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An Investigation of the Relationship Between Preservice Science Teachers' Epistemological Beliefs about the Nature of Science and Their Self-Efficacy Perceptions

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Abstract
This study aims to investigate the relationship between preservice science teachers' epistemological beliefs about the nature of science (NOS) and their science learning self-efficacy perceptions by adapting a science learning self-efficacy scale for use in Turkey. This study is model as "Relational Survey". A total of 125 preservice teachers (65 sophomores and 60 seniors) from a science education department of educational faculty in a state university participated in the study. Science Learning Self-Efficacy Questionnaire (SLSEQ) and The Scientific Epistemological Beliefs Scale (SEBS) was used data collection. This study, considering the scale adapted into Turkish by Alpaslan and Işık (2016), readapted the self-efficacy scale developed by Lin and Tsai (2013) for use in the field of science education. The scale has 5 factors and 28 items. The preservice science education teachers are thought to have high perception levels based on their scores on the SLSEQ and its factors. The results of SEBS show that the preservice science teachers had a positivist understanding of science. The results on the SEBS and the SLSEQ show that there is a positive linear relationship between the scores on the two scales, and the scores on the SLSEQ predict and explain 23% of the SEBS scores.
Keywords: epistemological beliefs, nature of science, self-efficacy perceptions, preservice science teachers.

1. Introduction

In today's technology and information age, scientific knowledge increase incrementally, technological innovations proceed at great speed, and one of the vital conditions of being is to use scientific knowledge. The development of scientific knowledge and NOS is related to the science epistemology (Lederman, 1992). This is because ideas about the nature of scientific knowledge were changed to a large extent by the works of science historians and epistemologists in the first half of the twentieth century (Gürses, Doğar and Yalçın, 2005). When determining appropriate methods for teaching NOS, these works and epistemological beliefs should be taken into consideration. Individuals' scientific epistemological beliefs are of critical importance because scientific epistemological beliefs, namely personal epistemology, reveals the views of individuals about science learning, the nature of scientific knowledge, the structure of science based on the individuals' areas of learning, teaching and knowledge (Hofer and Pintrich, 1997; Marra and Palmer, 2005; Muis, 2004; Weinstock, Neuman and Tabak, 2004). It is also affects the development of reasoning, discussion, learning approaches and academic success (Cano, 2005; Peters-Burton and Baynard, 2012; Schommer, 1993). From this point of view, scientific epistemological beliefs play a role in the formation of perceptions as the basis of knowledge (Cheng, Chan, Tang and Cheng, 2009).

People's perceptions of their abilities are their self-efficacy perceptions. Self-efficacy is the level of individuals' confidence in their capacity to perform particular actions and to achieve goals (Bandura, 1997). It is not a function of their skills but the product of their perceptions about what they can do with their skills (Zimmerman, Bandura and Martinez-Pons, 1992). There is a connection between self-efficacy perceptions and the outcome expectancy (Schunk, 2011). Successful individuals trust in their skills and think that their behaviors get positive results in learning and similar activities (Schunk, 1994). According to Pajares (1996), self-efficacy considerably affects teachers because their own self-efficacy perceptions affect their effectiveness, efforts, work with students and teaching (Ashton and Webb, 1986; Azar, 2010; Ramey-Gassert and Shroyer, 1992). Teacher self-efficacy is defined as teachers' beliefs about their ability to create an effective learning process by supporting students' development (Ashton, 1984; Tschannen-Moran, Hoy and Hoy, 1998). The general culture and pedagogical knowledge that are among the specific knowledge and skills required for teaching are closely related to teacher self-efficacy (Yeşilyurt, 2013). Therefore, it is very important to determine the self-efficacy perceptions of preservice science teachers.

The philosophical and scientific characteristics of preferred teaching methods are essential. Individuals' beliefs and perceptions of NOS are of great importance, especially in environments where a process based on the comparison of mental activities and scientific events is established. According to Izgar and Dilmaç (2008), teachers' self-efficacy perceptions and epistemological beliefs are related. There are some studies in the literature that examine epistemological beliefs about NOS and teacher self-efficacy perceptions (Erdem, 2008; Kapucu and Bahçivan, 2015; Paulsen and Feldman, 2005). Epistemological beliefs and self-efficacy studies vary by participant groups, tasks and measurement intervals. There seem to fewer of such studies in science education.

This study aims to answer to the question of whether there is a relationship between preservice science teachers' epistemological beliefs towards NOS and their science learning self-efficacy perceptions and adapting the Science Learning Self-Efficacy Questionnaire (SLSEQ) for use in Turkey.

2. Methodology

This study is model as "Relational Survey". Relational survey model is investigated the connections between two or more variables. Such relations are determined by correlation, regression or comparison (Karasar, 2016).

2.1. Population and Sample

A total of 125 preservice teachers (65 sophomores and 60 seniors) from a science education department of educational faculty in a state university participated in the study.

2.2. Data Tools

2.3.1. Science Learning Self-Efficacy Questionnaire (SLSEQ)

The Science Learning Self-Efficacy Questionnaire (SLSEQ) developed by Lin and Tsai (2013) was adapted as the Physics Self-Efficacy Scale by Alpaslan and Işık (2016). In this study, considering the scale adapted into Turkish by Alparslan and Işık, the self-efficacy scale developed by Lin and Tsai (2013) was readapted for use in the field of science education. To test sampling adequacy, the Kaiser-Mayer-Olkin (KMO) and Bartlett's test of sphericity (BTS) were used.

Tablo 1. KMO and Barlett sphericity tests results

KMO		0,876
BTS	Ki-Kare	1603,962
	Sd	378
	p	0,000

The results are shown in Table 1, which shows that this test's BTS scores are highly reliable (X2= 1603.962; $p<.01$). KMO score of 0.876 was calculated for the instrument. This score is considered very good for factor analysis (Çokluk, Şekercioğlu and Büyüköztürk, 2012).

Table 2. Announced total variance

Questions	Beginning Core Values			Sum of Sticker Values of Checked Charges		
	Total	Additive to Variance %	Cumulative %	Total	Additive to Variance %	Cumulative %
1	9.720	34.715	34.715	9.720	34.715	34.715
2	1.985	7.089	41.803	1.985	7.089	41.803
3	1.623	5.796	47.600	1.623	5.796	47.600
4	1.367	4.881	52.481	1.367	4.881	52.481
5	1.221	4.361	56.842	1.221	4.361	56.842
6	1.199	4.281	61.123			
7	0.948	3.386	64.509			
8	0.923	3.296	67.805			
9	0.823	2.941	70.746			
10	0.730	2.607	73.352			
11	0.723	2.582	75.935			
12	0.691	2.467	78.402			
13	0.636	2.272	80.673			
14	0.620	2.213	82.887			
15	0.552	1.973	84.860			
16	0.529	1.890	86.750			
17	0.470	1.679	88.429			
18	0.434	1.552	89.980			
19	0.421	1.505	91.485			
20	0.400	1.430	92.915			
21	0.345	1.231	94.146			
22	0.317	1.131	95.277			
23	0.276	0.984	96.261			
24	0.237	0,846	97.107			
25	0.231	0,824	97.931			
26	0.212	0,757	98.688			
27	0.202	0,723	99.411			
28	0.165	0.589	100.000			

Table 2 shows that the total variance explained by five factors was 56.84%. Scale's factors should explain at least 50% of the total variance (Seçer, 2013). In this case, the readapted scale sufficiently explains the total variance. The five factors explain 34.72%, 7.09%, 5.80%, 4.88% and 4.36% of the total variance.

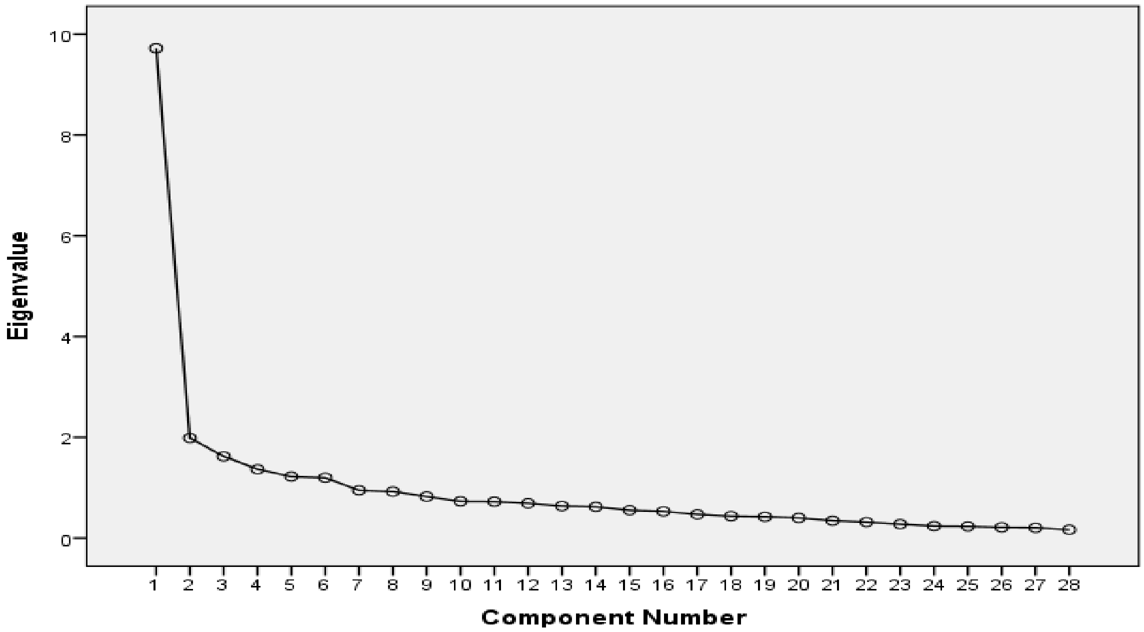

Figure 1. The Scree plot for the scale

The first inflection in the scree plot occurs in the fifth factor. This confirmed that the scale consisted of five factors. Since the scale was thought to be three-dimensional, to prevent possible cross-loading and to determine the factor loadings of the scale, rotated components matrix was analyzed (Figure 1).

Table 3. The Rotated components matrix table

Items	Components				
	1	2	3	4	5
VAR00027	.790				
VAR00022	.714				
VAR00009	.693				
VAR00013	.670				
VAR00024	.664				
VAR00003	.652				
VAR00023	.622		.469		
VAR00020	.621	.407			
VAR00006	.452				.348
VAR00019		.653	.452		
VAR00002		.591			.349
VAR00014		.532		.331	
VAR00010	.320	.510			
VAR00011			.645		
VAR00015			.533		
VAR00026	.387		.511		
VAR00005			.473		.365
VAR00017			.405		
VAR00008			.532	.638	
VAR00001				.607	
VAR00018		.463		.559	
VAR00012				.491	
VAR00021					.646
VAR00007					.619
VAR00004	.408				.617
VAR00016			.351		.581
VAR00025		.378			.541
VAR00028				.324	.480

When the items in Table 3 were analyzed in terms of whether they meet or exceed the acceptance level and cross-loading, there were no cross-loading items or items with a factor load below the acceptable level.

Table 4. Explanatory factor analysis for science learning self-efficacy scale

Factor	Item	Factor Load	Variance Ratio Explained (%)	Cronbach's Alfa
Daily Life Practice	27	0.790	34.715	0.809
	22	0.714		
	9	0.693		
	13	0.670		
	24	0.664		
	3	0.652		
	23	0.622		
	20	0.621		
	6	0.452		
Conceptual Understanding	19	0.653	7.089	0.701
	2	0.591		
	14	0.532		
	10	0.510		
Science Communication	11	0.645	5.796	0.789
	15	0.533		
	26	0,511		
	5	0.473		
	17	0.405		
Practical Application	8	0.638	4.881	0.689
	1	0.607		
	18	0.559		
	12	0.491		
Higher Level Thinking	21	0.646	4.361	0.847
	7	0.619		
	4	0.617		
	16	0.581		
	25	0.541		
	28	0.480		
Total Cronbach's Alfa= 0.928				
Total Variance Ratio Explained = %56.842				
KMO=0/876 , X^2=1603.962, Sd= 378, p<0.05				

Table 4 shows the analysis results for the Science Learning Self-efficacy Scale. The scale has 5 factors and 28 items.

2.3.2. The Scientific Epistemological Beliefs Scale (SEBS)

This 5-point Likert type scale ranges from strongly disagree to strongly agree. It was adapted into Turkish by Deryakulu and Bıkmaz (2003). The original form of the scale consisted of 50 items. Factor analysis for validity and reliability determined that the scale has one factor and consists of 30 items. Its Cronbach's alpha coefficient was 0.91. It was concluded that the scale has a bipolar form with the traditional understanding of science on one side and the non-traditional understanding of science on the other. Of the scale's 30 items, 22 items are positive, and 8 items are negative. A high score on the scale indicates a strong belief in the traditional understanding of science, and a low score indicates a strong belief in the non-traditional understanding of science.

2.4. Data Analysis

SPSS 20.0 software was used to analyze the data obtained by the study. Explanatory factor analysis was used for the SLSEQ. Minima, maxima, arithmetical means, standard deviations, correlation and simple regression were used to analyze the SLSEQ and SEBS data.

3. Findings

The descriptive data are shown in Table 5 and 6.

Table 5. The Descriptive values of the SLSEQ

Scales	N	Minimum	Maximum	Mean	Standard Deviation
SLSEQ	125	63.00	139.00	105.94 (3.78)	13.49
Practical Application	125	9.00	20.00	15.46 (3.87)	2.32
Conceptual Understanding	125	7.00	20.00	14.92 (3.73)	2.33
Daily Life Practice	125	18.00	40.00	30.31 (3.79)	4.19
Higher Level Thinking	125	11.00	30.00	21.64 (3.61)	3.36
Science Communication	125	14.00	30.00	23.60 (3.93)	3.21

Table 5 shows that the preservice science education teachers' average score per item on the SLSEQ was 3.78. Average scores are considered very low from 1.0-1.8, low from 1.81-2-60, moderate from 2.61-3.40, high from 3.41-4.20 and very high from 4.21-5.00. Thus, it can be inferred that preservice science education teachers have high science learning self-efficacy perceptions. The average scores on the factors of the SLSEQ range from 3.61-3.93 interval, and the preservice science education teachers had high scores on these factors.

Table 6. The Descriptive values of the SEBS

Scales	N	Minimum	Maximum	Mean	Standard Deviation
SEBS Score Interval	125	71.00	123.00	103.48 (3.45)	8.035
61-90	6	71.00	87.00		
91-120	117	93.00	120.00		
121-150	2	121.00	123.00		

Table 6 shows that six preservice science education teachers scored close to the non-traditional approach. The preservice science education teachers' average score per item on the scale was 3.45. Most of them had traditional scientific epistemological beliefs.

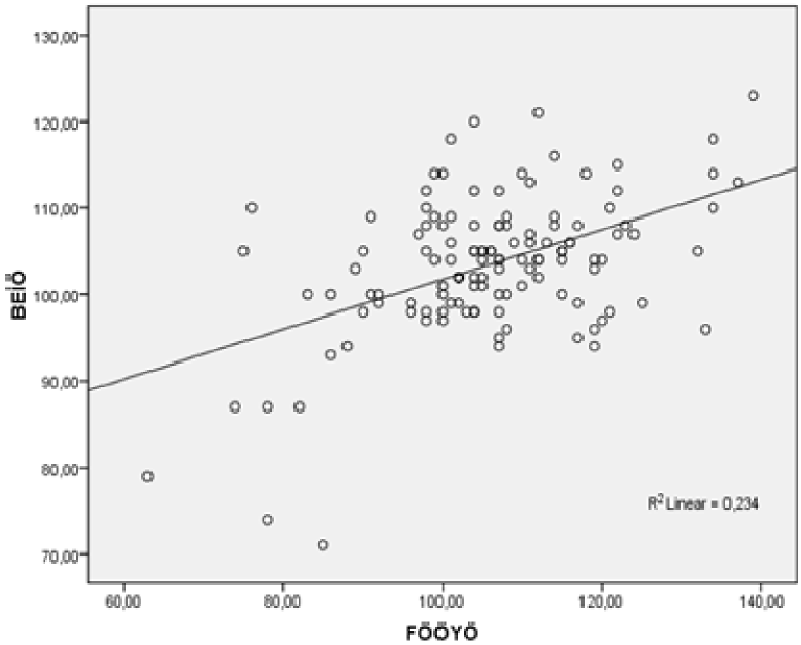

Figure 2. The Scatter plot for the total scores on the SEBS and the SLSEQ

Simple linear correlation found a statistically significant relationship between preservice science education teachers' scores on the SLSEQ and the SEBS. For Pearson's correlation coefficient, the relation is moderate where p= 0.01 (Pearson's r= 0.484; p= 0.000) (Figure 2).

Simple regression analysis was used to see if the scores on the SLSEQ predict the SEBS scores.

Table 7. The Results of simple regression analysis for the total scores on the SEBS and the SLSEQ

Variable	B	R	R^2	t	P
Invariant	72.930			14.533	0.000
SLSEQ	0.288	0.484	0.234	6.137	0.000

Total Students (n)= 125

Table 7 shows that the scores on the SLSEQ are statistically significant predictors of ones on the SEBS

($R=0.484$, $R2= 0,234$; $F(1, 124)= 37.659$; $p<0.05$). The scores on the SLSEQ explains 23% of the total scores on the SEBS. The regression formula to predict the scores on the SEBS was calculated as $Y_{SEBS}=0,288*X_{SLSEQ}+72.930$. Simple regression analysis was used to examine if the factors of the SLSEQ predict the SEBS (Table 8).

Table 8. The Results of simple regression analysis for the total scores on the factors of the SEBS and the SLSEQ

Variable	B	R	R^2	t	p
Practical Application	1.424	0.411	0.169	5.002	0.000
Conceptual Understanding	1.026	0.298	0.089	3.457	0.001
Daily Life Practice	1.089	0.567	0.322	7.641	0.000
Higher Level Thinking	0.803	0.336	0.113	3.953	0.000
Science Communication	1.078	0.431	0.185	5.290	0.000

Total Students (n)= 125

The simple regression results in Table 8 show that the scores on the factors of the SLSEQ are statistically significant predictors of the SEBS scores ($p<0.05$). The factors of the SLSEQ also explain between 9% and 32% of the scores on the SEBS. Of all the SLSEQ factors, conceptual understanding has the weakest relation with the SEBS and explains 9% of its scores, while adaptation to daily life has the strongest relation with the SEBS and explains 32% of its scores.

4. Discussion of the Results

Science education teachers teach science the way they understand it. Teachers may also, in line with their self-efficacy, affect students' participation in learning and their understanding of what is being taught (Klausmeier and Alen, 1978; Palmquist and Finley, 1997). Thus, it is essential to determine their epistemological beliefs about NOS and science learning self-efficacy perceptions. This study adapted the SLSEQ into Turkish to determine the relationship between preservice science education teachers' epistemological beliefs about NOS and their self-efficacy perceptions.

This study found that the vast majority of preservice science education teachers (95%) have epistemological beliefs closer to the traditional understanding of science (Table 6). According to the traditional understanding of science, scientific knowledge is information that yields infallibly correct answers through universal methods such as observation and experimentation. According to the non-traditional understanding of science, scientific knowledge is created by scientists and by nature contains the biases of people who make it. Therefore, it must be regarded as temporary and changeable truth. The SEBS results show that the preservice science teachers had a positivist understanding of science. Science is made up of positivist sciences. However, preservice teachers should consider positivism, constructivism and postmodernism in their professional career because neither a positivist science nor a postmodern science is adequate for education on their own. Both should be used appropriately and together at times. For this reason, the philosophical understanding of science should be given attention in teacher training, and a variety of practices should be performed to give preservice teachers a variety of scientific perspectives (Çakıcı, 2009; Schwartz, Akom, Skjold, Hong, Kagumba, & Huang, 2007).

The Science Learning Self-Efficacy Scale was developed by Lin and Tsai (2013). It was adapted as the Physics Self-Efficacy Scale by Alpaslan and Işık (2016). This study, considering the scale adapted into Turkish by Alpaslan and Işık (2016), readapted the self-efficacy scale developed by Lin and Tsai (2013) for use in the field of science education. The scale has 5 factors and 28 items. The preservice science education teachers are thought to have high perception levels based on their scores on the SLSEQ and its factors (Table 5). This high-level perception will contribute to academic achievement, problem solving, epistemological beliefs, motivation and learning strategies in their classes (Alpaslan and Işık, 2016; Gaylor and Nicol, 2016; Yumuşak, Sungur and Çakıroğlu, 2007; Yüksel and Geban, 2016). The students' high-level perception in understanding scientific concepts, high-level thinking skills, practical application, adaptation to daily life and science communication can be interpreted as meaning that they are open to improvement in these areas and can easily overcome their deficiencies (Lin and Tsai, 2013).

The results on the SEBS and the SLSEQ show that there is a positive linear relationship between the scores on the two scales, and the scores on the SLSEQ predict and explain 23% of the SEBS scores (Table 7). This indicates that there is a relationship between the preservice science teachers' the traditional understanding of science and self-efficacy perceptions. When the SLSEQ is examined in terms of its dimensions, it can be stated that it is closer to the traditional understanding of science. Solving problems, knowing how to use materials in an experiment, and renewable energy are the pure examples of positivist scientific knowledge (Giddens, 1991; Schwartz and Ogilvy, 1979; Terzi, 2005, Topdemir, 2008). This makes such a relationship an expected outcome. Of the SLSEQ factors, conceptual understanding has the weakest relation with the SEBS while adaptation to daily life factor has the highest relation with the SEBS (Table 8). When the conceptual understanding factor is considered, it appears that this factor is related to the use of cognitive ability (Lin and

Tsai, 2013). Using cognitive ability is also related to constructivism. Constructivism, a non-traditional understanding of science, uses mental constructs. This may be the reason for the weak relationship between this factor and the traditional understanding of science. Adaptation to daily life is actually closer to the traditional understanding of science. The knowledge obtained by observation and not likely to change is adapted to daily life. The adaptation of uncertain scientific knowledge to daily life is difficult. Being derived from similar or identical sources may be the reason for this relationship.

Instead of using only a positivist understanding of science, it is believed that postmodernism and constructivism help prepare preservice teachers for the teaching profession. Future studies about self-efficacy including constructivism and positivist understandings of science learning will contribute to the field.

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The Additional

Öz-Yeterlilik Ölçeği	Kesinlikle Katılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle Katılıyorum
Fen bilimlerine ait laboratuvar deneylerinde malzemelerin nasıl kurulacağını biliyorum.	A	B	C	D	E
Bilimsel kanun ve teorilerini arkadaşlarıma açıklayabilirim.	A	B	C	D	E
Günlük yaşamda karşılaştığım problemleri çözmek için bilimsel yöntemleri kullanırım.	A	B	C	D	E
Bir bilimsel problem ile karşılaştığımda önce aktif olarak üzerinde düşünür ve çözmek için strateji oluşturabilirim.	A	B	C	D	E
Fen bilimleri derslerinde fikirlerimi uygun bir şekilde ifade edebilirim.	A	B	C	D	E
Fen bilimleri ilgili sosyal meseleleri (Örneğin nükleer güç, genetiği değiştirilmiş gıdalar) bilimsel bir yaklaşımla anlar ve yorumlayabilirim.	A	B	C	D	E
Bir fen bilimlerine ait kavramı veya olgusu üzerine sistematik gözlemler ve araştırmalar yapabilirim.	A	B	C	D	E
Fen bilimleri laboratuvarında malzemelerin (örneğin dereceli silindir (mezür), hassas terazi, dinamometre, vs.) nasıl kullanılacağını biliyorum.	A	B	C	D	E
Okulda fen bilimleri ile ilgili öğrendiklerimi günlük yaşama uygulayabilirim.	A	B	C	D	E
Bir fen bilimleri sorusunu çözmek için uygun formülü seçebilirim.	A	B	C	D	E
Fen bilimleri laboratuvarında kendi görüşlerimi açık bir şekilde ifade edebilirim.	A	B	C	D	E
Fen bilimleri laboratuvarında deneysel basamakların nasıl uygulanacağını biliyorum.	A	B	C	D	E
Fen bilimleri ile ilgili iş alanlarını tanırım.	A	B	C	D	E
Farklı fen bilimleri konuları (örneğin biyoloji, kimya ve fizik) içeriklerine bağlayabilir ve aralarındaki ilişkileri kurabilirim.	A	B	C	D	E
Fen bilimleri konularını sınıf arkadaşlarımla tartışırken rahat hissederim.	A	B	C	D	E
Bir fen bilimleri olayını incelerken değişim sürecini gözlemleyebilir ve olası nedenleri düşünebilirim.	A	B	C	D	E
Öğrendiklerimi diğerlerine anlaşılabilir bir şekilde açıklayabilirim.	A	B	C	D	E
Fen bilimleri laboratuvarı sırasında nasıl veri toplandığını biliyorum.	A	B	C	D	E
Temel fen bilimleri kavramlarının (örneğin yerçekimi, fotosentez vs.) tanımlarını çok iyi bilirim	A	B	C	D	E
Günlük yaşamı fen bilimleri teorileri kullanarak açıklayabilirim.	A	B	C	D	E
Bir fen bilimleri problemini çözmek için çok sayıda geçerli çözümler önerebilirim.	A	B	C	D	E
Fen bilimleri laboratuvarında öğrendiklerimi başkaları ile yaptığım tartışmalarda kullanabilirim.	A	B	C	D	E
Günlük yaşamda yer alan birçok olgunun fen bilimleri ile ilgili kavramları içerdiğini bilirim.	A	B	C	D	E
Fen bilimleri kullanarak günlük problemlere çözümler önerebilirim.	A	B	C	D	E
Fen bilimleri problemlerin çözümlerini eleştirel olarak değerlendirebilirim.	A	B	C	D	E
Fen bilimleri laboratuvarında arkadaşlarımın yaptığı sunumlar üzerine yorum yapabilirim.	A	B	C	D	E
Televizyonda izlediğim fen bilimleri ilgili haber ve belgeselleri anlayabilirim.	A	B	C	D	E
Fen bilimleri ilgili hipotezlerimi doğrulamak için bilimsel deneyler tasarlayabilirim.	A	B	C	D	E