

## The Understandings of University Students Concerning the Nature of Science from European Union Member Countries and Turkey

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**Abstract:** In this study, the understandings of the nature of science of university students who go onto education in different European countries and in Turkey are investigated. The ideas of Turkish and foreign students concerning the nature of science and technology and the relations of the science-technology-society are compared. Issues discussed in this study are dimensions of the “nature of science:” “definition of science and its differences with other disciplines, meaning of scientific theory, the relation between scientific theory and laws, relation of science with social and cultural values, contribution of personal powers of scientists to their scientific studies, the relation among scientific information, invention and discovery, reasons for the differences among the scientists, proofs that scientific information are based on, quality of scientific information, the relationship between science and technology and the interpretation of statistical data and graphics.” In this study a qualitative approach is used. For revealing the understandings about the nature of science, “Views of Nature of Science Test” by Lederman is applied to twenty university students who attend education in different departments in Lithuania, Romania, Italy, Denmark, Estonia, Germany and Turkey and who work in the European Union Youth Programmes. The responses of the students are analyzed with a descriptive method. According to the findings, students from the European Union member countries have better understandings about the nature of science than Turkish students and there are dimensions that both groups require education about.

**Key words:** Science · Nature of Science · University Students · Education in European Union · Education in Turkey

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### INTRODUCTION

“Globalization, changing demands and expectations, gaining value of information” are the things that make international strategical cooperations inescapable in our era. One of the most important cooperation fields is education. Creating common projects and applying them with agreements among universities and getting unpaid financial support for providing short term changes of students, teachers, lecturers and staff are gaining importance [1]. From the Maastrich Agreement in 1992 to the Lisbon Treaty in 2010, educational partnership policies are handled as an important thing for more powerful, more competitive and dynamic information economies by the European Union. “Comenius, Erasmus, Gruntving, Lingua, Minevra, Socrates II, Tempus III and

Youth” are the programmes applied by the European Union [1]. “Youth Programme” aims to create communication among 15-25 years old students from different countries; improving their skills and supplying lifelong learning; creating the “European of Information” [1,2].

Being aware of science and the “nature of science” will create a mental base to make up the “information society.” This study aims to reveal the perceptions and understandings of university students about the “nature of science” from European Union member countries and the candidate country, Turkey. This will help us to see the ways of creating common concepts and perceptions about “science and nature of science,” between European Union member countries’ and Turkish students. With this common language, time spent in an exchange country

would become more efficient and Youth Programme activities would reach their aims better. Also with this research we will be able to understand the ways students gain information about science. Revealing the understandings and perceptions of students will indirectly help us to describe the understandings and perceptions of lecturers. Because, the understandings and perceptions of students stem from those of their lecturers. This will be a self-evaluation for each country that participated in the research.

**Problem Statement:** The era that we live in is characterized by globalization, which is a thing that makes change inescapable. For countries to adopt the changes a number of people who are good at scientific literacy play important roles. To create a society with a high rate of people who have a scientific literacy, an understanding of the nature of science and teaching is gaining importance [3]. Especially license level draws attention to its important effect of improving the knowledge and skills about the nature of science.

The license education systems applied in European Union countries are different from each other. To decrease these differences and create one common application is a project called "European Higher Education Area," which began in 1999 [4]. We can say, through inference, that European students will provide a general picture about the understandings of students from the European Union.

The lessons completed for teaching the nature of science both in secondary and license level schools are operated as teaching theories, laws and principals about various topics. In the studies done it is revealed: students have common delusions about the terms of nature of science [5]. Students think the theories and laws are tangible things (matters) that are found by scientists in hidden laboratories and stay in the lessons they attend [6, 7].

"Nature of science" includes the characteristic features of science being empirically based, not being certain, subjective, or creative and being combined both culturally and socially. People who understand the nature of science can understand the functions and the differences between observations, attempts, scientific realities, laws, hypotheses and theories [8].

Having an exact idea about the nature of science and having scientific information contribute to the scientific literacy of people in terms of some aspects [9]. Science teachers and researchers handle the scientific literacy in at least seven dimensions.

#### **The Person Who Has the Ability of Scientific Literacy Can:**

- Understand the nature of science,
- Apply the appropriate content of science, principals, laws and theories solely by relating them to their own lives,
- Use the steps of scientific problem-solving and decision process to understand their lives,
- Be consistent with scientific values while communicating their own lives' different sides,
- Understand the common attempts of science and technology with each other and society and appreciate them,
- Improve a point of view by making it richer, more satisfying and more exciting as a result of science education and make sustainable this education during their entire lives,
- Improve the beneficial skills about science technology.

Scientific literacy does not only include teaching realities and theories; but, also understanding these terms' natures and how they become functional with the relations of the physical world and other beliefs. Science is taught to us by scientists as a barrier typically exists between theories and realities [8]. At the base of the nature of scientific information, nine dimensions occur [10]:

Scientific information depends on experiments and observations. The most important feature of scientific information is control by other people and being dependent on the evaluated data. These data are gathered from experiments and observations. Science is factual and it tries to understand and explain the effects and reasons the results exist [11]. The feature of science that separates it from other disciplines like logic, math and religion is being partly dependent on observation [7, 10, 12, 13, 14]

Scientific information is creative. It is the product of people's creativity. There is no one scientific method to follow step-by-step to produce information. Though there are steps followed by everyone at the application of science like logical inferences, collecting data carefully; there is no one routine application used in the steps like a defining problem, hypothesis and its test, creating results, or reporting of the results [10].

Scientific information is open to be improved, therefore it is not certain; it depends on the data controlled and evaluated. Science is a kind of activity which is done by people like art, literature and philosophy. The scientists who have the same data or

who observe the same thing will analyze them differently because of their prior information, theories and other personal differences and they will tend to reveal different dimensions of the same event. Scientists know that scientific information is subjective. Including subjective features of scientific studies is an aspect that is trying to be increased by being open to supervision and control [7, 10, 12, 13].

Scientific theories and laws are different types of scientific information. The most frequent concepts of the delusions about the nature of science are these two things: when theories improve they become laws and laws are more powerful and convincing than theories. Scientific laws and theories are related but they are different types of information. They are both valuable in terms of science. Scientific laws are generalizations or descriptions about natural events. Scientific theories are the explanations of these laws or the relationships between facts [7, 10].

Scientists' implications, dreams and creative ideas make a big contribution to the production of scientific information. Scientists use their creative ideas and other personal features to determine which problem to investigate, to designate which type of research method and to analyze and present the data [7, 10].

Science is relative. It is the result of being a kind of activity done by many people. Two different scientists would see different things by looking at the same thing because of the different backgrounds and expectations [7, 10].

When scientific information is produced it is in a strict relationship with the social environment and culture. Science affects the culture in which it is performed in many dimensions and is affected by many factors of science. We can say that science is in a tight relationship with culture [7, 10].

Science and technology affect each other but they are not the same. Many people think that science's and technology's meaning are same. Some technological discoveries like the microscope helped scientists to understand the exact meaning of reality [10].

Science and its methods do not answer all questions. Science is factional. Science cannot give the answers to questions of other disciplines like logic, math and religion [10].

So many studies show that the ideas of teachers, students and even scientists about the nature of science are inappropriate or inadequate [6,7,8].

When people understand the nature of science they tend to develop skills of researchers like "personal time management, team working, assembling data and

arranging it for retrieval, being fascinated by the phase of immersion data, being creative to notice the patterns and reasons something emerges, synthesizing ideas, constructing and testing theories, self-awareness about their impact on what they are analyzing, being able to evaluate their comments in terms of others' view and reporting what they have done [15].

Youth Programmes are present for several social and scientific sharings among countries. Whenever the sharing is about students they always use their scientific literate students. Revealing the understandings of students to create better understandings about the "nature of science" is important for making these programmes more effective.

## METHOD

This study is designed as a case study appropriate with a qualitative approach. The aim of this study is to reveal university students' understandings of the nature of science who attend schools in member countries of the European Union and the candidate country, Turkey, which work with the European Union Youth Programme. For fulfilling this aim, the VNOS (Views of Nature of Science) test improved by Lederman *et al.* [12] with ten open-ended questions is applied to twenty university students from seven different countries. Two more items were added to the test for revealing the perceptions about "commenting statistics, graphics and numerical values" and "their relation with science." Data is collected from a twelve-item test. The sample of the study consists of twenty university students from different universities departments and different classes from Lithuania, Romania, Italy, Denmark, Estonia, Germany and Turkey who work in the European Union Youth Programmes. Ten of the students are Turkish and ten of them are from other countries.

Collected data is analyzed by a descriptive analysis method. For descriptive analysis, an analytical rubric with three levels is prepared by the help of similar studies' results [16].

### According to this Rubric the Levels Are:

**Appropriate:** Whether the choice has an appropriate statement with a nature of science model about the nature of science and technology and their relationship with society,

**Inadequate:** Whether the choice is not only appropriate but it includes a statement partly related to the nature of science and its relationship with society and about the model of nature of science.

**Not Suitable:** Whether the choice includes statements that are not appropriate with the nature of science model about the nature of science and technology and its relationship with society.

In the following step, the replies of students are classified according to the rubric. To make the results reliable, researchers collect the data independently from each person taking part in the sample. An important consistency assigned at the analysis is done by the researchers.

## FINDINGS AND DISCUSSION

In the following tables foreign and Turkish students' answers are given according to their frequencies. The total student number who answered the question can be different because some of the students have not answered some of the questions.

According to Table 1, frequencies of "appropriate" answers given to "What is the definition of science and what are the differences between other disciplines and

Table 1: Analyze Results of Answers Given To 1. 2. 3. and 4. Question

Question 1: What is the definition of science and what are the differences between other disciplines and science?				
	Turkish Students	F	Foreign Students	F
Not Suitable	A thing revealed by people (it has already been) and it contributes to create too many new and beneficial things. Thing separate it from other disciplines is the 99% of reliability.	3 30%	Science is, first of all, about nature. It is about theory, facts and proofs. It's not about thought only! Science is the human-beings who try to learn about nature, by making theories which they try to prove.	4 40%
Inadequate	Science can be a kind of field permanently improving. Philosophy is a science but religion can't be thought as science because it is dogmatic.	4 40%	Science appeared of human needs to explain the nature and to improve their lives. Logical and calculated theories make the difference. Religious things you feel them, science is proved with theories.	4 40%
Appropriate	I think that science is a kind of thing permanently changing and improving. Difference stems from this and these features of philosophy and religion are fewer.	3 30%	The point that separate science from other fields is that science is far from certainty and it can be supported with theories.	2 20%
Question 2: What does scientific theory mean?				
	Turkish Students	F	Foreign Students	F
Not Suitable	They don't change. Because theories can be accepted as "science" when they create same results at each kind of situation.	3 30%	Can not be change, because of that if many scientists agree of the same theory so it is true.	1 10%
Inadequate	They can be improved like each field of science though they can't totally change.	1 10%	People can find other important factors which can change the theory.	2 20%
Appropriate	Yes, they can change like the theory non-fragmentation of atom.	6 60%	Science theories can be changed later because as time goes by new things appear and are discovered. For example the theory that said the sun revolves around the earth was then changed.	7 70%
Question 3: What is the relation between the scientific theories and laws?				
	Turkish Students	F	Foreign Students	F
Not Suitable	Law is exactly proved and theory is only an idea.	3 30%	The law is proved. The theory is not. The world spins around all the time - Law - it is proved. There is life somewhere in the university - Theory. There is a possibility, but it isn't proved.	3 30%
Inadequate	Theory means an assumption. Law includes exact rules gathered after research. Law of gravity is a law and Communism of Marx can be thought as theory.	7 70%	The scientific law has been demonstrated and is beyond doubt. A theory is something that can be developed and cannot be completely demonstrated. Ex. The law of gravitation; the theory of Big-Bang.	5 50%
Appropriate	Theories and laws are different kinds of information and there is no hierarchical relation between them. Laws are the definitions of relations; theories are the definitions.	0 0%	Law is like rule and theory some kind considerations which lead to a new statement.	2 20%

Continued: Table 1: Analyze Results of Answers Given To 1. 2. 3. and 4. Question

Question 4: What is the relation of science with social and culturel values?				
	Turkish Students	F	Foreign Students	F
Not Suitable	Whether it reflects the socio-cultural values there can be no objective observation, value an result. So how can we reach to the reality or inaccuracy of science?	3 30%	Science must help people to live better life. For example the electricity gives the possibilty to everybody to read a book and mechanics gives to everbody travel.	2 20%
Inadequate	Only science field that socio-cultural factors can affect is Social Sciences. But there is no effect of socio-cultural dimensions on positive sciences.	4 40%	I think that science partially reflects cultural and social values because theories are according to the culture but scientific truth, the legitimate scientific truth is completely male pendent.	3 30%
Appropriate	I think that science reflects social and cultural values. When we think that "Pragmatism" is necessary science should be improved in a way that it can answer the needs. So it includes socio-cultural values.	3 30%	I think that beside social and cultural values, science also has a moral value. Science is, a part of all our lines and it can affect it is a good or a bad a way. For it to have a positive effect, social, cultural values must, definitely be neglected in it.	5 50%

Table 2: Analyze Results of Answers Given To 5. 6. 7. and 8. Question

Question 5: What is the contribution of personal powers of scientists to their scientific studies?				
	Turkish Students	F	Foreign Students	F
Not Suitable	Usage of investigating feature is more impotant than usage of creativity.	2 25%	Scientists do not use their imagination and creativity. Because scientific processes are realistic, everything is counted by formulas and there is no space for creativity.	1 10%
Inadequate	It is used after data collection phase.	2 25%	I think it depends. But they do not use imagination and creativity because the mathematical calculus doesn't allow this kind of mind.	1 10%
Appropriate	Science would never develop without creativity and imagination. Scientists use the original ideas that belong to them at the early phases of the study.	4 50%	To make theories and laws you need to use you creativity and imagination! You need to come up with the new ideas and look for solutions in new ways. You need to think in a new way. If the scientist were thinking like everybody else he would never discover new things.	8 80%

  

Question 6: What is the relation among scientific information, invention and discovery?				
	Turkish Students	F	Foreign Students	F
Not Suitable	Science is the discovery of the things that can be made and discovery of already existing things.	6 75%	I agree with both aspects, but I tend to go more towards "discovering", because every aspect of science exists, so people just have to discover them. For example: gravitation has always existed, Newton just transformed it into a theory.	3 37.5%
Inadequate	Though it is perceived like something based on discovery I think that it is often an invention. Like the invention of the phone.	2 25%	You can not answer yes or no. Some of the things we discovered, some of them were invented.	4 50%
Appropriate	Scientists construct the information themselves and they create original product, so scientific informations are discoveries.	0 0%	The theories may be invented but that's why most of them are doubted and denied, but scientists usually discover scientific knowledge.	1 12.5%

  

Question 7: What are the reasons for the opinion differences among the scientists?				
	Turkish Students	F	Foreign Students	F
Not Suitable	Differences happen because of the information based on guesses.	2 22.2%	Because they are not communicating with each other. And maybe they are living in other countries and affected by many reasons social, etc.	1 11.1%
Inadequate	Though there are differences among scientists these differences don't affect the studies much, because of the objective personality of scientists they reflect these differences to the studies they are doing.	0 0%	Depends on what way you choose I think even if you have the same data.	1 11.1%
Appropriate	Differences happen because of the experiences, cultures and points of views.	7 77.8%	Different opinions are formed because even though scientists may have similar data or do similar experiments, their knowledge, education and opinions are different. This is a positive thing mostly because it stimulates them more to research and discover new theories and truths.	7 77.8%

Continued: Table 2: Analyze Results of Answers Given To 5. 6. 7. and 8. Question

Question 8: What are the proofs that scientific information are based on?				
	Turkish Students	F	Foreign Students	F
Not Suitable	They can be sure according to the experiment results they get.	3 50%	They just did a lot of experiments in the past. Nobody still can discover something more, so this is evidence.	3 75%
Inadequate	People develop the opinions by setting out starting points previously (with informations about environment). After this trial-error and long process (after getting successful results) the go on the application (after this sudden behaviour).	3 50%	They are not that sure and those models may be changed in the future.	0 0%
Appropriate	Scientists can never be sure about the information they have about the structure of atoms, because most of proofs are based on indirect observations and extractions. These informations are always open to change.	0 0%	They cannot be sure of their knowledge because they do not have the most high-tech technology in order to research and can be changed.	1 25%

Table 3: Analyze Results of Answers Given To 9. 10. 11. and 12. Question

Question 9: What do you think about the quality of scientific information?				
	Turkish Students	F	Foreign Students	F
Not Suitable	I don't agree. Realities change according to people, but realities don't. Realities can't be discussed but realities can.	1 14.2%	Nobody discusses that outside cause as it seems clear, approved and undiscussable but still it could be. Technologies are improving people have more and more questions and scientists have possibilities to find something new.	2 25%
Inadequate	Informations proved can't be changed, but the theories that haven't proofed yet can be changed. So some of scientific informations can be discussed; while some other ones can't.	0 0%	Science is an inexact field. It is unguessable, but there are solid proof facts, support new things. Theories are undiscussable.	1 17.5%
Appropriate	It is discussed. Things that we say today can become wrong when enough proofs are gathered.	7 85.8%	I think that it is usual to discuss what is already proven because I say the world is changing so also we evolve and we can find so mistakes in the past.	5 62.5%
Question 10: What is the relationship between science and technology?				
	Turkish Students	F	Foreign Students	F
Not Suitable	Technology is the presented state to the people's usage of science.	3 60%	Technology is related to inventions and science to physics But one without another cannot exist. They depend on each other.	3 43.7%
Inadequate	I think that both science and technology are in the same direction but technology is the result of science. It is the conversion of theoretical information to practice.	2 40%	Technology is a program. Science can not be developed without technology and without technology we can not develop the science.	3 43.7%
Appropriate	Technology is the tool, methods and techniques which make peoples' lives more relaxed. Science and technology are independent fields but they are in a close relationship.	0 0%	Technology approved and also for it is help in daily life in old days there were washing machine, we use science to improve technology and we use technology in science.	1 12.5%
Question 11: Can you interpret the statistical data about the field you study and do you find it important?				
	Turkish Students	F	Foreign Students	F
Not Suitable	I can't interpret the statistical data about my field. I don't think that it is	4 40%	I can't interpret the statistical data and I think something important. it isn't important.	2 20%
Inadequate	a. Though I can interpret the statistical data about my field, I do it only when it is necessary; I don't find it important. b. I can't interpret the statistical values about my field, but I think that it is important.	4 40%	a. While I can interpret the statistical data of my field, I don't think it is significant. b. I think interpreting the statistical data of the field is very important but I can't do this.	5 50%
Appropriate	I think that interpreting the statistical data about my field is necessary and important. I can do it successfully.	2 20%	I can interpret the statistical data of my field and I think it is very important for scientific studies.	3 30%

Continued: Table 3: Analyze Results of Answers Given To 9. 10. 11. and 12. Question

Question 12: Can you interpret the graphics about the field you study and do you find it important?				
	Turkish Students	F	Foreign Students	F
Not Suitable	I can't interpret the graphics about my field.	3	I can't interpret the graphics related to the field. Also, this isn't important.	1
	I don't think that it is something important.	30%		10%
Inadequate	a. Though I don't think interpreting the graphics about my field isn't something important and I don't live difficulties to interpret.	4	a. I can interpret the graphics well, but it isn't important for the field. b. I think interpreting the graphics in the field is very important, but I can't.	5
	b. I can't interpret the graphics about my field and I think that it is a big lack for me.	40%		50%
Appropriate	I can interpret the graphics about my field and I aware of its importance.	3 30%	I think interpreting the graphics related to the field is very important. I can say that I understand and interpret the graphics well.	4 40%

science?" are low for both groups. Comparing Turkish and foreign students responses we can see that more Turkish students gave "appropriate" answers.

Frequencies of "appropriate" answers given to "What does scientific theory mean?" are high for each group. More foreign students gave "appropriate" answers than Turkish students.

When we look at the answers' frequencies of "What is the relation between the scientific theories and laws?" we can see that only two foreign students gave an "appropriate" answer. None of Turkish students gave "appropriate" answers. Neither of the groups is good, but we can say foreign students are better.

Answers given to "What is the relation of science with social and cultural values?" focus on "inadequate" level for Turkish students and "appropriate" for foreign students. We can say that students from the member countries are better.

According to Table 2 answers given to "What is the contribution of personal powers of scientists to their scientific studies?" were collected at the "appropriate" level for each group and foreign students' responses were better.

When we look at the answer frequencies of "What is the relation among scientific information, invention and discovery?" we find "not suitable" answers are highest for Turkish students and "inadequate" for foreign students. According to this, we can say that both groups have a problem with the relationship between scientific information, invention and discovery but foreign students are better.

When we evaluate the answer distribution to "What are the reasons for the opinion differences among the scientists?" most of them are "appropriate" and it is same for both groups.

"What are the proofs that scientific information are based on?" is the question which four Turkish students and six foreign students have not answered. Answers given as "not suitable" are high and are the same for both

groups. No "appropriate answers" were given to this question by Turkish students.

According to Table 3, answers given to "What do you think about the quality of scientific information?" were collected at the "appropriate" level for each group. Turkish students are better about this topic.

Only one "appropriate" answer was given to "What is the relationship between science and technology?" by foreign students. None of the Turkish students answered it appropriately. Both groups have problems with this issue.

"Appropriate" answers given to "Can you interpret the statistical data about the field you study and do you find it important?" are too low for both groups, but foreign students are better.

When we look at the frequencies of answers of "Can you interpret the graphics about the field you study and do you find it important?" we can see that there are few "appropriate" answers and foreign students are better about this subject.

## CONCLUSION

According to the findings of the study we can say that university students from member countries of the European Union have "appropriate" understandings about "scientific theories, including social and cultural values, contribution of personal powers of scientists to their scientific studies, reasons for the differences among the scientists and quality of scientific information." But those students who have "inadequate and not suitable" understandings about the "definition of science and its differences with other disciplines, the relationship between scientific theory and laws, characterizing the scientific information as inventions and discoveries, proofs that scientific information are based on, the relation between science and technology, interpreting the statistical data about the field they study and finding it important, interpreting the graphics about the field they study and finding it important."

When we evaluate the answers of university students from candidate country Turkey, we can see that they have “appropriate” understandings about “scientific theories, reasons for the differences among the scientists and quality of scientific information” dimensions. On the other hand those students have “inadequate and not suitable” understandings about “scientific theories, definition of science and its differences with other disciplines, the relation between scientific theory and laws, including social and cultural values, contribution of personal powers of scientists to their scientific studies, characterizing the scientific information as inventions and discoveries, proofs that scientific information are based on, the relation between science and technology, interpreting the statistical data about the field they study and finding it important, interpreting the graphics about the field they study and finding it important” dimensions.

When we evaluate all answers we can say that the students who participated in the study from the European Union member countries have better understandings about the nature of science than Turkish students. The only dimension that Turkish students have better understandings of is “the quality of scientific information.” Another thing we can say according to all the responses is that: the dimensions of the “definition of science and the differences from other disciplines, the relationship between science and technology, the relation among scientific information, invention and discovery, the proofs that scientific information are based on and interpretation of the statistical data about the field they study and finding it important” are the fields that both groups of students have low understandings in. These dimensions can be the priority for each group to be given education.

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