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Teachers' Beliefs About Learning and Teaching Nature of Science: Professional Development Program *

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Abstract

The Nature of Science (NOS) is an important component of science literacy, which is the main vision of science teaching programs. In contrast, science teachers face significant problems in transferring the nature of science to classroom practices. Science teachers' classroom practices are influenced by their belief in learning and teaching. Therefore, the development of teachers' beliefs in learning and teaching the NOS is important for the development of classroom practices. Thus, in this research, the effect of a continuing professional development (CPD) program aimed at improving science teachers' professional competences related to the NOS on their beliefs about learning and teaching of the NOS was searched. 18 volunteered science teachers participated in the research. A single group pretest-posttest experimental design was used in the study. The data were collected using the ''Beliefs About Reformed Science Teaching and Learning (BARSTL)''developed by Sampson and Benton (2006) and the ''Scale of Self-Efficacy Belief About Teaching the Nature of Science'' developed by researchers. Pre-test and post-test performances of the teachers were compared using the Wilcoxon test. As a result of the research, it has been shown that the CPD program is effective in developing teachers' self-efficacy beliefs about teaching the NOS and teachers' beliefs for reform approaches. Findings show that science teachers' self-efficacy beliefs are quite high, even though their views on the nature of science are inadequate before the professional development program. There is a risk that teachers who have inadequate views and misconceptions about NOS but who are eager to teach and who have high self-efficacy will be an obstacle to the education of science literate individuals. This has further clarified the need for CPD programs that will enable them to face current misconceptions and support their classroom practices, without compromising teachers' enthusiasm and self-

Keywords

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efficacy about NOS that is important component of scientific literacy. For this reason, it has been proposed to increase the number of such professional development programs in accordance with the changing professional development paradigms.

Introduction

The ability of giving insight about the NOS, which is defined as ''the values and assumptions inherent to the development of scientific knowledge and historical development of the scientific knowledge'' (Lederman, 1992, p. 331) is one of the qualifications of private field which every science teacher should have (Ministry of National Education, 2015). In order to give this insight to the students, teachers should demonstrate both informed views about the NOS (Erdaş Kartal, Cobern, Doğan, İrez, Çakmakcı, & Yalaki, 2018) and the ability to translate their understandings into the science instruction (Khishfe, 2008; Merill & Butts, 1969; Zeidler, Walker, Ackett, & Simmons, 2002). The results of the researches in this field indicate that teachers confront important problems while they are integrating the NOS themes (tentative NOS, empirical NOS, scientific method, nature of scientific theories and laws, subjective and theory-laden NOS, inference and theoretical entities in science, imagination and creativity in science, social and cultural embeddedness of science) into the classroom practices (Ertuğrul, 2017; Posnanski, 2010; Schwartz, 2009). Thus to solve the problems, which teachers confront during the classroom practices, it is primarily necessary to determine the variables, which affect the classroom practices (Kaya et al., 2016; Riggs & Enochs, 1990).

Korthagen (2004) explains the variables, which affects the teachers' classroom practices with the 6-level "Onion Model" (Figure 1).

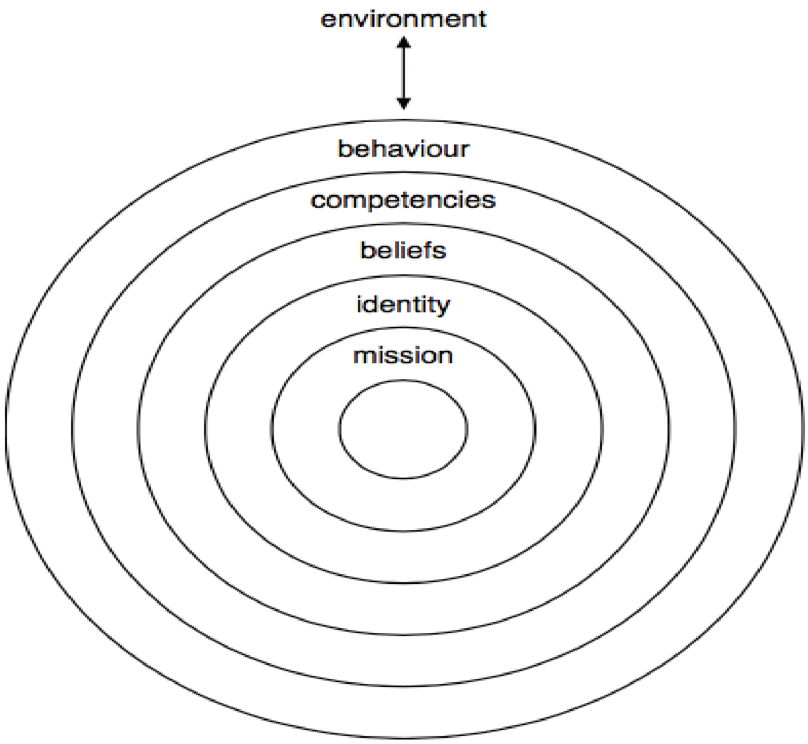

Figure 1. Onion Model (Korthagen, 2004)

Korthagen arrays the variables (environment, behavior, competencies, beliefs, identity and mission) in various levels like onionskins and mentions that variables correlate with and affect each other. Environment and behavior, the outer parts of the mentioned 6 variables, are mostly focal points because others can observe them. Thus, the studies conducted for the teachers and pre-service teachers generally focus on classroom practices (environment) and how teachers cope with the problems they face (behavior) (Korthagen, 2004). In this model, one of the most important variables that contain knowledge, ability and attitude is competencies. However, as emphasized by Korthagen (2004), " the competency that teachers have reflects existing potential behavior, not the behavior itself " (p. 80). Studies suggest that a teacher who has the competencies in the target education policy may not always show the right and expected behaviors (Tickle, 1999) and that behavior is influenced by personal (enthusiasm, flexibility, child love etc.) and internal (belief, identity and mission etc.) (Korthagen, 2004; Tickle, 1999) variables. Therefore, it is important to examine the belief, identity and mission variables in detail (Akerson, Pongsanon, Weiland, & Nargund-Joshi, 2014; Korthagen, 2004; Korthagen, Kim, & Greene, 2013).

Korthagen states that teachers' beliefs on teaching and learning (belief) affect their behaviors and this situation is ignored in behavioral approach. In science education researches, Hewson and Hewson are the ones who mention the necessity of studying the science teachers' beliefs about teaching and learning (1987, 1988). In these researches, Hewson and Hewson (1987, 1988) reports that science teachers' beliefs about teaching and learning can affect their classroom practices. Researches in this field have shown that there may be a relation among the beliefs of the science teachers about how to teach science, how students learn the science and how the science is thought (Abd-El-Khalick, Bell, & Lederman, 1998; Lederman, 1992, 1999). Tsai (2002) investigated the relationship between teachers' beliefs about science teaching, science learning, and the NOS in a research conducted in Taiwan with 37 science teachers. Researcher has classified teachers' beliefs about science teaching, learning, and the NOS as traditional, process, or constructivist. As a result of the research; it has been shown that teachers in the traditional category perceive science teaching as the transfer of knowledge from the teacher to the student, perceive science learning as producing or obtaining information from reliable sources, perceive scientific knowledge as correct answers or established facts. It has been found that teachers in the process category perceive science teaching and learning as an activity that focuses on the processes of science or problem solving procedures and that they perceive scientific knowledge as facts discovered by following coded procedures or through scientific methods. It has been shown that the constructivist teachers define science teaching as helping to construct student knowledge, define the learning of science as the construction of personal narrative and define the science as the way of knowing. As can be seen from the findings, this research has shown that teachers' beliefs about teaching science, learning science and NOS are highly compatible and related to each other (Tsai, 2002). To sum up, in most of the researches in this field, it is reported that the beliefs, which underlie the behaviors and is difficult to change, pedagogically affect teachers' decisions in class (Goodenough, 1963; Leatham, 2006; Ocak, Ocak, & Kalender, 2017) and indirectly their teaching practices (Borg, 2018; Cheng, Chan, Tang, & Cheng, 2009; Pajares, 1992).

Some of the teachers' teaching and learning beliefs, which are important determinants of effective teaching within the classroom, are self-efficacy beliefs and beliefs for the reform approaches advised in the teaching program. Teachers' belief about self-efficacy about teaching the NOS affects their practices about this subject (Mesci, 2016). In his work, which he conducted in 2016, Mesci revealed that the classroom practices of the teacher candidates were influenced by the content knowledge, pedagogical content knowledge and self-efficacy in this area. He also found that teacher candidates' self-efficacy beliefs play a critical role in identifying the problems and determining the instructional strategy to solve these problems during classroom practices in this area. Other researches in this area also emphasizes that to teach the NOS effectively, teachers should believe their ability to teach and they should be highly motivated and eager (Collette & Chiappetta, 1994; Schwartz & Lederman, 2002). That's why; to develop teachers' belief about self-efficacy is a basis to the adaptation of advised teaching applications to the classroom practices effectively (Luft & Hewson, 2014). On the other hand, teachers should have conceptual harmony with the new approaches in reform documents in order to teach the NOS effectively (Bell & Maeng, 2013; Erdaş, 2015). Because what teachers think about reform approaches, how they perceive these approaches and how they reflect these approaches to their classroom practices are the determiners for reform to reach its objectives (Fullan & Miles, 1992; Han, 2011). Therefore, it is necessary to develop teachers' beliefs about reform approaches for applying classroom practices effectively.

It is a difficult process to change or develop teachers' beliefs (Bayar & Gür, 2017; Fullan, 1991; Posnanski, 2002) and traditional approaches in classroom practices. It is reported that teachers should be monitored closely, they should be provided a suitable environment where they can change their classroom practices (Tobin, 1993) and classroom practices should be supported continuously (Bell & Maeng, 2013; Erdaş, 2015). Researches indicate that, teachers' beliefs about teaching and learning the NOS can be developed by PD programs (Bell & Maeng, 2013). In a study published in 2013 by Bell and Maeng, one of the limited studies on this field, they have found that the content-specific PD program that includes coaching, co-operation and implementation, reflection and feedback opportunities enhances the knowledge and competence of science educators and improves their self-efficacy in the implementation or support of reform-based science teaching. However, it is discovered that the paradigms about PD programs have changed (Korthagen, 2017; Lunenberg, Dengerink, & Korthagen, 2014; Munby, Russell, & Martin, 2001). Korthagen (2017) classified the PD programs differentiated by the paradigm shifts as in Table 1 from 1.0 to 3.0 by inspiring from "industry 4.0" model which reflects industrial revolutions.

Table 1. Classification of PD Programs from 1.0 to 3.0

Type of the Program	Content of the Program and Quality of the Program
1.0	From theory to practice approach is used in that kind of programs and it is aimed to transfer teaching and learning strategies into the classroom practices by explaining teaching and learning strategies to the teachers. However, researches, conducted for a long time, shows up that this strategy is not effective.
1.1	As a reaction to the failure of PD 1.0, it is aimed to make the theory more meaningful for teachers with the support of video and other pedagogical tools and by means of different strategies. In addition to the "from theory to practice approach, different strategies are used in PD 1.1 but it is discovered that this program is also unsuccessful.
2.0	Because of the unsatisfactory of the PD 1.0 and 1.1, it is recently focused on "practice". After teacher-training institutions take "practice" to the center of their teaching program, internship has started and this is called PD 2.0. Although PD 2.0 focuses on classroom practices, it finds out another problem, which has no solutions yet: how are the theory and practice united?
3.0	In this model, it is focused on theory, individual and practice; not the theory and practice. It offers that teachers should be motivated by considering their thoughts, emotions and wishes. It is mentioned that after considering these, PD realizes meaningful learning and teachers will be more successful in classroom practices.

When teacher-training applications are examined in Turkey, in-service training programs are seen at the level of PD 1.0 and PD 1.1. When these programs are analyzed, generally current science program is introduced in general terms, methods and strategies in this program are explained and these programs are short-term (1 day-1 month) to develop teachers' content knowledge. These short-term PD programs are reported in many researches not to reach aimed success in beliefs about teaching and learning and classroom practices (Dass & Yager, 2009; Doğan, Çakıroğlu, Çavuş, Bilican, & Arslan, 2011; Akerson & Hanuscin, 2007). In recent years, various PD programs, in which teachers' opinions, wishes and needs are considered seriously and multidimensional development is aimed, have been held (Doğan et al., 2011; Köseoğlu, Tümay, & Üstün, 2010). However, these studies are for developing teachers' views and practices about the NOS, scientific questioning, using technology, and argumentations. So, it is considered that they are not for developing teachers' beliefs about teaching and learning specifically. Today when PD 3.0 (Table 1) is on the front burner, different studies about the PD are needed. It is thought that this study, which is aimed to search the effect of a continuing professional development (CPD) program aimed at improving science teachers' professional competences related to the NOS on teachers' beliefs about learning and teaching of the NOS, will enlighten the changing PD program paradigms and fill the gap in literature.

Method

Research Design

The change in the performance of the teachers participating in the CPD program was assessed by comparing pre-test and post-test performances. There was no control group in the study. For these reasons, one group pre-test-post-test experimental design was used in this study.

Participants

In this study, 18 volunteer science teachers participated from Bolu (11 female, 7 male). It was determined that 5 of the participants continued their education at the graduate level. More than half of the participants (61.1%) were found to have less than 10 years of professional experience. It was stated that 13 of the teachers who participated in this study have taken the courses or trainings about History of Science, Philosophy of Science, and/or The NOS.

Research Process

This study is the output of a wide-scale teacher PD project that aims to develop science teachers' professional competences about the NOS. This project was conducted as 2 stage: "preparation and application stage" and was planned as 30-months projects between the years 2012-2015. The detailed process of the project was shown on the Figure 2.

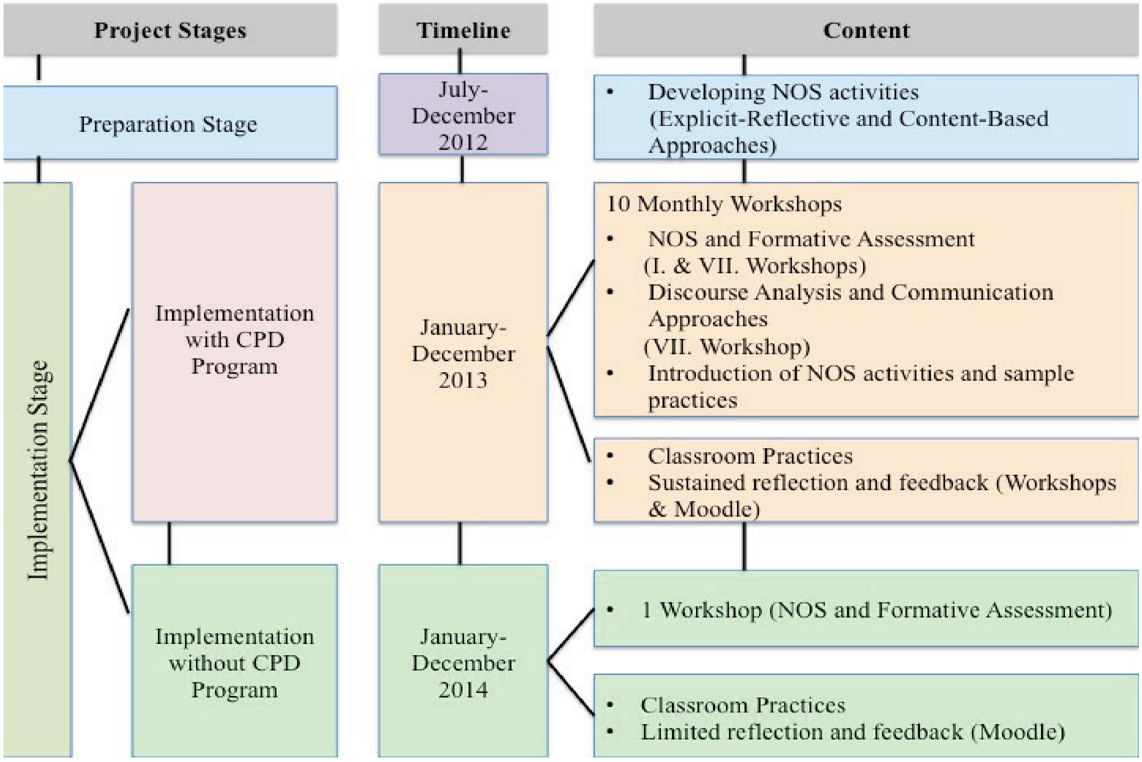

Figure 2. Process of the Project

In this study, which was a part of PD project mentioned above, 12-month CPD program was conducted. In this program, some approaches were based for PD model. These approaches were the usage of explicit-reflective teaching method, context-specific activities and formative assessment. Explicit-reflective approach and formative assessment were introduced to the teachers in teacher-training session and they were taken into consideration in developed context-specific activities. In order to use these approaches, which were based in PD model, long-term attendance and teaching discourse analysis were used. The umbra in the Figure 3 sums up the main approaches used in adopted the PD program.

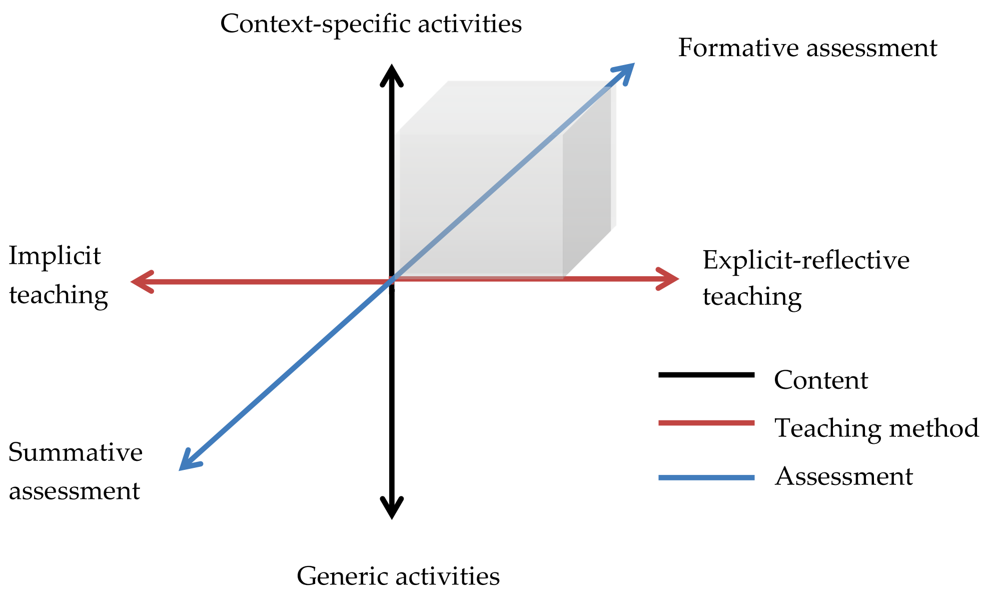

Figure 3. Main Approaches used in the PD Program (Çakmakçı & Yalaki, 2018)

In this PD program, which is held by taking this PD model as basis, ten of 8-hour workshops were carried out. In the workshops, teachers were trained on how to use the NOS, explicit-reflective teaching and formative assessment in the teaching of the NOS. Moreover, various discourse designs (classroom language) which teachers use unwittingly while teaching the NOS to the students and different discourse designs and communication approaches (Kaya et al., 2016) were introduced by being analyzed in-class video recordings.

Also, in these workshops, some activities, which were created by integrating the aimed main themes of the grade 5, 6, 7 and 8 science course units, were introduced. Teachers' opinions were asked about activities and they were asked to use these in classroom practices. In the following workshops, teachers were provided opportunity to reflect their experiences and thoughts about practices.

Teaching materials developed in line with the recommendations (some activities developed at the beginning of the professional development program are slightly above the student level, the gains of the unit in the science curriculum were less than the NOS gains, the process of classroom implementation leaded them to fall back from their coteries according to the annual plan indicated in the science curriculum etc.) of the teachers participating in the project have been rearranged. It has been observed that these arrangements in the process have had a positive impact on teachers' classroom practices and increased their desire for effective teaching of the NOS.

During the process, 57 context-specific teaching materials were prepared by considering the main approaches and teachers' experiences and brought into the use of the teachers (Doğan et al., 2016). During the preparation and implementation of the teaching materials; the aim of the teachers is to be more willing to practice and learn what they have learned by means of activities by considering their thoughts, expectations and experiences is a sign that this CPD program meets the criteria of professional development 3.0 (Table 1).

Data Collection Tools and Data Analysis Methods

The scale of self-efficacy belief about teaching the NOS

The data about teachers' self-efficacy beliefs about teaching the NOS was collected by carrying out pre-test and post-test of the "The Scale of Self-Efficacy Belief About Teaching the Nature of Science". The scale was developed by the research team and adopted from science teaching self-efficacy scale, developed by Riggs and Enochs (1990) and translated into Turkish by Özkan, Tekkaya and Çakıroğlu (2002). This scale was prepared as "4 point likert scale" (strongly agree, agree, disagree, strongly disagree) and it has 18 items. 11 of the items in the scale were positively worded and 7 of them were negatively worded. The answers given to the positive items on the scale were scored from 1 to 4 (strongly disagree-1, disagree-2, agree-3, and strongly agree-4); for the negative items, scoring was done with the same statements from 4 to 1. As a result, the highest possible score of the scale is 72 and the lowest possible score of the scale is 18.

In the beginning, a plot study was conducted in order to investigate the validity and reliability of the scale. There were 328 participants in the pilot study who were from two different cities (Kastamonu and Bolu, Turkey). Exploratory factor analysis was performed to explore the internal structure of the self-efficacy scale. Because of the interval nature of the instrument, polychoric correlations were produced for factor analysis instead of Pearson Product Moment correlations. Polychoric correlations were used for both determining the number of factors and extracting factors. In order to accomplish that, firstly, the diagonal values of the correlation matrix were replaced by squared multiple correlations in order to approximate the communality estimates. Secondly, parallel analysis was conducted to determine number of factors. This method is less subjective than the traditional decision rules (scree plot or Kaiser's rule of eigenvalues greater than one) of determining the number of factors (Franklin, Gibson, Robertson, Pohlmann, & Fralish, 1995).

The results of the parallel analysis revealed that there were 4-underlying factors that explains inter-item correlations of the self-efficacy scale. The promax rotation method was used to figure out item-factor relationship. Unlike the varimax method, the promax rotation method does not minimize the inter-factor correlations. The reason for preferring the promax rotation was the expectation that the factors would be correlated. the item-factor relationship after the promax rotation was displayed in Table 2.

Table 2. Factor Loading and Communality Estimates

Items	F1	F2	F3	F4	h^2	u^2
1	0.57	0.03	-0.07	-0.03	0.28	0.72
2	0.15	0.54	0.04	-0.21	0.29	0.71
3	-0.09	0.09	0.50	0.01	0.27	0.73
4	-0.07	0.52	0.25	0.02	0.42	0.58
5	-0.12	0.52	-0.04	0.12	0.29	0.71
6	0.71	-0.01	-0.02	0.13	0.59	0.41
7	-0.07	0.19	0.40	-0.13	0.19	0.81
8	-0.08	0.53	0.02	0.18	0.37	0.63
9	0.32	-0.04	0.39	0.02	0.36	0.64
10	0.45	-0.04	0.16	0.09	0.33	0.67
11	0.08	0.04	0.64	-0.06	0.44	0.56
12	0.23	-0.10	0.64	0.07	0.59	0.41
13	-0.04	0.43	0.04	0.43	0.50	0.50
14	0.11	0.17	-0.10	0.74	0.68	0.32
15	-0.14	-0.16	0.52	0.53	0.62	0.38
16	0.00	-0.10	0.41	0.24	0.28	0.72
17	0.19	0.15	-0.01	0.53	0.49	0.51
18	0.14	0.41	-0.09	0.13	0.25	0.75

h^2: The ratio of the variance of the item explained by the factor; u2: the ratio of the variance of the item not explained by the factor.

The loadings shown in Table 2 are the standardized item factor correlation values. Any correlation less than 0.30 was regarded as "no relationship". Then the item factor correlation values ranged from 0.32 to 0.71. When the table was examined it was found that the value of communality estimate of item 7 was low (h^2=0.19), but the removal of that item from the scale would damage the content validity of the scale. For this reason, this item has not been removed from the scale. Items 9, 13 and 15 had cross loadings. These items have been reviewed, and a decision was made as to which factor each belongs. Table 3 displays the meaning attached to each factor and which items belong to these factors.

Table 3. The Distribution of The Items in The Scale According to Their Factor

Factors		Items
F1	Personal self-efficacy belief about teaching the NOS	1, 6, 9, 10
F2	Teacher role on the teaching the NOS	2, 4, 5, 8, 18
F3	Self-efficacy belief about teaching process	3, 7, 11, 12
F4	Self-efficacy belief about assessment process	13, 14, 15, 16,17

Table 4 shows inter-factor correlations. The table shows that the underlying dimensions that emerged from the correlations among the factors indicate existance of distinct factors.

Table 4. Inter-factor Correlations

Factors	F1	F2	F3	F4	Eigenvalues	Alpha
F1	1.00	0.35	0.47	0.45	1.14	0.67
F2	0.35	1.00	0.38	0.16	1.89	0.68
F3	0.47	0.38	1.00	0.40	5.11	0.64
F4	0.45	0.16	0.40	1.00	1.13	0.77
Entire scale						0.84

Since the scale has known internal structure, and relaibility values that are close to acceptable ranges, the scores obtained using the scale could be used for research purposes. Pre-test and post-test averages of the teachers were compared at the $p < 0.05$ significance level using the Wilcoxon Test. The Wilcoxon test is preferred because the number of participants is less than 30 and the data are not distributed normally. In order to compare the pre-test and post-test averages from the factors of the scale, four Wilcoxon Tests were performed, in which case the p value was set to 0.05 / 4 = 0.0125 (Bonferonni adjustments) so as not to raise the second type of error rate due to multiplicity.

Beliefs about reformed science teaching and learning (BARSTL)

The information about the teachers' beliefs for reform approach in teaching program were collected from the pre-test and post-test of the "Beliefs About Reformed Science Teaching and Learning [BARSTL]. Developed by Sampson and Benton (2006) and originally in English, the scale was adapted to Turkish by Duru, Turgut, and Akçay (2011). The Cronbach Alfa factor of the whole scale is 0.90 and Spearman-Brown correlation factor is 0.93. The scale, implemented in the type of 4-Point Likert (strongly disagree, disagree, agree, strongly agree) has 32 items. The possible scores of the scale are between 0 and 96 and if the score taken from the scale is high, it shows that there is coherence between science teaching and learning and reform approaches in science teaching. The 32 items in BARSTL have 4 sub-dimensions and there are 8 items in each sub-dimension. (1) How do people learn science? (2) Design of the lessons and application, (3) The characteristics of the teaching and learning environment, (4) The nature of the science teaching programs. Under every sub-dimension, there are 4 items, which reflects traditional, and constructivist approaches. These sub-dimensions' items are given below (Table 5).

Table 5. The Distribution of the Sub-Dimension Items According to The Traditional and Constructivist Approaches

Sub-dimensions	Constructivist	Traditional
How do people learn science?	1, 2, 5, 8	3, 4, 6, 7
Design of the lessons and application	9, 10, 13, 14	11, 12, 15, 16
The characteristics of the teacher and learning environment	17, 19, 20, 24	18, 21, 22, 23
The nature of the science teaching programs	25, 28, 30, 32	26, 27, 29, 31

Teachers' pre-test and post-test answers for the items in the scale were scored by considering the items in every sub-dimension, which reflects the traditional approach. In this respect, the items reflecting the constructivist approach were scored from 3 to 0 (strongly agree - 3, agree - 2, disagree - 1 and strongly disagree - 0); for items reflecting the traditional approach, scoring was performed from 0 to 3 in the same terms. Pre-test and post-test averages of the teachers were compared at the $p < 0.05$

significance level using the Wilcoxon Test. Wilcoxon test is preferred because the number of participants is less than 30 and the data are not distributed normally. In order to compare the pre-test and post-test averages from the factors of the scale, four Wilcoxon Tests were performed, in which case the p value was set to 0.05 / 4 = 0.0125 (Bonferonni adjustments) so as not to raise the second type of error rate due to multiplicity.

Results

The Effect of the CPD Program on the Teachers' Self-efficacy Belief for the Teaching of the NOS

The results of the study showed that the implemented CPD program improved the teachers' self-efficacy beliefs towards the teaching of the NOS. When the findings were examined, it was found that the difference between the total pre-test and post-test scores taken from "The Scale of Self-Efficacy Belief About Teaching the Nature of Science" was significant (p <0.05) (Table 6).

Table 6. Wilcoxon Test Results in which Pre-test and Post-test Results from the Whole Scale are Compared

	PostT>PreT	PostT=PreT	PostT<PreT	p
Total Pre-test*Total Post-test	11	2	5	***.021****

* Bold and italic values are "p<0,05"; N=18
PostT>PreT: Number of teachers whose post-test score is higher than the pre-test score; PostT=PreT: Number of teachers whose post-test score equals the pre-test score; PostT<PreT: Number of teachers whose post-test score is lower than the pre-test score

On the other hand, when the research findings were examined at dimension level, the difference between the pre-test and post-test scores of all the factors of the scale was not significant (p >0.0125) (Table 7). An explanation for this were presented in the discussion.

Table 7. Wilcoxon Results in which the Pre-Test and Post-Test Scores from the Factors of the Scale are Compared

Dimensions	Pre-test Mean	Post-test Mean	PostT>PreT	PostT=PreT	PostT<PreT	p
Personal self-efficacy belief about teaching the NOS	2.90	3.15	9	7	2	.015
Teacher role on the teaching the NOS	3.30	3.32	9	0	9	.982
Self-efficacy belief about teaching process	3.01	3.17	8	6	4	.080
Self-efficacy belief about assessment process	2.92	3.22	8	6	4	.044

* Bold and italic values are "p<0,0125".
N=18

The Effect of the CPD Program for the Teachers' Beliefs About Reform Approaches

The results of the study showed that the CPD program developed positively for teachers' beliefs about reform approaches. When the findings were examined, it was found that the difference between the total pre-test and post-test scores taken from the BARSTL scale was significant (p <0.05) (Table 8).

Table 8. Wilcoxon Test Results in which Pre-test and Post-test Results from the Whole Scale are Compared

	PostT>PreT	PostT=PreT	PostT<PreT	P
Total Pre-test*Total Post-test	15	1	2	***.001****

* Bold and italic values are "p<0,05".
N=18

When Wilcoxon Test results, which is the comparison of teachers' pre-test and post-test performances in each dimension, were examined, it was seen that the difference between pre-test and post-test scores of "how do people learn science? and ''design of the lessons and application'' dimensions were significant. It was determined that development was mostly in the "design of the lessons and application" dimension. On the other hand, it was determined that the difference between pre-test and post-test scores of "teacher and learning environment characteristics" and "nature of science education programs" dimensions were not significant (Table 9).

Table 9. Wilcoxon Results in which the Pre-Test and Post-Test Scores from the Sub-Dimension of the Scale are Compared

Dimensions	Pre-test Mean	Post-test Mean	PostT>PreT	PostT=PreT	PostT<PreT	p
How do people learn science?	1.54	1.86	14	2	2	***.005****
Design of the lessons and application	1.73	1.98	14	3	1	***.003****
The characteristics of the teacher and learning environment	1.63	1.85	10	3	5	.039
The nature of the science teaching programs	2.19	2.41	11	2	5	.028

* Bold and italic values are "p<0,0125".
N=18

Discussion, Conclusion and Suggestions

Like teacher training programs, one of the most important aims of the PD programs should develop manner and belief systems about teaching and learning (Bümen, 2009; Nespor, 1987) which come from emotional accumulations with past experiences (Bümen, Ateş, Çakar, Ural, & Acar, 2012; Hart, 2002; Wilkins & Brand, 2004). Because change in teachers' beliefs about teaching and learning enables teachers to develop their classroom practices, to adopt themselves to the changes easily and realize this process fast and successfully (Erdaş, 2015).

The first belief of the teachers developed in this research was the teachers' self-efficacy beliefs about teaching the NOS. Mıhlandız and Doğan (2017) made a research among the science teachers and find out that the insufficiency of the science teachers about the NOS results from the lowness of the self-efficacy beliefs. In this research, it was established that PD program, which was held according to different variables and the needs of the country, was successfully developed teachers' self-efficacy beliefs about teaching the NOS. There is a potential for self-efficacy beliefs to be developed in the environments in which teachers are provided with sufficient time and opportunity to improve their performance (Bell & Maeng, 2013), allowed to experience other successful practices (indirect experience) (Bandura, 1977, 1994, 1997), appropriately motivated to succeed (verbal persuasion) Bandura, 1977, 1994, 1997), and their willingness to do so is enhanced (psychological state) (Bandura, 1977, 1994, 1997). Therefore, in the professional development program organized; it is thought that providing teachers with adequate time, active participation and interaction with other colleagues, providing them possibility of reflection and feedback throughout the process, allowing them to experience the practices of their colleagues, and including them in the development process of the teaching materials to be implemented in the classroom develop their self-efficacy beliefs with their willingness to teach the nature of science.

As evidenced by the findings, although the results of the pre-test and post-test performances of the teachers obtained from the whole scale were statistically significant, the difference between the pre-test and post-test performances of teachers obtained from the scale factors were not significant at $p < 0.0125$ (Table 6 and Table 7). This may be due to the fact that the pre-test averages of teachers are higher than expected. The fact that teachers had no prior knowledge of the misconceptions they had before their PD program and had not experienced the difficulties they may encounter in integrating the NOS into their classroom practice may explain their high self-efficacy in this regard. On the other hand, it was reported in the conducted researches that variables such as the level of the class, the kind of the graduated high school, preferred department, previous courses about the NOS and the history of science, crammer, projects etc. affects self-efficacy beliefs about teaching the NOS. It was also reported that pre-service teachers who had taken courses about the NOS had higher self-efficacy beliefs than pre-service teachers who had not taken courses about the NOS (Kubilay, 2014). This result may help us to explain the relatively high scores in the pre-test, because 13 out of 15 participants had course, crammer, and project experiences about the NOS. The main issue that needs to be addressed here is, the risk that teachers who have inadequate views and misconceptions about NOS but who are eager to teach and who have high self-efficacy will be an obstacle to the education of science literate individuals. This has further clarified the need for long-term PD programs that will enable them to face current misconceptions and support their classroom practices, without compromising teachers' enthusiasm and self-efficacy about NOS that is important component of scientific literacy.

Another teacher belief which was developed in this research is teachers' belief about reform approaches. The choice of reform approaches rather than traditional approaches in the implemented PD program and the support of teachers in integrating these approaches into their classroom practices; may have helped improve teachers' beliefs about reform approaches. Because, one of the biggest problems for teachers is that existing in-service training is a course or a seminar and does not offer them the chance to practice in this training process despite introducing current approaches and methods (Bümen et al., 2012). When teachers are forced to integrate these methods without giving them the chance to apply them to their classroom practices, they are reoriented to traditional approaches (Han, 2011). Mıhlandız and Doğan (2017) mentioned that pre-service teachers tend to traditional approach even if it is not advised in the curriculum while they are teaching the NOS. Even if teachers try to adopt themselves of the new approaches in classroom practices, the discrepancy between beliefs about these approaches and application causes teachers to change new curriculum into the traditional approach and use it (Mitchener & Anderson, 1989 as cited in Han, 2011). That's why, in the following researches, it is important to aim to develop teachers' beliefs about reform approaches in order to develop classroom practices. However, it is not easy for the teachers to change the traditional approaches that they use in classroom practices and use reform based approaches advised in the curriculum. It also need a process (Han, 2011; Fullan, 1991; Mitchener & Anderson, 1989). For this purpose, it is thought that PD 3.0 model (Table, 1), which take teacher as an individual and provide them adequate practice, can develop classroom practices with teachers' beliefs about teaching and learning the NOS and their beliefs about reform approaches.

During the 20th century, one of the biggest problems of the teachers in their undergraduate education and in-service teacher training is to see the theory and application as separate parts (Bümen et al., 2012; Lanier & Little, 1986). Recently, researchers have started to take into consideration the option to change this situation, fill the gap between theory and practice and attach theory to practice (Korthagen, Loughran, & Russell, 2006). The solution of this problem is possible when we answer the question how we can make theory related to the practice in teacher training programs (Korthagen, 2017). On the other hand, teacher training and classroom practices of the teachers are more complicated than it is thought. According to Korthagen (2017), if we don't have enough information about how teachers learn, every attempts in order to attach theory to application are nothing more than a shot to the darkness. Therefore, strategies which are unsuccessful in theory and practices parts, which waste time, cost, motivation and which is confirmed as ineffective, should be given up and teacher trainers, science researchers and policy makers should plan the PD programs considering teachers' profile and needs determined according to Turkey's education policy and philosophy.

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