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A Study on the Student Teachers' Acquisition of Science Process Skills

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Abstract

Problem statement: For individual and social life to be in line with the information age, the individual should have such characteristics as being able to access information, maintain a scientific point of view on events, and being able to analyse and evaluate events. This can only be achieved by teaching students about the skills involved in the scientific process skills. The research pointed out that teachers, who are expected to teach science process skills, often have inadequate science process skills themselves. This study aims to provide insight into student teachers' skills and the factors affecting these skills.

Purpose of Study: This study aims to determine student teachers' level of science process skills (SPS) and to investigate how and why these skills change across academic program and gender.

Methods: This study's data were collected from 150 final-year university students who were in biology, chemistry, general science and physics education programs in a state university in Izmir in Turkey, by using the relational survey method to explore relationships among the variables in the study. The research instruments of the study were Personal Information Form (PIF), Science Process Skills Scale (SPSS) and Science Process Skills Questionnaire Form (SPSQF). The SPSS was a scale of 20

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items with a KR-20 of 0.67. The SPSQF consisted of four open-ended questions dealing with the extent to which science process skills are part of classroom and laboratory activities. The quantitative data from the SPSS was analysed through t-tests, ANOVA and Scheffe tests. A five-level grading scale, which was based on the maximum score from the SPSS, was used in determining the average SPS level of students in various programs.

Findings and Results: According to the five-level grading of the SPSS, the physics education program obtained the highest score. The analyses of ANOVA indicated that there was a significant difference among the student teachers' science process skills in favour of physics education. The data from the SPSQF showed that classes in the physics program had the highest number of classroom and laboratory activities that introduced science process skills. There was no statistically significant gender difference in science process skills ($p > 0.05$), but the mean skill level of girls was slightly higher than that of the boys.

Conclusions and Recommendations: This study found that the levels of the science process skills of student teachers were "medium" and "good," and that there were statistically significant differences by program. It is believed that the source of this difference is the number of activities aiming at science process skills that each program implements. In the study, we did not find any statistically significant difference by gender.

In order to raise individuals who have adequate science process skills, we need to create an environment where students can actively participate in learning process. Therefore, in science teaching, students should be encouraged to implement science process skills in the classroom and to construct scientific knowledge through their own scientific investigations.

Keywords: Science process skills, student teachers, curriculum, teacher education

Rapid developments in science and technology have resulted in fundamental changes in individual and social life, by affecting the needs and priorities of individual and society. Now, individuals have to have a variety of skills in order to adapt to complicated daily life; in the "Information Age," as the 20th and 21st centuries are known, it has become increasingly important to have a proactive attitude towards the acquisition, analysis and synthesis of knowledge, in order to navigate the array of technology and vast amount of information that surrounds us.

In order to foster students' science process skills, we need to create a learning environment in which individuals actively participate in the learning process. Açıkgöz (2007) compares a traditional classroom environment with an active one, and states that individual should be an active participant of the learning process if we want her/him to have effective communication skills, to be creative, to be able to solve complex problems, and to think effectively. Therefore, in science education by inquiry, students should be encouraged to use science processes and reach conclusions through their scientific investigations. When students make a scientific investigation, not only they should generate scientific knowledge, but they should also develop skills to think scientifically and generate knowledge by using scientific processes if necessary (Bağcı-Kılıç, 2003).

Science process skills are fundamental skills that make science learning easier, develop students' understanding of research methods, make students active, help them develop a sense of responsibility for their learning, and improve their efficiency in learning (YÖK/MEB Development Project, 1997). Ostlund described science process skills as the most powerful tools we have to produce and organise the knowledge about our world (cited in Aydoğdu, 2006). According to Lind (1998) science process skills are thinking skills we use in producing knowledge, thinking about problems and formulising outcomes. According to Taşar, Temiz and Tan (2004), science process skills are fundamental skills which facilitate learning in science, develop an understanding of research methods in students, make sure that students are active participants in learning process, develop a sense of responsibility in their learning, and improve efficiency in learning.

Science process skills in science education have been defined and investigated by many researchers. Brotherton and Preece (1995) divided these abilities used in scientific investigations into two process skills; basic and integrated. The main basic process skills are observation, measurement, classification, prediction and inference. The integrated process skills, which are more advanced cognitive and psychomotor abilities, include formulating hypotheses, controlling variables, defining operationally, experimenting, and modeling. In a study named "Science- A process Approach," which was developed by "The American Association for the Advancement of Science" (AAAS) between 1963-1974, science process skills were divided into two groups: basic science process skills and integrated science process skills (McCain, 2005).

Science process skills can be classified as basic processes (i.e., observation, measurement, classification, data recording, and number and space relationships), casual processes (i.e., prediction, identifying variables, interpreting data and inferring), and experimental processes (i.e., hypothesis development, using data/formulating model, making experiment, manipulating and controlling variables, decision-making) (YÖK/MEB Development Project, 1997). According to Saat (2004), science process skills can be classified as either basic science process skills or advanced science process skills. In addition to these classifications, it was claimed that the skills investigated under "science process skills" are actually the skills that everybody uses (see, for example, Millar, 1994; Millar & Driver, 1987; Tolmann & Hardy, 1999). Millar (1994) claims that science process skills are cognitive skills used for a lifetime, even by people without any formal education.

Although various researchers classify science process skills in different ways, the definitions of these skills themselves are not different. Science process skills have a hierarchical structure, but this structure is not a rigid one. Despite this difference, we cannot dismiss the importance of science process skills in science education. "Science process skills constitute the basis of being able to do scientific research (Aydoğdu, 2006; p: 29). Furthermore, science process skills include the skills which can be used by each individual at every level of everyday life to be scientifically literate, and to improve her/his quality of life through understanding the nature of science (Harlen, 1999).

There are many studies investigating the level of science process skills and their relationships with different variables. In a study with 96 third year prospective primary school teachers, Ateş (2004) examined students' initial level of understanding of the identification and control of variables, and explored the efficiency of inquiry-based learning to teach science process skills. He administered four inquiry-based activities to a group of students, and found that students' science process skills improved after completing these activities.

In a study with ninth- and tenth-year biology students, Germann (1994) investigated the relationships between science process skills and parents' education, preferred language, gender, science attitude, cognitive development, academic ability, and biology knowledge. It was found that while academic ability, biology knowledge and preferred language had direct effects on science process skills achievement, the factors of cognitive development, parents' education, science attitude had indirect effects on science process skills achievement. Padilla, Okey and Dillashaw (1983) explored the relationship between advanced process skills and secondary school students' scientific thinking abilities. They found that there was a statistically significant relationship between scientific thinking abilities and advanced process skills.

In a study with 100 prospective science teachers, Aydoğdu, Yıldız, Akpınar, and Ergin (2007) looked at the gender and school year differences in science process skills and the relationship between academic performance and science process skills. It was found that there was a statistically significant difference between science process skills and school year, and that academic performance was positively related to science process skills, albeit at a medium level. Şaşmaz and Tatar (2006) also investigated the relationships between science process skills of prospective science teachers, and gender and academic performance. They reported a gender difference in science process skills, and positively related these skills to academic performance.

Beaumont-Walters and Soyibo (2001) investigated Jamaican high school students' level of performance on five integrated science process skills, and studied whether there were statistically significant differences in their performance that could be linked to their gender, grade level, school location, school type, student type and socio-economic background (SEB). They found statistically significant differences in students' performance based on their grade level, school type, student type, and SEB. There was a positive, statistically significant and fairly strong relationship between their performance and school type, but weak relationships among their student type, grade level and SEB and performance. Kanlı and Yağbasan (2008) explored the effects of the 7E learning cycle and deductive laboratory approaches on first-year university students' science process skills in an introductory physics laboratory. The study focused on the skills of defining variables, defining operations, hypothesis development and identification, interpreting graphics/data, and research design. They found that the 7E learning cycle and deductive laboratory approaches were effective in developing science process skills. Gender differences in science process skills were investigated among ninth-year students (Temiz, 2001), high school students (Beaumont-Walters & Soyibo, 2001), and primary school students (Arslan, 1995). While some studies did not report gender differences in science process skills (Aydoğdu, Yıldız, Akpınar & Ergin, 2007), some reported a gender difference in favour of girls (Şaşmaz & Tatar, 2006; Temiz, 2001), and some found a gender difference in favour of boys (Arslan, 1995).

In other studies, researchers looked at teachers' effects on students' science process skills (Ewers, 2001), and the relationship between teachers' science process skills and students' performance (Aiello-Nicosia, Sperandeo-Mineo & Valenza, 1984). Ewers (2001) investigated the effects of teacher-directed and learning cycle methods and teacher characteristics on students' science process skills. They found that teachers had substantial effects on students' possession of science process skills. Aiello-Nicosia et. al. (1984) explored the relationship between the science process skills of 35 teachers (ages 29-42) and the academic success of 780 primary school students, and found a statistically significant positive relationship between them. The fact that there is an association between teacher possession and use of science process skills, and student academic success, raises the question of how to foster science process skills for prospective teachers in different teacher education programs. Therefore, this study aims to identify prospective science (biology, chemistry, physics and general science) teachers' level of science process skills and to explore the differences in these skills according to program and gender. In this way not only will we identify the prospective science teachers' general state of science process skills but we will also show the science process skill sub-categories in which they are inadequate, as well as the programs in which they are registered. We expect that this line of investigation will be useful for the program development studies in this field.

Method

This section will provide information about the population, sample and methodology of the study. The investigation has been carried out by the descriptive survey method. The relational survey method, which belongs to the family of the descriptive survey methods, was used to explore the relationships between the variables in the study (Karasar, 2007).

Sample

The population of the study consists of prospective biology, chemistry, physics and general science teachers at the Buca Educational Faculty (BEF) in the İzmir province in Turkey. The sample consisted of 150 prospective biology, chemistry, physics and general science teachers attending their last classes in the 2007-2008 academic year at the BEF, Dokuz Eylül University. Of the 150 student teachers in the sample, 81 (59.33% of the sample) were female, and 69 (40.67% of the sample) were male. Of the 150 student teachers, 23 (15.33% of the sample) were registered in biology education program, 13 (8.66% of the sample) were registered in the chemistry education program, 48 (32% of the sample) were registered in the physics education program, and 66 (44% of the sample) were registered in a general science education program.

Research Instruments

Quantitative and qualitative survey methods were selected as the investigation model to collect data. The data were collected through a Personal Information Form (PIF), Science Process Skills Scale (SPSS) and Science Process Skills Questionnaire Form (SPSQF). The PIF were used to collect gender and program information. The SPSS was a scale of 20 items with a KR-20 of 0.67, and measured the following skills: observation, developing a hypothesis, identifying variables, planning experiments, measurements, inferring, and interpreting a data-formulating model (Yıldırım, 2010). The student teachers were given one point for each correct answer, so the maximum score for the SPSS was 20 points. The scores were categorized as "not developed" (0-4 points), "under-developed" (5-8 points), "medium" (9-12 points), "good" (13-16 points), and "very good" (17-20 points). The sub-categories were graded as shown in Table 1. The levels of the science process skills of the student teachers were determined by this grading scale.

Table 1

Grading Scale for the Sub-Categories

Level	Observation	Developing hypothesis	Identifying variable	Planning experiment	Measurement	Inferring	Interpreting data-formulating model
Not developed	0-0.19	0-0.6	0-0.3	0-0.7	0-0.3	0-0.6	0-0.9
Under-developed	0.20-0.39	0.7-1.2	0.4-0.7	0.8-1.5	0.4-0.7	0.7-1.2	1.0-1.9
Medium	0.40-0.59	1.3-1.8	0.8-1.1	1.6-2.3	0.8-1.1	1.3-1.8	2.0-2.9
Good	0.60-0.79	1.9-2.4	1.2-1.5	2.4-3.1	1.2-1.5	1.9-2.4	3.0-3.9
Very good	0.80-1.0	2.5-3.0	1.6-2.0	3.2-4.0	1.6-2.0	2.5-3.0	4.0-5.0

Four open-ended questions in the SPSQF were used to collect information from two instructors and five student teachers about the classroom and laboratory activities used to introduce and develop science process skills.

The statistical software package, SPSS 13.0, was used to analyse the quantitative data from the SPSS through the calculations of mean, standard deviation (SD), t-test, and ANOVA statistics. The quantitative data from the SPSQF were analysed by placing the responses in the main categories (see Table 5). The results from the analysis of the SPSQF were compared with the qualitative findings from the SPSQF, and the differences in the overall results and the sub-categories of skills were interpreted and some suggestions were made.

Findings

The mean values of the SPSS items were presented in Table 2.

Table 2

Mean Values of the SPSS

Sub-categories of SPS	Number of questions	Maximum score	$\overline{X}$ (Mean)
Observation	1	1	0.78
Developing hypothesis	2	2	0.95
Identifying variable	3	3	2.26
Planning experiment	4	4	2.05
Measurements	2	2	1.64
Inferring	3	3	1.41
Interpreting data-formulating model	5	5	3.56
Total	20	20	13.18

Note: SPS is for science process skills

The mean of the SPSS was 13.18 out of 20 (see Table 2). The grading scale developed indicates that the student teachers had a good level of science process skills. When we look at the sub-categories, we realise that the students were "good" in the skills of *observation* and *identifying variables,* but "under-developed" in the skill of *developing hypothesis*. While they were "medium" in the skills of *planning experiment* and *inferring,* they were "good" in the skills of *measurement* and *interpreting data-formulating model*. Table 3 presents the mean values of the scores from the SPSS by program.

The mean of the SPSS was 15.70 for the physics education students, 13.93 for the general science education students, 11.63 for the chemistry education students, and 11.46 for the biology education students (see Table 3). These means suggest that the level of the science process skills was "good" for the physics and general science education students, "medium" for the chemistry and biology education students. In the sub-categories, the level of the *observation* skill was "very good" for the physics and general science education students, and "good" for the chemistry and biology education students. The level of the *developing hypothesis* skill was "medium" for the physics education students, "under-developed" for the general science and chemistry education students and "not developed" for the biology education students. The level of the *identifying variable* skill was "good" for the physics, general science and biology education students and "medium" for the chemistry education students. The level of the *planning experiment* skill was "good" for the physics and general science education students, "medium" for the chemistry and biology education students. The level of the *measurement* skill was "very good" for the physics, general science and biology education students, "good" for the chemistry education students. The level of the *inferring* skill was "medium" for the physics, general science and chemistry education students and "under-developed" for the biology education

Table 3
Mean Values of the SPSS by Program

Programs	Physics education	Chemistry education	Biology education	General science education
N (The number of student teacher)	48	13	23	66
Observation	0.8	0.7	0.7	0.95
Developing hypothesis	1.29	0.76	0.52	0.89
Identifying variable	1.45	0.93	1.16	1.48
Planning experiment	2.98	1.73	1.86	2.79
Measurement	1.86	1.46	1.66	1.78
Inferring	1.74	1.61	1.26	1.53
Interpreting data-formulating model	4.52	3.0	2.13	3.76
$\overline{X}$ (Mean of totals)	15.70 (SD: 2.71)	11.63 (SD: 2.56)	11.46 (SD: 2.51)	13.93 (SD: 2.71)

Note: SD is for standard deviation

students. The level of the *interpreting data-formulating model* skill was "very good" for the physics education students, "good" for the general science and chemistry education students and "medium" for the biology education students. Table 4 presents the ANOVA analysis of the SPSS total scores by program.

The analyses indicated that there was a statistically significant difference in science process skills among the student teachers, in favour of the physics education students. Through similar analyses, the analyses of the sub-categories indicated that a positive outcome existed at *the level of observation* in favour of the general science education program when compared to the physics education program, at *the level of developing hypothesis* in favour of the physics education program compared to the general science education program, at *the level of identifying variable* in favour of the physics education program when compared to the chemistry education program, and in favour of the general science education program compared to the biology and chemistry education programs, at *the level of planning experiment* in favour of the physics education program compared to the other programs, and at *the level of interpreting data-formulating model* in favour of the physics education program compared to the other programs. There was no statistically significant difference in the skills of *measurement* and *inference*. Table 5 presents the SPSQF data for introducing and teaching the SPS.

Table 4
The ANOVA Analysis of the SPSS Total Scores by Program

	Source of variance	Sum of squares	SD	Mean of squares	F	p (p<0,05)	Meaningful difference (According to Scheffe test)
Observation	Between groups	7.161	3	2.387	4.793	.003	Between P and GS
	In groups	72.712	146	.498			
	Total	79.873	149				
Developing hypothesis	Between groups	10.452	3	3.484	9.048	.000	Between P and GS
	In groups	56.221	146	.385			
	Total	66.673	149				
Identifying variable	Between groups	14.030	3	4.677	6.740	.000	Between P and C, GS and C, GS and B
	In groups	101.303	146	.694			
	Total	115.333	149				
Planning experiment	Between groups	15.476	3	5.159	7.099	.000	Between P and C, B, GS
	In groups	106.097	146	.727			
	Total	121.573	149				
Measurement	Between groups	.784	3	.261	.771	.512	
	In groups	49.489	146	.339			
	Total	50.273	149				
Inferring	Between groups	2.278	3	.759	1.786	.152	
	In groups	62.095	146	.425			
	Total	64.373	149				
Interpreting data formulating model	Between groups	95.933	3	31.978	28.638	.000	Between P and C, B, GS
	In groups	163.027	146	1.117			
	Total	258.960	149				
Total	Between groups	354.776	3	118.259	16.561	0.000	Between P and GS, C, B Between GS and C, B
	In groups	1042.557	146	7.141			
	Total	1397.333	149				

Note: P is for physics education students, C for chemistry education students, B for biology education students, and GS for general science education students

Table 5

The data from the Science Process Skills Questionnaire Form

Program	Classroom and laboratory activities for introducing the SPS	Classroom activities for teaching the SPS	Laboratory activities for teaching the SPS	Laboratory evaluation activities for teaching the SPS
Physics education	*Direct courses*: Special Education Methods I-II *Indirect courses*: Practice Teaching, School Experience I-II, Instructional Technology and Material Development, Analysis of Secondary Education Textbooks	Applying the SPS to secondary school physics courses, discussing the learning outcomes through physics laboratory observations, manufacturing simple and cheap tools, designing experiments, doing projects, method of problem solving, preparing visuals	A few closed-ended or open-ended experiments	Questions before experiment, interview after experiment, reporting experiment outcomes, written half-term exams, evaluation based on application in some laboratory courses
General science education	*Direct courses*: Laboratory Applications in Science and Technology, Special Education Methods II, Methods of Scientific Investigation	Problem-based learning appropriate for the constructivism, project-based learning, demonstrations, observations	A few closed-ended, open-ended or investigative experiments	Reports of observations and experiments during term, assessment with scales, half-term practical exams
Chemistry education	*Direct courses*: Special Education Methods II, *Indirect courses*: Practice Teaching, Some laboratory courses	Problem-based learning appropriate for the constructivism, project-based learning, learning through experiments	Closed-ended or open-ended experiments	Questions before experiment, interview after experiment, reporting experiment outcomes, written half-term exams, evaluation based on application in some laboratory courses
Biology education	Laboratory Applications, Special Education Methods II	Case studies in pure science courses, solving problems, project-based learning	A few closed-ended or open-ended experiments	Assessment of laboratory reports and/or written exams

The physics education program was the program with the largest number of classroom activities for introducing and teaching science process skills. The general science education program was the only program which offered the 'Methods of Scientific Investigations' course. Table 6 presents the mean science process skills by gender (out of 20).

Table 6

t-test Results of the SPS by Gender

Gender	N (Number of student)	$\overline{X}$ (Mean)	SS	t	p
Female	89	15.1	3.36	1.518	0.13
Male	61	14.3	2.74		

Note: SS is for standard deviation

There was no statistically significant gender difference in the science process skills. However, the girls' mean score was a bit higher than the boys' mean score. Although it was not seen in Table 6, the analyses of the sub-categories indicated that the girls were better than the boys only regarding the *identifying variable* skill.

Conclusions and Recommendations

This study found that science process skills were "medium" and "good" for the student teachers (see Table 2), and that there were statistically significant differences in SPS among the programs (see Tables 3 and 4). The physics education program had the highest SPS mean score (15.70) in the programs. However, it was found that the students found some SPS difficult to learn and apply, since these SPS required advanced level cognitive and motor skills (Griffiths & Thompson, 1993; Germann & Odom, 1996; Ateş & Bahar, 2004). One of these skills is the skill of identifying and controlling variables. The literature suggests that this skill is not used at the stages of problem-solving and decision making, and it is more difficult to learn this skill compared with the other science process skills. It was found that the students were "good" in the *identifying variable* skill, but "under-developed" in the *developing hypothesis* skill. On the basis of the SPSQF data, it appears that the reason for this situation is that the students do not use open-ended or investigative activities very often in laboratory courses in such a way that could improve this skill. In this study, although there were no statistically significant differences between *measurement* and *inference*, there was a statistically significant difference in favour of the physics education program in *developing hypothesis*, *identifying variable*, *planning experiment*, and *interpreting data-formulating model* skills. We believe this difference in the programs is linked to the activities for improving science process skills that the classes in these programs incorporate. The physics education program uses more courses and applications dealing with the teaching of science process skills and the activities related to them than the other programs (see Table 5). We can expect that this situation will cause more science process skills to be acquired. When we look at the sub-category of *observation*, the fact that there is a significant difference in the skill of *observation* between the physics education and general science education programs in favour of the general science education program means that, besides closed-ended experiments, there were more open-ended and investigative experiments in the general science education program compared with the other programs, and the assessments in the program were carried out on the basis of observations in the laboratory activities. To the best of our knowledge, there is not any study investigating the variation of prospective science teachers' science process skills by the program in which they are registered in the literature.

There was not any gender difference in the data obtained in this study (see Table 6). The only observed gender difference was related to the sub-categories, and girls were better than boys in the*identifying variable* skill. Aydoğdu et. al. (2007) could not find any statistically significant gender differences in the science process skills of general science education student teachers. On the other hand, some studies reported that boys had a higher proficiency level than girls in science process skills (Şaşmaz & Tatar, 2006; Temiz, 2001; Beaumont-Walters & Soyibo, 2001; Arslan, 1995).

Açıkgöz (2007) suggested that the individual should actively participate in learning process. We need to create a teaching environment in order to raise individuals with science process skills. Practical tasks are helpful for teaching about the nature of science, the understanding of scientific concepts, and the acquisition of science process skills and advanced level skills (Zuzovsky, 1999). This is because through laboratory activities, students can develop hypotheses, collect and record data, evaluate findings, and make assessments (Tamir, Doran and Chye, 1992). In a study with first-year university students attending an introductory physics laboratory, Kanlı and Yağbasan (2008) found that the laboratory approach based on the 7E model and the deductive laboratory approach were effective in developing science process skills. In science education through investigations, students should be encouraged to take part in the process of doing science, and to acquire scientific knowledge through their own scientific investigations.

Therefore there should be more activities for the introduction and acquisition of science process skills in teacher education programs, and the course contents related to these programs. The differences by program can be investigated by different research instruments and techniques of analysis. We suggest the conduct of similar studies with different samples, in order to generalise from the findings of this study and to make comparisons. In this way we can provide concrete suggestions for science teacher education.

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Öğretmen Adaylarında Bilimsel Süreç Becerileri Kazanımı Üzerine Bir Çalışma
(Özet)

Problem Durumu

Bireysel ve toplumsal yaşamın bilgi çağıyla uyumlu olabilmesi için birey; bilgiye ulaşabilme, bilimsel bakış açısına sahip olma, olayları analiz edebilme ve değerlendirebilme gibi özelliklere sahip olmalıdır. Bu da ancak öğrencilere bilimsel süreç becerileri kazandırılarak yapılabilir. Bu amaçla bilimsel araştırma yoluyla fen öğretiminde, öğrenciler bilim yapma sürecine yönlendirilmeli ve bilimsel bilgileri kendi bilimsel araştırmaları sonucunda oluşturmaları desteklenmelidir. Yapılan araştırmalar, öğrencilere bilimsel süreç becerilerini kazandıracak olan öğretmenlerin kendilerinin de gerekli becerilere sahip olma konusunda sorunları olduğunu ortaya koymaktadır. Öğretmenlerin bilimsel süreç becerileri ile ilgili bilgileri ve bunları kullanmaları ile öğrenci başarısı arasında pozitif bir ilişki bulunmaktadır. Öğretmenlerin bilimsel süreç becerilerine sahip olmaları bu derece önemli iken üniversitelerde yetiştirilen öğretmen adaylarının süreç becerilerine ne düzeyde sahip oldukları ve bu becerilerin hangi değişkenlere bağlı olarak değiştiği de önem kazanmaktadır. Çalışmamızda bu konuya ilişkin bulguların sağlanması hedeflenmektedir.

Araştırmanın Amacı

Bu araştırma ile öğretmen adaylarının sahip oldukları bilimsel süreç becerileri düzeylerini belirlemek, bu becerilerin okumakta oldukları programlar ve cinsiyet değişkenleri açısından değişimini nedenleriyle birlikte incelemek amaçlanmıştır.

Araştırmanın Yöntemi

Araştırmada genel tarama modeli kullanılmıştır. Değişkenler arasındaki ilişkiyi betimlemek üzere genel tarama modellerinden ilişkisel tarama modeli seçilmiştir. Araştırmanın evrenini, İzmir ilindeki tezsiz yüksek lisans ve fizik, kimya, biyoloji, fen bilgisi öğretmenliği lisans programlarında okuyan öğretmen adayları oluşturmaktadır Araştırmanın örneklemini, 2007 – 2008 öğretim yılında DEÜ Buca Eğitim Fakültesi Fizik Eğitimi, Kimya Eğitimi, Biyoloji Eğitimi ve Fen Bilgisi Eğitimi son sınıfında okumakta olan 150 öğretmen adayı oluşturmaktadır. Verileri toplamak amacıyla ölçme araçları seçilirken nicel ve nitel tarama modelleri göz önünde bulundurulmuştur. Araştırmanın verileri, öğretmen adayı Kişisel Bilgi Formu (KBF), Bilimsel Süreç Becerileri Ölçeği (BSBÖ) ve Bilimsel Süreç Becerileri Anket Formu (BSBAF) aracılığıyla toplanmıştır. BSBÖ, güvenirliği 0,67 olan 20 soruluk bir ölçektir. BSBAF ise BSB'nin ders ve laboratuar etkinlikleri içinde ne kadar tanıtıldığına ve edinildiğine yönelik dört açık uçlu sorudan oluşmaktadır. Bu anket formu araştırmanın yapıldığı her programdan iki öğretim elemanına ve son sınıfta okumakta olan beş öğretmen adayına uygulanmıştır. BSBAF'den elde edilen veriler t-testi, tek yönlü varyans çözümlemesi (ANOVA) ve Scheffe testi kullanılarak çözümlenmiştir. Programların bilimsel süreç becerileri düzeyleri belirlenirken BSBÖ'den alınabilecek en yüksek puana göre hazırlanmış beşli derecelendirme ölçeği kullanılmıştır.

Araştırmanın Bulguları

BSBÖ'deki beşli derecelendirmeye göre en yüksek puanı Fizik Eğitimi Programı alırken ardından sıra ile Fen Bilgisi Eğitimi, Kimya Eğitimi ve Biyoloji Eğitimi Programları gelmektedir. Ayrıca tek yönlü varyans çözümlemesi (ANOVA)

incelendiğinde ise öğretmen adaylarının bilimsel süreç becerileri arasında Fizik Eğitimi için anlamlı bir fark olduğu görülmektedir. Bilimsel süreç becerilerine yönelik etkinlikleri içeren BSBAF verilerine göre, bilimsel süreç becerilerini tanıtmaya yönelik Özel Öğretim Yöntemleri I –II, Okul Deneyimi I-II, Öğretmenlik Uygulaması, Öğretim Teknolojileri ve Materyal Geliştirme, Konu Alanı Ders Kitabı İncelemesi dersleri ve becerileri edindirmeye yönelik lise fizik konularına BSB' ni uyarlama, BSB' ne yönelik deney gözlemi, basit ve ucuz araç gereç üretimi, proje hazırlama, kapalı ve az sayıda açık uçlu deneyler, laboratuvar değerlendirme çalışmaları gibi ders içi etkinlikler ile laboratuvar etkinliklerinin en fazla bulunduğu program Fizik Eğitimidir. Fen Bilgisi Eğitiminde ise öteki programlardan farklı olarak Bilimsel Araştırma Teknikleri dersi, kapalı uçlu deneyler, açık uçlu deneyler ve az sayıda araştırmaya dayalı deneyler ile deney çalışmalarının gözlem yoluyla değerlendirilmesi yer almaktadır. Cinsiyet değişkeni açısından incelendiğinde bayan ve bay öğretmen adaylarının BSB kazanımlarında görülen farkın anlamlı olmadığı ($p>0,05$); ancak, bayanların aritmetik ortalamasının baylarınkinden biraz daha yüksek olduğu görülmektedir.

Araştırmanın Sonuçları ve Önerileri

Bu araştırmada öğretmen adaylarının BSB'leri ortalamalarının *orta* ve *iyi düzeyde* olduğu, programlar arasında ise anlamlı farklılıklar gösterdiği ortaya konulmuştur. Toplam sonuçlarda Fizik Eğitimi Programında okumakta olan öğretmen adaylarının BSB'lerinin daha fazla geliştiği görülmektedir. Alt kategorilerde ise *ölçüm yapma* ve *sonuç çıkarma* becerilerinde fark gözlenmezken; *denence geliştirme, değişken belirleme, deney planlama ve verileri yorumlama - model oluşturma* becerilerinin gelişiminde Fizik Eğitimi Programı için anlamlı fark bulunmaktadır. Programlar temelinde ortaya çıkan bu farklılığın, BSB'ne yönelik etkinliklerden kaynaklandığı düşünülmektedir. Alt kategorilerden *gözlem yapma* incelendiğinde, Fizik Eğitimi ile Fen Bilgisi Eğitimi Programları arasında Fen Bilgisi Eğitimi açısından anlamlı bir fark çıkması ise Fen Bilgisi Eğitimi Programında laboratuvar etkinlikleri içerisinde, kapalı uçlu deneyler yanında, öteki programlara göre daha fazla sayıda açık uçlu deney ile araştırmaya dayalı deneyler yaptırılmasından ve laboratuvar çalışmalarının gözlem yoluyla değerlendirilmesinden kaynaklanabileceği düşünülmektedir. Araştırmamızda elde edilen veriler cinsiyet değişkeni açısından incelendiğinde anlamlı bir fark ortaya çıkmamıştır.

Bilimsel süreç becerilerine sahip bireyler yetiştirebilmek için öğrencinin aktif olarak katılabildiği bir eğitim-öğretim ortamı yaratılmalıdır. Bu amaçla bilimsel araştırma yoluyla fen öğretiminde, öğrenciler bilim yapma sürecine yönlendirilmeli ve bilimsel bilgileri kendi bilimsel araştırmaları sonucunda oluşturmaları desteklenmelidir.

Sonuç olarak, öğretmen yetiştirmeye yönelik öğretim programları ve ders içeriklerinde bilimsel süreç becerilerinin gerek tanıtılması gerekse edinilmesine yönelik etkinliklere daha fazla yer verilebilir. Programlara göre farklılığın nedenleri ise farklı veri toplama araçları ve analiz teknikleriyle araştırılabilir.

Anahtar Sözcükler: Bilimsel süreç becerileri, öğretmen adayları, öğretim programı, öğretmen yetiştirme