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Fen Bilgisi Öğretmen Adaylarının Bilimsel Süreç Becerilerini Uygulama Hakkındaki İnançları: Bir Durum Çalışması

Preservice Science Teachers' Beliefs about Application of Science Process Skills: A Case Study

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Öz

Bu çalışmanın amacı, fen bilgisi dersi öğretmen adaylarının bilimsel süreç becerilerine (BSB) yönelik inançlarının ve bu becerilerin uygulama dersi kapsamında yaptıkları ders anlatımları üzerinden uygulanabilirliğine yönelik inançlarının incelenmesidir. Durum çalışması yaklaşımı bu çalışmada kullanılmıştır. Çalışmanın katılımcıları, uygulama dersini alan öğretmen adaylarıdır. Sonuçlar, öğretmen adaylarının BSB'leri öğretme konusunda yeterli olmadıklarını, fakat bu becerileri anlama konusunda gereken bilgi birikimine sahip olduklarını göstermiştir. 200 ders planının incelenmesi sonucunda toplam 77 ders planının öğretmen merkezli yaklaşımlara göre hazırlandığı ve genelde temel BSB'lerin geliştirilmesinin ders amaçları olarak belirlendiği bulunmuştur. Öğretmen adaylarının BSB'ler ve bunların uygulanabilirliği hakkındaki inançları, geliştirilen bir model ile gösterilmiştir.

Anahtar Sözcükler: Bilimsel süreç becerileri, fen bilgisi öğretmen adayları, ilköğretim

Abstract

The purpose of this study was to investigate preservice science teachers' (PSTs) beliefs about scientific process skills (SPS) and application of SPS during microteaching session. A case study approach was used. Participants were elementary PSTs enrolled in the practice teaching in elementary education course. Findings revealed that PSTs were not proficient in teaching SPS to students, however, their beliefs about SPS were found as satisfactory. After examining 200 lesson plans, it was observed that 77 of the lesson plans were prepared based on teacher-centered teaching methods and included basic SPS in their lesson plans and tried to develop these skills in students. A model was developed to explain factors that may influence PSTs' beliefs of SPS and their application.

Keywords: Science process skills, preservice science teachers, elementary education

Introduction

Developing scientific skills, or scientific process skills (SPS), is accepted as a main goal of the science education (Bybee & DeBoer, 1993). The scientific method, scientific thinking, and critical thinking are the terms have been used at various times to describe these science skills. Most recently the term "science process skills" is commonly used by researchers (e.g., Brotherton & Preece, 1995). Students, like scientists, use SPS to construct knowledge, to think on problems, and to formulate the results. According to researchers, students' failure in science can be attributed to not using SPS effectively. In the literature there is a strong relationship between students' science achievement and use of SPS (e.g., Shayer & Adey, 1993).

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In the past, SPS could be explained with a multilevel model; however, others believed that SPS have a two-level hierarchy (basic and integrated skills) (Brotherton & Preece, 1995). In this study SPS were classified in two different forms; these are basic SPS and integrated SPS. Basic SPS consist of observing, using space/time relationships, inferring, measuring, communicating, classifying, and predicting. Integrated SPS consist of controlling variables, defining operationally, formulating hypotheses, interpreting data, experimenting, formulating models, and presenting information. Our accepted classification also showed parallelism with new Turkish elementary science curriculum, which was revised by Ministry of National Education (MoNE) in 2004. In light of the inclusion of the new dimensions in science curriculum, the course name was changed from "science" to "science and technology". The science and technology course aims to increase students' science literacy by enabling them to master seven areas. These are: (1) the nature of science and technology, (2) key science concepts, (3) SPS, (4) the relation of science, technology, society, and environment, (5) scientific and technical psychomotor skills, (6) the values constructing the essence of science, and (7) attitude and values toward science (MoNE, 2004). In here SPS are categorized under three headings. These are planning, experimentation, and analyses and interpretation. Planning includes most basic SPS, while experimentation and analyses and interpretation include both basic and integrated SPS. The skills associated for each category were similar to the skills we highlighted above.

To integrate appropriate SPS into their courses and successfully implement curriculum reforms, teachers should be proficient in using their own SPS as well as in teaching SPS to students. Unfortunately, there is little information available about teacher' proficiency in using and teaching SPS. However, studies related to teachers' experiences with inquiry and nature of science (NOS) provide some information about teachers' practices with SPS in their courses. For example, in the U.S., national science standards have been recently revised to focus on implementation of inquiry teaching approaches in science classrooms (National Research Council (NRC), 1996). According to the National Science Education Standards, students' use of "appropriate scientific processes and principles in making personal decisions" is accepted as an important cornerstone in science teaching (NRC, 1996, p.13). Inquiry is defined as "a multifaceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in light of experimental evidence; using tools to gather, analyze, and interpret data; proposing answers, explanations, and predictions; and communicating the results" (p. 23). From this definition it is clear that, inquiry emphasizes the use of basic and integrated science process skills (SPS) such as observation, collecting data, experimenting etc. in learning scientific knowledge. In the same way Lederman, Abd-El-Khalick, Bell, and Schwarts (2002) determined eight basic characteristics of NOS as (1) the empirical nature of scientific knowledge, (2) observation, inference, and theoretical entities in science, (3) scientific theories and laws, (4) the creative and imaginative nature of scientific knowledge, (5) the theory-laden nature of scientific knowledge, (6) the social and cultural embeddedness of scientific knowledge, (7) myth of the scientific method, (8) the tentative nature of scientific knowledge. Similar to the inquiry based teaching approach, NOS also reflects the characteristics of SPS in that it includes observation and inference skills and skills related to scientific method ("observe, compare, measure, test, speculate, hypothesize, create ideas and conceptual tools, and construct theories and explanations" Lederman et al., 2002, p. 501). Based on above information one can conclude that NOS and scientific inquiry both give emphasis on use of SPS such as observation, inferences and knowledge generation in science. Thus, studies on inquiry teaching approach and NOS were helpful in understanding the teachers' proficiencies with and beliefs about SPS and implementation of these skills in their classrooms.

Without focusing on the development and use of SPS, which is the main ingredient of inquiry based instruction, teachers tend to "teach only the knowledge aspects of science, emphasize vocabulary rather than balance knowledge claims with knowledge generation and evaluation, and present science as the method of understanding the world (Gess-Newsome, 1999, cited in Gess-Newsome, 2002, p. 56). Studies related to preservice science teachers' (PSTs) effectiveness in teaching inquiry-based instruction revealed important information about their competencies in using SPS and developing their students' SPS. Eick and Reed (2002) found that PSTs were better in implementing inquiry based instruction if they had strong inquiry role identities based on previous experiences with learning through inquiry teaching and knowledge about strategies for inquiry based teaching. They were better in encouraging their students to work together, ask questions, carry our investigations, and sharing and discussing data. PSTs without inquiry identities could not implement effective inquiry based instruction. Similarly Windschitl (2003) supported that little is known about teachers' knowledge about inquiry process skills. They found that earlier experience with inquiry based instruction was the most important parameter for PSTs to implement inquiry instruction of any kind (open ended, guided or structured) in the classroom.

The effective use and teaching SPS in inquiry oriented courses related to PSTs early experiences with inquiry learning experiences. Roth (1999) studied with 25 PSTs and found that teachers had difficulties in posing research questions and identifying variables as operationally that resulted in having incorrect measurement.. Instead of using their results to support or fail to support their hypothesis they used them to proof the causal relationships among the variables (cited in Windschitl, 2003). Regarding NOS, studies indicated that, preservice teachers recognized the importance of observations of natural world for scientific knowledge, but many of them (75%) did not demonstrate the importance of inferences, which scientists draw to construct scientific explanations (Abd-El-Khalick & Akerson, 2004). In the same way, another study showed that more than half of prospective teachers did not distinct observation and inferences form each other. For instance, they stated about atomic structure is discovered by means of direct observations of phenomena not inference by scientists (Akerson, Abd-El-Khalick, & Lederman (2000). These studies revealed that PSTs had problems with using and implementing SPS.

In light of aforementioned studies, one can assume that teachers may have enough knowledge and capability in teaching SPS. Being unsuccessful in developing their own SPS may lead PSTs to have inadequate beliefs about and practices of SPS. Teacher education programs prepare PSTs to enact reform-based instruction in science. With the latest wave of curricular reforms, it is important that PSTs are needed to be prepared to help their students develop SPS. Teacher education programs, however, cannot simply assume that their students can developed these skills themselves. Thus, it is necessary to investigate this matter during teacher education programs to better help PSTs to develop their SPS during their teacher education programs. At this point it is necessary to point out how we operationalized beliefs in this study. Preservice teachers' beliefs about what makes an effective teacher shape their instructional practices. According to Pajares (1992, p. 316) educational beliefs can be defined as "beliefs about confidence to affect students' performance (teacher efficacy), about nature of knowledge (epistemological beliefs), about causes of teacher's or student's performance attributions, locus of control, motivation, writing apprehension, math anxiety), about perceptions of self and feelings of self-worth (self-concept, self-esteem), about confidence to perform specific tasks (self-efficacy)." Pajares (1992) suggest that preservice teachers' educational beliefs are an important parameter in gaining and understanding of the knowledge necessary for teaching and learning. In this study all these beliefs characteristics were considered while understanding participants' beliefs regarding SPS teaching and practicing it. Similar definitions of beliefs was also considered in Turkish context by different researchers (e.g., Yalaki, 2010; Özyalçın-Oskay, Erdem, Yılmaz, 2009)

The purposes of this study were to determine PSTs' beliefs about SPS and to explore factors that may influence their SPS teaching practices.

Method

Research Approach

The practice teaching in elementary education course, which was offered during the spring semester of 2006, represents the case of this study. Fourth year PSTs took this course. The course provided opportunities for PSTs to observe and participate in teaching activities in selected cooperating schools and university. Thus, PSTs who took this course had high potential to provide necessary data to answer our research questions. According to Merriam (1998), researchers in case studies are interested in "process rather than outcomes, in context rather than a specific variable, in discovery rather than confirmation" (p.19). This study can be characterized as interpretive case study (Merriam, 1998) because our purpose was to provide a rich and thick description about the PSTs' beliefs and teaching practices about SPS by considering the practice teaching course context as a whole.

Participants and the Study Context

A total of 50 elementary PSTs enrolled in two sections of the course whoseages ranged between 21 and 23. As being in the same cohort, all of the participants had similar background for taken science and education courses. The practice teaching in elementary education course consisted of both a theoretical part (methods of teaching) at the university and practical part (field experience) at the cooperating schools. During the theoretical part the PSTs met at the university once a week for 2 hours. For practical part, PSTs spent a total of 60 hours, 6 hours per week in their placement schools. In each section the PSTs were assigned to their own science units. From their units the PSTs were required to prepare 4 lesson plans by using the lesson plan format prepared by the course instructor. For each lesson plan PSTs were asked to use different teaching methods and include SPS objectives highlighted in the currently implemented science curriculum. In the curriculum SPS were categorized under three headings: planning, experimentation, and analyses and interpretation (MoNE, 2004). These categories and associated SPS can be seen in below:

Planning: Observation, Comparison- classification, Inference, Prediction/ Estimation, Defining variables

Experimentation: Hypothesizing, Planning an experiment, Recognizing and using equipments and materials, Designing an experiment, Controlling and changing variables, Operational definition, Measurement, Data collection, Recording data

Analyses and Interpretation: Analyzing data and modeling, Interpretations and conclusion, Presentation

Through micro-teaching two of these lesson plans were implemented during class meetings at universities. Each lesson plan presentation took 20-25 minutes. Throughout their field experience the PSTs were required to teach at least three lesson plans. Those lesson plans were prepared based on the mentor teachers' lesson plan format. Each PSTs was observed in one of their macro teachings.

Data Collection

In order to gain in-depth information about the case, we relied on "multiple sources of information" (Creswell, 1998) interviews, observations, and lesson plans. Interviews with 19 PSTs constituted the main data collection strategy of this study. The interview protocol and observation protocol was prepared by the researchers by considering the highlighted issues in the literature. Other data collection methods and procedures are summarized in Table 1. Similar to micro-teachings macro teaching was also observed. Only 3 students gave permission to use their macro teaching observations in this study. However, since these PSTs used their mentor teachers' lesson format, they hardly included SPS objectives in their plans. Thus, these observations did not provide rich information for the purpose of this study. The number of participants varied in different parts of the data collection procedure (Table 1) because their participation to each part of this study was voluntarily.

Table 1.

Data Collection Sources, Types, and Procedure

Data Sources	Types of Data Collection Methods	Number of PSTs	Data Collection Procedure
Primary Data Sources	Individual Interviews	19	All interviews were carried out individually in the scheduled time after their first micro teaching. Each lasted 30-40 minutes and audio taped.
	Lesson Plan Analyses	50	Each PST prepared four lesson plans during the semester. Totally 200 lesson plans were analyzed.
	Observations		
	Micro teachings	41	Micro teachings were observed and two researchers filled observation sheets separately.
Secondary Data Sources	Discussion	40	After micro teachings researchers and PSTs discussed their teaching during 10-15 minutes.
	Macro Teachings	3	Macro teachings were observed

Data Analyses

Data analyses in a case study research are generally aimed at providing an intensive and holistic description about the case. In this study, researchers tried to make sense of data obtained from interviews, observations, and lesson plans. In this study, interpretations were made based on codes and categories and a model developed by them. Constant comparative method of data analysis (Glaser & Strauss, 1967) was used for interview and observation data. In this method the researchers followed steps: first units of data or meaningful segment of a data were placed under a category, where they share the most common characteristics. This process is also called open coding. Second, the researchers interconnected the categories with each other based on their characteristics (axial coding). During the third and final stages (selective coding) the researchers examined uniformities among categories and their properties to build a model. Two researchers established 80% inter-rater reliability for interviews and observations. Disagreements were resolved through discussion.

Lesson plans were analyzed by using the outline developed by MoNE (2004) to identify the SPS written by PSTs in their lesson plans. The PSTs used this outline in preparing their lesson plans.

Results and Discussion

The qualitative analysis of data yielded a total 5 sub categories that are summed under two main categories. These categories were participants' beliefs and teaching practices about SPS.

Beliefs about SPS

Content or SPS: PSTs perceived that SPS are related to content. They proposed two opposing ideas. In one idea they argued that teaching SPS should be the main focus of science courses.

Therefore, by using their SPS students can learn science content better in their science courses. In another one PSTs supported the idea teaching science content should be the main focus. They believed that when learning science content students can develop their SPS.

Among the participants 89% (17 PSTs) indicated that teaching SPS are more important than teaching content knowledge. Most of the PSTs whom we interviewed believed that when students learn to develop and use their SPS then they can use these skills to better learn the science content during their science courses. One of the PSTs clarified his idea with an analogy. He argued that when we think SPS as a car then the content will be its fuel oil. The following quote is representative of this view:

S1: I believe that SPS are definitely more important [than content]. If I explain everything to my students they will only memorize the concepts. If we teach how they can conduct an experiment [by using their SPS] they will be more successful in learning science.

Of 17 PTS 12 of them argued that if students gain necessary SPS it would be easier for them to learn the new science content by themselves. In other words, gaining necessary SPS helps students become independent learners.

S1: Developing SPS lead to independent learner. Students can comprehend and link the science concepts better by using their SPS. Moreover, they will be able to learn the new knowledge by themselves. Otherwise they will depend on their teacher to learn science.

For the opposing idea 47% (9) of the PSTs believed that SPS can be taught while teaching the content. They stated that while students are learning content knowledge they can develop necessary SPS.

S3: Students gain SPS while I am teaching the content. For example, while teaching specific science content I led them to develop their skills related to observation.

Even though during interviews the PSTs emphasized two opposing ideas and most of them supported the former one, our micro teaching observation data revealed that the majority of the PSTs gave emphasis to teaching content and several of them accomplished in attaining their SPS objectives. Most PSTS (28) implemented teacher-centered teaching methods (such as lecturing). Of these PSTs, 15 of them successfully attained some of their SPS objectives included in their lesson plans during their micro teachings and 13 of them successfully attained all of their SPS objectives. However, student-centered teaching methods (such as inquiry) were implemented by 13 PSTs. Among these PSTs, all SPS objectives were successfully attained by 4 PSTS, partially attained by 5 PSTs and not attained by 6 PSTs. Thus, we can say that more than majority of PSTs (63%) had difficulty in attaining their SPS objectives during micro teachings. Lederman and Gess-Newsome (1991) and Mellado (1998) found that student teachers give emphasis to content and activities rather than behavioral objectives while planning their lesson plans. In Mellado's (1998) study, out of four student teachers, only one of them gave emphasis to behavioral objectives written in the curriculum in her lesson plans, other three planned their lesson plans based on content. Lederman and Gess-Newsome (1991) found that during their student teaching experience preservice teachers "rarely mentioned the writing of objectives as part of the planning process…. began the planning process by reviewing the subject matter to be taught and then immediately searching for analogies, demonstrations, metaphors, stories, or activities to "best" communicate the content" (p. 450). In this study even though our PSTS were asked to write lesson objectives and SPS objectives while teaching and they gave priority to teaching content. But while teaching content they hardly provide effective learning environment for students to help them develop their SPS especially the integrated SPS. Moreover, almost two decades ago Tobin and Espinet (1989) found that secondary school teachers gave the greatest importance to covering the material stated in the science curriculum by direct explanation of them to students. In our study lecturing was also the most popular teaching methods to teach science among PSTs.

Inquiry and SPS: The PSTs (73 %, 14) also had beliefs about relationships between SPS and inquiry. They argued that learning SPS help students think like a scientist.

S2. SPS can help students think like a scientist because SPS aimed to teach students what scientists think and do while conducting their studies.

S3. Determining a problem, doing observations, differencing, and hypothesizing are the skills scientists use for their studies.

As it was indicated in the introduction section of this paper inquiry based teaching may not be meaningful without using science process skills. In this study quite large amount of PSTs realized the importance of this link. Cavallo (2007) tried to understand how students link inquiry and SPS. During a science course students were encouraged to think and act like a scientists by conducting inquiry based science activities. The main ingredient of this course was to enable students to use their science process skills. During activities the students used science process of observing, incorporating ideas and views of others, negotiating, and making connections to prior knowledge and experience. At the end of the activities the students realized that "they are in fact scientists, equipped with an understanding and scientific thinking and nature of science" (p. 88). This study revealed that students are ready to see the relationship between inquiry and SPS. Since our PSTs already see this link, we may conclude that these teachers will be successful when they provide environment to students to relate inquiry and SPS.

Meaningful Learning and SPS: The participants argued that SPS will help students to learn concepts meaningful rather than rote memorization. The relationship among critical thinking and SPS was also indicated by 68 % (13) of the participants of this study. Students, like scientists, need to construct their knowledge while learning scientific concepts. This relationship was also emphasized by 57 % (11) of the participants as below:

S14: When we transmit the knowledge to students through verbal explanations, students tend to memorize this knowledge. However when students construct their knowledge by themselves, they accomplish meaningful learning. In other words, when we give a man a fish, he will eat for a day. But if we teach how to fish, he will eat fish for the rest of his life. Similarly if we teach students how to learn knowledge then they learn to reach the information when they needed.

Meaningful learning or gaining necessary SPS are also important for students to cope with daily life issues. Of the PSTs 52% (10) of the PSTs argued that SPS are not only necessary to learn science but also necessary for social life.

S10: In Turkey most of the students will not have a chance to enter universities. Thus from elementary school to high school students should learn to use their SPS to better cope with the things that they will come across in their daily life. Especially in the elementary schools the purpose of the science should be teach SPS.

This quotation also highlighted that students should start to learn to use their SPS in elementary school. It will be too late to teach SPS at high school and university education. Of the 73% (14) PSTs believed that students should gain SPS during elementary school rather than high school or university.

Teaching practices: Methods, content, and SPS

Results revealed interesting relationships among methods, content, and SPS practices. Of the participants 42% (8) of them argued that content identifies the type of methods they used and 36% (7) of them argued that type of methods identified the type of SPS they attained during their teaching.

Methods and Content: The PSTs stated that based on the subject matter such as biology, chemistry, and physics they decided to select appropriate methods. For example, when they taught biological concepts they felt themselves comfortable teaching with expository methods.

S4: I defined my method according to content. I separated [content] based on physics, chemistry and biology then defined the methods.

S5: Biological concepts can be best taught with expository method because there is knowledge and you need to transfer it to students.

Methods and SPS: Interestingly, the selected method influenced the type of SPS included in the lesson plan. For example, for traditional teaching methods such as lecturing PSTs used basic SPS skills. However, when they implemented laboratory methods they included basic and integrated SPS skills.

S5: Different types of methods need different types of SPS. Diverse SPS are not used while teaching with expository method.

S6: Laboratory method can be seen as higher level than other methods because it needs usage of different types [basic and integrated] of SPS.

Above quotations revealed two important pieces of information. First PSTs preferred to use teacher-centered teaching methods (such as lecturing and demonstration) to teach biology concepts. Moreover, they stated that for teacher-centered methods they generally used basic SPS. On the contrary for student-centered methods (such as inquiry and laboratory) they both used basic and integrated SPS.

Micro Teachings and Lesson Plans: In this course, in each section, 25 units were assigned to PSTs. Of these units 7 were belong to biology, 7 were belong to chemistry, 9 were belong to physics, 1 was belong to astronomy. Analyses of 200 lesson plans revealed that 77 of the lesson plans were prepared based on teacher-centered teaching methods. As opposed to the above interview results for biology, this finding showed that PSTs also used teacher-centered teaching methods for other subject matters. Demonstration was the next commonly used teacher-centered method in their lesson plan. We argued that if we did not force PSTs to use different methods, number of lecturing will be more than what we observed in this study. Discovery, inquiry, discussion were moderately preferred by PSTs. Analogy, cooperative work, and questioning were less preferred by PSTs. Very few PSTs selected project-based, technology-based, field trip, and V-diagram methods in their lesson plan. Micro teaching and lesson plan analysis revealed that PSTs had difficulty in including and attaining SPS related to analysis and interpretation categories. This situation gets worst for the SPS included in the experimentation category. For example, the PSTs, who presented laboratory lesson plans, did not let their students to develop hypotheses, define and control variables, and design an experiment. In most cases they gave the materials to students and expect them to answer the questions in their work sheets. Griffiths and Thompson’s (1993) and Beaumont-Walters and Soyibo’s (2001) studies, summarized in the introduction section, stated that PSTs might not develop these SPS. This could be a reason of unsuccessful practices with SPS in this study.

Conclusion and Implications

The model (Figure 1) developed for this study shows the relationships among main codes and categories that may shape PSTs’ beliefs of SPS and their practices with it. In this framework arrows show the direction of the relationships. The thickness of the arrows emphasizes the strength of the relationships based on the frequencies we obtained. The outer circle includes the main categories of the study, which are beliefs, inquiry teaching, and teaching practices.

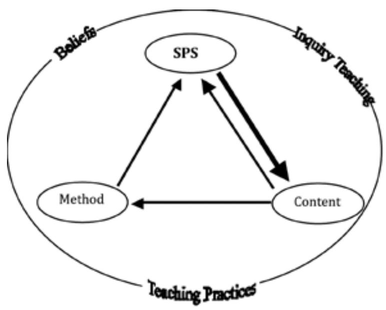

Figure1. A Model for Factors Affecting SPS.

Even though relationship between inquiry teaching and SPS were categorized under PSTs' beliefs, issues raised for this relationship may in relationship with PSTs' preferences about content, method, and SPS. For example, related to inquiry teaching, most of the PSTs argued that SPS are important for students to think like a scientists. To accomplish this, teachers should implement student-centered methods to help their students to learn the concepts meaningfully, rather than rote memorization. Meaningful learning through scientific investigation will let students to understand the process of science and how scientists' work, which is an important issue for inquiry based teaching. We thought that this beliefs might influence PSTs' selection of content, method, and SPS. Issues raised in the big circle shaped PSTs' selection of method, content, and SPS. Finally size of the letters is also important. For example "teaching practices" is in larger type than beliefs and inquiry teaching. Based on our findings we found that teaching practices shaped the use of SPS, content, and method more than other categories.

Inside the outer circle, types of content influenced types of SPS that PSTs used and vice versa. Moreover, selected method influenced the types of SPS that used in lesson plans. PSTs decided their method based on content that they taught. For example, when they teach biology they chose expository methods.

This study revealed that there are some areas of tension for PSTs about SPS, content, and method. These areas of tensions include: whether to teach SPS or content; whether to choose method for SPS or SPS for method; whether to choose content for method or method for content. Thomas, Pedersen, and Finson (2001) argued that process skills, content knowledge and skills about student-centered and teacher-centered methods are important issues in implementing effective science instruction. Since all these mentioned tensions related to effective teaching, these conflicting areas need to be addressed during teacher education programs. Furthermore, PSTs had difficulty in application of SPS with student-centered methods. Thus, they mostly chose expository methods of teaching.

The PSTs' beliefs about SPS revealed that they hold well acceptable ideas about SPS. For example, they thought that SPS help students think like scientist, be independent learner, do meaningful learning, and do inquiry learning. However, during their micro teachings they rarely addressed these issues. We propose several reasons to explain this contradictory situation. First, as we discussed above PSTs do not have enough experience about teaching with student-centered methods. Second, PSTs mainly gave importance to content knowledge objectives more than SPS objectives. Finally, we observed that PSTs had lack of content knowledge. When they felt that they did not know the content well, they did not let their students to do science activities. Many researchers argued that preservice teachers do not master science concepts well and in depth (e.g. Ginns & Watters, 1995; Rice & Roychoudhury, 2003. Poor science knowledge decreases teachers' confidence to teach science with student-centered methods rather they prefer direct transmission of knowledge from textbooks (Appleton, 1995; McDiarmid, Ball, & Anderson, 1989).

Researchers found that while planning and teaching their lesson plans, student teachers concerned lesson objectives related to conveying subject matter, (content), but not to science process skills (Lederman & Gess-Newsome, 1991; Mellado, 1998). In this study PSTs gave the biggest significance to attaining content based objectives rather than SPS objectives. The reason of this could be for our PSTs is experiencing text-based, expository teaching methods in their science lessons during their elementary, middle, high school, and even in college education (Tobin, Briscoe, & Holman, 1990).

Studies conducted in nonwestern cultures may also enrich and develop the available knowledge on this matter. Keys and Bryan (2001) argued that it is imperative to collect data about "teachers' beliefs, knowledge, practices, and student learning from teacher designed inquiry instruction" (p.642) in different research contexts. Data from variety of contexts might be useful in realistic implementation of inquiry based teaching by using necessary SPS.

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