The investigation of science process skills of elementary school teachers in terms of some variables: Perspectives from Turkey

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Contents

Abstract

Individuals benefit from science process skills while trying to solve problems through research (Bağcı-Kılıç, 2003). To solve these problems individuals must acquire sufficient science process skills. Teachers must be able to understand these skills so that students can obtain the required proficiency (Mutisya, Rotich & Rotich, 2013). This study aims to investigate the science process skills of elementary school teachers in terms of gender, seniority, working place and their students' grades. This quantitative study was carried out as a survey. The study population consisted of 158 elementary school teachers from a province located in the Aegean region of Turkey. Researchers obtained study data from "Science Process Skills Test for Teachers (SPSTFT)". SPSTFT consists of 7 scenarios and 9 questions (multiple choice questions were explained with reasons). The results of the study revealed that the integrated skills of elementary school teachers are not sufficient. It also indicated that science process skill scores of elementary school teachers differed significantly by gender and seniority. This study suggests conducting some further studies to bring the science process skills of elementary teachers to the desired level.

Keywords: elementary teachers, science process skills, seniority, gender, working place

Introduction

The ability to use science process skills (SPS) for everyday problems is important for individuals living in a rapidly developing society. Individuals with these skills have the ability to make a major contribution to the improvement of society. Most individuals develop these skills through formal education and interaction with their teachers. Therefore, teachers play an important role in the development of SPS. However, before investigating the SPS of students, it is useful to study teachers' science process skills and the effect of several variables on these skills.

Science process skills

Students need well organized knowledge in learning process. In addition, Burke (1996) claims that SPS may help students organize the knowledge while they are learning. In fact we know that SPS is related to scientific research process in a way of searching knowledge. In this reason, students should learn the scientific research process (Gay, Mills & Airasian, 2009). The scientific research process can be taught using SPS (American Association for the Advancement of Science, 1989). The scientific research process can be described as identifying a problem, gathering data, analyzing the data, and interpreting the gathered results (Fraenkel & Wallen, 2006). Therefore, scientific research develops students' higher level thinking skills, such as asking questions, doing research, solving problems and communicating affectively (Cuevas, Lee, Hart & Deaktor, 2005). SPS are among the most frequently used thinking skills (Aydoğdu, Tatar, Yıldız-Feyzioğlu & Buldur, 2012; Gagne, 1965), and their acquisition is one of the most important aims of science teaching (Bybee & Deboer, 1993). Therefore, everyone should acquire these skills, not only scientists (Huppert, Lomask & Lazarowitz, 2002). Rillero (1998) emphasized that individual who cannot use SPS will have difficulty succeeding in everyday life. Because the development at science process skills enables students to gain the skills necessary to solve everyday problems (Kazeni, 2005). These skills are not only used during education, they are also used in daily life (Rillero, 1998). Acording to Opateye (2012), individuals using the science process skills have a positive attitude towards science. Researches emphasize that science process skills are highly important for science literacy (Espinosa, Monterola, Punzalan, 2013; Harlen, 1999). Scientific literacy is extremely important in terms of sustainability of the modern society (Turiman, Omar, Daud & Osman, 2011). Ewers (2001) reports that if science process skills are not acquired, students may be unable to acquire science literacy since science literacy is not limited to reading and hearing instead it requires efficient use of science process skills. Therefore, these skills affect the personal, social, and global lives of individuals (Aktamış & Ergin, 2008).

SPS are defined as tools that individuals use to acquire information about the world and order this information (Osborne & Freyberg, 1985; Ostlund, 1992). Tobin & Capie (1982) define SPS as identifying a problem, formulating a hypothesis about the problem, making valid predictions, identifying and defining variables, designing an experiment to test the hypotheses, gathering and analyzing data and presenting rational findings that support the data. These skills are handled in the related literature in two categories: basic SPS and integrated SPS (Burns, Okey & Wise, 1985; Carey et al., 1989; Germann, 1994; NRC, 1996; Rubin & Norman, 1992; Saat, 2004; Wellington, 1994; Yeany, Yap, & Padilla, 1984). Basic science process skills form the basis of integrated science process skills (Padilla, 1990; Rambuda & Fraser, 2004, Rubin & Norman, 1992). While basic SPS include skills like observing, classifying, communicating, measuring, using space/ time relationships, using figures, inferring, and predicting; integrated skills include skills such as identifying a problem, identifying and controlling variables, formulating hypotheses, interpreting data, defining operationally, reading and constructing graphs, and experimenting (Chabalengula, Mumba, & Mbewe, 2012; Germann, Aram & Burke, 1996; Padilla, 1990; Turiman et al., 2011; Yeany et al., 1984). Generally, basic science process skills can be acquired from the preschool period onward while integrated skills can begin to be acquired in secondary (5th -8th grades) school (Ergin, Şahin-Pekmez & Öngel-Erdal, 2005; Tobin & Capie, 1982). Students are in the concrete operational stage during preschool + primary school (1st- 4th grades) while the formal operational stage starts in secondary school. A study conducted by Padilla, Okey & Dillashaw (1983) found that there was a positive and high correlation (r=0.73) between students' integrated SPS and formal operational skills. In this context, when students go to secondary school they are expected to acquire integrated SPS. Acquisition of SPS becomes deeper in higher stages (Çepni & Çil, 2009). However, in order for students to gain these basic and integrated skills at a desired level, the teachers cognitively understand skills (Mutisya et al., 2013).

The role of teachers in the acquisition of students' science process skills

Harlen (1999) reports that the acquisition of SPS at desired level is very important for students, as students who are unable to sufficiently acquires these skills cannot comprehend the world and cannot establish necessary connections. For this reason, teachers should develop students' SPS (Miles, 2010). Having SPS is highly important for the resolution of many problems. For this reason, it can be assumed that SPS and content knowledge complete each other (Rillero, 1998). It is known that teachers should have the required knowledge, understanding and materials to teach SPS (Chabalengula et al., 2012; Miles, 2010). However, some studies found that the SPS of science teachers and elementary school teachers are generally not sufficient (Aydoğdu, 2006; Harty & Enochs, 1985; Karslı, Şahin, & Ayas, 2009; Lotter, Harwood & Bonner, 2007; Pekmez, 2001, Türkmen & Kandemir, 2011) and teachers rarely use these skills in their classrooms (Oloruntegbe & Omoifo, 2000). Lotter et al. (2007) found that teachers did not have sufficient conceptual understanding of SPS. Mutisya et al. (2013) emphasized that the teachers should understand SPS cognitively, in order to get their students gain these skills at a desired level. Studies revealed that teachers having developed SPS teach these skills more actively in their classrooms (Downing & Gifford, 1996) and, thus, develop students' SPS more effectively (Aydoğdu, 2006). To conclude, it is known that teachers should have sufficient SPS and teach these skills to students efficiently (Harlen, 1999; Miles 2010).

The purpose and the significance of the study

Regarding the results of the Trends in International Mathematics and Science Study ([TIMSS], 2011), some Asian countries (Korea, Singapore, Japan, Hong-Kong, China) are successful. As a rapidly developing region, Asia-Pacific countries have similar cultural and societal concepts, traditions, and experiences (Lai, Ye & Chang, 2008). As we know, most of the borders of Turkey are located in Asia. But, Turkey scores low on TIMSS exams. On the TIMSS-1999, Turkey was 33rd among 38 countries in the general ranking, while on the TIMSS-2007 exam, Turkey ranked 31st among 50 countries, and in TIMSS-2011, Turkey ranked 36th among 50 countries for 4th grade students, 21st among 42 countries for 8th grade students. Some questions on this exam were intended to evaluate students' knowledge about scientific research and the nature of science. Turkey was 33rd in this field. The headings under scientific research and the nature of science are the scientific method (formulating a hypothesis, making an observation, inference, generalization), designing experiments (experimental control, materials and processes), scientific measuring (validity, repetition, experimental mistakes, consistency, scale), using scientific equipment, carrying out routine experimental processes, data collection, organization, representation (units, tables, images and graphics), and describing data and interpretation (Bağcı-Kılıç, 2003). The TIMSS-2007 exam included questions that evaluated reasoning skills, including problem solving, conducting analysis and synthesis, formulating a hypothesis, making predictions, designing experiments, and the planning, deducing and generalizing, and evaluating stages of an experiment (Bayraktar, 2010; National Center for Education Statistics-NCES, 2007; NCES, 2011). The TIMSS-2011 questions' content was adapted from the content of TIMSS-2007. These results indicate that in Turkey, primary school students' knowledge of SPS is low (NCES, 1999; 2007; 2011). This was also observed in other studies such as Temiz, 2001; Tan & Temiz, 2003; Aydoğdu, 2006; Çakar, 2008; Hazır & Türkmen, 2008. Studies conducted in Turkey show that students at high schools also had poor SPS (Dönmez & Azizoğlu, 2010; Şen & Nakipoğlu, 2012). The similar situation was also true for the university level (Akar, 2007; Aydoğdu, Yıldız, Akpınar & Ergin, 2007; Aydoğdu, Buldur & Kartal, 2012; Bağcı-Kılıç, Yardımcı & Metin, 2009; Karslı & Ayas, 2010; Özbek, Çelik & Kartal, 2012). Teachers have great responsibilities to develop the SPS of students. To achieve this goal, science process skill levels should be known and effective variables on these levels should be determined. By analyzing studies conducted in Turkey, it can be seen that there are very few studies on science process skill levels of elementary school teachers. Due to this lack of research, this study investigated SPS of elementary school teachers in terms of some variables.

Problem

How do SPS of elementary school teacher differ in terms of some variables?

Sub-problems

1. Are there any significant differences between the basic and integrated skill scores of elementary school teachers?
2. Are there any significant differences between SPS scores of elementary school teachers related to gender?
3. Are there any significant differences between the SPS scores of elementary school teachers regarding their seniority?
4. Are there any significant differences between the SPS scores of elementary school teachers regarding their working place?
5. Are there any significant differences between the SPS scores of elementary school teachers regarding their students' grades?

Method

The design of the study

This quantitative study was carried out as a survey, which possesses three basic characteristics: (1) the collection of data (2) from a sample (3) by asking questions, in order to describe its aspects (Fraenkel & Wallen, 2006).

Participants

The study population consisted of 158 elementary school teachers from villages (N=25), towns (N=39), districts (N=25) and the city center (N=69) of a province located in the Aegean Region of Turkey. Distribution of the participants regarding their gender, seniority and working place is presented in Table 1.

Table 1. Distribution of participants regarding their gender, seniority and working place

Variables		N	%
Gender	Male	88	56
	Female	70	44
	Total	**158**	**100**
Seniority	0-5 years	20	12
	6-10 years	31	20
	11-15 years	31	20
	16-20 years	40	25
	21 and more years	36	23
	Total	**158**	**100**
Working place	Village	25	16
	Town	39	25
	District	25	16
	City center	69	43
	Total	**158**	**100**

Data collection instrument

Science Process Skills Test for Teachers (SPSTFT): SPSTFT arranged by Aydoğdu (2006) was used as the data collection instrument. SPSTFT consists of two chapters which comprised 7 scenarios and 9 questions (multiple choice questions) with 0.70 reliability. In these chapters, answers were explained with reasons. The questions were developed by Enger & Yager (1998) and adapted into Turkish by Aydoğdu (2006). The scenarios were developed by Aydoğdu (2006) through investigating other studies consisting case scenarios (Anonymous, 2006; Dana, 2001; Enger & Yager, 1998; Ergin et al., 2005). In addition, Aydoğdu (2006) emphasized that these seven scenarios were sent to two outside academics, who are expert in science teaching. Aydoğdu (2006) stated that final revisions were made and used in the SPSTFT after he received the outside academics' comments regarding whether the scenarios include and assess the SPS of teachers.

The SPS measured with SPSTFT and maximum scores to be taken from these skills are presented in Table 2.

Table 2. The SPS measured with SPSTFT and maximum scores to be taken from these skills

Questions	Contents of multiple choice questions	Maximum scores to be taken from SPSTFT
1	Observing	2
2	Classifying	2
3	Inferring	2
4	Identifying and controlling variables	2
5	Interpreting data	2
6	Measuring	2
7	Formulating hypotheses	2
8	Experimenting	2
9	Experimenting	2
Total		18
	Scenario	
10	Observing	4
11	Experimenting	4
12	Formulating hypotheses and Identifying variables	4
13	Formulating hypotheses and Identifying variables	4
14	Classifying	4
15	Measuring	4
16	Experimenting	4
Total		28

Each participant earns 1 point if they mark the correct multiple-choice answer and another 1 point if she/he justifies his or her answer. Totally, each participant can earn 2 points from the multiple-choice test at maximum. Scenarios are twofold: short-response and open-ended. The short-response scenarios have four sub-categories and each of these sub-categories scored as 1 point. In other words, a participant can earn 4 points from a short-response scenario at maximum. Correspondingly, open-ended scenarios, one of which is given above, are scored as 4 points. So, the maximum total score of this test is 46. As seen in Table 2, the SPS measured by SPSTFT are doing observation (1 multiple choice item and 1 scenario), classification (1 multiple choice item), inferring (1 multiple choice item), controlling variables (1 multiple choice item, 2 scenarios), interpreting data (1 multiple choice item), measuring (1 multiple choice item), hypothesizing (1 multiple choice item) and fair testing (2 multiple choice items and 1 scenario). As seen in Table 3, skills measured with SPSTFT are analyzed individually as basic and integrated skills.

Table 3. Distribution of questions in SPSTFT according to basic and integrated skills and maximum scores

	SPS	Question number	Question type	The score for each question	Maximum Score depending on the question number
Basic SPS	Observing	1	Justified multiple choice test	2	2
		1	Scenario	4	4
	Classifying	1	Justified multiple choice test	2	2
		1	Scenario	4	4
	Measuring	3	Justified multiple choice test	2	6
	Inferring	1	Justified multiple choice test	2	2
	Total	8			20
Integrated SPS	Formulating hypotheses	1	Justified multiple choice test	2	2
		2	Scenario	1	2
	Identifying and controlling variables	1	Justified multiple choice test	2	2
		2	Scenario	3	6
	Experimenting	2	Justified multiple choice test	2	4
		2	Scenario	4	8
	Interpreting data	1	Justified multiple choice test	2	2
	Total	9			26
	Overall Total	16			46

As seen in Table 3, the basic skills of SPSTFT are “observing”, “classifying”, “measuring” and “inferring” and the integrated skills of SPSTFT are “formulating hypotheses”, “identifying and controlling variables”, “experimenting” and “interpreting data”.

Data analysis methods

Analysis of the data obtained from the SPSTFT was conducted in two stages. In the first stage, SPSTFT were evaluated by two researchers individually. This analysis was conducted to obtain quantity data via open-ended scenario questions in the test. In order to ensure reliability, the tests were analyzed individually by two researchers during the SPSTFT evaluation. First, researchers analyzed 25 participants' tests individually. The qualitative data gathered from the scenarios were analyzed by two researchers and the consistency between the researchers was found to be 0.87. A sample scenario (and its ratings by the two authors) from the SPSTFT is given in Table 4. Finally, all the data were analyzed by two researchers individually and the coefficient of agreement was calculated as 0.93, which is quite reliable (Miles & Huberman, 1994).

Table 4. A sample scenario (and its ratings by the two authors) from the SPSTFT

Scenario: Engin and Hasan wonder whether heat transfer rates of two different metals are same or not. For this purpose, they took copper and aluminum wires of different thicknesses but equal length and heated the two wires at the same point with equal amount of candle wax. Do you think that Engin and Hasan would reach a correct conclusion through this experiment? If not, how would you design an alternative experiment to serve their purpose?

Sample Response of a teacher to the scenario and its ratings by the two experts.

Statement of Elementary school teacher	**Initial Differences**		**Consensus Result**	
	Field expert-1	**Field expert -2**	**Field expert -1**	**Field expert -2**
They would not reach a correct conclusion, because in order to do a controlled experiment one should change only one independent variable. If more than one independent variables are changed, then it would not be a controlled experiment. Same thing is happening in this scenario, because both the length and kind of the wires are different. Instead, in this experiment, only the kind of the metals has to be changed and other variables have to be kept the same.	Correct	Partially correct	Correct	Correct

In the second stage, the distribution of SPSTFT scores in each group was tested with normality tests. As distribution was found to be normal, the t-test and one-way analysis of variance (ANOVA) were decided to be used. The t-test was used to detect whether SPSTFT scores of elementary school teachers differ by gender and one way analysis of variance (ANOVA) was used to detect whether these scores differ by seniority and their students' class level. In addition, ANCOVA test was used to detect whether the SPS of elementary school teachers differ by working place or not.

Results

Scores that elementary school teachers obtained from basic and integrated skills of SPSTFT are presented in Table 5.

Table 5. Scores that elementary school teachers obtained from basic and integrated skills of SPSTFT

SPS	Highest score	M	Success percentage (M/Highest score)	Std. Deviation
Basic SPS				
Observing	6	2.37	% 39	1.95
Classifying	6	4.04	% 67	1.70
Measuring	6	3.59	% 59	1.60
Inferring	2	1.01	% 50	0.83
Total	20	11.03	% 55	3.91
Integrated SPS				
Formulating hypotheses	4	2.01	% 50	0.72
Identifying and controlling variables	8	3.04	% 38	2.27
Experimenting	12	5.93	% 49	3.30
Interpreting data	2	1.48	% 74	0.58
Total	26	12.47	% 48	5.06
Overall Total	46	23.50	% 51	7.99

As it can be seen in Table 5, elementary school teachers' success percentage (level of success) of basic skills and integrated skills were 55 % and 48 % respectively. These results indicate that elementary school teachers' basic skills were better than their integrated skills.

A t-test was performed on dependent variables in order to detect whether the difference between basic and integrated skills were significant or not and the results are presented in Table 6.

Table 6. T-test results of basic and integrated SPS scores of SPSTFT

Measuring	N	M	Std. Deviation	Result
Basic Skills	158	0.55	0.19	t : 3.28
Integrated skills	158	0.48	0.19	Sig: 0.000* P<0.01

As seen in Table 6, it was found that there was a significant difference between the basic and integrated skill scores of elementary school teachers (t (157)= 3.28, $p<0.05$), and this difference was in favor of basic skill scores.

The results of t-test performed to detect whether there was a difference between total scores of basic and integrated skills, and overall science process skills of elementary school teachers according to their gender are presented in Table 7.

Table 7. T-test results of basic and integrated skills and overall SPS scores of elementary school teachers for independent samples regarding their gender

SPSTFT	Gender	N	M	Std. Deviation	Result
Basic SPS	Female	70	12,24	3,36	t: 3.602 Sig:0.000* P<0.01
	Male	88	10,06	4,05	
Integrated SPS	Female	70	14,10	5,04	t: 3.761 Sig:0.000* P<0.01
	Male	88	11,17	4,71	
Overall SPS (Basic SPS + integrated SPS)	Female	70	26,34	7,36	t: 4.193 Sig:0.000 P<0.01*

Table 8. ANOVA results of elementary school teachers' total scores of basic and integrated skills and overall SPS of SPSTFT regarding elementary school teachers' seniority

SPSTFT	Seniority	N	Mean	Std. Deviation	ANOVA results
Basic SPS	(0-5) years	20	13,1000	3,05907	F: 3.331 Sig: 0.012 P<0.05
	(6-10) years	31	11,7419	4,68307	
	(11-15) years	31	11,4516	3,25411	
	(16-20) years	40	10,3500	3,27030	
	(21 and more) years	36	9,6667	4,26949	
Integrated SPS	(0-5) years	20	15,7500	5,74800	F: 5.517 Sig: 0.000 P<0.01
	(6-10) years	31	13,8387	5,59224	
	(11-15) years	31	13,0000	5,07280	
	(16-20) years	40	11,3250	4,17187	
	(21 and more) years	36	10,2778	3,78426	
Overall SPS (Basic SPS + integrated SPS)	(0-5) years	20	28,8500	7,49228	F: 5.813 Sig: 0.000 P<0.001
	(6-10) years	31	25,5806	9,42965	
	(11-15) years	31	24,4516	7,11261	
	(16-20) years	40	21,6750	6,33827	
	(21 and more) years	36	19,9444	7,34436	

As seen in Table 7, there was a significant difference between basic and integrated skill scores, and overall SPS scores of elementary school teachers according to their gender. It was detected that these significant differences were in favor of female teachers.

The ANOVA results of elementary school teachers' total scores of basic and integrated skills and overall science process skills of SPSTFT regarding elementary school teachers' seniority are presented in Table 8.

As seen in Table 8, elementary school teachers' basic, integrated skill scores and total scores of overall science process skills differ by their seniority. To determine where the difference is, Scheffé post hoc was run. Results are indicated in Table 9, Table 10 and Table 11.

Table 9. Post hoc analysis (Scheffé) for elementary school teachers' basic SPS scores of SPSTFT regarding their seniority

SPSTFT	(I) Seniority	(J) Seniority	Mean Difference (I-J)	Std. Error	Sig.
Basic SPS	0-5 years	6-10 years	1.35806	1.08967	.817
		11-15 years	1.64839	1.08967	.683
		16-20 years	2.75000	1.04048	.143
		21 and more years	3.43333*	1.05958	.037
	6-10 years	0-5 years	-1.35806	1.08967	.817
		11-15 years	.29032	.96502	.999
		16-20 years	1.39194	.90912	.673
		21 and more years	2.07527	.93091	.295
	11-15 years	0-5 years	-1.64839	1.08967	.683
		6-10 years	-.29032	.96502	.999
		16-20 years	1.10161	.90912	.832
		21 and more years	1.78495	.93091	.454
	16-20 years	0-5 years	-2.75000	1.04048	.143
		6-10 years	-1.39194	.90912	.673
		11-15 years	-1.10161	.90912	.832
		21 and more years	.68333	.87283	.961
	21 and more years	0-5 years	-3.43333*	1.05958	.037
		6-10 years	-2.07527	.93091	.295
		11-15 years	-1.78495	.93091	.454
		16-20 years	-.68333	.87283	.961

* The mean difference is significant at the 0.05 level.

Table 10. Post hoc analysis (Scheffé) for elementary school teachers' integrated skill scores of SPSTFT regarding their seniority

SPSTFT	(I) Seniority	(J) Seniority	Mean Difference (I-J)	Std. Error	Sig.
Integrated SPS	0-5 years	6-10 years	1.91129	1.37527	.748
		11-15 years	2.75000	1.37527	.410
		16-20 years	4.42500*	1.31319	.026
		21 and more years	5.47222*	1.33729	.003
	6-10 years	0-5 years	-1.91129	1.37527	.748
		11-15 years	.83871	1.21796	.976
		16-20 years	2.51371	1.14741	.313
		21 and more years	3.56093	1.17491	.062
	11-15 years	0-5 years	-2.75000	1.37527	.410
		6-10 years	-.83871	1.21796	.976
		16-20 years	1.67500	1.14741	.712
		21 and more years	2.72222	1.17491	.257
	16-20 years	0-5 years	-4.42500*	1.31319	.026
		6-10 years	-2.51371	1.14741	.313
		11-15 years	-1.67500	1.14741	.712
		21 and more years	1.04722	1.10160	.924
	21 and more years	0-5 years	-5.47222*	1.33729	.003
		6-10 years	-3.56093	1.17491	.062
		11-15 years	-2.72222	1.17491	.257
		16-20 years	-1.04722	1.10160	.924

* The mean difference is significant at the 0.05 level.

Table 11. Post hoc analysis (Scheffé) for elementary school teachers' overall SPS scores of SPSTFT regarding their seniority

SPSTFT	(I) Seniority	(J) Seniority	Mean Difference (I-J)	Std. Error	Sig.
Overall SPS (Basic SPS + integrated SPS)	0-5 years	6-10 years	3.26935	2.16353	.684
		11-15 years	4.39839	2.16353	.392
		16-20 years	7.17500*	2.06588	.020
		21 and more years	8.90556*	2.10379	.002
	6-10 years	0-5 years	-3.26935	2.16353	.684
		11-15 years	1.12903	1.91606	.986
		16-20 years	3.90565	1.80507	.326
		21 and more years	5.63620	1.84833	.059
	11-15 years	0-5 years	-4.39839	2.16353	.392
		6-10 years	-1.12903	1.91606	.986
		16-20 years	2.77661	1.80507	.669
		21 and more years	4.50717	1.84833	.209
	16-20 years	0-5 years	-7.17500*	2.06588	.020
		6-10 years	-3.90565	1.80507	.326
		11-15 years	-2.77661	1.80507	.669
		21 and more years	1.73056	1.73301	.910
	21 and more years	0-5 years	-8.90556*	2.10379	.002
		6-10 years	-5.63620	1.84833	.059
		11-15 years	-4.50717	1.84833	.209
		16-20 years	-1.73056	1.73301	.910

* The mean difference is significant at the 0.05 level.

As seen in Table 9, Table 10 and Table 11, in terms of seniority, significant differences in basic skill scores were in favor of 1-5 year-teachers compared to 21 and more year-teachers; in integrated skill scores were in favor of 1-5 year-teachers compared to 16-20 year-teachers and in favor of 1-5 year-teachers compared to 21 and more year-teachers; in overall science process skills scores were in favor of 1-5 year-teachers compared to 16-20 year-teachers and in favor of 1-5 year-teachers compared to 21 and more year-teachers.

Researchers observed that most of the low-seniority elementary school teachers were working in the villages and most of the high-seniority teachers were working in the city center. Therefore, seniority had to be controlled in ANCOVA analyses. Then, the differences between basic and integrated and overall SPS of elementary school teachers were analyzed through ANCOVA. According to their working places, total scores of basic and integrated skills and overall SPS of elementary school teachers are presented in Table 12.

Table 12. Descriptive statistics of total scores of basic and integrated skills and overall SPS of elementary teachers according to their working places

SPSTFT	Working place	N	Mean	Corrected Mean
Basic SPS	Village	25	11.72	11.13
	Town	39	12.05	11.72
	District	25	11.72	11.25
	City center	69	9.95	10.52
Integrated SPS	Village	25	13.84	12.53
	Town	39	13.12	12.40
	District	25	13.04	12.00
	City center	69	11.39	12.64
Overall SPS (Basic SPS + integrated SPS)	Village	25	25.56	23.66
	Town	39	25.17	24.13
	District	25	24.76	23.26
	City center	69	21.34	23.16

ANCOVA was computed to detect whether the difference between corrected scores of SPS of the teachers were significant or not, and the results are presented in Table 13.

Researchers observed that low-seniority elementary school teachers were working in the villages and high-seniority teachers were working in the city center. For that reason, differences between basic and integrated and overall science process skills of elementary school teachers were analyzed in terms of their seniority.

Descriptive statistics of total scores of basic and integrated skills and overall science process skills of elementary school teachers according to their working places are presented in Table 12.

Results of ANCOVA test performed to detect whether the difference between corrected scores of science process skills of the groups were significant or not are presented in Table 13.

Table 13. ANCOVA results of total scores of basic and integrated skills and overall SPS of elementary school teachers according to their working places

SPSTFT	Source of Variance	Sum of Squares	Df	Mean Squares	F	Significance Level (p)
Basic SPS	Seniority	71.426	1	71.426	5.000	.027*
	Working place	28.908	3	9.636	.675	.569
	Error	2185.421	153	14.284		
	Total	21629.000	158			
Integrated SPS	Seniority	354.510	1	354.510	15.415	0.000**
	Working place	6.382	3	2.127	0.093	0.964
	Error	3518.603	153	22.997		
	Total	28588.000	158			
Overall SPS (Basic SPS + integrated SPS)	Seniority	744.189	1	744.189	13.073	0.000**
	Working place	21.729	3	7.243	0.127	0.944
	Error	8709.926	153	56.928		
	Total	97285.000	158			

*P<0.05
**P<0.01

According to the ANCOVA results presented in Table 13; there was no significant difference between total scores of basic and integrated skills and overall science process skills of elementary school teachers in terms of their working place ($F(3-153) = 0.675$, $p>0.05$; $F(3-153) = 0.093$, $p>0.05$; $F(3-153) = 0.127$, $p>0.05$).

ANOVA results of elementary school teachers' basic and integrated skill scores and overall SPS scores of SPSTFT regarding their students' class levels are presented in Table 14.

Table 14. ANOVA results of elementary school teachers' basic and integrated skill scores and overall SPS scores of SPSTFT regarding their students' class levels

SPSTFT	Students' Grades	N	M	Std. Deviation	ANOVA result
Basic SPS	1st grade	48	12.00	3.75	F : 2.398 Sig: 0.070
	2nd grade	35	10.25	3.96	
	3rd grade	32	9.96	3.58	
	4th grade	43	11.37	4.07	
Integrated SPS	1st grade	48	12.47	5.21	F: 1.500 Sig: 0.217
	2nd grade	35	12.34	4.59	
	3rd grade	32	11.09	4.32	
	4th grade	43	13.58	5.63	
Overall SPS (Basic SPS + integrated SPS)	1st grade	48	24.47	7.96	F: 1.886 Sig: 0.134
	2nd grade	35	22.60	7.65	
	3rd grade	32	21.06	6.67	
	4th grade	43	24.95	8.89	

As seen in Table 14, elementary school teachers' basic and integrated skill scores and total scores of overall SPS did not differ significantly by their students' grades. However analyzing arithmetic means of SPS of elementary school teachers, it can be seen that 4th grade teachers had the highest score and 1st, 2nd and 3rd grade teachers followed in that order respectively.

Conclusion and discussion

In order to give more detailed information regarding teachers' skills, the science process skill levels of elementary teachers were analyzed in two stages (basic and integrated skills). The descriptive statistics indicated that elementary teachers' skill level was 55% in basic skills and 48% in integrated skills. According to the t-test, the differences between basic and integrated skill scores were significant in favor of basic skills. According to t-test, it was detected that these differences between basic and integrated skill scores were significant in favor of basic skills. Ergin et al., (2005) reports that basic SPS can be acquired from the preschool period onward while integrated skills can begin to be acquired in secondary (5th through 8th grades) school. In this case, science elementary school teachers are responsible for teaching basic skills and these skills are used in classrooms, it can be assumed that teachers have more opportunities to develop basic skills, rather than integrated skills. Similarly, some report that teachers with higher SPS were more active in teaching these skills in classroom (Aydoğdu, 2006; Downing & Gifford, 1996). Investigating science process skill levels of elementary school teachers, a study shows that science process skill levels of elementary school teachers are medium (Ercan, 2007). Similarly, another study conducted to understand levels of integrated SPS of elementary school teachers finds the levels of integrated SPS of elementary school as medium (Yılmaz & Meral-Kandemir, 2012). The literature, however, is inconsistent in this regard. In the study conducted by Türkmen and Kandemir (2011); the researchers find that elementary school teachers' knowledge about SPS was poor. Similarly, in another study done by Işık and Nakipoğlu (2011); it is found that elementary school teachers' knowledge about SPS was poor. The related literature shows that SPS of pre-service elementary school teachers were also at low level (Akar, 2007; Aydoğdu & Buldur, 2012; Laçin-Şimşek, 2010). These results might indicate that teachers in this study have already had low levels of SPS long before starting to teach. Even if we assume that the teachers have already developed SPS during their teacher education, then, this might mean that SPS of elementary school teachers deteriorate throughout their teaching career. It is very important that teachers understand SPS sufficiently to make their students gain these skills at a desired level, (Mutisya et al., 2013) however, Lotter et al. (2007) report that elementary school teachers did not have sufficient conceptual understanding of science process skills. Additionally, pre-service elementary teachers did not have sufficient conceptual understanding of science process skills (Chabalengula et al., 2012). The problem of not having conceptual understanding of science process skills should be resolved through both pre-service and in-service trainings which would focus on the conceptual and cognitive understanding of SPS.

This study found a significant difference between basic and integrated skill scores and overall SPSTFT scores of elementary school teachers with regard to their gender. It was detected that these significant differences were in favor of female teachers. In a study was reported that the science process skill levels of elementary school teachers did not differ significantly in terms of gender (Ercan, 2007). Another study examined integrated science process skills of elementary school teachers in terms of gender, and it was found that there were significant differences in favor of female teachers in their study (Yılmaz & Meral-Kandemir, 2012). The reason for the gender difference could be cultural factors, such as upbringings of males and females in Turkish culture. The patriarchal nature of Turkish culture requires males to be more relaxed and females to be detailed oriented and more responsible individuals (İkram, 2010). This is reflected in school attitudes and success of females who seem to be more focused and learning oriented.

The present study notes that seniority factor has a significant impact on basic skill scores favoring 1-5 year-teachers as compared to the group that has taught for more than 21 years. The integrated skill scores were also in favor of 1-5 year teachers compared to 21 and above group. The overall SPSTFT scores were in favor of 1-5 year-teachers compared to 21 and above group and in favor of 1-5 year teachers compared to 16-20 year teachers. The findings are supported by Yılmaz and Meral-Kandemir (2012) who investigated the SPS of elementary school teachers in terms of the teachers' seniority, and found there is a negative correlation between SPS and seniority of elementary school teachers. They state that there are significant differences in "identifying and controlling variables", "formulating hypotheses", "analyzing of data and constructing graphs", and "experimenting" in terms of seniority of elementary school teachers. In a study conducted by Ercan (2007), the SPS of elementary school teachers were investigated according to their seniority. According to the results, as the seniority of elementary teachers increased, their SPS decreased. The reason of high science process skill levels of low seniority elementary school teachers could be the fact that they are newly graduated from university with these skills. However, as the skill levels of senior teachers decrease over time, it may be show that senior teachers cannot develop these skills. It can be said that low seniority pre-service teachers may gain the SPS during "Science Teaching Course" theoretically and "Practice Teaching Course" practically. When they start to teach, those skills will be used by them. One of the reasons for low seniority teachers with high SPS may be the new Science and Technology education program. Since this program was launched in 2004, it has been used more intensively in the elementary school curricula. The use of experimental activities including SPS may contribute to the improvement of teachers' SPS. Celep and Bacanak (2013) state that the SPS may improve through laboratory activities. Low seniority teachers (having 0-5 year experience) have been exposed to the 2004 science and technology program launched by Turkish Ministry of National Education, on the other hand, high seniority teachers have been exposed to different science and technology program (i.e., 1968, 1992, 2000 and 2004). Especially, high seniority teachers may resist to the latest program changes which emphasize the SPS more. This comment is consistent with other studies claimed that high seniority teachers resist to general program changes (Gökmenoğlu & Eret, 2011; Tekbiyik & Akdeniz, 2008). Depending on the increase in seniority, the reason for the decrease in these skills should be analyzed in a more detailed way.

As a result of ANCOVA employed to determine whether elementary school teachers' SPS differed on working place, controlling for their seniority, no significant difference was found between the total scores of basic and integrated skills and overall SPS of elementary school teachers in terms of their working place. However, when the arithmetic means are examined, it can be seen that teachers working in villages had the highest score in basic skills; those working in districts had the highest score in integrated skills, and those working in towns had the highest score in overall total skills. These results showed that teachers working in villages had high levels of SPS. Probably, one of the reasons why teachers working in villages have high SPS is that they have low seniority status, namely they are newly graduate teachers. The Republic of Turkey, Ministry of National Education assigns new teachers starting from villages. Ministry of National Education assigns teachers having high seniority to the city centers according to teachers' will. As a result of this, low seniority teachers mostly work in villages, and those teachers have high SPS. But, Ercan (2007) finds significant differences in subgroups of only "formulating hypotheses" and "performing experiment" in favor of teachers working in villages, but not controlling for seniority.

There was no significant difference between the total scores of basic, integrated and overall SPS of elementary school teachers in terms of their students' grades. However, when the arithmetic means of SPS of elementary teachers were analyzed, it was noted that 4th grade teachers had the highest score and 1st, 2nd and 3rd grade teachers followed them respectively. In the study conducted by Lotter et al. (2007), they indicated that teachers were inadequate while teaching SPS according to different grade levels. According to Ercan's study (2007) no significant differences were found between the SPS of elementary school teachers in terms of their students' grades. In the current study, the reason for the high science process skill scores of 4th grade teachers could be science and technology lessons in the 4th grade curriculum that focuses on SPS intensely. Thus, 4th grade teachers have more opportunity for teaching (thus developing) these skills. Farsakoğlu, Şahin & Karslı (2012) stress that individuals develop their SPS through practice. Therefore, elementary school teachers' SPS should be developed through practice. For this reason, elementary school curricula (especially 1st-3rd grades) should be revised so that teachers can practice their SPS more.

Suggestions

1. Pre-service elementary school teachers should actively use their SPS in practical courses they take.

2. Experienced elementary school teachers should be provided in-service teacher trainings for their effective use of SPS.

3. Elementary school science curricula should be analyzed in-depth and elementary school teachers should be informed of the significance of SPS at the outset of the academic year.

4. Curricula of other subjects, such as life sciences, social studies, and soon. should be reconsidered and revised, so that they support the development of SPS of teachers.

5. Further studies should be conducted to investigate why and how seniority and gender have an impact on differing levels of SPS.

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