' content knowledge. Sample excerpts are presented below:

> Teacher should guide students and students should be active in the learning environment. Science lesson in the laboratory is better than other classical teaching methods. (Batuhan, teaching methods)
>
> I like my primary teacher because she communicates well and interacts well with us. (Serkan, personality of teacher)
>
> Teacher should provide environment for students' science understanding. In order to do this, teacher

Table 1. Frequency of Codes in the Pre-Service Teachers' Responses Regarding Learning Histories

	Frequency	
	Number of participants	Percentage
Teaching methods	22	100
Personality of teacher	12	55
Motivations of students and teachers	12	55
Content knowledge of teacher	4	18

Table 2. Frequency of Codes in the Pre-Service Teachers' Responses Regarding the Characteristics of Teaching Methods

	Frequency	
	Number of participants	Percentage
Laboratory	24	100
Application of knowledge	8	34
Daily life applications	19	79
Learning by experience	13	54
Problem solving	10	42
Technology	4	17
Availability of materials	16	67

should use every technique and students should participate in the class willingly. Students should come to the class by desire. (Banu, motivations of students and teachers)

In order to good and effective science teaching, teacher should make students to like lesson and then teacher should have sufficient content knowledge. Teacher could transfer this knowledge to the students. Students should learn according to the principle of learning by experience. (Feride, content knowledge of teacher)

After the coding, the codes of the characteristics of teaching methods were categorized as follows: importance of laboratory, application of knowledge, daily life applications, learning by experience, problem solving, technology, and materials. Table 2 provides the frequencies with which the codes were referred to in relation to the characteristics of teaching methods.

As indicated in the table, all the pre-service teachers recognize the importance of having a laboratory for science classes. After laboratory, the second and third most frequently highlighted factors are the importance of daily life applications and availability of materials. Sample excerpts are as follows:

My favorite teacher was my secondary teacher because he usually brings us to the laboratory. He makes us observe the growing period of eggs in the egg incubator. Also, we broke the eggs in each week and observe the development of eggs. This is the most interesting experience for me. (Emine, laboratory)

I would like to be a teacher because I would like to make students learn something. Then, I would like to make students apply their scientific knowledge to daily life applications. (Zeliha, daily life applications)

Teachers should have every kind of materials, should have environments for doing experiments. The classroom should have less number of students. (İsmail, availability of materials)

The results on science learning histories demonstrated that all the pre-service teachers, except three, had sophisticated epistemological beliefs.

Classroom Observation Reports

To analyze the pre-service teachers' classroom observations, their descriptions of the learning environment were examined. The teachers were required to provide information related to how teaching and learning were achieved in the observed class and their suggestions on the teaching methods implemented in the classes. Most of the teachers stated that they observed the use of traditional approaches in the classrooms. The frequency with which the approaches were used was calculated. The percentages of the teaching approaches used in the classrooms are listed in Table 3.

Sample excerpts are presented below:

In science lesson, teacher presented the topic to the students. Students only joined the discussion when teacher asked the question to the students. Teacher generally used question-answer technique. Also, teacher usually used "Teacher Helping Book". The lessons were generally theoretical. (Maya, traditional)

Teacher told that every sound has source. At the beginning of the lesson, students listened the sound from internet and teacher asked students the

Table 3. Percentages of the Teaching Approaches Used in the Classrooms

	Percentage
Traditional	67
Constructivist	17
Mixed	17

Table 4. Percentages of teaching environments.

	Percentage
Laboratory	67
Lecture	84
Question-answer	42
Drama	8
Modeling	25
Technology	50
Daily life experiences	17

Table 5. Percentages of Epistemological Beliefs.

Epistemological belief dimensions	Naive	Moderate	Sophisticated
Certain knowledge	0	5	95
Innate ability	0	64	36
Source of knowledge	18	55	27
Quick learning	9	18	73
Simple knowledge	0	27	73

source of the sound that they heard. Students play "ear to ear play" and so they were active in the learning environment. (Hale, constructivism)

Teacher usually do lecturing and used textbook in their lesson. Also, teacher used experiments and observation in their lesson. Teacher was active in the class. Students were passive except doing experiments (İlayda, mixed)

The pre-service teachers then supplied information related to the teaching environment in the actual classrooms. The percentages of the types of teaching environments are given in Table 4.

As indicated in Table 4, the observation of the pre-service teachers is that most of the teachers in the classrooms delivered lectures and then used laboratory approaches. All the pre-service teachers mentioned the importance of fostering a constructivist environment for science learning. A sample excerpt is as follows:

The science teacher presented muscle types to the students in the classroom. She used video for presenting the information then she used question-answer technique in the classroom. Although models related to the muscles were present in the classroom, the teacher did not use it. A lot of materials were present in the closet but they are still in the box. I think teacher should do experiments and use models in the classroom. In science teaching, students should be active and several methods and techniques should be used and students learn by experience.

Open-ended Questionnaires on Epistemological Beliefs

The pre-service teachers' responses to the open-ended questions were scored by using the belief classifications: naïve, moderate, and sophisticated. The percentages of the epistemological beliefs are listed in Table 5.

The table indicates that most of the pre-service teachers held sophisticated epistemological beliefs on certain knowledge (95%), moderate epistemological beliefs on innate ability (64%), moderate epistemological beliefs on source of knowledge (55%), sophisticated epistemological beliefs on quick learning (73%), and sophisticated epistemological beliefs on simple knowledge (73%). Sample excerpts are presented below:

Scientific knowledge changes in time because new developments occur by the time goes by and so changes happen. For example, a long time ago, it is believed that the shape of the earth was circle but after time goes by, it is believed that it is not circle. (Certain knowledge, sophisticated)

I think people could be successful by studying hard because every person know something when they born and person develops himself. However, I think that genetic is important for success. I think

some people could have innate ability but they should develop this ability. (Innate ability, moderate)
I think that studying is important for success because person cannot be successful if she did not study. (Innate ability, sophisticated)
If I did not achieve my task, I get help from my colleagues. (Source of knowledge, naive)
If I did not achieve my task, first I examine the task. If I could not achieve it yet, I get help from other people that could help me. (Source of knowledge, moderate)
If I did not achieve my task, first I tried to understand the problem and I admit this problem. Then, I prepare a purpose and plan for achieving this task. I produce alternative ways to achieve this task. I determine my strategy and I apply it. I am happy when I achieved the task. (Innate ability, sophisticated)
I think knowledge construction process could be fast. Time goes fast in new world so every event, every situation happens very fast. (Quick learning, naive)
The construction of knowledge depends on the how knowledge learned. If teacher active, students listened the teacher, there is slow knowledge construction. However, if teacher passive, students were active, knowledge was learned fast. (Quick learning, moderate)
I think the knowledge construction process was slow because the transferring of knowledge to long term memory and good construction takes time. (Quick learning, sophisticated)
Some students view the problem more than one side and they could find more than one answer to the problem. However, some students view the problem and events only one side and they could fine only one answer to the problem. (Simple knowledge, moderate)
Every student has different views toward the world. These different views could be welcome because one problem could have more than one answer. The learning environments could be designed for revealing these different views. (Simple knowledge, sophisticated)

The results of the open-ended questionnaires indicated that the pre-service teachers had mixed beliefs.

Lesson Plans

The analysis of the pre-service teachers' written lesson plans and micro teaching sessions showed that all the pre-service teachers used experimentation and lectures in micro teaching. One of the pre-service teachers used argumentation. Another pre-service teacher stated that he intended to use argumentation in his written lesson plan but did not apply this approach in his micro teaching session. This discrepancy indicates that although the pre-service teachers had sophisticated epistemological beliefs, they did not use constructivist approaches in micro teaching.

Reflective Diaries

When the participants were asked why they did not use constructivist teaching methods in their lesson presentations, their justifications generally revolved around the following statements: the class was only a simulation and that their classmates were already familiar with the topic; they did not have enough materials; the class was very crowded; and classroom management was difficult to accomplish. Some of them stated that although they understand the characteristics of the teaching methods, they are unaware of how these are implemented in actual classes.

DISCUSSION AND CONCLUSION

This study investigated pre-service teachers' epistemological beliefs and teaching practices. The pre-service teachers' epistemological beliefs were mostly sophisticated, and they used some constructivist approaches in their teaching practice. These findings are attributed to the fact that in the university where the pre-service teachers were studying, pre-service teachers were generally instructed with a constructivist approach that focused on their epistemological beliefs. The reason of this result could be that pre-service teachers could be familiar with the properties of constructivist teaching approach, and they all know that this approach is a better approach for the development of student learning (because in the faculty all instructors emphasize the importance of this approach). In addition to this, in the present study, pre-service teachers were instructed about epistemological beliefs and so they used constructivist approach. For example, pre-service teacher having sophisticated beliefs believe that knowledge is tentative and so he/she designs his/her teaching method accordingly. In the present study, pre-service teachers epistemic belief in "science" was developed by using teaching approach promoting epistemological beliefs in the course taught in educational faculty. Also, pre-service teachers' classroom observation reports demonstrated that epistemological belief in "knowledge production" (i.e. constructivist) was developed. Besides this, pre-service teachers' reflective diaries showed that their belief about science teaching was promoted. Like Sandoval and Çam (2011) suggestion that students' epistemological beliefs can be promoted by using teaching methods that center on the promotion of epistemological beliefs; in the present study, the pre-service teachers implemented a teaching method that

advanced their epistemological beliefs and so their epistemological beliefs were promoted. Under this method, the pre-service teachers were provided articles related to the teaching method, which was to be presented the following week. In class, the teaching method was discussed in terms of its properties, usage in class, and the advantages and disadvantages of using the approach. During the discussion, the instructor emphasized epistemological beliefs. Thus, the pre-service teachers understood the importance of students' and teachers' roles in class. They also reported having experienced such importance in their classes.

As indicated in the science learning histories, all the pre-service teachers' views (except those of three teachers) on teaching practices are underlain by constructivism. The classroom observation reports indicated that all the pre-service teachers recognize the importance of fostering a constructivist environment for science learning. The results of the open-ended questionnaires revealed that the pre-service teachers held diverse beliefs for each epistemological belief dimension. The analysis of the pre-service teachers' lesson plans and micro teaching showed that the pre-service teachers did not use different teaching methods in their micro teaching sessions. Similar to the respondents of Mansour (2013), those of the present study held mixed beliefs for each epistemological belief dimension. All the pre-service teachers were aware of the importance of sophisticated epistemological beliefs, but they could not regularly incorporate these in their teaching practice. An important requirement, therefore, is to simultaneously develop and incorporate sophisticated epistemological beliefs into instruction. This goal can be achieved by using constructivist approaches.

Similar to the beliefs of the participants in Cheng et al.'s (2009) study, those of the pre-service teachers in the current work affected their classroom practices. In the present study, most of the pre-service teachers had sophisticated epistemological beliefs and used constructivist approaches in instruction. Conversely, a few of the pre-service teachers had naïve epistemological beliefs and used traditional approaches in teaching. For some of the pre-service teachers, however, this study found no positive relationship between the pre-service teachers' epistemological beliefs and their teaching practices. For example, some pre-service teachers held sophisticated epistemological beliefs, but they used traditional instruction methods. Brownlee, Purdie, and Boulton-Lewis (2001) stated that these inconsistencies can be attributed to pre-service teachers' transition from naïve beliefs to sophisticated beliefs. Given this situation, an essential task is to observe pre-service teachers' teaching practices in other periods of their career because they can use constructivist approaches in later periods.

The results on the pre-service teachers' written responses to the learning histories, open-ended questions, and classroom observations demonstrated that most of the teachers had sophisticated epistemological beliefs. However, their lesson plans and reflection papers did not demonstrate the existence of such views. Like Viholainen, Asikainen and Hirvonen (2014) study, the present study suggested that the teacher education programs should focus on students' epistemological beliefs. Even as the pre-service teachers demonstrated sophisticated epistemological beliefs, they used traditional strategies in instruction. Thus, it could be stated that like Chinn et al. (2011), students could develop tacit epistemological beliefs because they could not describe the knowledge. The result of the present study could lead to suggest that pre-service teachers' epistemological beliefs could be investigated by using different frameworks such as Chinn et al. (2011) view. The findings of the present study showed that the pre-service teachers recognize the importance of epistemological beliefs and the development of such perspectives in science education. This result is similar with Kittleson (2011) study and the author found that third grade students' epistemological beliefs were developed by using instruction focusing on the development of epistemological beliefs. The results of the present study are important in that they facilitate understanding of the importance of teaching methods that focus on pre-service teachers' epistemological beliefs. Although almost all the pre-service teachers understand the importance of experience, laboratory facilities, and constructivism, they generally did not use these for their presentations. Thus, teaching programs that encourage the use of such components should be designed for pre-service teachers. Furthermore, longitudinal studies on pre-service teachers' epistemological beliefs and teaching practices should be carried out. Also, this study could be conducted with pre-service teachers having different disciplines such as mathematics, science, chemistry pre-service teachers. Then, whether there is difference between the relation between these pre-service teachers' epistemological beliefs and teaching practices, could be investigated. Further research can also be devoted to primary pre-service teachers of other grade levels and primary teachers working at schools. The present study is qualitative one and so there are some limitations. First, the result of the present study were depended on the properties of the participants of the present study. And the result of the present study cannot be generalizable to the population. However, in the present study, by using qualitative approach, in depth explanations were obtained about pre-service teachers' epistemological beliefs and teaching approaches.

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