Teaching and Learning Beliefs of Preservice Science Teachers from Different Grade Levels[1]

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Abstract

Preservice teachers' beliefs about teaching and learning have gained increased attention. Therefore, many studies in the field of educational research have focused on preservice teachers' beliefs to reveal their images of teaching and learning through different instruments. Preservice teachers' drawings of teaching and learning situations constitute one of these instruments. Drawing is used commonly because it allows one to represent vivid images of mental models which may not be expressed verbally. In this study, the Draw-a-Science-Teacher-Test (DASTT) was used to reveal participants' beliefs of teaching and learning of science. The research sample included 134 preservice science teachers from different grade levels. Also, the relationships between gender and among grade levels of the participants were investigated. The results showed that preservice science teachers had educational perspectives including characteristics of both teacher-centered and student-centered instruction. The results also showed that there was no significant difference between educational perspectives with respect to gender and the grade levels of the participants. However, senior students had different instructional understandings from other participants by giving science teachers a role of doing experiments or activities instead of spending the whole class time just by talking and standing in front of students. Similarly, the senior students imagined a science class as arranged with U-shaped rows or with oval tables, which allows their students to study in groups instead of a science class arranged in rows.

Keywords: *Teaching and learning of science, preservice teachers, the draw-a-science-teacher-test*

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Farklı Sınıf Düzeylerinden Fen Bilimleri Öğretmen Adaylarının Öğrenme ve Öğretme Anlayışları [1]

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Öz

Öğretmen adaylarının öğrenme sürecine yönelik anlayışları hep merak konusu olmuştur. Bu nedenle, bu konu üzerine birçok araştırma yapılmış ve bu araştırmalarda veri toplamak için farklı araçlar kullanılmıştır. Bu araçlardan biri de çizim tekniğidir. Bu teknik, kelimelerle ifade edilmesi zor olan birçok şeyi ifade etme imkânı sağladığından yaygın olarak kullanılmaktadır. Bu çalışmada da öğretmen adaylarının öğrenme sürecine yönelik düşüncelerini ortaya çıkarmak amacıyla "Bir Fen Öğretmeni Çiz Testi" (Draw-a-Science-Teacher-Test-DASTT) kullanılmıştır. Çizimlerin yorumlanması için ise Bir Bilim İnsanı Çiz Testi Kontrol Listesi (Draw-a-Science-Teacher-Test Checklist- DASTT-C) kullanılmıştır. Çalışmanın örneklemini Fen Bilgisi Öğretmenliği lisans programında öğrenim gören toplam 134 öğrenci oluşturmuştur. Çalışmanın hedefi doğrultusunda, öğretmen adaylarının, cinsiyet ve sınıf düzeylerinin fen eğitimi anlayışları üzerine anlamlı bir etkisinin olup olmadığı da incelenmiştir. Bulgular genel olarak fen bilimleri öğretmen adaylarının eğitim anlayışı olarak öğrenci ve öğretmen merkezli anlayışın arasında kaldıklarını göstermiştir. Ayrıca cinsiyet ve sınıf düzeyi olarak katılımcıların fen eğitimi anlayışları üzerinde istatistiksel anlamlı bir etkisinin olmadığı da ortaya konmuştur. Buna karşın son sınıf öğrencilerinin, öğretmeni, dersi sadece konuşarak işleyen rolünden, deney ya da etkinlik yapan rolüne yaklaştırdığı ve sınıf ortamında merkezi konumdan uzaklaştırdığı görülmüştür. Ayrıca son sınıf öğrencileri sınıfın fiziki düzenini arka arkaya dizilmiş sıralardansa U biçimli ya da grup çalışmalarının olduğu masalar şeklinde tasarlamışlardır.

Anahtar Kelimeler: *Fen öğretme ve öğrenme, öğretmen adayları, bir fen öğretmeni çiz testi*

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INTRODUCTION

Numerous researchers are of the opinion that the success of science education reforms is associated with teachers' mental images (Minogue, 2010). Since many of tomorrow's science teachers are today's preservice teachers, the mental models they hold should be of concern to any teacher education program (Ambusaidi & Al-Balushi, 2012).

Two factors are prompting for trying to reveal the mental images of preservice teachers about science teaching. The first one is to reveal the effects of teacher education programs on preservice teachers' thoughts, values, and beliefs. The literature shows that these programs play important roles in preservice teachers' approaches to learning and teaching (Hancock & Gallard, 2004). The other factor is to foresee the atmosphere in preservice teachers' future classrooms. Some researchers argue that individuals' current thoughts are important predictors of their future behaviors (Bandura, 1986; Nespor, 1987).

Mental models can be thought as psychological representations of real, hypothetical, or imaginary situations. They may represent individual's beliefs system with the help of their predictive and explanatory power (Norman, 1983). They are also used to predict future behaviors of people (Johnson-Laird, 2001). Therefore, these models may provide important understandings about teachers' beliefs regarding the teaching and learning of science (Minogue, 2010). Examining preservice teachers' mental models can reveal their action plans (Ajzen, 1985) or their personal pedagogic understandings of science education (Kagan, 1992).

Using drawings is a tradition to reveal individuals' understandings and beliefs (Vosniadou & Brewer, 1992, 1994; Glynn, 1997). In this study, the Draw-a-Science-Teacher-Test-DASTT was used to reveal preservice science teachers' views about science teaching. Among current assessment techniques, drawings provide a relatively rich source of information from individuals. Drawings help individuals to arrange things in a place and to reveal the interactions between these things while describing a mental image. They represent clear images of interior understandings that can be captured rather quickly (Weber & Mitchell, 1996; Hancock & Gallard, 2004). The beliefs captured in the form of drawn mental models can provide a view into preservice teachers' decision making, practices, and actions in their future classrooms (Nespor, 1987; Pajares, 1992).

The technique of drawing was chosen as a way to capture an image of the beliefs held by the preservice science teachers. Drawing is one of the important methods used to reveal teachers' mental images of teaching and learning (Glynn, 1997). This technique allows investigation of thoughts thoroughly which are difficult to be expressed orally or in written form since it makes it possible to convey the things beyond expression (Akkuş, 2013). In this respect, a variety of studies focused on revealing individuals' thoughts using drawings (*e.g.* Minogue, 2010; Elmas, Demirdöğen & Geban, 2011; Al-Amoush, Markic, Abu-Hola & Eilks, 2011; Ambusaidi & Al-Balushi, 2012; Ulu, 2012; Akkus, 2013; Tatar, 2015).

In some of these studies the relationship between preservice teachers' beliefs about teaching and learning and self-efficacy beliefs has been examined. In some studies conducted with preservice teachers, the effects of variables such as gender, their desire to be a teacher, their branch of education, taking science teaching courses and inquiry-based science teaching on the teaching and learning approaches have been examined. On the other hand, in some studies made by students, the relationship between students' perception of science teaching and multiple intelligence types and the effects of variables such as grade level, gender, socio-economic level and parental education level on students' perception of science teaching were investigated.

As a measurement technique, drawing yields a great amount of data. The drawing technique makes it possible for the individual to create a setup, to organize the objects in a physical environment, and to demonstrate the interaction between objects (Minogue, 2010). The mental images obtained through drawings pave the way for understanding teachers' behaviors (Ertmer, 2005).

Purpose

In this scope, the objective of this study was to reveal preservice science teachers' beliefs about teaching and learning of science. The study also aimed to examine these beliefs in terms of the participants' gender and grade levels.

METHOD

In the study, the survey research design was used. Survey is a method that aims to obtain information to understand the attitudes, beliefs, or knowledge of a specific group (Swain, 2017). The research data were obtained through the participants' drawings. Then, the qualitative data obtained from the drawings were turned into quantitative data through content analysis. Following this, the data were interpreted with the help of certain statistical analyses.

In the present study, the participants were asked to draw a picture of themselves as a science teacher at work, to write a brief description of their drawings and to answer the following questions specifically: "What is the teacher doing?" and "What are the students doing?". The participants were given 30 minutes to complete their drawings. Then, the drawings of the participants were scored according to a checklist.

Population and Sample

The target population of this study included Turkish preservice science teachers. The research sample was made up of 134 preservice teachers studying in the Department of Science Teacher Education at a state university in Turkey. Among the 134 participants, 45 of them were freshman; 43 were sophomore; 19 were junior; and 27 were senior undergraduates. Moreover, 99 of the participants were female, and 30 were male. In addition, five participants did not state their gender. The participants of the study were selected using the convenience sampling technique. This technique is a type of non-probability sampling strategy in which subjects are selected based on their convenient accessibility. There are two reasons for using this technique in this study. First, there was only one department of science teacher education at the university where the present study was carried out. Secondly, the participants were readily accessible.

Data Collection Tools

The Draw-a-Science-Teacher-Test (DASTT) and the Draw-a-Science-Teacher-Test Checklist (DASTT-C) were used as the data collection instrument and coding tool in order to reveal preservice teachers' beliefs about teaching and learning science.

These tools were used by numerous researchers to reveal preservice teachers' thoughts. DASTT was made up of two parts. In the first part, the participants were asked to imagine themselves as a science teacher at work and draw what was going on in their minds when they were teaching. There were two open-ended questions in the second part. With these questions, the participants were asked to explain what the teacher and the students in the drawings were doing. The responses given to these questions were useful for the interpretation of the drawings. DASTT-C included three main components, which were teacher, student, and environment. While analyzing the participants' drawings, two criteria were used for the teacher and student components. These criteria were about what the teacher and the students did in science lesson and what their positions were. All the main and sub-components of DASTT-C were defined briefly. The checklist was made up of 5, 3, and 5 items from the components of teacher, student, and environment, respectively, and it produced scores ranging from 0 at least to 13 at most. A score of 0 or near-zero showed that the participant had a student-centered teaching approach, while the scores close to 13 represented a teacher-centered approach (Thomas & Pedersen, 2003). More specifically, the scores of the participants were assessed in three categories. A score ranging between 0 and 4 represented student-centered approach, while a score ranging between 10 and 13 represented a teacher-centered approach. In addition, a score between 5 and 9, on the other hand, meant that the participant had neither student nor teacher-centered approach (Yılmaz, Turkmen, Pedersen & Huyugüzel-Cavas, 2007). Student-centered approach (a score of 0-4) is represented by exploratory, enquiry, and constructive education approach. According to this approach, students actively participate in the learning process, and teachers have the roles of a guide or facilitator. On the other hand, teacher-centered approach (a score of 10-13) is an educational approach where the teacher is in the central position as a knowledge transmitter and dominant factor, and the students are passive receivers of the teacher's instructions. The scores between

these two understandings (a score of 5-9) represent the conceptual teaching. In this approach, students are central, but it also includes more teacher-centered drawings. The teacher is viewed as the provider of information and as the leading factor in concept development. Students are generally drawn as they do research and use materials (Thomas, Pedersen & Finson, 2001). First of all, the research data were examined in terms of inter-coder reliability. The inter-coder reliability was tested by coding some of the drawings by a second researcher. Accordingly, inter-coder reliability was found to be 79%, and the Cohen kappa was revealed to be .49. A ratio of 79% indicates good fit (Miles & Huberman, 1994). A Cohen kappa coefficient of .49 indicates a higher level of fit (Landis & Koch, 1977). As a result, these findings indicated an acceptable fit between the coders.

Data Analyses

The distribution of the overall data was examined in terms of normality before performing the subsequent statistical analyses. Shapiro-Wilks test ($p<.05$), Q-Q plots and box plots revealed that the data obtained using DASTT-C did not have a normal distribution. As a result, the data were analyzed using non-parametric statistical techniques.

FINDINGS

When the data were analyzed, preservice teachers' understanding of science education was determined to be M=3.53, SD=1.06 for teacher sub-dimension, M=2.20, SD=1.06 for student sub-dimension and M=2.66, SD=1.29 for environment sub-dimension. The overall mean scores was M=8.39, SD=2.65 out of 13.

The present study also investigated whether the participants' beliefs about science teaching differed in terms of their gender and grade levels. As can be seen in Table 1, the mean scores of the participants' beliefs about science teaching with respect to their grade levels ranged between 8.13 and 8.79. The mean scores of the female and male students were 8.41 and 8.13, respectively. Table 1 also presents the mean scores obtained from the sub-dimensions with respect to gender and grade levels. When the data in the Table 1 were examined, it was seen that the overall mean scores were within the range of 5-9, which represents conceptual teaching. Other notable data in Table 1 were related to the absence of a steady increase or decrease in overall mean scores depending on grade levels. The same situation was also true for the sub-dimensions.

Table 1
Participants' mean scores in terms of gender and grade levels

	Gender		Grade Levels			
	Female	Male	1	2	3	4
Overall Mean Score	8.41	8.13	8.13	8.63	8.79	8.15
Teacher Sub-dimension	3.61	3.27	3.44	3.65	3.68	3.37
Student Sub-dimension	2.14	2.30	2.00	2.21	2.53	2.30
Environment Sub-dimension	2.67	2.57	2.69	2.77	2.58	2.48

Since the distribution of the overall data was not normal, Mann Whitney U test was performed to examine the relationship between the male and female participants' overall scores and the scores obtained from the sub-dimensions. The results are presented in Table 2 below. Accordingly, although the mean scores of the male students were lower than those of the female students in terms of the total scores and the sub-dimensions except for the student sub-dimension, this difference was not statistically significant ($p>.05$).

Table 2
Mann Whitney U results of overall mean scores and mean scores obtained from the sub-dimensions in terms of gender

		Mean Ranks	Sum of Ranks	U	*p*
Overall Mean Scores	Female	65.89	6523.50	1396.500	.617
	Male	62.05	1861.50		
Teacher Sub-dimension	Female	67.72	6704.00	1216.000	.106
	Male	56.03	1681.00		
Student Sub-dimension	Female	63.73	2076.00	1359.000	.439
	Male	69.20	6309.00		
Environment Sub-dimension	Female	65.70	1881.00	1416.000	.692
	Male	62.70	6504.00		

Another aim of this study was to reveal the difference in the participants' beliefs about science teaching in terms of grade levels. Table 3 presents the Kruskal-Wallis test results. As can be seen in Table 3, there was no significant difference in the participants' overall scores and the scores obtained from the sub-dimensions in terms of grade levels.

Table 3
Kruskal-Wallis test results of overall mean scores and mean scores obtained from the sub-dimensions in terms of grade levels

		M	Mean Ranks	sd	χ^2	*p*
Overall Mean Score	Freshman	8.13	64.68	3	1.545	.672
	Sophomore	8.63	72.59			
	Junior	8.79	69.87			
	Senior	8.15	62.43			
Teacher	Freshman	3.44	68.28	3	3.090	.378
	Sophomore	3.65	72.05			
	Junior	3.68	70.24			
	Senior	3.37	57.04			
Student	Freshman	2.00	60.21	3	5.781	.123
	Sophomore	2.21	65.50			
	Junior	2.53	81.58			
	Senior	2.30	72.93			
Environment	Freshman	2.69	69.39	3	1.399	.706
	Sophomore	2.77	71.13			
	Junior	2.58	62.76			
	Senior	2.48	61.91			

The participants' overall scores and the scores obtained from the sub-dimensions were compared, and no statistically significant difference was found in terms of gender and grade levels. In order to elaborate the data collected in the study, the participants' mean scores obtained from each item in the DASTT-C were compared in terms of gender and grade levels. The mean scores obtained from each item in the DASTT-C were calculated in terms of gender and grade levels, and the data related to the items, which yielded significant differences, are presented in Table 4 and Table 5.

Table 4
Mann Whitney U Test results for each item in terms of gender

Item No		M	Mean Ranks	Sum of Ranks	U	p
1	Female	.52	69.73	6903.00	1017.000	.002*
	Male	.20	49.40	1482.00		
9	Female	.48	61.27	6066.00	1116.000	.017*
	Male	.73	77.30	2319.00		
13	Female	.49	68.42	6774.00	1146.000	.028*
	Male	.27	53.70	1611.00		

*significant at the level of .05

When Table 4 was examined, significant differences were observed between male and female participants in terms of item 1, which belonged to the teacher sub-dimension; and in terms of item 9 and 13, which belonged to the environment sub-dimension. Item 1 was about the teacher's preference of conducting activities or experiments. Accordingly, the female students (M=.52, SD=.50) viewed themselves as teachers conducting more activities in science lessons compared to the male students (M=.20, SD=.40). In item 9, the presence of a traditional desk arrangement in a classroom was expressed. When the mean scores related to this item were examined, it was found that the female students (M=.48, SD=.50) had less traditional classroom environment beliefs compared to the male students (M=.73, SD=.45). Item 13 was about the presence of science equipment and experiment materials in the learning environment. The average scores indicated that the female students (M=.49, SD=.50) placed these materials and equipment in the learning environment more than the male students (M=.27, SD=.45).

Table 5
Kruskal-Wallis Test results for each item in terms of grade levels

Item No		M	Mean Ranks	sd	χ^2	p
1	1st year	.47	69.27	3	10.209	.017*
	2nd year	.42	66.05			
	3rd year	.16	48.58			
	4th year	.63	80.19			
2	1st year	.78	70.61	3	8.129	.043*
	2nd year	.77	69.92			
	3rd year	.84	74.92			
	4th year	.52	53.24			
4	1st year	.71	63.64	3	8.260	.041*
	2nd year	.84	72.09			
	3rd year	.95	79.47			
	4th year	.63	58.19			
9	1st year	.60	71.70	3	12.134	.007*
	2nd year	.56	68.90			
	3rd year	.74	80.87			
	4th year	.26	48.87			
13	1st year	.33	59.83	3	14.461	.002*
	2nd year	.51	71.78			
	3rd year	.21	51.61			
	4th year	.70	84.65			

*significant at the level of .05

As can be seen in Table 5, statistical differences in terms of grade levels were found in items 1, 2, and 4, which belonged to the teacher sub-dimension. In item 1, the teacher's preference of conducting

experiment or activity was indicated. Item 2 expressed that the teacher mostly instructed verbally. Item 4 expressed that the teacher was in a central position in the classroom. The senior students had higher scores in item 1 (M=.63, SD=.49) but lower scores in items 2 (M=.52, SD=.50) and 4 (M=.63, SD=.49). In other words, the senior students viewed themselves as a teacher conducting experiments and activities in the classroom rather than instructing verbally and being in a central position.

In items 9 and 13, which belonged to the environment sub-dimension, significant differences were found between grade levels. A significant decrease in the senior students' scores (M=.26, SD=.44) was observed in item 9. However, a significant increase in their scores (M=.70, SD=.46) was also found in item 13. Item 9 was related to the traditional desk arrangement in the classroom. Item 13 was about the presence of science symbols (science equipment, experiment materials, charts on the wall, etc.). These findings showed that the seniors thought that a science classroom should include science equipment and that the organization of desks should be U-shaped instead of traditional desk arrangement, which will make it easier for students to cooperate. The student drawings given below illustrate this situation better (See figure 1).

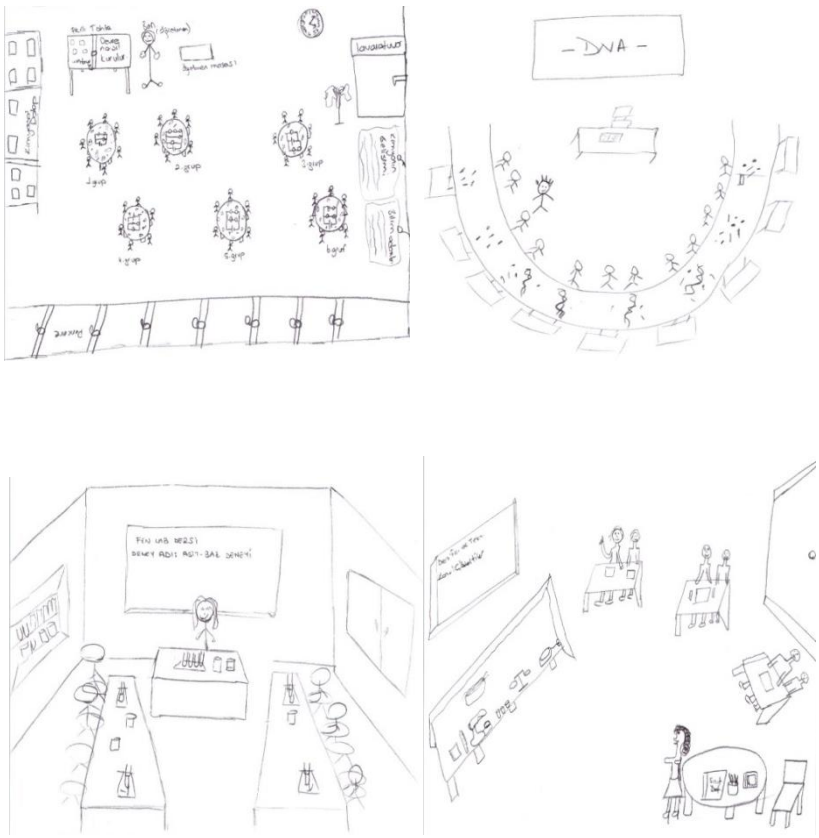

Figure1. Samples showing a learning environment with U-shaped organization and roundtables drawn by the senior participants

DISCUSSION & CONCLUSION

The participants' overall mean scores obtained from DASTT-C ranged between 5 and 9, which indicated a score between teacher- and student-centered approach. This situation implies that the preservice teachers did not adopt the teacher-centered approach or the student-centered approach solely, but based on the situation, it could be stated that they had an approach in-between. Similar findings were revealed by other researchers (Elmas, Demirdöğen & Geban, 2011; Saçıcı, 2013; Akkus, 2013). When the drawings and the written expressions related to these drawings were examined, it was also observed that the preservice teachers' beliefs about learning and teaching did not differ significantly in terms of gender and grade levels. However, when the mean scores obtained from each item in DASTT-C were examined separately, it was confirmed that some of the items differed significantly in terms of gender and grade levels. These

differences were especially found in the teacher and environment dimensions. It appeared that the female participants had a tendency to involve more activities in the learning process, to get rid of the traditional order of student desks, and to draw science equipment more frequently when compared to the male participants. This is in agreement with the findings of Elmas, Demirdöğen & Geban, (2011), which is the reason that female preservice teachers are more likely to use student-centered approach than male preservice teachers. There are also some studies in the literature that show that female preservice teachers are active in learning environments and use a constructivist approach (Laird, Garver & Niskode, 2007; Chudgar & Sankar, 2008). On the other hand, in the literature, there are studies in which preservice teachers do not have any effect of gender on their understanding of the learning process (Yılmaz *et al.,* 2007; Akkuş, 2013). As for the tendencies in different grade levels, it was observed that the senior students depicted the teacher as doing experiments or activities rather than just talking throughout the lesson and that they placed the teacher in a more decentralized position in the classroom. Similarly, instead of a traditional desk arrangement, the seniors organized the desks in U shape or the tables around with the students gathered who studied cooperatively. Moreover, it was seen that they attached more importance to the presence of science-related equipment. The data obtained from the student sub-dimension revealed that the preservice teachers regarded students as passive receivers and gave them the role of sitting down on their desks, behaving in accordance with teachers' instructions or watching the events in the classroom no matter what their gender or grade levels is.

All these results demonstrate that preservice science teachers may be in an attempt to create a learning environment somewhere between teacher-centered and student-centered education in their future science classes. In these classrooms, the students will be partly active, while the teachers will be in a central position. Moreover, although the classrooms will involve traditional desk arrangement with a variety of science equipment, it should be noted that U-shaped desks or roundtables will also be present in the classrooms. Considering the contemporary student-centered approach where the teacher is a guide and where the student is in the center as well as considering the efforts to reflect this approach into school curricula, it could be stated that the preservice teachers with their current science education understandings aren't ready for this system. The reason behind this situation may be attributed to the teacher-centered education given throughout university education, which disregards the student-centered education targeted in primary and secondary school levels.

IMPLICATIONS

As can be seen in the present study, the preservice teachers did not adopt the teacher-centered approach or the student-centered approach, solely. The reasons behind this situation can be revealed through interviews with undergraduates as well as through observations in their learning environment, which will reflect their educational approach. Interviews with preservice teachers or examination of course contents in university may make this inference more reliable and apprehensible. In this way, teacher training programs will be able to consider the results of such studies and take some precautions in terms of training more qualified teachers.

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