Investigation of in-Service and Pre-Service Science Teachers' Perceptions of Scientific Process Skills

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Abstract: This study aims to determine the perceptions of the use of scientific process skills of in-service and pre-service teachers working in branches related to science courses in secondary and high schools. Therefore, this research was designed based on a relational survey model and was carried out with 150 science teachers in Turkey and 260 pre-service teachers from two different universities. The Scientific Process Skills Perception Scale was used to measure their perceptions of scientific process skills. An independent sample t-test was applied to compare the difference between the perceptions of scientific process skills of in-service and pre-service teachers. The results showed no significant difference between the two groups. The ANOVA results further showed that the duration of teachers' service did not make a significant difference in their scientific process skill perceptions. The results of this study revealed that in-service and pre-service teachers should be supported with training to reduce their reservations about using scientific process skills.

Keywords: Pre-service science teachers, Scientific process skills perception, Science teachers,

1. Introduction

In the Science curriculum published by the Ministry of National Education (MoNE) in Turkey in 2018, assessment-evaluation approach, area specific skills, content knowledge, and general objectives were primarily discussed. In addition, special objectives for science teaching were included, and in four of these special objectives, consisting of ten items, the following scientific process skills are emphasised: (a) To adopt scientific process skills and scientific research approach in the process of discovery of nature and understanding of the human environment relationship and to find solutions to the problems encountered in these areas, (b) To take responsibility for daily life problems and use knowledge of science, scientific process skills and other life skills to solve these problems, (c) To help understand how scientific knowledge is created by scientists, and how this information is generated and used in new research, and (d) To develop reasoning skills, scientific thinking habits and decision-making skills using socio-scientific subjects (Ministry of National Education (MoNE), 2018). These goals indicate that in science teaching, the skills of accessing information, creating knowledge and using scientific means are important, raising the question, 'what are the intended scientific process skills?'

In today's concept of education, teachers are a guide for their students. Therefore, in-service and pre-service teachers can only pass on these skills to their students if they are informed about the importance of scientific process skills and possess the said skills (Aktaş & Ceylan, 2016). Studies have shown that teachers, including self-confident teachers, are inadequate in subjects related to the use, detection and implementation of scientific process skills (Lloyd, Braund, Crebbin & Phipps, 2000). Whether or not students gain scientific process skills depends on the teachers being able to adequately present the teaching environments and practices to enable the students to apply the necessary skills (Yıldırım et al., 2011). Beh (2011) asserted that pre-service teachers enrolled in science education programmes at the tertiary level were influenced by the way they were taught science at the secondary school level, which means teachers' perceptions and subsequent approaches in using scientific skills have long term repercussions on learners. Hence this study aimed to determine the perceptions of in-service sciences teachers in secondary schools, and pre-service science teachers on their use of scientific process skills. In this context, answers to the following questions were sought:

1) What are the perceptions of in-service science teachers in using scientific process skills?
2) Is there a significant difference between teaching experience of science teachers and their perception of usage of scientific process skills?
3) What is the perception of pre-service science teachers in using scientific process skills?

4) Is there a difference between the perceptions of in-service and pre-service science teachers in using scientific process skills?

2. Literature Review

An examination of related literature shows that scientific process skills have been classified differently by various researchers. In some sources, basic, causative and experimental science process skills have been investigated in three stages, while in most sources basic and integrated science process skills are examined in two stages (Aktaş & Ceylan, 2016; Rambuda & Fraser, 2004; Tan & Temiz, 2003; Yeany, Yap & Padilla, 1984; Martin, Sexton, Wagner & Gerlovich, 1998). According to the most accepted classification, basic science process skills are determined by using observation, inferring, measuring, communicating, classifying and using space/time relationships, using numbers, and estimation, whereas high-level skills are defined as controlling variables, formulating hypotheses, interpreting data, operational identification, and conducting experiments (Padilla, 1990). The basic science process skills, as the name implies, form the basis of high-level skills and should be introduced to students from an early age. Integrated science process skills are those that should be learned and taught to students after basic skills.

The Science curriculum in Turkey aims to adapt scientific process skills to science teaching processes for students to engage in research and inquiries, to understand nature, and to be able to integrate this knowledge into scientific processes and comprehend how scientific knowledge is obtained (MoNE, 2018). Thus, there is a need for teachers who use and make use of scientific process skills to prepare such learning environments. An examination of the research about science teaching reveals many studies on scientific process skills at different teaching levels (Aktamış & Şahin-Pekmez, 2011; Ambross, Meiring & Blignaut, 2014; Böyük, Tanık, & Saraçoğlu, 2011; Şahin, Yıldırım, Sürmeli & Güven, 2018; Türkmen, & Kandemir, 2011; Yıldırım, Atila, Özmen, & Sözbilir, 2013). Studies that determine whether scientific process skills are introduced to learners are also frequently encountered (Anagün & Yaşar, 2009; Hazır & Türkmen, 2008; Koray, Özdemir, Prestley, & Köksal, 2005; Öztürk, Tezel & Acat, 2010; Şahin, Güven & Yurdatapan, 2011; Yurdatapan, 2013).

The intensity of research on this subject can be considered as an indicator of the place and importance of scientific process skills in science teaching. Science is not just information; it is a way of systematically understanding the environment. Scientific process skills are necessary for the students to learn about science and the world of technology in more detail. For this reason, these processes should be used by teachers to teach science courses effectively (Aydoğdu, 2009; Turiman, Omar, Daud & Osman, 2012).

3. Methodology

This research, designed as a relational survey model, was applied to 150 science teachers working within the Ministry of National Education in 60 cities from different regions in Turkey, and 260 pre-service teachers in years 3, 4 and 5, in biology, science, physics and chemistry teaching programmes at two different universities in Ankara and Istanbul. The relational survey model aims to determine the existence and/or degree of change between two or more variables (Karasar, 2013). Table 1 provides detailed information on the demographic characteristics of the sample.

Table 1: Demographic data on the sample

			f	**%**
Teacher	Branch	Biology	83	55
		Science	31	21
		Physics	33	55
		Chemistry	3	2
	Experience	1-10 years	62	41
		10-20 years	50	33
		20 years and more	38	25
Pre-service teacher	Field	Biology	82	31.
		Science	110	5
		Physics	30	42
		Chemistry	38	11.
				5
				15
	Grade	Year 3	55	21
		Year 4	159	61
		Year 5	46	18

The Scientific Process Skills Perception Scale, developed by Rambuda and Fraser (2004) and adapted to Turkish by Yıldırım, Sürmeli, Güven and Ergun (2016), was used to measure the perceptions of in-service and pre-service teachers on scientific process skills. The scale consists of 22 four-point Likert type items (1 never; 4 always) and two subscales of basic scientific process skills (Items 1-13) and integrated scientific process skills (Items 14-22). Cronbach’s alpha reliability coefficient, which was calculated by the pilot test data in this study, was .90 and .91 for the subscales and .93 for the overall scale.

The data obtained from the study were analysed with SPSS programme version 23.0. The normal distribution of the data was examined using the Kolmogorov-Smirnov test. In the current study, the Kolmogorov-Smirnov test, which was calculated for the average scores of scientific process skills, was not significant in either group (p

> 0.05). According to this result, scientific process skills were a normally distributed variable (Stevens, 2009).

The Levene Homogeneity Test was applied to determine whether the participants' perceptions of scientific process skills were comparable in terms of demographic variables. The in-service and pre-service teachers' perceptions of scientific process skills were examined in terms of variables that provided the assumption of homogeneity. In this context, an independent sample t-test was used to determine whether there was a significant difference between the perceptions of scientific process skills of in-service and pre-service teachers. In addition, the impact of in-service teachers' professional experience on scientific process skills perceptions was also examined using one-way analysis of variance (ANOVA).

4. Findings

The average score and standard deviations obtained by the in-service and pre-service teachers from each item of the Scientific Process Skills Perception Scale are given in Table 2. The highest average score in both groups ($\bar{X}_{teacher} = 3.23$, $\bar{X}_{pre\text{-}service\ teachers} = 3.44$), was from the statement, "I encourage students to use conceptual information, tables, charts, symbols, graphs and diagrams to use the information learned to communicate in any way". The lowest scores from the in-service teachers with a 2.53 average were from "I design exercises in which my students need to create a data table", and the lowest scores of the pre-service teachers with an average of 2.74 were from "I design exercises in which my students have to create graphics". When the averages are examined, it is notable that both groups had higher scores in the first dimension of the scale.

Table 2: Average and standard deviations from the scientific process skills perception scale

Scientific process skills perception	**In-service teachers**		**Pre-service teachers**	
	X	**SS**	**X**	**SS**
First Subscale: Basic Scientific Process Skills				
1- I give my learners many opportunities to identify important scientific problems.	3.12	.69	3.18	.67
2- I organise classroom activities in which learners classify the observed scientific features.	2.77	.71	3.11	.65
3- I encourage learners to use any means to communicate the learned information; i.e. draw concept maps, tables, charts, symbols, graphs and diagrams to communicate the information.	3.23	.73	3.44	.68
4- I link the work in science on diagrams to the everyday life of the learners; i.e. encouraging learners to bring examples from newspapers and magazines for discussion in class.	2.95	.86	3.26	.76
5- I organise activities in which my learners compare objects using standardized units of measure and suitable measuring instruments.	2.71	.86	3.01	.74
6- I organise my learners to observe scientific phenomena such as plant growth, water boiling, cell in microscope, floating object and mirror image etc.	3.02	.87	3.37	.70
7- I encourage my learners to predict future scientific events based upon their observations.	3.20	.69	3.23	.66
8- I encourage learners to use various forms of data to determine the correctness of scientific theory.	2.99	.77	3.08	.72
9- I encourage learners to describe a scientific event in relation to other scientific events.	3.15	.72	3.23	.66
10- I give my learners many opportunities to observe scientifically important problems.	3.05	.78	3.25	.68
11- I encourage my learners to use any means to communicate the investigated information.	3.15	.72	3.22	.68
12- I link the work in science on graphs to the everyday life of the learners; i.e. asking learners to bring examples from newspapers and magazines for discussion.	2.97	.81	3.20	.72
13- I organise activities in which my learners arrange scientific experiments in logical order.	2.74	.81	3.13	.71
First Subscale Average	**3.00**	**.53**	**3.21**	**.46**
Second Subscale: Field-integrated Scientific Process Skills				
14- I encourage my learners to identify variables that affect scientific phenomena; e.g. how variables such as humidity, temperature, soil structure, and light influence plant growth (germination)	3.14	.79	3.36	.68

15- I devise exercises in which my learners have to construct tables of data.	**2.53**	.82	2.80	.77
16- I devise exercises in which my learners have to construct graphs.	2.58	.79	**2.74**	.78
17- I devise exercises in which my learners conduct investigations	2.86	.79	3.19	.71
18- I devise activities in which my learners identify the variables under investigation.	2.75	.81	3.06	.70
19- I give my learners scientific problems for which they are encouraged to construct hypotheses.	2.74	.83	3.07	.75
20- I give exercises in which my learners define scientific features by using observable characteristics of the features.	2.83	.76	3.21	.66
21- I give my learners hypotheses and request them to design investigations to test the given hypothesis.	2.57	.86	3.04	.74
22- I devise exercises in which my learners have to describe the relationship between variables on a graph.	2.75	.74	2.98	.76
Second Subscale Average	**2.75**	**.63**	**3.05**	**.53**

The results of the independent sample t-test conducted to examine whether there was a significant difference between the perceptions of in-service and pre-service teachers on scientific process skills is given in Table 3.

Table 3: Results of the comparison of the in-service and pre-service teachers' perceptions

Groups	**N**	$\underline{X}$	**S**	**sd**	**T**	**p**
In-service teacher	150	2.90	.54	408	4.85	.000
Pre-service teachers	260	3.14	.46			

According to the results of the t-test, there was a significant difference between the perceptions of in-service and pre-service teachers concerning scientific process skills ($t_{(408)} = .4.85$, $p < .05$). The pre-service teachers had higher scientific process skills than the in-service teachers.

The average scores of the teachers on the scientific process skills perception scale were calculated as 2.90 for the in-service teachers with one to 10 years of experience, 2.91 for those with 10 to 20 years of experience, and 2.89 for those with 20 years of experience. Table 4 presents the ANOVA results that determined whether there were statistically significant differences between the average scores of the teachers in these three groups, taking into account the number of years they worked as teachers in terms of professional experience.

Table 4: ANOVA results of scientific process skills perception scores of teachers

	Source of Variance	**Total of Squares**	**sd**	**Mean of Squares**	**F**	**p**
In-serviced teachers' scientific process skills	Inter-group	.02	2	.01	.03	.972
	Intra-group	44.17	147	.30		
	Total	44.18	149			

As shown in Table 4, there were no significant differences between the three groups of in-service teachers with different professional experiences in terms of the average scores obtained from the scientific process skills test [$F_{(2\text{-}147)} = .03, p > .05$].

5. Discussion

According to the results of the research, the responses of the in-service teachers were between 2.53 and 3.23, and those of the pre-service teachers ranged from 2.74 to 3.44. Since the responses to the items in the scale ranged from 1 to 4, it was observed that the perceptions of in-service and pre-service teachers about scientific process skills were at middle and upper levels. Kandemir and Yılmaz (2012) applied a multiple-choice test to class teachers and reported that the teachers' high-level scientific skills were at a medium level. This is also consistent with the results of our research, as well as other studies (Demir, 2007; Karapınar & Şaşmaz Ören, 2015).

When the responses given to the items in the scale were examined, it was determined that both the in-service and pre-service teachers had the highest score in the statement, "I encourage students to communicate the information learned in any way; i.e. to use concept maps, tables, charts, symbols, graphs and diagrams". The lowest score was in response to "I design exercises in which my students need to create a data table" for the in-service teachers, and "I design exercises in which my students have to create graphics" for the pre-service teachers. This result can be interpreted as follows: While neither in-service nor pre-service teachers had any problem in encouraging students to use concept maps, tables, tables, symbols, graphs and diagrams, they scored lower in relation to the statements referring to the design of data tables and graphics. However, it is an important requirement for teachers to design these exercises so that students can be encouraged to use these processes. In some other studies, it has been shown that pre-service science teachers have low level of skills related in drawing tables/graphics, interpreting, and modelling (Muşlu, Kaygısız, Benzer & Uçar, 2017; Chabalengula, Mumba & Mbewe, 2012). The findings from our research and previous studies suggest that in-service and pre-service teachers should be supported in order to reduce their reservations about designing these exercises.

According to the results of our study, the teachers' years of service does not make a significant difference to their level of perception of scientific process skills. Kandemir and Yılmaz (2012) compared the teacher's duration of service and their level of understanding of high-level scientific skills using a multiple-choice test and determined that teachers with teaching experience of less than one year to 10 years had higher scores than those with teaching experience of 20 years and above. This can be understood because scientific process skills have only begun to be included in teacher education and science education programmes in recent years; thus, novice teachers can achieve better results in a test of understanding scientific process skills. However, in some qualitative studies, it was determined that scientific process skills were not fully understood by the teachers and that they did not have sufficient knowledge and awareness to conduct the curriculum (Türkmen & Kandemir, 2011; Demir & Baştürk, 2016). The current study examined the in-service teachers' perceptions of how they evaluated themselves in terms of scientific process skills and their perceptions of their skills. It is considered that the reason that there was no difference in relation to the duration of service is that the details of the scientific process skills were not fully understood and were confused with other subjects. In addition, there was insufficient awareness on this issue.

6. Conclusion

The most striking point in the study is that the pre-service teachers' perceptions of scientific process skills were higher compared to in-service teachers and that the difference was significant. This result can be explained in two different ways. Firstly, there have been changes to teacher training programmes in recent years. In order to train teachers in accordance with the requirements of the times, the curriculum has been revised after several studies in recent years. In this context, contents and courses for scientific process skills have been included in the programme. Considering the effect of this curriculum revision on the pre-service teachers' perceptions of scientific process skills, it is recommended that teachers who are in service as well as teachers in the training process should be supported through various channels (online, offline, face to face) and content on scientific process skills. The second explanation is that the in-service teachers' perceptions of scientific process skills may have been lower because they faced the realities of the school and the classroom environment, while the pre-service teachers were mostly concerned with theoretical knowledge in the teaching process. Their practical experience was limited to teaching practice. When responding to the items in the scale, it was most likely that the in-service teachers gave their opinions whilst keeping in mind the realities of the school and classroom environment and their problems. In fact, they attributed the main problems of teaching scientific process skills to students as overcrowding of classes, time constraints, content in the curriculum, presence of hyperactive students in the classroom, students' differentiated learning levels, and problems in supplying materials for activities (Türkmen & Kandemir, 2011). Nevertheless, students' acquisition of scientific process skills depends on the teachers who guide them in the learning and teaching process. In fact, the students' level of success could be considered as a reflection of their teachers' level of possessing these same skills. Therefore, it is important to increase the awareness of pre-service teachers about the realities of the school and classroom environment during the education process, and to support them in developing their scientific process skills for their future workplace.

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