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Investigation of Teacher Candidates' Nature of Science Beliefs In Terms of Gender, Program, and Class Level

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Abstract

This research aims to examine teacher candidates' nature of science beliefs in terms of certain variables (gender, program, and class level). The participants of the research are 364 teacher candidates studying at the faculty of education of a public university in three programs; science education, elementary mathematics education, computer education, and instructional technology. Convenience sampling was applied and a relational screening model from descriptive research design was used. "Nature of Science Beliefs Scale" developed by Özcan and Turgut (2014) was used as a data collection tool. Subsequently, data analysis was conducted through SPSS statistical software by applying independent samples t-test and one-way ANOVA analysis. According to the results of the study, teacher candidates' nature of science beliefs was found on the undecided level. Additionally, female teacher candidates have a higher level than male teacher candidates related to the nature of science beliefs dimensions of tentativeness, observation and inference, scientific method/methods, assumptions and boundaries, socio-cultural embeddedness, and theories and laws, and it was found that this difference was statistically significant. In terms of program variables, only a difference was found in the dimension of scientific method/methods in favor of science teacher candidates. Finally, there was a statistically significant difference in the dimensions of tentativeness and theories and laws in terms of a class-level variable. Consequently, new activities and subjects that can be added to the curriculum are recommended.

Keywords: nature of science, science education, teacher candidates

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A. Introduction

Following new technologies emerging as results of science and scientific activities and individuals' adaptations to developing technologies are important in the age we live in. In this sense, the role of science education is more crucial than it has ever been. The base purpose of science education is to educate scientifically literate individuals (Ministry of Education, 2013), and these individuals are the individuals who are able to understand the nature of science. The nature of science beliefs of individuals and societies may be interpreted as the indicator of quality of science education. This research aims to put forth the nature of science beliefs of teacher candidates that would work in educational institutions and educate scientifically literate individuals. Additionally, the relation of beliefs in terms of gender, program, and class level are investigated.

From the past (Lederman & Zeidler, 1987, Lederman, 1992) to the present (Akerson, Pongsanon, Rogers, Carter & Galindo, 2017; Khishfe, 2017, Karışan & Cebesoy, 2018) definition of the nature of science is expressed as the sum of the answers to the questions such as "what the science is, how the science works, how the scientists perform the scientific researches, how scientific knowledge is created, how science developed and which factors affect the science". Therefore, science beliefs and the related variables have been seen as important and discussed for a very long time in science education literature(Abd-El-Khalick & Lederman, 2000; Burton, 2013; Lederman & Zeidler, 1987; Şahin, Deniz & Görgen, 2006). In addition to these, the epistemological and social structure of science, assumptions, and values in the developmental process of science are included in the literature on the nature of science (Lederman, 1992). However, the fact that a certain definition of the nature of science could not be made is mentioned because of the tentativeness of scientific knowledge and change in time structure. Absolute views of scientific knowledge are powerful in the human mind. Even if after a study changes students' opinions about scientific knowledge, some participants hold their views of scientific knowledge Bilican, Çakıroğlu, Öztekin, 2015). Therefore, scientists indicated some common properties of the nature of science as follows (Bala, 2013);

- Scientific knowledge is in change and development.
- Scientific knowledge is based on logical inferences and evidence obtained from experiments and observations.
- Scientific knowledge includes observations and inferences; these are different from each other.
- The perspectives of scientists that produce scientific knowledge are subjective.
- Scientific knowledge is affected by the social and cultural environment.
- Creativity and imagination have a role in the production of scientific knowledge.
- Theories and laws are different kinds of knowledge so; they do not turn into each other.

Özcan and Turgut (2014) constructed seven sub-dimensions of the nature of science by emphasizing these common properties as seen in Figure 1.

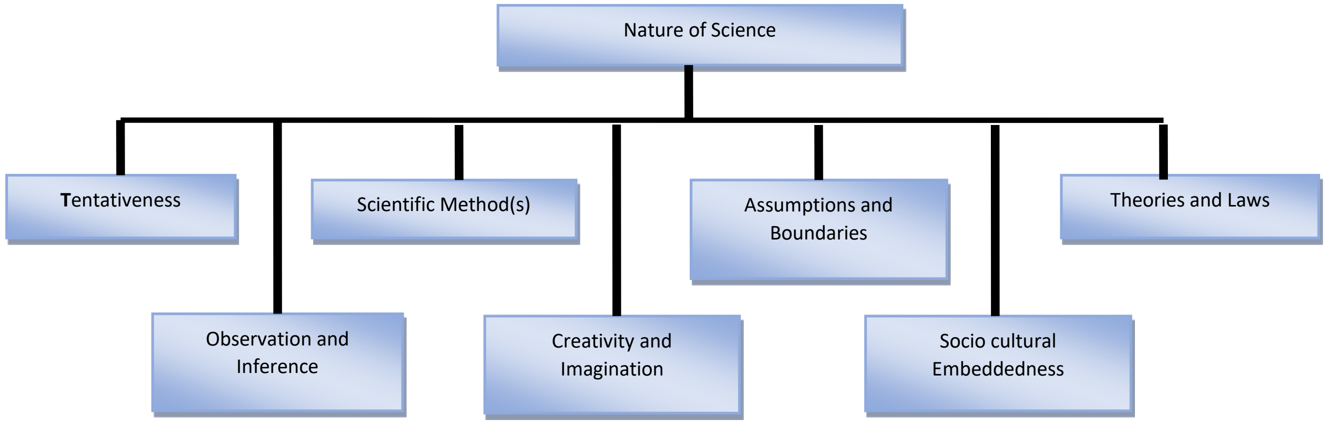

Figure 1 Sub-dimensions of Nature of Science

Tentativeness: It can be said that scientific knowledge can be reliable and long-lived, but it cannot be said it is accurate and definite (Popper, 1963). Although according to the traditional approach, scientific knowledge exists regardless of whether we care about it or pay attention to it, according to the constructivist approach, it is a kind of human activity (Gürses, Doğar, & Yalçın, 2005). This situation shows that knowledge is constructed in hthe uman mind, except written in the books, according to the constructivist approach. That is to say, scientific knowledge can be affected by the social and the cultural field of the society (Özcan, 2011) and also scientists' views of the development of science and its role in society (McComas, 2020).

Observation and Inference: Science is based on observations and inferences reached at the end of these observations. Cullinane and Erduran (2022) claim that without observations, the study is limited and it is necessary to determine its influence. While observations occur with human senses and different devices, inferences require making explanations and comments about the observed events (Lederman, Abd-El-Khalick, Bell, & Schwartz, 2002). For example: While seeing the fall of an apple from the tree is an observation, knowing that the objects fall to the ground because of gravity is an inference.

Scientific Method(s): Seeking evidence through a variety of scientific methods is an integral part of scientific processes (Hanson, Leden & Thulin, 2021). It is impossible to say scientists have always used one type and the same method during scientific research (Abd-El-Khalick, 2001). Einstein's definition of science as an effort to establish harmony between the data devoid of all kinds of order and regular thoughts indicates that scientists cannot reach scientific knowledge with only one scientific method (Bala, 2013). By starting from this point, it can be concluded that each scientist uses a scientific method that is suitable for their research.

Creativity and Imagination: Creativity and imagination have an important place in the process of the formation and the development of scientific knowledge (Köseoğlu, Tümay, & Üstün, 2010). Einstein's saying "Imagination is more important than knowledge" emphasizes how imagination is important in terms of creativity (Altındağ & Senemoğlu, 2015). Science does not consist of sequential activities with certain rules, so the formation and the development of science include creativity and imagination in addition to the observation of nature(Abd-El-Khalick, 2001). For example, "Transition from a point to another point in the universe or another universe by using wormholes in the black holes" is completely the result of imagination and creativity (Bala, 2013).

Assumptions and Boundaries: The fact that the definitions of science and the nature of science cannot be made fully indicates that it is a complex phenomenon that remains unclear in terms of acceptances and boundaries (Özcan, 2011). However, we can say that they have explicit or implicit sets of beliefs and assumptions (Yıldırım, 2007). These assumptions are listed by Hocaoğlu (1996) as follows:

- Reality: Nature is a real being and the real world exists regardless of whether we care about it or not or we pay attention to it or not.
- Regularity: All sciences in the universe are in absolute order, and studying science is all about regularity.
- Knowability: The cosmic world is an accepted existence area that can be known by human beings so that the universe is opened to human beings and the universe becomes more understandable.
- Rationality: Knowledge of the rationality of the world is intelligible to the mind, meaning that the mind can afford it.
- Causality: Being orderly means that there is a hierarchy among all occurrences, which is only possible with the existence of a cause-effect relationship.
- These assumptions mentioned here can be accepted as the basic assumptions and boundaries of science.

Socio-cultural Embeddedness: According to the view that sees science as developing prescriptive -logical calculations to prove scientific claims, nature of science approach will be affected by subjective, social, and cultural values (Leblebicioğlu, Metin, & Yardımcı, 2012). Since the person who discovers and seeks scientific knowledge is a part of the society, he will be affected by the socio-cultural environment and may even be interrupted by political, social, or religious factors (Bala, 2013). For example, Copernicus was published by Papacy for suggesting the heliocentric universe model.

Theories and Laws: While the laws are generalizations that express the relationships between a perceptible or observable phenomenon in the universe and the factors affecting this phenomenon with models (in general mathematical equations), theories are inferences that consistently explain the cause of events with the help of observations, concepts, proofs, principles, and laws (Güneş, 2017). Although the definitions of the law and theory seem close to each other, they are different concepts. A misconception has been identified that there is a gradual progression from hypothesis to theory, from theory to law (Çınar & Köksal, 2013). What should be known between the concepts of law and theory is that one cannot be turned into another and that there is no hierarchical relationship between them (Muğaoğlu, 2006).

When the literature about the nature of science is examined, it is stated that there are many studies and most of them have been conducted with teacher candidates (Taşkın, 2021; Cullinane & Erduran, 2022). Peşman, Arı & Baykara (2017) state that there is a significant relationship between teacher candidates' nature of science beliefs and decision-making skills. Additionally, a significant difference is also reported in a study conducted with teacher candidates about the self-efficacy of nature of science and nature of science courses(Tatar & Özenoğlu, 2018). These studies indicate that teacher candidates' nature of science beliefs may be affected by different variables and a descriptive study should be conducted with them to find out their existing situations.

On the other hand, the studies conducted with teachers indicate that teachers have insufficient or incorrect opinions about the definition of science, nature of observation, the changeable nature of scientific knowledge, hypothesis, the structure of laws, and theories and scientific methods (Aslan, Yalçın & Taşar, 2009; Bayır, 2016). This finding shows that there are some deficiencies in teachers' beliefs about the nature of science So, the description of the nature of science beliefs may be helpful for teacher candidates' to overcome these missing parts.

It is also stated in the literature that the nature of science beliefs is crucial in terms of science education (Çakıcı, 2009). The effects of model-based inquiry learning (Batı & Kaptan, 2017), open-thought-provoking and history-based science teaching (Aslan, Göksu, Özel & Zor, 2016), and scientific discussion-oriented science teaching activities on nature of science are investigated. In addition to these, why individuals should understand nature of science is stated as follows: it is necessary to understand science and technological objects encountered in daily life, to make socio-scientific issues more meaningful to them, to see the science as a part of modern culture, to consciously understand norms and values set forth by the scientific community (Macaroğlu, Şahin, & Baysal, 1999).

However, researches about the nature of science show that individuals do not have sufficient understanding and the main reason for this is the teachers that are responsible for teaching (Abell & Lederman, 2007). In the direction of these findings and opinions, it is very important to reveal the beliefs of teacher candidates studying in teacher training institutions in Turkey about the nature of science. This research is limited to teacher candidates who are voluntarily participating in and who are studying in science education, elementary mathematics education, and computer education and instructional technology programs in an education faculty of a public university.Another limitation of the study is that this research is arranged with a relational screening model so, it does not explain the cause-effect relationship.

The general aim of the research is to examine teacher candidates' nature of science beliefs in terms of variables of gender, program, and class level studying at the faculty of education of a public university in Turkey. The answers to the questions below have been searched to reach this general aim:

- How is the teacher candidates' nature of science beliefs?

- Is there a significant difference in teacher candidates' nature of science beliefs in terms of gender, program, and class-level variables?

B. Research Methodology

The research method, population and sample, data collection tools, and data analysis of this research are presented in this method section.

1. Research Method

In this research, the relational screening model from descriptive research methods was used. The relational screening model is a kind of quantitative research method and aims to indicate the existence of variation and the level of relationship between the variables (Ayık and Ataş, 2014; Toytok, 2016; Üredi, 2017). This model does not provide a real cause and result relationship, but it provides an opportunity to predict the other in case of knowing the one (Karasar, 2008).

2. Population and Sample

The population of the study consists of teacher candidates studying science education, elementary mathematics education, and computer education and instructional technologies programs at the faculty of education of a public university in Turkey. There were a total of 756 teacher candidates (272 were in science education, 307 were in elementary mathematics education, and 177 were in computer education and instructional technologies programs). This research is conducted in the spring semester of the 2016-2017 academic year.

Convenience sampling was applied for the sampling process of the research. 364 teacher candidates from these three programs participated in the research voluntarily. The demographic properties of the participants are presented in Table 1.

Table-1. Demographic Properties of Participated Teacher Candidates

Variables		Frequency (f)	Percentage (%)
Gender	Female	231	63.5
	Male	133	36.5
Program	Science Education	140	38.5
	Elementary Mathematics Education	115	31.6
	Computer Education and Instructional Technologies	109	29.9
Class Level	1. grade	117	32.1
	2. grade	89	24.5
	3. grade	82	22.5
	4. grade	73	20.9

According to Table 1, 231 (65.5%) of teacher candidates were female and 133 (36.5%) were male. 140 (38.5%) were from science education, 115 (31.6%) were from elementary mathematics education, and 109 (29.9%) were from computer education and instructional technologies. 117 (32.1%) of them were 1st grade, 89 (24.5%) were2nd grade, 82 (22.5%) were 3rd grade and73 (20.9%) were 4th grade.

3. Data Collection Technique

"Personal Information Form "developed by the researchers and "Nature of Science Beliefs Scale" developed by Özcan and Turgut (2014) were applied.

Personal Information Form: This form is developed by researchers to identify the gender, the program in which teacher candidates are studying, and class level.

Nature of Science Beliefs Scale: This scale is developed by Özcan and Turgut (2014) to investigate nature of science beliefs of teacher candidates. There were 37 items in 7 factors on the scale. 6 items of the scale were in factor "tentativeness" (sample item: "If a knowledge is scientific, it has been proved and cannot be changed anymore"). 4 items were in "observation and inference" (sample item: "*A student saying that a released object falls to the ground expresses an observation*". 4 items were in "scientific method(s)" (sample item: "*There is only one scientific method which scientists follow the steps in order*"). 5 items were in "creativity and imagination" (sample item: "*Scientists use creativity and imagination while interpreting the scientific data*"). 8 items were in "assumptions and boundaries" (sample item: *"Science deals only with directly observable phenomena*"). 4 items were in "socio-cultural embeddedness" (sample item: "*Science is dependent on social values (political, religious, philosophical, etc.) and is affected by these values in the development process*"). 6 items were in "theories and laws" (sample item:"*Scientific theories are statements about entities that cannot be directly observed, based on certain assumptions*").

The degrees of 5-point Likert's type scale changes from 1(strongly disagree) to 5(strongly agree). So the total point of the scale ranges between 37-185. The points in the intervals are interpreted as follows: "1.00-1.80: strongly disagree", "1.81-2.60" disagree, "2.61-3.40" undecided, "3.41-4.20" agree, "4.21-5.00" strongly agree". The reliability coefficient (Cronbach Alpha) was calculated for the total of the scale as .78 and for the factors .80 for tentativeness.70 for Observation and Inference, .83 for Scientific Method(s), .71 for Creativity and Imagination, .76 for Assumptions and Boundaries, .73 for Socio-cultural Embeddedness and .70for Theories and Laws.

4. Data Analysis Technique

Data analysis was done through SPSS 22.0 statistical software by applying independent samples t-test and one-way ANOVA analysis. Skewness and Kurtosis values were checked to understand whether the data were distributed normally or not. The findings are presented in Table 2.

Tablo-2. Skewness and Kurtosis Values of Nature of Science Beliefs Scale

	N	Minimum	Maximum	Mean	Sd.	Skewness	Kurtosis
Nature of Science Beliefs	363	62.00	188.00	120.36	18.57	-.40	1.04

According to Table 2, Skewness coefficient of nature of science scale is found as -.40 and Kurtosis coefficient as 1.04 and p>.05 is found in Kolmogorov-Smirnov Z analysis. If Skewness and Kurtosis values are in between "-1.5 and+ 1.5", the data are accepted as normally distributed (Tabachnick & Fidell, 2013). After normality analysis, descriptive statistics, t-test, and ANOVA tests were applied in the research. In addition to these analyses, effect size calculations were done to describe the level of difference. Analyze tests reveal whether there is a significant difference between compared groups, but effect size calculations give information about the degree of these differences (Can, 2016). For this reason, effect size calculations were used. How much of the total variance of the dependent variable is explained by the independent variable or factor can be calculated by the effect size statistics of eta-square (η2) (Büyüköztürk, 2010). Effect size changes between 0.00-1.00 and .01 means "small", .06 "medium" and .14 "high" effect size. In ANOVA test, Bonferroni correction was applied to control Type I error.

C. Findings

Nature of science beliefs of teacher candidates in general and the statistical analysis done in terms of gender, program, and class level are presented in this findings section.

1. Teacher Candidates' Nature of Science Beliefs

Descriptive statistics for nature of science beliefs of teacher candidates in general are seen in Table 3.

Table 3. Teacher Candidates' Nature of Science Beliefs Scores

Factors	N	X	Ss
Tentativeness	363	3.12	.57
Observation and Inference	363	3.50	.78
Scientific Method(s)	363	3.27	.68
Creativity and Imagination	363	3.35	.70
Assumptions and Boundaries	363	3.22	.58
Socio-cultural Embeddedness	363	3.29	.68
Theories and Laws	363	3.34	.77
Nature of Science Beliefs	363	3.28	.49

According to Table 3, nature of science beliefs of teacher candidates, in general, is at an "undecided" level (X=3.28). The highest arithmetic mean score has been seen in the factor of observation and inference (X=3.50), and the lowest one has been seen in tentativeness (X=3.12).

2. Teacher Candidates' Nature of Science Beliefs in Terms of Gender

Findings of teacher candidates' nature of science in terms of gender variable are presented in Table4.

Tablo-4. Teacher Candidates' Nature of Science Beliefs in Terms of Gender

Factor	Gender	N	X	Ss	Sd	t	p	Effect Size (η2)
Tentativeness	Female	230	3,17	,57	361	2.249	.025*	.014
	Male	133	3,03	,56				
Observation and Inference	Female	230	3,59	,70	361	2.891	.004*	.023
	Male	133	3,34	,89				
Scientific Method(s)	Female	230	3,35	,64	361	2.927	.004*	.023
	Male	133	3,13	,74				
Creativity and Imagination	Female	230	3,35	,62	361	.084	.933	.000
	Male	133	3,34	,83				
Assumptions and Boundaries	Female	230	3,29	,54	361	3.201	.001*	.028
	Male	133	3,09	,63				
Socio-cultural Embeddedness	Female	230	3,38	,64	361	3.185	.002*	.027
	Male	133	3,14	,73				
Theories and Laws	Female	230	3,41	,60	361	2.250	.025*	.014
	Male	133	3,22	,99				
Nature of Science Beliefs	Female	230	3,35	,43	361	3.281	.001*	.029
	Male	133	3,17	,56				

According to Table 4, there is a statistically significant difference between female and male teacher candidates' nature of science beliefs mean scores (t_{361}= 3.281; p<.05) in favor of females (X_{Female}=3.35; X_{Male}=3.17).In addition to this finding, when the factors of nature of science beliefs are examined, it is found that there is no statistically significant difference in the factor of creativity and imagination (t_{361}=084; p=.933; X_{Female}=3.35; X_{Male}=3.34) in terms of gender. On the other hand, there are significant differences in factors of tentativeness (t_{361}=2.249; p=.025; X_{Female}=3.17 ; X_{Male}=3.03), observation and inference (t_{361}=2.891; p=.004; X_{Female}=3.59 ; X_{Male}=3.34), scientific method(s) (t_{361}=2.927; p=.004; X_{Female}=3.35; X_{Male}=3.13), assumptions and boundaries (t_{361}=3.201; p=.001; X_{Female}=3.29; X_{Male}=3.09), socio-cultural embeddedness (t_{361}=3.185; p=.002; X_{Female}=3.38 ; X_{Male}=3.14), theories and laws (t_{361}=2.250; p=.025; X_{Female}=3.41 ; X_{Male}=3.22). The difference in the factors are seen in favor of female teacher candidates.

Effect sizes in the factors that were found statistically significant were calculated by using eta-squares (η2). The mean scores difference between females and males has small effect sizes because of eta squares are in between.014 and .029.

3. Teacher Candidates' Nature of Science Beliefs in Terms of Programs

Findings of teacher candidates' nature of science in terms of programs variable are presented in Table 5.

Tablo-5. Teacher Candidates' Nature of Science Beliefs in Terms of Programs

Factor	Source of Variance	Sum of Squares	sd	Mean of Squares	F	p	Effect Size (η2)
Tentativeness	Between Groups	.443	2	.221	.672	.511	.004
	In Groups	118.591	360	.329			
	Total	119.033	362				
Observation and Inference	Between Groups	2.329	2	1.164	1.877	.155	.010
	In Groups	223.338	360	.620			
	Total	225.667	362				
Scientific Method(s)	Between Groups	2.850	2	1.425	3.027	**.050***	**.017**
	In Groups	169.466	360	.471			
	Total	172.316	362				
Creativity and Imagination	Between Groups	.956	2	.478	.953	.386	.005
	In Groups	180.573	360	.502			
	Total	181.530	362				
Assumptions and Boundaries	Between Groups	.240	2	.120	.351	.704	.002
	In Groups	123.348	360	.343			
	Total	123.589	362				
Socio-cultural Embeddedness	Between Groups	.099	2	.049	.104	.901	.001
	In Groups	170.868	360	.475			
	Total	170.967	362				
Theories and Laws	Between Groups	1.744	2	.872	1.464	.233	.008
	In Groups	214.402	360	.596			
	Total	216.147	362				
Nature of Science Beliefs	Between Groups	.523	2	.261	1.086	.339	.006
	In Groups	86.637	360	.241			
	Total	87.160	362				

According to Table 5, at the end of the ANOVA analysis, it was found that there is no statistically significant difference in teacher candidates' nature of science belief scores in general in terms of programs that they are studying at education faculty ($F_{2,362}$= 1.086; p>.05; η2=.006). In addition to this finding, when the factors of nature of science beliefs are examined, it is found that there are no statistically significant difference among programs in the factors of tentativeness ($F_{2,362}$= .672; p>.05; η2=.004), observation and inference ($F_{2,362}$= 1.877; p>.05; η2=.010), creativity and imagination ($F_{2,362}$= .953; p>.05; η2=.005), assumptions and boundaries ($F_{2,362}$= .351; p>.05; η2=.002), socio-cultural embeddedness ($F_{2,362}$= .104; p>.05; η2=.001), theories and laws($F_{2,362}$= 1.464; p>.05; η2=.008). On the other hand, there is a statistically significant difference in terms of program in a factor scientific method(s) ($F_{2, 362}$= 3.027; p>.05; η2=.017). When the mean scores of teacher candidates in terms of program were examined, this difference was found in favor science education program ($X_{Science:}$ 3.38 ; N:140; Ss:.66). It is also found that mean scores of elementary mathematics (X_{Mat}: 3.20; N: 115; Ss: .60) and computer education and instructional technology (X_{CEIT}: 3,20; N:109; Ss:,68) are close to each other.

The effect size for the factor science method(s) is found as η2=.017 and this value shows that there is a small effect size.

4. Teacher Candidates' Nature of Science Beliefs in Terms of Class Level

Findings of teacher candidates' nature of science in terms of class level variable are presented in Table 6.

Table-6. Teacher Candidates' Nature of Science Beliefs in Terms of Class Level

Factor	Source of Variance	Sum of Squares	sd	Mean of Squares	F	p	Effect Size (η2)
Tentativeness	**Between Groups**	**3.383**	**3**	**1.128**	**3.501**	**.016***	**.028**
	In Groups	**115.650**	**359**	**.322**			
	Total	**119.033**	**362**				
Observation and Inference	Between Groups	3.466	3	1.155	1.867	.135	.015
	In Groups	222.201	359	.619			
	Total	225.667	362				
Scientific Method(s)	Between Groups	2.219	3	.740	1.561	.199	.013
	In Groups	170.097	359	.474			
	Total	172.316	362				
Creativity and Imagination	Between Groups	.648	3	.216	.429	.733	.004
	In Groups	180.882	359	.504			
	Total	181.530	362				
Assumptions and Boundaries	Between Groups	.506	3	.169	.492	.688	.004
	In Groups	123.083	359	.343			
	Total	123.589	362				
Socio-cultural Embeddedness	Between Groups	1.017	3	.339	.716	.543	.006
	In Groups	169.950	359	.473			
	Total	170.967	362				
Theories and Laws	**Between Groups**	**4.932**	**3**	**1.644**	**2.794**	**.040***	**.023**
	In Groups	**211.214**	**359**	**.588**			
	Total	**216.147**	**362**				
Nature of Science Beliefs	Between Groups	1.422	3	.474	1.985	.116	.016
	In Groups	85.738	359	.239			
	Total	87.160	362				

According to Table 6, at the end of the ANOVA analysis, it was found that there is no statistically significant difference in teacher candidates' nature of science belief scores in general in terms of class level that they are studying at education faculty ($F_{3,362}$= 1.985; p>.05; η2=.016). In addition to this finding, when the factors of nature of science beliefs are examined, it is found that there are not statistically significant differences among the class levels in the factors of observation and inference ($F_{3,362}$= 1.867; p>.05; η2=.015), scientific method(s) ($F_{3,362}$= 1.561; p>.05; η2=.013). Creativity and imagination ($F_{3, 362}$= .429; p>.05; η2=.004), assumptions and boundaries ($F_{3, 362}$= .492; p>.05; η2=.004), socio-cultural embeddedness ($F_{3, 362}$= .716; p>.05; η2=.006). On the other hand, there are statistically significant differences in terms of the class level in a factor tentativeness ($F_{3, 362}$= 3.501; p>.05; η2=.028) and theories and laws ($F_{3, 362}$= 2.794; p>.05; η2=.023). When the mean scores of teacher candidates in terms of class level were examined in the factor tentativeness, the difference was found in between 1st($X_{1. grade}$:3.20 ;N:117 ; Ss: .56) and 4th ($X_{4. grade}$:2.96 ;N:76 ; Ss:.55) grades in favor 1st grades, in between 2nd ($X_{2. grade}$:3.20;N:89; Ss: .55) and 4th grades in favor 2nd grades. In the factor theories and laws, the difference was found in between 2nd ($X_{2. grade}$:3.43; N:89 ; Ss: .63) and 4th($X_{4. grade}$:3.13;N:76 ; Ss: .73) grades in favor 2nd grades.

Effect sizes for the factors tentativeness and theories and laws are found as η2=.028; η2=.023and these values show that there is a small effect size on these factors.

D. Discussion

Nature of science beliefs of the teacher candidates that are studying in science education, elementary mathematics education, and computer education and instructional strategies programs were investigated in this present research in terms of gender, program, and class-level variables. It was found that teacher candidates' nature of science beliefs was at the level of "undecided". Mellado (1997) stated that teacher candidates' beliefs were at a weak level in a similar study. Yenice, Öden, and Balcı (2015) found in their study that science and elementary education teacher candidates' nature of science beliefs were insufficient. Similarly, Aydemir (2016) reached the conclusion that teacher candidates could not reflect their nature of science beliefs in their lessons. Additionally, Keskin and Timur (2020) found that teacher candidates have misunderstandings and misconceptions about nature of science.

The present research found that when the sub-dimensions of nature of science beliefs were evaluated, observation and inference had the highest mean and tentativeness had the lowest mean scores. Similarly, Adak and Bakır (2017) found that teacher candidates have the beliefs about observation and inference as the source of scientific knowledge mostly. Taking history and nature of science courses (Yüce & Önel, 2015) and STEM applications (Yıldırım, Şahin & Tabaru, 2017) have a significant effect on teacher candidates' nature of science beliefs. As a result of the present study finding that teacher candidates' nature of science beliefs were on the undecided level, so can cause delays in reaching ministry of education's goal of "the purpose of science education is to educate scientifically literate individuals". In the curriculum, there are only two courses about nature of science, first one is "Nature of Science and Its Teaching" course in the science education curriculum, and the second one is "History of science and its philosophy" in elective courses (Council of Higher Education, 2021). The only compulsory course is in science education curriculum and it is for 4th grade students. Nature of science courses can be included in elementary mathematics and computer education and instructional technologies programs. Furthermore , new courses including STEM applications may be helpful to develop teacher candidates' nature of science beliefs.

In the present study, when teacher candidates' nature of science beliefs was evaluated in terms of gender, female teacher candidates have higher nature of science beliefs than male teacher candidates. While there are some studies supporting this conclusion in the literature (Toz, 2012; Saban & Saban, 2014), a study (Yüce & Önel, 2015) found no significant difference in terms of gender variables. This situation may be explained by the different samples of the studies. Therefore, nature of science beliefs may differ in terms of the universities that the studies were conducted. New studies can be arranged by academicians to see the nature of science beliefs of their own teacher candidates.

In addition to the conclusion about gender variable, when the sub-dimensions are examined, a significant difference in favor of female teacher candidates was found in sub-dimensions of tentativeness, observation, and inference, scientific method(s), assumptions and boundaries, socio-cultural embeddedness, and theories and laws. However, this difference had a small effect size. There is also no significant difference found in the sub-dimension of creativity and imagination. Based on these findings it can be concluded that female and male teacher candidates are at similar levels to put forth new, creative, and original values. Similarly, Akgün & Özenoğlu (2018) found significant difference only on theories and law sub-dimension in favor of female teacher candidates.

It was determined that according to the programs that teacher candidates are studying, there is no statistically significant difference among the programs in terms of nature of science beliefs. It is supported by Arı (2010) and Çavuş (2010) as stating that science and mathematics education teacher candidates have similar opinions about nature of science. On the contrary, a significant difference was reported on teacher candidates' nature of science beliefs in terms of programs variable (Yenice, Özden & Balcı, 2015;Kubilay Tatar & Özenoğlu, 2018). Similar to this study, a significant difference is stated between students studying in verbal and numerical programs by Doğan (2011).In addition to these conclusions, the present study found that there is a statistically significant difference in favor of science education programs in a sub-dimension of the scientific method(s). It may be originated from science education teacher candidates who have higher beliefs to reach scientific knowledge with scientific methods.

The number of laboratory and practical courses is more than the other programs in the science education curriculum and science education teacher candidates are spending more time in these courses when compared with the other groups (Council of Higher Education, 2021). Çelik and Karataş (2015)'s study was conducted with university students from the faculty of art and sciences and education faculty and was found that there were significant differences in favor chemistry, physics, biology, and mathematics students in terms of objectivity and nature of science. They also stated that there is a relationship between the students' opinions about nature of science and the program that is studying. Nature of science concepts such as laboratory usage, nature of science and its philosophy lesson, STEM applications as done in science education program should be added to the other programs.

According to the last finding of the present study, it was found that there are significant differences in "tentativeness" and "theories and laws" sub-dimensions in terms of class level. These differences were between 1st and 4th grade levels in favor of 1st grades and between 2nd and 4th grade levels in favor of 2nd grades in the tentativeness sub-dimension. This finding may be interpreted as that while the class level is increasing, the belief of teacher candidates about the changeability of scientific knowledge is disappearing. Also, a significant difference was found between 2nd and 4th grade levels in favor of 2nd grades in theories and laws sub-dimension. This may be caused by the fact that teacher candidates are taking courses in their fields until 2nd grades and the context of these field courses supply that their knowledge about theories and laws more recent. So some courses like "Nature of Science", "Science Philosophy" and "History of Science" can be added to the curriculum in 3rd and 4th grades. This may be appropriate for teacher candidates because their beliefs are getting weak in these grades. Bilen and Köse (2012) stated that while students have misconceptions about nature of science in secondary education, their situations are changing after taking courses at the university.

As an important concept, understanding of nature of science by students should be seen and emphasized as a worldwide educational goal. However, like the present research and previous researches, students have misunderstandings and misconceptions about nature of science. So according to the findings of this research, science activities should be arranged to motivate male students. Additionally, new concepts can be added to the curriculums of elementary mathematics education, computer education and instructional technology programs. Finally, the lesson of nature of science in science education program is in 4th grade level can be taken to 1st or 2nd class levels to make difference on students' mind.

E. Conclusion

As a conclusion of the research, teacher candidates' nature of science beliefs are on the undecided level, female teacher candidates have higher nature of science beliefs than male teacher candidates, the beliefs of science education teacher candidates' about the scientific method are different than the other program teacher candidates, and the nature of science beliefs are getting weak as the class level increases in tentativeness and theories and laws sub-dimensions. In the light of this conclusion, some recommendations are designed for the academicians that may want to study in this field:

- The present research was conducted with the variables of gender, a program that teacher candidates were studying, and class level. The same or different variables like family education level, socio-economic status, and educational opportunities may be conducted with new study groups from elementary, secondary, or graduated education levels.
- The present research was conducted with teacher candidates that were studying science education, elementary mathematics education, computer education, and instructional technologies in education faculty. New studies may be conducted with the other faculties like faculty of art and sciences, faculty of literacy, etc., or teachers working in public and private schools.
- The present research was conducted with a relational screening model from descriptive research methods. Qualitative research methods like phenomenology, case study, or focus group researches can be used to reach deeper findings on the

nature of science beliefs, also mixed research methods can be used to enrich the researches.

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