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Opinions of University Students about the Nature of Science

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Abstract: One of the main aims of science education is to bring students to the level of scientific literates. In the research, totally 248 students including 124 from Physics Education Department of Education Faculty and 124 from Physics Department of Science Faculty were participated. It was aimed to determine the comprehension levels of students about the nature of science in terms of their faculty, class and gender. In this research, "Scale for Nature of Scientific Information" developed by Rubba was used. This scale constitutes of 48 statements in 5 optional Likert type. In each sub-scale, there are 8 statements which include 4 positive and 4 negative ones. Data analysis were carried out with independent t test a done-directional variance analysis by using SPSS 11 packaged software. According to the results of analysis, there was a difference in favor of Education Faculty students about being severe in explanations and being testable dimension of the scale while there was no significant difference in other dimensions. While there was a difference in favor of males about creative dimension of the scale and in favor of females about being connective dimension, there was no significant difference about other dimensions in terms of genders. When scientific manners of students were compared in terms of their class levels, there was a significant difference just in moral value dimension of the scale.

Key words: Students · Scientific attitude · Gender · Physics education

INTRODUCTION

One of the main targets of science education is to educate scientific literate individuals being researchers and having scientific manner and behaviors. Scientific literacy is a necessity for every human being. The nature (structure) of science is defined as a dimension of scientific literacy in the literature. Scientific literacy is to know the nature of science, to understand how to get the information about this field and to perceive that the information in science is dependent on known realities and may vary when new clues are collected [1]. At the same time, scientific literacy necessitates giving individual decisions, to contribute on the solutions of social problems, knowing and understanding necessary scientific concepts and periods for economical production.

Education of scientific literate individuals is among the targets of our country as well as many countries. Education of individuals who have scientific power of thinking, are creative and who can make cause-effect relationship between events was emphasized among general targets of National Education in 1739 numbered National Education basic law and being scientific is respected as a basic principle.

To make aware of students about the nature of science which is the most important dimension of scientific literacy underlies the science education programs of many countries [2].

In U.S.A., it was determined in the report titled with "National Science Education Standards" [3] that it was aimed to gain "scientific literacy" to all American citizens by science education.

Since one of the most important aims of science lectures is to gain students basic concepts, nature and process of science, in other words, science literacy, it should be given importance to science lectures (physics, chemistry, biology) in order to understand present and modern opinions about the nature of science. Also it should be held scientific trips at schools. It is stated that if these trips applied according to a plan, it will be useful [4].

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The subjects and concepts of science lectures are present in different scope and form in the programs of different countries [5].

The scientists advocate that it's necessary to teach students the concepts related with the nature of science [6]. The nature of science started to be within the literature of science in the beginning of 20th century. In the studies of Downing in 1925, the first signal about the studies of nature of science was indicated with the sentence saying "understanding the scientific methods necessitates scientific thinking" [7]. According to McComas, Clough and Almozroa [7], the nature of science combines the researches of disciplines investigating the social part of science such as history of science, philosophy of science and science sociology together with psychology and is defined as an interdisciplinary study area which tries to understand what science is, how it works, how society of science is organized by scientists, how society affects science and how society is affected from scientific developments. The nature of science mostly refers to the epistemology of scientific information, in other words, to the values and beliefs present in the nature of development of scientific information.

According to Driver *et al.* [8], understanding the nature of science by human beings is necessary when they would like to comment on science and manage technological subjects and periods that they encounter in their daily lives. This opinion brings period approach to science and defines the nature of science by questioning method. Understanding the nature of science by human beings is necessary in the period of decision that they want to understand social-scientific events. Understanding the nature of science by human beings is necessary at a situation when they cherish science as a basic element of modern culture. Learning something about the nature of science may contribute to the development of awareness against the nature of science.

Understanding the nature of science supports being a successful science student. Learning the nature of science may help to learn science subjects more effectively. As cited in [9], Southerland *et al*. (2003); Brickhouse (1990); Gallegher (1991); Wellington, (1994) emphasized that the beliefs of educators about science and learning are effective in their lecture planning and presentation and their definitions about nature of science should be given within academic programs.

Hodson [10] indicated that it's inevitable for students who learn science lectures without understanding the nature of scientific information to gain empiricist thoughts about scientific theories. In order for students to benefit from science lectures adequately, it should be tried to give the information and period dimensions of these lectures in an integration and order [11]. The researches revealed that the students were affected from the thoughts of teachers about science [12].

Many researchers underlined the critical role of science teachers who have necessary information and full complement about the nature of science and perceive the importance of emphasizing the nature of science in getting around the scientific literacy in the society.

In order to teach science concepts correctly to the students, first of all, teachers should know the nature of science and have information about this subject. Feldman and Davidson [13] emphasized the importance of teachers knowing the information about the nature of science by personally participating in the studies of scientists.

It's extremely important for the candidates of science teachers to gain the concepts about the nature of science. Trying to learn phenomenon and theories without understanding the basic principles of science in a real sense is a wrong tendency [14]. In a research, it was revealed that many teachers have difficulty in teaching the source of information in science [15].

It's likely for teachers who do not understand or misunderstand the nature of science will encounter with difficulties in physics education [16]. Gould [17] defended that the teachers who do not understand the nature of science and the ways of getting information cannot teach science lectures effectively and convey the subjects superficially.

In the research of Lederman [5], it was indicated that high school students believed in "scientific information is absolute" and the teachers had inadequate comprehensions about the nature of science. It was also determined that scientific information is not definite, is dependent on experiments, is subjective, is partly a product of imagination and creativeness of human beings and is structured socially and culturally.

Scientific theories are one of the most important factors of scientific information. Theories might change when new data are obtained and scientists analyze events with different points of view. Being indefinite is the basic characteristic of scientific information. The pure, realist, determinist or positivist nature of scientific information is the most adopted aspect by students [18].

The source of beliefs that the students have related with the nature of science might be their experiences related with learning science and doing experiments [19,20].

Çepni [16], searched that how candidates of physics teacher know the basic terms (law, theory and hypothesis) constituting the nature of information in science and how they perceive these terms. He revealed that approximately 60% of teacher candidates did not know law, theory and principle terms and hypothesis term was understood by 55% of the sample.

Most of the researches in which the thoughts of students about the nature of science were investigated were focused on secondary school students [20, 21], high school students [22-24] and the students at college level [25].

Soloman, Scott, Duveen [19] carried out a research in order to determine the opinions of English students at 9th and 10th classes (14-15 years old) about the nature of science. The scale which was formed with 800 students from 10 different regions was then applied to 7 classes from 3 different schools. As a result of the research, it was observed that the students could not know exactly the meaning of the words such as experiment, theory and scientific information and could not establish a relation between them.

Macaroğlu, Baysal, Sahin [26] performed a research to determine the opinions of 283 university students about the nature of science. It was determined that all department students participated in the research generally accepted the accuracy and provableness of scientific information while they thought it to be questioned.

A similar study was carried out by Rubba and Anderson [27] to determine the opinions of students about the nature of science.

It's necessary to determine the opinions of students getting physics education at our universities about the nature of science and whether they have accurate and scientifically acceptable information about the main terms used to get information in this field or not.

Aim: This research was carried out in order to reveal the levels of students from Physics Education Department of Education Faculty and Physics Department of Science Faculty in comprehension of the nature of science.

Problem of the Research: The question of this research is "What are the levels of students from S.U. Physics Education Department of Education Faculty and S.U. Physics Department of Science Faculty in comprehension of the nature of science?"

Sub-Problems of the Research:

- Are the comprehension levels of students about the nature of science different in terms of their faculties?
- Are the comprehension levels of students about the nature of science different in terms of their genders?
- Are the comprehension levels of students about the nature of science different in terms of their classes?

Method: Survey method was used in this research. Survey study is a kind of research which is carried out in order to determine present situation. Answers are searched for the questions such as "What is the present situation of the event or problem that is desired to be researched?" and "Where are we?". In such researches, the range of the sample is kept rather wide. The simplest way of obtaining a wide sample is questionnaires. For this reason, questionnaires are used in survey studies [28].

Sample of the Research: The sample of this research constitutes of totally 248 students including 124 from first, second, third and fourth classes of S.U. Physics Education Department of Education Faculty and 124 from first, second, third and fourth classes of S.U. Physics Department of Science Faculty.

Data Collecting System Used in the Research: In this research, nature of scientific information scale developed by Rubba in 1976 and adapted to Turkish by Ozuonu and Bilgic in 1982 was used as a questionnaire [29]. The scale is one of the means used commonly and measures the comprehension level for the nature of science. The scale is composed of 5 multiple-choice Likert type 48 statements. In this scale, total points and the points of 6 sub-scales are calculated. There are 8 statements in each sub-scale and 4 of them are positive and 4 of them are negative statements.

Sub-scales:

- Not having moral value: Scientific information cannot be judged itself as good or bad.
- Creativeness: Scientific information is one of the products of human being's creativeness.
- Being open to improvement: Scientific information develops with skepticism and is always open to questioning.
- Being severe in explanations: The explanations of scientific information should not be complex, should be simple and understandable.
- Being testable: Scientific information is tested directly or indirectly by observation.
- Being connective: Scientific information is reciprocally with other subjects, theories and concepts.

Table 1: Student distribution in terms of genders

Faculty	Female	Male
Education	55	69
Science	57	67

Table 2: Difference in scientific manner of students in terms of faculties

Sub-scales	Faculty	N	Arithmetic mean	Standard deviation	t	p
Not having moral value	Education	124	27.32	4.34		
	Science	124	27.17	4.14	0.285	0.776
Creativeness	Education	124	23.82	6.28		
	Science	124	24.20	5.73	-0.496	0.620
Being open to improvement	Education	124	29.21	4.48		
	Science	124	28.31	4.64	1.545	0.124
Being severe in explanations	Education	124	26.56	3.56		
	Science	124	25.23	3.75	2.869	0.004*
Being testable	Education	124	31.82	3.47		
	Science	124	30.52	3.50	2.955	0.003*
Being connective	Education	124	29.75	4.58		
	Science	124	28.92	4.42	1.453	0.148

Analysis of the Data: Analysis of all data was carried out with independent t-test, one-way analysis of variance (Anova) and tukey test by using SPSS 11.00 packaged software. The significance level was accepted as 0.05.

Findings: The data collected from the sample group including Physics Department students of Science Faculty and Education Faculty by questionnaires are presented in tables and then commented. The distribution of students in terms of their genders is given in Table 1.

The difference in scientific manners of students in terms of faculties is given in Table 2.

According to the results in Table 2, there wasn't a significant difference in the moral value of the scale since it was $p > 0.05$. This result indicates that the students of both faculties gave similar answers to one of the questions among 8 questions in moral value dimension of the scale which was "the applications of scientific information can be evaluated as good or bad, however, scientific information itself cannot be evaluated as good or bad".

The average of Education Faculty in creativeness dimension was found as 23.82±6.28 whereas it was found as 24.20±5.73 for Science Faculty. Independent t test value between groups was-0.496. This result did not present a significant difference. This result indicates that the students of both faculties gave similar answers to one of the questions among 8 questions in creativeness dimension of the scale such as "scientific information resembles to art, both of them are creative".

There was no significant difference between the answers of both faculty students in being open to improvement dimension. According to this result, the students of both faculties gave similar answers to one of the questions among 8 questions in being open to improvement dimension of the scale which was "we accept scientific information as scientific even if there is margin or error".

In being severe in explanations dimension, p value was found as 0.004.

According to this result, there was a significant difference between groups in being severe in explanations dimension. This result indicated that there was a significant difference between the answers of students of both faculties to one of the questions among 8 questions in being severe in explanations dimension which was "scientific information is presented in a plain language as much as possible".

In being testable dimension, p value was 0.003. There was a significant difference between groups in being testable dimension ($p < 0.05$). This result indicated that there was a significant difference between the answers of students of both faculties to one of the questions among 8 questions in being testable dimension such as "the proof of scientific information should be in a quality of being repeatable".

In being connective dimension, there wasn't a significant difference. This result indicates that the students of both faculties gave similar answers to one of the questions in being connective dimension which was "the laws and theories of biology, chemistry and physics are correlated with each other".

Table 3: Scientific manner of students in terms of their genders

Sub-scales	Gender	N	Average	Standard Dev.	t	P
Not having moral value	Female	113	27.72	4.28		
	Male	135	26.85	4.16	1.608	0.109
Creativeness	Female	113	23.23	5.99		
	Male	135	24.67	5.95	-1.937	0.049
Being open to improvement	Female	113	28.88	4.64		
	Male	135	28.67	4.54	0.358	0.720
Being severe in explanations	Female	113	25.99	4.05		
	Male	135	25.81	3.41	0.388	0.698
Being testable	Female	113	31.31	3.40		
	Male	135	31.05	3.65	0.571	0.568
Being connective	Female	113	30.39	4.21		
	Male	135	28.45	4.58	3.441	0.001

Table 4: Variance analysis of difference between scientific manner of students in terms of classes

Sub-scales		K.T	S.D	K.O	F	P
Not having moral value	Inter groups	140.701	3			
	In groups	4283.295	244	46.900		
	Total	4423.996	247	17.554	2.672	0.048
Creativeness	Inter groups	72.873	3			
	In groups	8828.091	244	24.291		
	total	8900.964	247	36.181	0.671	0.570
Being open to improvement	Inter groups	31.126	3			
	In groups	5139.837	244	10.375		
	Total	5170.964	247	21.065	0.493	0.688
Being severe in explanations	Inter groups	67.495	3			
	In groups	3322.566	244	22.498		
	Total	3390.060	247	13.617	1.652	0.178
Being testable	Inter groups	20.129	3			
	In groups	3066.758	244	6.710		
	Total	3086.887	247	12.569	0.534	0.659
Being connective	Inter groups	55.056	3			
	In groups	4974.165	244	18.352		
	Total	5029.222	247	20.386	0.900	0.442

Table 5: Results of tukey tests for students in terms of classes

Classes	Difference of averages	P
1-2	0.42	0.620
1-3	0.091	0.913
1-4	1.77	0.029*
2-3	-0.33	0.662
2-4	1.35	0.058
3-4	1.67	0.018*

Whether there was a significant difference between manners of students in terms of their genders is calculated by using independent t test. The data obtained are presented in Table 3.

In Table 3, p value in terms of gender in creativeness dimension is 0.049 ($p<0.05$). According to this result, there was a significant difference between girls and boys in creativeness dimension. While there was no significant difference between groups in not having moral value, being open to improvement, being severe in explanations, being testable dimensions, there was a significant difference in creativeness and being connective dimensions in terms of genders. When scientific manners of students were compared in terms of their classes, one-way analysis of variance (Anova) was used. The results are given in Table 4.

According to the results in Table 4, in moral value dimension which is a sub-scale of Nature of Scientific Information scale, F value was found as 2.67, in creativeness dimension of sub-scales, it was 0.67, in being open to improvement dimension of sub-scales, it was found as 0.493, in being severe in explanations dimension of sub-scales, F was found as 1.652, in being testable dimension of sub-scales, it was found as 0.534 and in being connective dimension of sub-scales, F value was found as 0.900. According to these results, there was a significant difference between classes just in moral value dimension ($p<0.05$).

Tukey test was applied in order to put forth the source of difference. The data obtained are given in Table 5.

According to the results in Table 5, it was observed that the manner averages of 4th class students were lower than 1st and 3rd class students in moral value dimension (scientific information cannot be judged itself as good or bad) among sub-scales of nature of scientific information scale.

DISCUSSION

How do teacher candidates who are expected to let students at schools to be scientific literates understand the nature of science? Do they have accurate and scientifically acceptable information about main terms used in getting information in this field? The results of this research which tried to find answers for these questions are discussed as follows. As a result of this research, while there was a difference in favor of education faculty in the answers of students of both faculties in being severe in explanations (scientific information is presented in a plain language as much as possible) and in being testable (the proof of scientific information should be in a quality of being repeatable) dimensions of the scale, there was no significant difference in other dimensions. While there was a difference in favor of boys in creativeness (scientific information resembles to art, both of them are creative) and in favor of girls in being connective dimensions (the laws and theories of biology, chemistry and physics are correlated with each other), there was no significant difference in other dimensions in terms of gender.

Gücüm [30] searched the levels of H.U. Education Faculty Science Teaching students about the comprehension of the structure of scientific information. As a result of questionnaires applied to 176 students, there was no significant difference in the whole scale and in sub-scales in terms of genders.

Okçu, Bindak [31] determined the scientific manner and behavior indicating levels of senior class students in classroom teaching department of Siirt Education Faculty. Being honest and sincere against himself and environment was the most indicated scientific manner. There wasn't a significant difference between female and male students in terms of the scientific manner and behavior indicating levels.

In this research, there was a significant difference in just moral value dimension of the scale in terms of class levels in the answers of students. It was observed that the manner averages belonging to moral value dimension (scientific information cannot be judged itself as good or bad) among sub-scales of nature of scientific information scale of students in the 4th class were lower than 1st and 3rd class students

Doymus *et al*., [14] asked a question such as "what is theory? Explain it with examples" to 89 students in the first and fourth classes of science department of Kazım Karabekir Education Faculty in order to reveal the importance of theory concept in comprehension of nature and process of science. As a result of the research, it was determined that only one student among 89 students had an opinion being close to correct about theory concept and there wasn't a significant difference between first and fourth class students in knowing theory concept.

In the research of Yakmacı [32], it was revealed that the opinions of teacher candidates about the nature of science were better than head teachers. Can [33] determined that the opinions of senior class science teacher candidates were inadequate as expected.

Temel *et al*. [34] determined in their research that the opinions of 1st and 5th class chemistry teacher candidates about the nature of science differed. While 1st class teacher candidates had difficulty in supporting their explanations with examples, 5th class teacher candidates were more successful in this subject.

Sahin-Pekmez *et al*. [35] indicated in their research that just totally 5 academic members from 5 different universities among 30 academic members presented their opinions such as to support the description of nature of science precisely.

In the research of Lederman and O' Malley [36], it was determined that the students, teacher candidates and teachers had inadequate information about indefinite nature of scientific information.

Researches indicated that high school students had inadequate comprehensions against science. High school students believed that scientific information is definite and took scientific hypothesis and theories for granted [5].

In the research of Küçük and Çepni [37] which was applied to primary school second grade students, it was concluded that science teaching experiences might be ineffective in terms of teaching the nature of science to students in our country. It was also indicated that 30% of the students participated in this research had epistemological thoughts accepted in terms of science.

Many studies in the literature indicated that the students [38] and teachers [39] had misconceptions about scientific theory and laws.

Carey *et al*. [21], Solomon *et al*. [19] found in their researches that the students adopted science as a period of collecting and exploring of new events.

In the study of Lin and Chen [40], it was resulted that the explanations of students in experiment group about the nature of science before application were based on their intuitions.

Yalvaç and Crawford [41] determined in their research that pre-service science teachers in Turkey participated in teacher educating programs with inadequate and incorrect information about the nature of science.

In the research of Irez [42] which was applied to 15 graduate students (nine of them were sent to UK and 6 of them were sent to USA for the aim of getting master's degree), it was determined that the students had misconceptions and incorrect opinions about science and nature of science. Only three (20%) of students advocated the opinion of "there isn't a unique and global scientific method, while 12 (80%) of them indicated that there is a global scientific method.

In this research, it was observed that arithmetic means obtained from scale and sub-scales were low when the tables were considered. This result was similar with the research of Gücüm [30]. This indicated that the opinions of students taking education at different universities about the nature of science were similar.

As this is the case in many places on the world, the results of researches in turkey indicated that the opinions of students, teacher candidates and teachers at each level were lacking and inadequate. This result is more or less challenging.

RESULTS

Results and Suggestions: As a result of the research, there was a difference in favor of Education Faculty about being severe in explanations and being testable dimensions of the scale while there was no significant difference in other dimensions.

While there was a difference in favor of males about creativeness dimension of the scale and in favor of females about being connective dimension, there was no significant difference about other dimensions in terms of genders.

There was a significant difference just in moral value dimension of the scale in terms of class levels of students.

When tables are taken into consideration, it was observed that the arithmetic means obtained from the scale and sub-scales were low. According to these results, it can be concluded that the opinions of university students participated in the research about the nature of science were inadequate.

Suggestions: Some of the suggestions proposed depending on the findings of the research can be given as follows:

- Education of science history and nature of science should be allowed in physics lectures.
- The concepts such as theory, law, hypothesis, modeling which are present in scientific periods in physics lectures and important for physics lectures should be allowed.
- In institutions where teachers are educated, the teacher candidates should be helped to be learned and adopted with modern opinions about the nature of science.
- In faculties giving physics education, lectures such as science history and research techniques should be added and the scientific manners of students should be developed.
- Courses dealing the subject of the nature of science should be organized for the students taking education in all departments of universities.

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