

Pre-service Elementary Teachers' Preferences and Competencies in Relation to Inquiry-based Instruction and High Quality Questions

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ABSTRACT This study investigates pre-service elementary teachers' preferences and competencies related to the design of inquiry-based instruction and the posing of questions in science lessons. The three Lesson Plans (LPs) that pre-service teachers created were analyzed for their preferences in terms of the types of instruction and questions. The pre-service teachers completed two forms inquiring about their preferences. Volunteer participants in focus groups were then interviewed about their general preferences. The results of this study reveal that pre-service elementary science teachers' general preferences were for active direct instruction, didactic direct instruction, and guided inquiry. In most of their lessons plans they employed didactic direct and active direct instruction. The results indicate that pre-service teachers' beliefs influenced their choice of instructional design. Even as they write better questions, they seem to have difficulty asking high-level questions in microteaching activities, limited, no doubt, by unfamiliarity with questioning techniques and lack of teaching experience.

INTRODUCTION

Inquiry-based instruction has been regarded to be an effective teaching method in which students investigate questions and gather data as evidence to answer these questions (Crawford 2000). The benefits of inquiry-based instruction are emphasized in literature, such as promotion of scientific literacy (Hodson 1992), increased academic achievement (Balim 2009; Hwang et al. 2015), conceptual development (Minner et al. 2010; Zacharia and Anderson 2003), potential improvement in understanding of science and engagement in science (AAAS 1993; NRC 1996) and increased learning motivation (Hwang et al. 2015).

Considering the advantages of teaching through inquiry, one can conclude that teacher candidates must be trained to have competence in the design and implementation of inquiry-based instruction in their classroom. In order to employ inquiry in their classrooms, teachers must believe the benefits of inquiry and be competent to implement it. However, teachers enter the classroom

with their own beliefs and values. Thus, their preferences and competencies for implementing inquiry-based instruction play a crucial role for the development of teacher education programs.

Gillies and Nichols (2014) reported that although the teachers had positive reflections on their experiences, they also had concerns about the challenges that inquiry imposes, such as directing student discussions and the constraints imposed by the requirements of the curriculum and assessment. The researchers draw attention to teachers' beliefs that they lack the tools to let them teach inquiry science and they point out the importance of teachers' role in implementing inquiry in their science class. They also stress the teachers' role to encourage their students to make investigations and discourses and think critically and reflectively to draw evidence-based conclusions.

Considering the teachers' positive experiences and challenges about inquiry teaching, it seems that investigating pre-service teachers' preferences and competencies to implement inquiry-based instruction in their science class is necessary. However, studies examining teachers' enactment of inquiry in their classroom rarely focus on both their choice of the level of inquiry and the quality of questions posed by the teachers. This research has been carried out to fulfill this requirement.

In the following section the researcher will discuss the term "inquiry," inquiry-based in-

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struction and different types of inquiry that can be employed in a science classroom. Then the researcher will argue about the importance of asking high-level questions during instruction associated with inquiry. The following section is a review of recent literature on inquiry-based teaching. Finally, the researcher will point out the necessity of probing pre-service elementary teachers' competence to design and implement inquiry.

Theoretical Framework

Inquiry-based Teaching

The term "inquiry" is frequently linked with effective science education. Among appearances of the term in the National Science Education Standards (NSES), the following meaning will be considered in this paper. "Inquiry refers to the activities of students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world" (National Research 1996: 23).

Inquiry-based teaching may be pitched at different levels of inquiry, from "structured" inquiry to "open" inquiry. The amount of teacher and student involvement in any activity determines its classification as "full" or "partial." For example, Schwab (as cited in Settlage and Southerland 2007) developed a scale to indicate levels of inquiry in science instruction. Level 0 is the lowest level, at which the teacher retains complete control over questions, methods, and interpretations. At level 1 the teacher still has control over questions and the procedure used to answer them, but interpretation of the results is student generated. At level 2, the teacher determines the question to be answered and the students determine the methods to answer the interpretation of results. At level 3, the students control all three components.

Cobern et al. (2013) developed a scale to indicate levels of inquiry in science instruction and used the term "didactic direct" to describe the sort of structured instruction characterized by direct presentation and explanation of science concepts and principles. Typically, the teacher illustrates the concepts and principles with examples or a demonstration and answers student questions with additional explanations. Other than their questions, there are no student activ-

ities. The "active direct" type of instruction begins like "didactic direct" instruction, but it is followed by a student activity based on the concept or principle presented. "Guided inquiry" includes a teacher-guided exploration of some event or phenomenon that manifests the concept or principle selected for study. "Open inquiry" provides only minimum guidance from the teacher, as the students devise the procedure for exploring the event or phenomenon that manifests the concept or principle. The teacher facilitates the exploration without prescription.

In spite of the centrality of inquiry in the NSES standards, in-service and pre-service teacher education programs often fail to provide teachers with the necessary knowledge and skills to guide inquiry in their classrooms. For this reason, many teachers prefer the "didactic direct" approach in which knowledge is transmitted directly to the students (Hofstein and Lunetta 2004). In light of this information, it can be concluded that pre-service teachers' competencies and preferences and the factors affecting their preferences of instruction must be investigated in order to encourage them to design and implement higher levels of inquiry.

Asking Questions during Teaching

Asking questions is an important part of teaching and learning science in the context of inquiry-based instruction. Questioning is a variant of inquiry-based instruction, as students become engaged in scientifically oriented questions and their teachers become guides in the process of finding the answers (Chin 2006).

Six features of classroom inquiry applicable across grade levels have been identified. These include, learners engage in scientific questions, plan and conduct investigations in response to their questions, gather evidence in the pursuit of answers, propose explanations for evidence, evaluate their explanations in the light of scientific knowledge, and communicate and justify their proposed explanations (Alake-Tuender et al. 2012). Since inquiry begins with a scientific question to be answered through investigation, teachers and students should be capable of asking those questions.

The National Science Education Standards state, "inquiry into authentic questions generated from student experiences is the central strategy for teaching science" (National Research

Council 1996: 31). In order for students to be active learners and independent thinkers, they should be encouraged to pose such questions (Singer as cited in Herscovitz et al. 2012). According to Arzi and White (as cited in Herscovitz et al. 2012), it is possible to teach students to ask the sort of questions that lead to inquiry.

The Institute for Inquiry (2013) has developed workshops focused on the fundamentals of inquiry, one of which is questioning. Its goal is to help teachers develop their students' questioning skills. The workshop suggested ways to let the students raise questions about phenomenon that interests them, to classify their questions as investigable or non-investigable, and then to transform non-investigable questions into investigable questions.

Herscovitz et al. (2012) used five categories to classify students' reflections according to the thinking level. Questions contributing to textual understanding and adding interest to a text are classified as knowledge level. Those that reflect wonder about the usefulness or efficiency of an innovation or application are classified as "application level." Those requiring inquiry related to a scientific topic are classified as "analysis level." Those questions requiring value judgments and appraisal of the value of the research are classified as "critical thinking level." It is evident from Herscovitz and her colleagues' study that the "analysis level" questions may help learners engage in inquiry activities.

Researches on Inquiry-based Teaching

Balim (2009) investigated the discovery learning method, in which fifty-seven seventh grade students were encouraged to create and discuss their own questions, on their academic achievements, retention of knowledge, and perception of learning skills both on cognitive and affective levels. Their results showed that there was a significant difference in favor of the experimental group in terms of all aforementioned variables.

Sadeh and Zion (2009) assessed the level of fifty high school students' inquiry performances through interviews, students' written tasks of their inquiry projects, their logbooks, and reflections. The results of this study revealed that open-inquiry students outperformed other students regarding their inquiry performances in general and in particular the "changes occurring during inquiry" and "procedural understanding".

An opposing conclusion was also reached by Cobern et al. (2010). They conducted a controlled experimental study comparing the effectiveness of inquiry instruction and direct instruction in realistic science classroom environments at the middle school grades in a two-week program. The findings showed no significant differences between the two groups in terms of the students' concept learning. The researchers concluded that the effectiveness of the instruction might depend upon the topic being taught; however, inquiry instruction by its nature is more burdensome to teachers because it requires students do science for themselves. According to the researchers, in direct instruction it is easier to teach the point of view, especially for less-experienced teachers or those who are unconfident about their content knowledge.

Capps and Crawford (2013) examined twenty-six qualified and highly motivated fifth through ninth grade teachers' teaching practice and views of inquiry and NOS by analyzing the teachers' lesson descriptions, classroom observations, videotape data, questionnaires and interviews. The results showed that the teachers had limited views of inquiry-based instruction and the abilities, understandings and features of inquiry were observed in less than half of the classrooms. These results indicate the necessity to investigate pre-service teachers' competence and preference to employ inquiry teaching in their science classes.

In light of the theoretical background, it seems only prudent to develop the competency of pre-service teachers to ask good questions themselves and to expect students to ask the sort of questions that elicit higher-order thinking skills and lead to scientific investigations. However, research examining pre-service teachers' ability to pose that kind of questions is rare. The study presented here examines pre-service elementary teachers' competency to ask such questions in the context of inquiry-based instruction.

Mulder (2007) and Mulder et al. (2006) assigned the competencies of elementary school science teachers to three categories: knowledge, attitudes and skills (as cited in Alake-Tuender et al. 2012). While such clarification is helpful, it also seems necessary to extend the definition of teacher competence to the design of inquiry-based instruction. In a previous study conducted by the researcher and a colleague (Mugalo-

glu and Saribas 2010), the researchers examined pre-service teachers' competence in terms of higher inquiry levels. More recently, a review of the literature highlights the importance of posing higher-level, investigable questions in the context of inquiry-based instruction. Here, the researcher examines the competence to design inquiry-based instruction as a cognitive process, disregarding attitudes. The pre-service teachers' preferences were examined as a separate variable in order to give a detailed picture of their knowledge and their beliefs related to inquiry.

This is a qualitative research study examining pre-service elementary teachers' preferences and competencies related to the design of inquiry-based instruction and the posing of questions in science lessons. It is hoped that the study will contribute to the literature on curricular issues and perhaps guide the development of teacher training courses that have as their outcome the design and implementation of effective science lessons.

Research Aims and Questions

The study addresses two research questions, each of which leading to two other questions.

1. To what extent do the pre-service elementary teachers show a preference for inquiry-based instruction during a science education course?
 - a. What is the inquiry level of the instruction that the pre-service elementary teachers design?
 - b. Which factors affect the level of instruction that the pre-service elementary teachers design?
2. Do the pre-service elementary teachers tend to ask questions during instruction?
 - a. Are the questions asked by pre-service elementary teachers' investigable questions?
 - b. What thinking levels are elicited by the questions asked by pre-service elementary teachers?

METHODOLOGY

Research Design

The participants were told at the outset that they would create three lesson plans during the study. The treatment was implemented over 17

weeks. The participants were randomly assigned to two sections of the course, each composed of approximately same number of students, each taught by the researcher, and each covering the same topics using the same instructional method.

Participants

Sixty-three students enrolled in the Science and Technology Education course of the Elementary Teacher Education Program of a private university in Turkey and participated in the study during the fall-spring semester of 2012-2013.

Instruments and Analyzing Data

Lesson Plans

The participants were asked to create three lesson plans, and the data for this study are derived from these plans. The first and third lesson plans (LP1 and LP3) were created by the participants working alone, while the second (LP2) was created and presented by groups of three or four students. The reports of the LP2 were submitted after the participants presented them in the classroom. LPs were analyzed by the researcher and the second independent researcher on science education regarding the inquiry level of the LPs, the thinking level of the questions that the participants generated and whether these questions were investigable or not. The researchers resolved any conflicts through discussion and additional reading and 100 percent agreements were made on coding the participants' responses.

Reflections

Asked to justify the choices they had made in their lesson plans, the participants answered open-ended questions on two different forms. The first (F1) asked them to explain their choice of instructional method in LP1 and LP2. The second (F2) asked them to explain their preferences related to inquiry in the LPs in general and to list the factors that could affect their preferences. The data was coded and analyzed by the same independent science education researchers. Expert judgment was made during the preparation of these forms. According to the feedback an expert on educational science gave, the questions were revised.

Focus-group Interviews

Focus-group interviews were used in this study based on the assumption that sense making is achieved collaboratively through social interaction. This kind of interview is more likely to require the use of discursive analysis (Wilkinson 2003). Expert judgment was made during the preparation of the questions. Based on the critics and suggestions that the same expert made, the questions were revised.

The researcher conducted one focus group interview with seven volunteers from each section; each lasted over approximately one hour. The interviews were audio recorded, and the data was transcribed then analyzed and coded with the assistance of the same second science education researcher. They resolved any conflicts through discussion and additional audio analysis. The data was analyzed by hand.

Procedure

The students were told at the outset that they would create three lesson plans during the study. They were given general instructions about designing a science lesson for the elementary grades, including writing objectives, employing various learning approaches (behaviorism, cognitivism, constructivism), and posing questions. The types of questions were emphasized upon in the first three weeks. In the fourth week, the students learned about and designed activities related to science process skills and inquiry skills. In the fifth week, they practiced writing lesson plans in small groups and as a whole group discussed the various approaches in the plans, particularly their treatment of inquiry and science processing skills. In the sixth week, they created LP1. Between weeks seven and ten, the groups presented LP2s. During the following three weeks, they learned about the influence of prior knowledge and social interaction on conceptual understanding of science. In the fourteenth week, they were introduced to the four levels of inquiry suggested by Schwab (as cited in Settlage and Southerland 2007) and the four instructional types identified by Cobern et al. (2013). In the fifteenth week they completed F1. In the sixteenth week, they created LP3. In the seventeenth week, the focus-group interviews were made and

all the students in each section completed F2. The whole procedure is summarized in Table 1.

Table 1: Procedure

Week	Teacher	Participants
1	Objectives and designing a LP	
2	Learning approaches (behaviorism, cognitivism, constructivism)	
3	Science process skills and inquiry skills	
4	Information about posing questions during instruction	
5	Practice writing LPs	
6		Creating LP1
7-10		Presenting LP2
11	The role of prior knowledge on learning science	
12	The role of social interaction on learning science	
13	Conceptual understanding	
14	Levels of inquiry	
15		Completing F1
16		Creating LP3
17	Focus group interviews	Completing F2

FINDINGS

The three lesson plans and two open-ended forms were analyzed and coded by the research and an independent researcher of science education. The focus-group interviews were audio recorded, and the same two researchers conducted the analyses of audio recordings.

Research Question 1a

The researcher and colleague independently analyzed the LPs regarding the pedagogical approach that the participants' LPs depended on. The same criteria were applied to each LP. After analyzing 92 participant papers, the percentage agreement of the interpretations was calculated as seventy-three percent. The researchers resolved any conflicts through discussion and additional reading. The percentages of participants working at each level in each of the three LPs are shown in Table 2. These percentages are taken as a measure of their preferences.

As shown in Table 2, the pre-service teachers' preferences are similar in LP1 and LP2. Most preferred to pitch their instruction as didactic direct and active direct in all three LPs, although there are fewer instances of didactic direct instruction in the LP3s. Few preferred guided in-

Table 2: Percentages of preferences

	<i>LP1</i> (%)	<i>LP2</i> (%)	<i>LP3</i> (%)	<i>General</i> (%)
Didactic direct (level 0)	53.97	60.32	44.44	26.98
Active direct (level 1)	33.33	30.16	47.62	34.92
Guided inquiry (level 2)	7.94	9.52	7.94	23.81
Open inquiry (level 3)	4.76	0	0	3.17

quiry and even fewer preferred open inquiry—none at all in LP2 and LP3. In general, the preferences for didactic direct and guided inquiry are similar and trail the number of preferences for active direct. The number who favored open inquiry in LPs was very small.

Research Question 1b

The researcher and colleague analyzed the participants' reflection forms and constructed categories of the questions on two forms independently. The categories were discussed after the first analysis. The categories were constructed and the participants' responses were coded based on the participants' responses. After coding three categories the analyses were compared and a sixty-one percent agreement was calculated between the coding results. Any conflicts were resolved through discussion and additional reading.

The participants were asked in F1 to justify their instructional preferences in LP1 and LP2. In F2 they were asked to identify and justify their general preferences at the end of the course. The factors that affect the participants' preferences are presented in Table 3.

As shown in Table 3, the principal's influence on pre-service teachers' instructional preferences was the topic of the lesson to be taught (30.16% for LP1 and LP2 and 33.33% for topics in general). The next most influential factor was their "usual preference," or, in other words, the methodology they were familiar with (23.81% for LP1 and LP2, and 33.33% in general). Some other factors influenced instructional preferences in general—classroom conditions (17.46%) and student properties, such as grade level, prior knowledge, and readiness (20.63%)—although neither of these two factors had much influence on LP1 and LP2 (1.59% and 4.76%, respectively, as re-

Table 3: Factors that affect the participants' preferences

	<i>LP1 and LP2</i> (%)	<i>General</i> (%)
Topic	30.16	33.33
Usual preference	23.81	33.33
Students' properties	4.76	20.63
Classroom conditions	1.59	17.46
Objectives	1.59	4.76
Exam and presentation	6.35	0
Individual and group work	7.94	0
Limited time	3.17	0
Preparation	3.17	0
Change in point of view	7.94	0
Insufficient pedagogical knowledge	6.35	0
Not specified	4.76	14.29

vealed in F1). Some of the participants' preferences seem to have been affected by the context of the LPs in the course (designing an LP in an exam: 6.35 percent, and individual or group work: 7.94 percent in LP1 and LP2; however, none of the participants indicated that these factors influenced their preferences in general). Some other factors have been identified as the factors affecting preferences (limited time and the opportunity to prepare for the design and presentation of their LPs: 3.17 percent in LP1 and LP2, but 0 percent in general; objectives: 1.59 percent in LP1 and LP2, but 4.76 percent in general). Respectively, 4.76 percent of the participants in F1 and 14.29 percent in F2 did not identify any factors influencing their choice of instructional type.

The focus group interviews allowed the researchers to observe how views are shared, discussed, and supported within the context of debate with others. The researcher aimed to create an atmosphere in which participants could relax, talk freely and enjoy the discussion. So, the researcher avoided interfering in the discussion unless the interviewees digressed.

Two questions were prepared for the interviews, one of which asked the participants' reasons for preferring a certain type of instruction in LP1 and LP2 and the other asked their preferences in general. In order to make the interviewees feel comfortable and free for the discussions after completing F2, they were interviewed in the classroom in the absence of the rest of the class. Chairs were arranged in a circle in order to enable each interviewee to see the whole group. The discussions flowed well, often without need-

ing to ask additional questions. The interviews were conducted in Turkish, and the researchers translated these responses. They transcribed and coded each interview and compared the codes.

The following discussion is a part of the first group interview:

S1a: It depends on my instructor. If the instructor tends to behaviorism, I design my LP in a behaviorist way. I think you tend to behaviorism.

S2a: [Cuts in] I don't think you tend to behaviorism. I designed my LP in didactic direct type because I don't have confidence about my pedagogical knowledge.

S3a: [Approves S2a and adds] I don't think you tend to behaviorism either. I think it's difficult to keep the inquiry level of a lesson high.

S4a: I usually design LP in guided inquiry, independent from my instructors' tendency.

The following discussion is a part of the second group interview:

S1b: I preferred to design my LP in written exam in didactic direct in order not to take a risk because it's easier to design a LP in the lowest level of inquiry.

S2b: We used to be taught by a behaviorist approach. So it's easier to design our LP in direct didactic type of instruction.

S3b: I am confused because of the different view of our instructors. I cannot decide which type of instruction is the best one for teaching.

S4b: [Nods] Neither can I.

It is evident from these responses that preferences for the didactic direct type of instruction are associated with the participants' low self-efficacy beliefs. Some just do not feel confident that they can design LP at higher levels of inquiry. However, external factors such as the topic of the lesson, students' properties, such as their grade level and readiness, and the number of students in the classroom—all mentioned in the reflection forms and the interviews—are also considered to be influential.

The participants themselves were taking a course and were subject to evaluation. For some, their interpretation of the teacher's preferences had some influence on their own preferences. Also mentioned were strategies for visualizing

information and for using daily life events, both believed to be features of effective instruction. Although none of the interviewees mentioned these factors on the reflection forms, their occurrence during the interviews indicates that preconceived beliefs about instruction influence instructional preferences.

Research Question 2a

The researchers analyzed the LPs regarding whether the questions that the participants generated were investigable or not. After the first analysis of the participants' papers, the percentage agreement of their interpretations was calculated as seventy percent.

The questions that can be investigated by doing something concrete such as observing and/or experimenting are classified as "investigable questions", while those that cannot be answered by investigating by using materials and process skills are classified as "non-investigable questions" (Institute for Inquiry 2013).

The pre-service elementary teachers were asked to include questions in all three LPs. Investigable questions accounted for 50.79 percent of questions in LP1, 57.14 percent in LP2, and 71.43 percent in LP3, respectively.

Research Question 2b

The questions appearing in the participants' LPs were analyzed and coded for thinking levels according to criteria adapted from Herscovitz et al. (2012). A question was scored 1 if it required a response at the cognitive level of knowledge (for example, "What is the matter?"); 2 if it required a response at the application or analysis level (the ability to identify problems and draw conclusions) (for example, "How can a toy car speed up or slow down when going along the floor? Design your own investigation and show the movement of your toy car."); 3 if it required a judgment, the value of an idea, or the relationship between objects, facts, or phenomena (the ability to think critically) (for example, "What do you suggest to avoid environmental pollution? List your suggestions by providing evidence."). If there were no questions in the LP, it was assigned the score of 0.

The researcher and colleague analyzed the LPs independent from each other regarding the thinking level of the questions that the partici-

pants generated. After the first analysis of the participants' papers, the percentage agreement of the interpretations was calculated as sixty-three percent. The percentages of questions at these four levels are shown in Table 4.

Table 4: Percentages of thinking levels found in questions

	Thinking level 0 (%)	Thinking level 1 (%)	Thinking level 2 (%)	Thinking level 3 (%)
LP1	15.87	25.40	46.03	12.70
LP2	4.76	50.80	39.68	4.76
LP3	0	28.57	49.21	22.22

Table 4 shows an increase in higher thinking levels throughout the duration of the course. However, the thinking level of the questions in LP2 seems to be quite different from those in LP1 and LP3. About half of the participants asked questions requiring a response at the knowledge level and 39.68 percent asked questions at the application or analysis level, while very few (4.76 %) asked a question at the highest level.

DISCUSSION

The results of this study, during which pre-service elementary science teachers created three lesson plans, reveal that their general preferences at the end of the Science and Technology Education course were for active direct instruction, didactic direct instruction, and guided inquiry. Almost none of them claimed a preference for open-inquiry instruction. In most of their lessons plans they employed didactic direct and active direct instruction. Very few were able to design and implement a lesson plan employing guided inquiry instruction. These findings are consistent with the literature showing that elementary teachers have difficulty in designing and implementing inquiry-based instruction (Lee et al. 2004; McDonald and Songer 2008; van Zee et al. 2005).

Interviews with the participants showed that low self-efficacy beliefs about inquiry-based teaching and their beliefs concerning the planning/teaching context also influence their instructional preferences. This result is consistent with the findings of a study by DiBiase and McDonald (2015) that pointed out teachers' concerns, such as those that their students will not be able to master basic skills to implement inquiry,

how their students behave during collaborative activities and that they should perform lab work with known outcomes, and so on. These researchers believe that teachers' negative beliefs as well as their lack of knowledge hinder the use of inquiry. Thus, pre-service teachers' beliefs about themselves and the learning environment should also be considered in the planning of teacher education programs.

Pilitsis and Duncan (2012) advocated that building awareness amongst the pre-service teachers of their beliefs by the help of discussions is significant for changing their beliefs. Lalor et al. (2015) also suggested reflective practices enabling students to make sense of their knowledge. Although the teacher candidates reflected their beliefs in the study presented here, it didn't seem to succeed enough to change their instructional preferences in favor of inquiry.

Questioning is one of the most common strategies for teaching science. As such, it is crucial to consider to what extent engaging students with questions facilitates learning science (Shapiro 2015). The study presented here went beyond this consideration and investigated pre-service elementary teachers' competency to ask high-quality questions in the context of inquiry-based instruction.

In this study the quality of the pre-service teachers' questions improved throughout the course. Teacher candidates are more likely to ask investigable questions as their knowledge and experience increase. However, even as they write better questions, they seem to have difficulty asking high-level questions in microteaching activities, limited, no doubt, by unfamiliarity with questioning techniques and lack of teaching experience. The results of this study are consistent with the findings of another research by Bektas and Sahin (2007), which shows that the fifth grade elementary school teachers use mainly factual or recall questions. These researchers conclude that the teachers must be provided with a practical and continuing training about questioning in their pre-service training in order to develop their questioning skills. The study presented here aimed to achieve this purpose.

"Students should develop an understanding of the enterprise of science as a whole—the wondering, investigating, questioning, data collecting and analyzing" (NRC 2013: 96). In order for teachers to employ inquiry in their classrooms and develop such an understanding in

their students first, they must develop such an understanding.

CONCLUSION

Considering the findings of this study, it can be concluded that pre-service teachers have difficulty in designing and implementing high levels of inquiry during teaching science. The pre-service teachers' reflections also indicate that their beliefs influenced their choice of instructional designs. One can therefore conclude that the beliefs of pre-service elementary teachers' should be known and taken into consideration in planning teacher education programs. Besides preference for inquiry-based instruction, the pre-service teachers should acquire the knowledge and skills to pose high-level, investigable questions that lead to inquiry.

RECOMMENDATIONS

Notably, the course in which this study took place lasted only 17 weeks. Further research over longer periods of time, with greater exposure to inquiry teaching and more opportunities to gain teaching experience, might have greater impact on pre-service teachers' ability to ask questions and plan lessons.

The research presented in this paper investigated the teacher candidates' preferences and competencies in relation to inquiry-based instruction. Further research investigating the effect of pre-service teachers' beliefs on their preference of inquiry-based instruction throughout a course may bring light to this issue.

Understanding the enterprise of science as a whole may lead the pre-service teachers to ask high-level questions and, in this way, design high levels of inquiry during instruction. Thus, teacher-training programs should be designed to let them have such an understanding. The participants of this study were assumed to have such. Overcoming the limitation of this study, researchers investigating the impact of methods in teacher training courses aim at developing an understanding of science as a whole on pre-service teachers' employment of inquiry in their classroom may bring new insight to this issue.

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