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EXAMINATION TEACHERS' OPINIONS ABOUT THE NATURE OF SCIENCE

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Abstract:
The aim of this study is to investigate the Science and Technology, Math, Turkish, Social Studies and English teachers' views about the nature of science. The participants of the study consisted of five teachers who were from different branches. In the study, the "case study research method" which is a sort of "qualitative research methodology" was used. Teachers' views about the nature of science were determined through open-ended questions. The data of the research had been collected via voice records, and then the analyses had been done. The results of the study were presented as tables in parallel of teachers' answers which were about the description of science, variability of scientific knowledge, structure of laws and scientific method. The findings of the study showed that teachers have inadequate and wrong opinions. In order to change the situation, the teachers should be steer to reshaped petro programs.

Keywords: scientific knowledge, the nature of science, teacher opinion

1. Introduction

Curiosity, which is an uninhibited feeling in humankind, is one of the most important reasons to enable science to come into existence. People try to explain all events they observe or predict, which allows science to emerge. We try to understand events and ascribe meanings to concepts through science.

1.1 The Nature of Science

The nature of science was in education system long years ago and it has constantly been developed by scientists. McComas, Clough and Almozroa (1998:4) defined the nature of science as *"an interdisciplinary study field trying to understand what science is, how it functions, how science community constituted by scientists is organized, how society affects science andit is affected by scientific developments bycombining the disciplines examining the*

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social aspects of sciences such as history of science, philosophy of science and sociology of science with the studies of the disciplines including psychology". Lederman (1992) explained the nature of science as "the nature, scope and resource of knowledge or beliefs and values in the process for the development of scientific knowledge".

A variety of different definitions with regard to the nature of knowledge have been made by scientists. However, it has generally been defined as "*the development of scientific knowledge and nature of science*".

The characteristics of the nature of science explained by the scientists (AAAS, 1993; Ryan & Aikenhead, 1992) as follows:

1. Scientific Knowledge Subjects to Change.
   Theories, laws and concepts used in science are open to change. The fact that scientific knowledge are constantly renewed, changed and refuted, can change this knowledge. New knowledge is derived from the re-interpretation of old one. However, the derived knowledge is not absolute and stable.
2. Scientific knowledge is based on experiment.
   Scientific knowledge is based on observation. Observations are interpreted from theoretical studies and are filtered through our perceptions and are explained with experimental studies under proper circumstances.
3. Subjectivity.
   A scientist's personal opinions, namely perspectives, beliefs and personal values, affect scientific studies.
4. Creativity and Imagination in Science.
   Building imagination with logic contributes to science, but this is insufficient for science. It is not possible to create knowledge without creativity and imagination. Scientists' creativity and imagination are used in all phases starting from a problem identification to its conclusion.
5. Structure of Scientific Theories and Laws.
   The relationship between scientific theories and laws can be accounted for the nature of science explanation. Teachers and students generally think that theories turn into laws by being proved. Therefore, they accept that laws are superior to theories. However, theory and law represent different scientific terms. Theories try to explain phenomena taking place in nature, whereas laws identify phenomena occurring in nature. Theories never turn into laws by being proved. Laws like theories are always open to change. Laws do not have a higher value or status compared with theories.
6. Social and Cultural Structure of Scientific Knowledge.
   Scientists are influenced by the social and cultural structures of the society where they live, when they conduct their scientific studies. Science includes political, social, socio-economic and religious factors. However, these factors do not limit its progress.

1.2 The Subject for the Nature of Science in Teaching Science

Science and technology change and develop in the world every second. Because of these concepts, countries compete with each other. It can be possible to ideally follow and use science and technology through manpower. Therefore, countries strive to train skilled human capital. Skilled human capital is possible with a good education. The studies in science and technology are effective on societies' progress. The Ministry of National Education (MoNE, 2006) argues that individuals need to be scientific literate to catch up with this development. Teaching the nature of science is known to be the most important milestone in teaching science. Schwartz, Lederman and Lederman (2008) claim that individuals need to understand not only conceptual knowledge concerning science but also the nature of science and scientific research. The expressions with regard to the nature of science refer to the phases of scientific process and the obtained result indicates the product. According to Driver et al. (1996:136), understanding the nature of scientific knowledge enables students to successfully learn science at school and use this knowledge in their daily lives. As a result, the general rule in teaching science is that teachers need to instill "the nature of science" into their students. However, the conducted studies indicate that teachers, who are supposed to convey knowledge to their students, have misconceptions about the nature of science. Aslan, Yalçın and Taşar (2009) revealed that teachers have insufficient and wrong opinions about the definitions of science, the nature of observations, the instability of scientific knowledge, the structure of laws and theories and scientific method. Besides, it was seen that the teachers are inadequate in the knowledge concerning the instability of scientific one and cannot differentiate the concepts such as law and theory. Çelik and Karataş (2016) demonstrated that science and mathematics pre-service teachers have insufficient understanding concerning the other characteristics of nature of science apart from objectivity, imagination and creativity in the nature of science. It was found in another study that the science pre-service teachers get misconceptions for the sub-dimensions of the nature of science including scientific theory and structure of laws, stability and experimental of scientific knowledge (Önen Öztürk & Bayram, 2017). The fact that all the science pre-service teachers in the sampling group in the other study (Önen Öztürk & Bayram, 2014) misconceive scientific knowledge which is proved with experiments, supports the results of the former study. It was indicated in the study conducted by Mıhladız and Doğan (2017) that the science pre-service teachers have naive opinions concerning observable nature of scientific knowledge and the relationships among hypothesis, theory and law and realistic opinions with regard to what science is and what qualities scientists have.

1.3 The Purpose and Importance of the Study

Nowadays many students are still insufficient in the opinions with regard to the nature of science. Teachers are regarded as the main reason for their insufficiencies. Therefore, attention has been focused on teachers recently and their knowledge concerning the nature of knowledge has been questioned. Thus, in this study the perceptions of the teachers in the different subject areas were examined thoroughly.

2. Methods

2.1 Research Method

In this study, the qualitative research technique was used to identify the perceptions of the teachers in the different subject areas (Science and Technology, Mathematics, Turkish, Social Science and English) with regard to the nature of science. The qualitative research method was conducted with 5 teachers in the different subject areas to obtain a detailed analysis. The purpose of a quantitative research method is to describe and predict relationships, whereas the purpose of a qualitative research method is to identify what and how others make sense of (Büyüköztürk, Çakmak, Akgün, Karadeniz & Demirel, 2008). Events in qualitative studies are examined in natural setting and several descriptions are made by directly deriving data from their resource. Based on these steps, some generalizations are made. Case study, which is one of the qualitative methods, was implemented in this study. Büyüköztürk et al. (2008) defined case study as "*a method where a more cases, circumstances or a social group are examined thoroughly*". In case studies, detailed descriptions are made and case is dealt with how it stands. For that reason, it is difficult to make generalizations in case studies. In this study, it was planned to describe and present by profoundly examining the perceptions of Science and Technology, Mathematics, Turkish, Social and English teachers concerning the nature of science.

2.2 Participants

The study group of the research consisted of 3 female and 2 male teachers, in total 5 teachers (Science and Technology, Mathematics, Turkish, Social and English) working in Yeşilova Mehmetçik Middle School, Koçyiğit Middle School and Derecik Multi-Program High School which are located in the district of Şemdinli of Hakkari province. The participants were selected according to maximum variation sampling method, which is one of the purposeful sampling methods. Some characteristics of the participants are displayed in Table 1. The teachers voluntarily participated in the study. The effect of the obtained answers from the teachers on this table was taken into account (FT: Female teacher, MT: Male teacher). The participants' identities were not revealed owing to the respects for their personal rights and research ethics.

Table 1: Participants' characteristics

Participants	**$FT_{1,1}$**	**$FT_{2,2}$**	**FT_3**	**$MT_{1,1}$**	**$MT_{2,2}$**
Age	26	26	25	27	24
Subject Area	Social Sciences	Turkish	Science	Mathematics	English
Experience in teaching	3	3	2	4	1
Whether taking in-service training	Yes	No	No	Yes	No

2.3 Data Collection and Analysis

Semi-structured interview technique was used to identify the teachers' perceptions for the nature of science. Face to face interview was conducted with the participants in a convenient setting. Tape recorder was used during the interview and the conversations

were recorded. The teachers were asked 10 open ended questions, which were prepared beforehand. However, additional questions were posed to elicit their detailed perceptions with regard to the subject matter. These questions were created by the researcher. Based on the literature review, they were formed. The questions were aimed to include the main components of the nature of science. In this regard, 10 questions were prepared. 5 field experts were consulted for the content validity of the questions. Besides, one Turkish expert was also consulted. The necessary changes were made in the questions based on their feedbacks. The questions were finalized.

The open-ended questions which were posed to the participants as follows:

1. What are your opinions for science definition?
2. How do you think scientific developments have emerged?
3. What does dynamism mean in scientific knowledge?
4. Does science contribute to cultural development? Why?
5. Does society influence science? How?
6. What are the importance of creativity and imagination in scientific knowledge?
7. Do theory, rule and law turn into each other? Why?
8. Does scientific knowledge evolve in progress of time? Why?
9. What are scientists' qualities?
10. Can you regard science independent from daily life? Why?

The recorded interviews were transcribed and written on paper. The derived data were evaluated by another researcher apart from the researcher of this study and a consensus between two researchers was ensured. The inter-rater reliability calculation was conducted according to the formula [Reliability=consensus / (consensus + disagreement) x 100) by Miles and Huberman (1994). As a result of the calculation, the reliability outcome was found to be 85%.

In the findings part, the answers and results derived from the interview were presented. The teachers' answers were directly evaluated. That is, any changes were not made in the answers. The participants were not asked "Yes" or "No" questions.

3. Findings

The teachers' answers for the questions aiming to reveal their perceptions for the nature of science are provided in the following tables.

Table 2: The distributions of the teachers' answers for the question "What is science definition?"

$FT_{,1}$	It is a mass knowledge which constantly renews itself.
$FT_{,2}$	Experiment is a data collection derived from research method.
$FT_{,3}$	It is a consistent and right data collection.
$MT_{,1}$	It is an accumulation of knowledge deriving from past to present.
$MT_{,2}$	It is a right knowledge which can be acquired through experiment and observation.

The teachers' perceptions for "science definition" are moderately the same. Their expressions for science definition are valid and acceptable. The given answer for the

science definition is generally as "*Science is a consistent and accumulated knowledge deriving from past to present through experiment, research and observation.*"

Table 3: The distributions of the teachers' answers for the question "How do you think scientific developments have emerged?"

$FT_{,1}$	Science has emerged by humans' conducting research in accordance with their needs.
$FT_{,2}$	Science has emerged through curiosity, research and needs.
$FT_{,3}$	Human beings have ever lived with curiosity. The first scientific research emerged through the combination of needs with curiosity.
$MT_{,1}$	Science has mostly emerged according to societies' needs.
$MT_{,2}$	Humans have daily needs to sustain their lives. They have needed to overcome their needs through science, which is easier way.

The answers for the 2nd questions are based on "needs and curiosity" concepts. The participants think that peoples' being firstly curious and meeting this curiosity was one of the most important factors to discover science.

Table 4: The distributions of the teachers' answers for the question "What does dynamism mean in scientific knowledge?"

$FT_{,1}$	It means that knowledge constantly renews itself.
$FT_{,2}$	It means that it constantly progresses without stopping.
$FT_{,3}$	It means that it is not static, namely constantly progresses.
$MT_{,1}$	It means keeping. Dynamism in knowledge should be on-going.
$MT_{,2}$	It means that something should be constantly created by adding.

The participants associated dynamism concept with science deriving from the dynamism definition. They indicated in their interpretations that "Scientific knowledge is an on-going process without stopping."

Table 5: The distributions of the teachers' answers for the question "Does science contribute to cultural development? Why?"

$FT_{,1}$	Yes, it does. Because our cultural values are constantly in change with scientific knowledge.
$FT_{,2}$	Yes, it does. Cultural development progresses through science.
$FT_{,3}$	Yes. Cultural developments progress through science.
$MT_{,1}$	Certainly. It has certainly positive contributions to enabling societies to go one level further. Throughout history, it has continued in this way.
$MT_{,2}$	Of course. Telephone and the Internet we use through science nowadays, are important in cultural exchange.

Based on the teachers' responses, it was observed that "culture and science" are inseparable. They stated in their expressions that acculturation comes from past and makes contribution to future.

Table 6: The distributions of the teachers' answers for the question "Does society influence science? How?"

$FT_{,1}$	Yes. Social events play a significant role in developing scientific knowledge.
$FT_{,2}$	It does. In the end, every person is influenced by the society where he/she lives.
$FT_{,3}$	Yes, it does. Science derives its resource from a society.
$MT_{,1}$	Society influences science and science influences society, too. In the end, as science emerges owing to societies' needs, it cannot be thought that society and science are separate.
MT_2	As science emerges because of a society's needs, society influences science. In the end, it is a society that enables science to progress or to make no progress.

According to the participants, it can be generalized that "Peoples' ideas in a society carry the traces of the science they have emerged." As a matter of fact, according to MT's opinion," society influences science and science influences society." indicating that there is a mutual interaction between science and society.

Table 7: The distributions of the teachers' answers for the question "What are the importance of creativity and imagination in scientific knowledge?"

$FT_{,1}$	If people are not curious and do not conduct research, they cannot conduct research what they do not know. For that reason, it is necessary for them to be curious for knowledge to be creative.
$FT_{,2}$	People pursue what they are curious for. They reach knowledge using their imagination and creativity.
$FT_{,3}$	Scientists' studies are the works of their creativity and imagination.
$MT_{,1}$	Innovations can be reached through creativity and imagination in scientific knowledge. These can make contribution to developing science.
$MT_{,2}$	Non-existent thing is imagined. Imagination and accordingly creativity have developed in the societies where science has improved.

The teachers base imagination on "curiosity" concept. It can be deduced from this question that "The curious thing in progress of time is regarded to be imaginative and creative."

Table 8: The distributions of the teachers' answers for the question "Do theory, rule and law turn into each other? Why?"

$FT_{,1}$	Yes, they can. Law of gravity is an example for this. It firstly appears as a theory, then rule and ultimately a law.
$FT_{,2}$	Yes, they do. When a theory is proved, it turns into a rule and a law.
$FT_{,3}$	No, knowledge is not absolute and it is constantly in change and improvement. Some knowledge does not have supremacy over others.
$MT_{,1}$	Definitely, they cannot. Theory, rule and law are different from each other and they are independent terms. It is not possible for these terms to turn into each other.
MT_2	Yes, they do. Theories turn into rules and rules into law when they are proved.

Most of the teachers support the opinion that "when scientific knowledge is proved with experiments, it turns into a rule and when a rule is proved, it becomes a law." On the other hand, two teachers indicated that scientific theory and rules cannot turn into each other and these are different types of scientific knowledge."

Table 9: The distributions of the teachers' answers for the question "Does scientific knowledge evolve in progress of time?"

$FT_{,1}$	Yes, it can evolve. The scientists, who thought that the structure of an atom could not be split beforehand, discovered that it could be split through their curiosity.
$FT_{,2}$	Certainly, it evolves. Knowledge can evolve every day.
$FT_{,3}$	Yes, it does. Knowledge can be refuted or supported.
$MT_{,1}$	It does. A definite knowledge concept has never existed and it will not exist, either.
MT_2	Knowledge makes progress and it can evolve. There is not absolute knowledge. A possibility for new knowledge to emerge always exists.

All of the teachers support that "knowledge can evolve in progress of time and it is not static." The idea that scientific knowledge can evolve in future is the same in the participants' responses.

Table 10: The distributions of the teachers' answers for the question "What are scientists' qualities?"

$FT_{,1}$	Their being curious, always inquisitive and objective are the most important qualities.
$FT_{,2}$	They are innovative, curious and they conduct experiments.
$FT_{,3}$	A scientist is curious, creative, dreamer and he/she enjoys conducting research and questioning.
$MT_{,1}$	Curious, intelligent, objective, hardworking and patient. We can add more qualities.
$MT_{,2}$	A scientist should be curious, hardworking, objective and intelligent.

There is a consensus among the participants concerning scientists' qualities in the sense that they should be intelligent, objective, patient and curious.

Table 11: The distributions of the teachers' answers for the question "Can you regard science independent from daily life? Why?"

$FT_{,1}$	No. this is not possible as everything including phones in our hands is a product of science.
$FT_{,2}$	No, we cannot because we use science in every part of daily life.
$FT_{,3}$	No, because science has come into existence on account of daily needs.
$MT_{,1}$	Science cannot be regarded independent from society and life. There is not a part where science does not have an impact. Science definitely influences every part of life.
MT_2	Science cannot be regarded independent as they have come into existence owing to daily life needs. The more needs there are, the more developments in science will occur.

It was indicated by most of the teachers that daily life and science cannot be separated definitely, namely both of them are embedded with each other. What is more, this question was illustrated with daily life circumstances.

4. Results and Discussion

As a result of this study, it is seen that the teachers have different points of view. Some answers express modern approach, whereas the others indicate traditional approach. The following results are derived from the frequency and validity of the answers given for the questions in the context with the current research: the teachers' answers for the science definition are almost the same and their answers for the definition are seen to be

valid. This result is similar with the one of the study conducted by Mıhladız (2010). The answers for the process of emerging knowledge are based on "curiosity and needs" concepts. Scientists create scientific knowledge by conducting research on the issues they are curious about (Çakıcı, 2009). So, there are curiosity and needs at the beginning of science. Most of the teachers who participated in the present research have realistic perceptions concerning the evolving nature of scientific knowledge. The concepts in science such as temporariness, dynamism, creativity and imagination were associated with science by the teachers. This result shows parallelisms with the ones of the studies implemented by Doğan Bora (2005), Aslan (2005) and Arık (2010).

The participants revealed that there is a mutual interaction between science and society. Most of the participants in the study by Aikenhead (1987) stated that society influences scientists' studies. This result is similar with the one of the current research.

A number of the teachers in the current research gave wrong answers with regard to theory and laws turning into each other and claimed that law is superior to theory. The number of the teachers distinguishing theory and law as two different scientific knowledge is quite low. The participants' opinions concerning the ranking among these concepts can be accounted for the fact that they have lack of knowledge about theory and law. The similar results were derived in the study conducted by Abd-El-Khalick and Akerson (2004). The participants indicated in the other findings that scientists should be "patient, objective, curious and hardworking." Besides, it was emphasized by the teachers that the relationship between science and society are inseparable.

4.1 Recommendations

It was identified that the teachers do not have sufficient knowledge in the concepts including science definition, scientific knowledge and scientists' qualities and they need the necessary training for these issues. Thus, teachers are required to join in-service training, courses and seminaries to make up their deficiencies in this context. Constantly changing and evolving science should be closely followed and it should be implemented in our country.

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