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Investigation of Gifted Secondary School Students' Assessment of the Nature of Science in Turkey

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Abstract

The objective of this study is to uncover the NOS evaluations of students enrolled in Science and Art Centers in Türkiye. We conducted the research using a case study design, which is a qualitative research method. The study focuses on 60 gifted secondary school students who will continue their education at the Seljuk Science and Art Center in the 2022-2023 academic year. The study evaluated the nature of science among gifted students using the Nature of Science Assessment Scale.The data underwent a descriptive analysis. This study, aimed to evaluate the nature of science among gifted students, revealed that students typically presented perspectives that aligned with the nature of science. However, an examination of gifted students' views on the structure of scientific knowledge revealed that most of them believed the views of scientists would not influence scientific knowledge. The study also revealed that gifted students primarily believed that scientists' observations led to the emergence of scientific knowledge. From this point of view, it was concluded that there are gifted students who have views on the role of the scientist in the production of scientific knowledge and the basis of scientific knowledge that are not appropriate for the nature of science. In this context, we believe it's crucial to implement certain activities targeted at enhancing the NOS evaluations of students within the research's scope.

Keywords: Gifted students, nature of science, qualitative research

Introduction

Developments in science and technology in the world necessitate the existence of individuals compatible with these developments in the system. Educational scientists have reflected the changes in educational paradigms brought about by these change and transformation movements in their educational programs. Our age emphasizes science literacy as a learning outcome among the objectives of education programs in various countries (American Association for the Advancement of Science [AAAS] 1990; National Research Council [NRC] 1996, 2011; National Science Teachers Association [NSTA] 2000; Ministry of National Education [MoNE] 2018; Roberts, 2007; The Organisation for Economic Co-operation and Development [OECD] 2013; Centurino & Kelly, 2021). Those with science literacy should also understand the nature of scientific knowledge, its acquisition process, and the interplay between science, technology, and society (Shamos, 1995). Individuals' ability to apply this skill to the decisions they make in their daily lives is one of the **most** important indicators of education systems (OECD, 2013).

Nature of Science, Definition, and Principles

When the literature on the nature of science is examined, it is seen that there are some common views on the definition of the nature of science, although there is no clear and precise limitation on the definition of the concept. McComas et al. (1998) stated that "Science is a rich hybrid field that includes many social fields of study such as history, sociology, philosophy, and psychology and interacts with cognitive sciences to create rich definitions". According to Khishfe and Abd-El Khalick (2002), "It is not surprising that philosophers, historians of science and sociologists alone cannot define the nature of science because science is complex, dynamic and multiple". In other words, the intersection of various disciplines such as philosophy, history, sociology, and psychology forms knowledge of the nature of science, or the description of scientific endeavor. In this context, when we look at the definitions of the nature of science, we can say that the nature of science covers the qualities of scientific activities and scientific knowledge applied to explain what happens in nature. For instance, the scientific method directly relates to the stages of scientific processes, like making observations, hypothesizing, and obtaining results, but the nature of science influences these processes based on the scientist's understanding.

Using post-positivist methods, modern educational scientists who believe that teaching NOS is an important part of scientific literacy for understanding how science works have come up with some basic NOS principles (Lederman et al., 2002; McComas, 2014). Thus, science educators have reached a degree of consensus (Deng et al., 2012). For example, according to Lederman et al. (2002), there are seven basic principles of NOS. These principles are (a) the empirical nature of scientific knowledge; (b) the relationship between scientific theories and laws; (c) the creative nature of scientific knowledge and imagination; (d) the theory-laden nature of scientific knowledge; (e) the relationship of scientific knowledge to the social and cultural environment; (f) the myth of the scientific method; and (g) the changeable nature of scientific knowledge.

The fact that scientific knowledge derives, at least in part, from observation of the natural world is one of the principles of the empirical nature of scientific knowledge (Lederman, 1999). Scientific knowledge progresses based on data. Observations and experiments yield scientific knowledge. However, scientists do not always have direct access to natural phenomena. Therefore, they make some inferences. Therefore, all researchers in scientific studies do not use a single method, nor do they write down and follow individual steps. Accordingly, students with sophisticated views on the empirical nature of science should be able to distinguish between observation and inference. Such a distinction enables students to better grasp theoretical or inferential situations (Lederman et al., 2002).

The second tenet of NOS involves students distinguishing between scientific theories and laws and understanding that they are different types of knowledge. While laws are explanations about the relationships between observable phenomena, theories provide inferred explanations for large sets of seemingly different observations in different fields of inquiry (Lederman et al., 2002). Experiments and observations provide some of the scientific knowledge, but inferential interpretation of these data reveals some of it.

According to the third principle of the nature of science, creativity, and imagination are also important for knowledge production in the creation of scientific theories and laws (Lederman et al., 2002). This principle asserts that the acquisition of scientific knowledge extends beyond mere observations and experiments. Every step of the research requires the creativity and imagination of scientists, from designing the scientific study to collecting data and drawing inferences from it.

The fourth principle emphasizes the theory-laden nature of scientific knowledge. According to this principle, scientists' prior experiences, knowledge, and theoretical commitments influence their work. Therefore, their background beliefs and experiences can shape their observations and how they interpret them (Lederman et al., 2002; Okasha, 2002). In addition, the fifth principle emphasizes the social and cultural embeddedness of scientific knowledge. In reality, a larger culture produces scientific knowledge, and scientists grow up within this culture. Therefore, science is not independent of culturally situated places and time but rather interacts with them. This principle generally states that various factors, such as social, political, and economic ones, both influence and are influenced by science (Allen & Baker, 2017; Lederman et al., 2002).

The sixth principle of the nature of scientific knowledge is about the myth of the scientific method. There is a common misconception that all scientists follow a single scientific method, resulting in the development of infallible knowledge. However, there is no single method, such as the inductive method, which all scientists follow step by step. For example, Galileo did not initiate the laws of pendulum motion by making systematic observations of several pendulums and then making generalizations (Matthews, 2015). Rather, he used the language of mathematics. He believed that mathematics could effectively describe the behavior of objects in the material world. He also emphasized the experimental testing of hypotheses (Okasha, 2002).

Finally, Lederman et al. (2002) propose the last principle of the nature of science, which involves the transient nature of scientific knowledge. As stated by Lederman et al. (2002), scientific knowledge, including theories and laws, although reliable and durable, can change as new evidence becomes available. For example, Newtonian physics has long been accepted by scientists as the fundamental truth. However, in the early years of the 20th century, two revolutionary developments—the theory of relativity and quantum mechanics—showed that Newtonian mechanics does not apply to all objects (Okasha, 2002).

Examining how and to what extent Türkiye's elementary science curricula (MoNE, 2018) reflect the nature of science reveals that the curriculum incorporates science literacy into its specific objectives and domain-specific skills. However, one of the necessary dimensions for raising science-literate individuals is knowledge about the nature of science (Lederman & Druger, 1985; Lederman, 1992, 1999, 2010; Lederman et al., 2002; Shamos, 1985). It is also important that students comprehend the basic skills in the curriculum and transfer them to their daily lives.

Science and Art Centers are important institutions in Türkiye that offer education to gifted students outside of formal education and serve to help gifted students realize their potential. Given their unique characteristics, gifted students require a tailored education program and an educational environment that aligns with their needs (MEB, 2022, p. 11). The activities to be implemented should have components such as higher-order thinking skills, open-ended and creative thinking, discovery, reasoning, research, group interaction, and freedom of choice in the process dimension, and finally, to differentiate the product dimension, components such as problem awareness, working with real-life problems, real target audience, evaluation, creativity and diversity in the product. In other words, it is the application area of the science process skills that are structured in the science education given in formal education institutions.

Examining the literature on NOS reveals that students' perspectives on NOS are quite limited and lack accurate information (Abd-El-Khalick & Lederman, 2000; Mellado, 1998; Moss, 2001; Lederman, 2007). In Türkiye, there is no study investigating gifted students' perceptions of the nature of science in Science and Art Centers**.** In this sense, it is important to reveal the perceptions of students studying at Science and Art Centers towards the nature of science in this study. In addition, the study's results will provide important information to the literature, program developers, and book authors. From this point of view, this study aims to determine how students studying in Science and Art Centers perceive the evaluation of the nature of science.

Method

We conducted this research using a case study design. According to Ekiz (2003), case studies require a detailed examination to describe and interpret all points related to a situation. This study conducted a detailed investigation to understand the perceptions of gifted students about the nature of science.

Study Group

We researched 60 gifted middle school students who continue their education at the Selçuklu Science and Art Center in Türkiye during the 2022–2023 academic year. Using a purposeful sampling method, we determined the sample. Table 1 provides information about the participants.

Table 1. Demographic Information of Participants

Variable		n	%
Class level	5th grade	18	30
	6th grade	15	25
	7th grade	10	17
	8th grade	17	28
Gender	Female	30	50
	Male	30	50
School type	Imam hatip middle school	5	8
	Middle school	25	42
	Private middle school	30	50,00

According to Table 1, 18 of the gifted students were in the 5th grade, 15 in the 6th grade, 10 in the 7th grade, and 17 in the 8th grade. It is noteworthy that 30 of them are girls and 30 of them are boys. On the other hand, 30 of the gifted students were enrolled in private secondary schools, 25 of them in public middle schools, and 5 of them in Imam Hatip middle schools.

Data Collection Tool

In the study, Muşlu (2008) developed the "Nature of Science Assessment Scale" to determine gifted students' NOS assessment status. This scale consists of 15 questions and allows the participants to express their different opinions about the other option. Questions 1 and 2 are about Science; questions 3,4,5,6,7,8,15 are about the Structure of Scientific Knowledge and questions 9,10,11,12,13 and 14 are about the Scientific Method. We also asked the participants about their grades, genders, and school types to gather their demographic information.

Data Collection and Analysis

We collected the data by applying the scale to the students in a physical environment, adhering to the principle of voluntariness. We provided the participants with information about the study's purpose before the application and answered their questions during it. The applications carried out on different groups lasted approximately 20 minutes.

The data underwent a descriptive analysis. We calculated the participants' responses to the scale questions based on the available options, collected some opinions from the available options or categories, and presented them through direct quotations. We coded the participants' opinions in this process to include them in multiple categories. We paid attention to the harmony among the coders in determining the categories in question, ensuring validity and reliability.

Findings

Findings Related to the Perceptions of Gifted Students Regarding Science

The discussion focused on the answers to questions 1 and 2. First, we analyzed the gifted students' responses to the question "Why do scientists do science?" in the context of the title. Table 2 presents the opinions expressed on this issue.

Table 2. Gifted Students' Perceptions of the Reasons Why Scientists Do Science

1. Why do scientists do science?

Answers	n
A. For information	8
B. To find the unknown	14
C. To acquire knowledge for the benefit of humanity	27
D. To understand nature	4
E. For financial gain	6

F. To fulfill a need	2
G. To improve the quality of life	2
Other	1

Table 2 analysis reveals that gifted students primarily pursue science to gain knowledge for the betterment of humanity (n = 27). Finding the unknown (n = 14), acquiring knowledge (n = 8), and making financial gains (n = 6) are the next steps. Some of the opinions of the gifted students who selected the Other option (those who selected choices other than A, B, C, and D) are as follows:

- *Scientists use science to improve life quality and fulfill a need* (S26).
- *Scientists use science to discover what they are curious about* (S27).
- *Scientists do science to make money* (S45).
- *Scientists use science to understand the events in the universe* (S54).
- *Scientists do science to learn the secrets of science and to be useful to humanity (S60).*

We asked the second question, "What is science?". Table 3 presents the obtained answers.

Table 3. Gifted Students' Perceptions of the Science Concept

2. What is science

Answers	n
A. To find the unknown	22
B. To understand nature and human beings	21
C. To obtain evidence	7
D. Data obtained as a result of research	2
E. It is a process of discovery.	3
F. Unlocking the Universe's Secrets	3
Other	2

Table 3 reveals that gifted students primarily define science as exploring the unknown (n = 22), comprehending nature and humans (n = 21), and gathering evidence (n = 7). The opinions of some of the gifted students who chose the Other option (those who chose options other than A, B, C) are as follows:

- *The term "science" refers to data obtained through research* (S2).
- *People benefit from discoveries and inventions* (S15).
- *Science investigates how everything in the universe works* (S19).
- *Science involves developing technology and solving the universe's secrets* (S51).
- *Science is about exploring nature, the world, and finding innovations* (S57).

Findings Related to the Perceptions of Gifted Students on the Structure of Scientific Knowledge

We first determined whether the thoughts of the scientist who discovered it affected the perceptions of gifted students about the structure of scientific knowledge **or not.** Table 4 presents this situation.

Table 4. Gifted Students' Perceptions of Whether the Thoughts of the Scientist Who Found It Influence Scientific Knowledge or not

3. Scientific knowledge is the discovery of the scientist;

Answers	n
A. Personal thoughts do not have an impact.	34
B. One's thoughts have an impact.	23
Other	3

Analyzing Table 4, we found that 34 of the gifted students believed the personal thoughts of the scientist who discovered it would not affect scientific knowledge, whereas 23 of the students believed the personal thoughts of the scientist would influence scientific knowledge. In this context, the opinions of the students in the Other option are as follows:

- *The thoughts of the scientist who discovered something can sometimes influence or not affect scientific knowledge* (S6).
- *A person's interests and curiosity influence scientific knowledge. However, we cannot fully measure this* (S11).
- *The person's knowledge either influences or does not affect the value of the scientist's knowledge and equipment* (S51).

Whether scientific knowledge would change over time or not was the second issue relating to gifted students' perceptions about the structure of science. Table 5 presents the opinions of gifted students within this scope.

Table 5. Perceptions of Gifted Students Regarding Whether Scientific Knowledge Will Change or not

4. Scientific knowledge found by scientists;

Answers	n
A. May change over time	52
B. Absolutely unchanged	4
Other	4

Analysis of Table 5 revealed that the majority of gifted students (n = 52) believed that scientific knowledge could evolve. In this context, it is noteworthy that four students think that scientific knowledge will never change. Additionally, we discussed the opinions of four students under the title "Other." These opinions are as follows:

- *It may change over time, but it remains the same as a pattern* (S11).

- *Depending on the situation, scientists' findings may or may not change* (S39).
- *Scientists find that scientific knowledge sometimes changes and sometimes does not change. It depends on knowledge* (S50).

The third question pertained to the perceptions of gifted students regarding the structure of scientific knowledge, specifically whether the number of scientists working on it would influence its structure or not. Table 6 presents the opinions of gifted students in this context.

Table 6. Gifted Students' Perceptions of Whether Scientific Knowledge Will Change Depending on the Number of Scientists Working on It or not

5. Scientific knowledge;

Answers	n
A. The more people working on it, the faster it may change.	40
B. The number of people working on it does not matter.	14
C. Because it is unchangeable, the number of people working on it has no impact.	4
Diğer	2

According to Table 6, the majority of gifted students think that scientific knowledge can change more quickly as more people work on it. However, it's noteworthy that 14 of the students expressed the belief that the number of people working on scientific knowledge would not affect its evolution. On the other hand, it's significant for the reliability of the findings that four students, who had previously stated that scientific knowledge would never change, now agreed with this statement. In this context, the gifted students who expressed their opinions in the Other option provided the following statements:

- *Scientific knowledge can change independently of the number of people working on it* (S18).
- *It depends on whether the people working on it change scientific knowledge or not* (S50).

The fourth issue pertains to gifted students' perceptions of the structure of scientific knowledge, specifically focusing on its foundation. Table 7 provides the opinions of gifted students in this context.

Table 7. Perceptions of Gifted Students on the Basis of Scientific Knowledge

6. Scientific knowledge ;

Answers	n
A. It emerges as a result of scientific observations.	38
B. The information is based on the knowledge of scientists.	1
C. Using the reasoning of scientific experts	5
D. It is based on scientific experience and logic.	10
Other	6

Analysis of Table 6 reveals that gifted students primarily believe that scientists' observations lead to the emergence of scientific knowledge (n = 38). In addition, it is noteworthy that 10 of the students stated that scientific knowledge is based on the experiences and logic of scientists, while 5 of the students think that scientific knowledge emerges only based on the logic of scientists. In this context, some of the gifted students who chose the Other option have the following opinions:

- *It is based on scientists' observations, experiences, and curiosity* (S2).
- *It is based on scientists' observations and logic* (S9).
- *It is based on scientists' observations and reasoning* (S16).

The fifth point pertains to the perceptions of gifted students regarding the structure of scientific knowledge and the methods scientists employ to create it. Table 7 provides the opinions of gifted students in this context.

Table 8. Gifted Students' Perceptions of the Paths Scientists Follow in Creating Scientific Knowledge

7. Scientists create scientific knowledge;

Answers	n
A. First conducts research, observation, and experimentation, and then hypothesizes.	6
B. Conducts research by making predictions and then making inferences.	12
C. Observation comes first, followed by research, experimentation, and hypothesis.	3
D. Observation, research, prediction, hypotheses, and experiments come first.	30
Other	9

Analysis of Table 7 reveals that more gifted students (n = 30) believe that observation, research, prediction, hypothesis, and experiment stages lead to the emergence of scientific knowledge. Those (n = 12) who believe that the stages of prediction, research, and inference form scientific knowledge come next. In this context, it is also noteworthy that gifted students preferred the answers (A = 6, C = 3) for the final establishment of the hypothesis. In this context, some of the students who preferred the other option expressed the following:

- *Ask questions, conduct research, formulate hypotheses, conduct experiments, and prepare reports and presentations* (S1).
- *The individual finds problems, makes observations, hypothesizes, conducts research, and conducts experiments* (S3).
- *Ask questions, conduct research, formulate hypotheses, conduct experiments, and prepare reports and presentations* (S26).
- *The researcher finds a problem, makes observations, hypothesizes, and conducts research and experiments* (S38).

- *The researcher identifies the problem, investigates, hypothesizes, and conducts experiments* (S60).

Sixthly, the effect of dreams on the perceptions of gifted students about the structure of scientific knowledge was discussed in the process of scientists creating scientific knowledge. Table 8 presents the opinions of gifted students on this issue.

Table 9. Perceptions of Gifted Students on the Effect of Imagination on Scientists' Creation of Scientific Knowledge

8. Scientists create scientific knowledge;

Answers	n
A. Their imagination is effective.	6
B. Because it has no place in science, imagination has no effect.	7
C. Their imagination and creativity are effective.	40
D. Their imagination and creativity are ineffective.	4
Other	3

Upon conducting an in-depth analysis of Table 8, it can be inferred that a substantial majority of the gifted students, comprising a sample size of 40, perceive imagination and creativity as vital components in the generation of scientific knowledge by scientists. It is also noteworthy that six of the students exclusively attributed scientific knowledge creation to imagination. In contrast, the responses of seven students who deemed their imagination to be ineffective and four of the students who believed that their imagination and creativity were both ineffective carry significant weight. Moreover, the gifted students who opted for the 'other' category expressed their views as follows:

- *Scientists' imagination, knowledge, creativity, determination and curiosity are effective* (S1).
- *Scientists' imagination, knowledge, creativity, determination and curiosity are effective* (S26).
- *Imagination is effective in some knowledge, but not in others* (S60).

Finally, we investigated gifted students' perceptions of the structure of scientific knowledge in terms of who benefits from it. Table 9 presents gifted students' perspectives on this issue.

Table 10. Perceptions of Gifted Students on Who Scientific Knowledge Is for

15. Scientific knowledge ;

Answers	n
A. For the people	2
B. Only for scientists	2
C. For both scientists and the public	56

Analysis of Table 9 reveals that the majority of gifted students (n = 56) believe that scientific knowledge is for both scientists and the public. In addition, some students think that scientific knowledge is only for the public (n = 2) and for scientists (n = 2).

Findings Related to the Perceptions of Gifted Students Regarding the Scientific Method

We first discussed the prerequisites for accepting scientific knowledge, as well as gifted students' perceptions of the scientific method. Table 10 presents gifted students' perspectives on this matter.

Table 11. Gifted Students' Perceptions of the Prerequisites for Scientific Knowledge Acceptance

9. For the acceptance of scientific knowledge;

Answers	n
A. Observational data must prove it.	10
B. Must incorporate experimentation and observation.	23
C. Does not necessarily involve experimentation and observation.	1
D. Experimental data must validate the claim.	24
Other	2

Analysis of Table 10 reveals that gifted students advocate for the acceptance of scientific knowledge based on experimental data (n = 24), experiment and observation (n = 23), and observation data (n = 10). However, one student noted that acceptance of scientific knowledge does not necessarily require experimentation and observation. Those who chose the "Other" option on this issue put forward the following:

- *If possible, it should include observation and experiment data. If not possible, it should be based on observation and logic* (S16).
- *We need to prove it in every way* (S20).

The second issue, which pertained to gifted students' perceptions of the scientific method, concerned the motivations behind scientists' experiments. Table 11 presents the perspectives of gifted students on this issue.

Table 12. Perceptions of Gifted Students on the Reasons Behind Scientists' Experiments

10. Scientists carry out experiments because;

Answers	n
A. They want to make new inventions.	4
B. They want to test their ideas.	15
C. They want to prove their ideas.	16
D. They want to find something to help people.	19
Other	6

Table 11 reveals that gifted students believe scientists conduct experiments to find solutions for people (n = 19), validate their ideas (n = 16), and test their ideas (n = 15). In addition, some gifted students think that scientists conduct experiments to make discoveries (n = 4). Those who chose the other option and expressed their opinions on the issue stated the following:

- *They want to meet their needs and improve their quality of life* (S1).
- *They want to be pioneers in development* (S10).
- *They want to earn money* S48).

The third issue, which pertains to gifted students' perceptions of the scientific method, concerns scientists' knowledge and prediction of results before experimentation. Table 12 presents the opinions of gifted students on this issue.

Table 13. Gifted Students' Perceptions of Scientists' Knowing and Predicting the Results Before Experimenting

11. Before scientists conduct experiments;

Answers	n
A. Understand their experiments' results.	0
B. They do not know the results of their experiments.	9
C. Forecast the results of their trials.	47
D. They do not predict the outcome of their experiments.	3
Other	1

Analysis of Table 12 reveals that the majority of gifted students (n = 47) believe scientists predict experiment results. Furthermore, gifted students expressed that scientists do not know the results of experiments (n = 9) and do not predict the results (n = 3). In this regard, one student who chose the other option stated the following:

- All of these can happen. It depends on the research type (T22).

The fourth question, which pertained to gifted students' perceptions of the scientific method, inquired whether the opinions of scientists influenced the experiment results. Table 13 presents the opinions of gifted students on this issue.

Table 14. Gifted Students' Perceptions of Whether Scientists' Ideas Influence the Results of Experiments

12. Experiment results from scientists' opinions;

Answers	n
A. Affected	28
B. Unaffected	28
Other	4

Examining Table 13, it becomes clear that gifted students disagree on whether scientific ideas influence experiment results. In this regard, 28 of the students believed that the ideas of scientists influenced the experiment results, whereas another 28 of the students held the opposite opinion. In addition, four students chose the Other option and expressed their opinions on this issue. We can list some of these opinions below:

- *It may differ depending on the scientist's attitude (S4).*
- *Sometimes it is affected, and sometimes it is not (S20).*
- *Sometimes it is affected, and sometimes it is not (S50).*

Fifthly, we examined the reasons for the shift in gifted students' perceptions of the scientific method. Table 14 presents the opinions of gifted students on this subject.

Table 15. Gifted Students' Perceptions of the Reasons Behind the Change of Some Theories

13. Some theories in science can change because

Answers	n
A. We now have more advanced technology.	24
B. Scientists can make mistakes.	12
C. Scientists are now applying different methods.	10
D. We can obtain additional evidence.	10
Other	4

An analysis of Table 14 reveals that gifted students primarily attribute changes in science theories to the use of more advanced technology (n = 24). Additionally, some students expressed the belief that scientists can make mistakes (n = 12), apply different methods (n = 10), and obtain more evidence (n = 10). Below is a list of some of the opinions expressed by those who selected the other option:

- *Technology has developed, and scientists can also make mistakes* (S1).
- *Theories can become obsolete over time* (S7).
- *Theories can't be changed (S*43).

Finally, we examined gifted students' perceptions of the scientific method and how they would behave if scientists had to choose between two theories. Table 15 presents the views of gifted students on this issue.

Table 16. Perceptions of Gifted Students on How Scientists Would Behaving If They Had to Choose One of Two Theories

14. When scientists have to choose between two theories,

Answers	n
A. They choose what is closer to the truth.	29
B. They choose what is more useful in daily life.	13
C. They select the option that receives the most acceptance from scientists.	7
D. They choose the one with more advanced technology.	4
Other	7

Upon analyzing Table 15, we find that the majority of gifted students (n = 29) expressed their preference for the theory that is closer to the truth. This is followed by students who stated that they would choose the one that is more useful in daily life (n = 13), the one accepted by more scientists (n = 7), and the one that involves more advanced technology (n = 4). The opinions of some of the gifted students who preferred the **O**ther option are as follows:

- *They choose what they have reached as a result of their experiments and observations* (S26).
- *They do not select both. They do research again* (S44).
- *They should choose the safest one* (S45).

Discussion

When the perceptions of gifted students about science are analyzed, it is determined that the majority of the students think that scientists do science to obtain information for the benefit of humanity and to find the unknown. On the other hand, it was determined that gifted students defined science as finding the unknown and understanding nature and human beings. These findings reveal that gifted students have a realistic view of the nature of science. These findings are in line with the results of the study conducted by Muşlu (2008). However, the view that scientists do science to earn money is not considered valid in terms of the nature of science.

We first discussed whether the thoughts of the scientist who discovered scientific knowledge influence it within the context of the research and gifted students' perceptions about its structure. In this regard, the majority of gifted students (n = 34) believe that the thoughts of the scientists who discovered it do not influence scientific knowledge. However, the number of gifted students who think in the opposite direction is also quite high (n = 23). In the literature, studies conducted by Lederman (1992) and Bell and Lederman (2003) demonstrated that the thoughts of the scientist who discovered something can influence scientific knowledge. In this regard, Ryan and Aikenhead (1992) stated that certain characteristics of scientists (gender, age, education, experience, beliefs, disciplines they are affiliated with, etc.) have an impact on their studies. Therefore, the majority of gifted students lack a perspective that aligns with the nature of science.

Second, we examined whether scientific knowledge can change over time within the scope of gifted students' perceptions of the structure of scientific knowledge. This examination determined that the majority of gifted students held the opinion that scientific knowledge can change over time. According to Popper (1963), who stated that scientific knowledge is reliable and valid for a long time, this situation is not completely true or certain. All kinds of laws, theories, and hypotheses accepted as scientific are open to change (Çelik, 2009; Renn, 2020).

Thirdly, the study examined how gifted students perceive the structure of scientific knowledge and whether the number of scientists working on it can influence its evolution. The research revealed that the majority of gifted students (n = 41) believed that the more people work on scientific knowledge, the faster it can change. We can accept this finding as a correct view, given the nature of science. This finding aligns with the findings of Muşlu's (2008) study.

The fourth issue pertains to gifted students' perceptions of the structure and basis of scientific knowledge. The research reveals that gifted students primarily believe that scientists' observations lead to the emergence of scientific knowledge (n = 38). Examining the assumptions about the nature of science emphasizes the importance of observation in the development of scientific knowledge, but also highlights the effectiveness of creativity and imagination in this process (Bell, 2009; Lederman, 2010). In this context, it is considered necessary for the scientist to use inference skills as well as observation in the production process of scientific knowledge (Abd-El-Khalick et al., 2001). These explanations lead to the conclusion that most gifted students approach scientific knowledge from an empirical perspective.

Fifthly, the research addressed gifted students' perceptions about the structure of scientific knowledge and how scientists create it. The research reveals that more gifted students (n = 30) believe that observation, research, prediction, hypothesis, and experiment stages lead to the emergence of scientific knowledge. Furthermore, it is noteworthy that some students assert that different methods contribute to the formation of scientific knowledge. In this regard, Abd-El-Khalick et al. (2001) state that there are various ways that scientists use the process of producing scientific knowledge. Due to this situation, scientists do not have an obligation to carry out scientific activities by following a certain order (Muğaloğlu, 2006). In this context, students' gathering around different views can be considered as a situation that should exist in terms of the nature of science.

Sixth, we examined how imagination affects gifted students' perceptions of the structure of scientific knowledge. The study revealed that most gifted students (n = 40) believed that scientists used imagination and creativity effectively to create scientific knowledge. This finding is in line with the results of the studies conducted by Liu and Liberman (2002) and Muşlu (2008). On the other hand, this finding is consistent with the nature of science's assumptions. To address this issue, Irez and Turgut (2008) state that scientists use imagination and creativity in their studies.

Finally, we analyzed gifted students' perceptions of the structure of scientific knowledge in terms of who should benefit from it. The study revealed that most gifted students (n = 56) believed that scientific knowledge should benefit both scientists and the public. This finding aligns with the findings of Muşlu's (2008) study.

The objective of the current research was to investigate the conditions necessary for gifted students to embrace scientific knowledge related to their understanding of the scientific method. The study revealed that gifted students demonstrated a strong preference for experimental data (n = 24) as a means of supporting scientific knowledge. Additionally, the majority of participants (n = 23) highlighted the importance of including experimentation and observation as an intrinsic component of scientific inquiry. Furthermore, a smaller group of participants (n = 10) believed that observational data played a critical role in validating scientific knowledge. These findings suggest that gifted students place significant importance on the integration of experimentation and observation methods in the pursuit of scientific inquiry. This result can be considered realistic in terms of science's nature. Popper (1979) stated that scientific knowledge should be verifiable or falsifiable and revealed the nature of science's approach to this issue. According to the literature, experiments and observations have an important place in the production of scientific knowledge (Erçetin & Görgülü, 2018). Alexander et al. (2012) emphasize the significance of experiments and observations in learning about and becoming interested in science.

Second, the discussion focused on gifted students' perceptions of the scientific method and the motivations behind scientists' experiments. The research revealed that gifted students attribute scientists' experiments to their desire to find solutions, validate their theories, and test their hypotheses. This discovery reveals scientists' motivational sources. Therefore, we can assert that "scientists who conduct experiments find motivation in helping people and in testing and proving their ideas." Venville et al. (2013) also advanced this assumption in their research. This research identified scientists' passion for knowledge and science and revealed that these are the most important sources of motivation.

Thirdly, we analyzed gifted students' perceptions of the scientific method, specifically their belief that scientists know and predict experiment results before conducting them. The study revealed that most gifted students believed scientists predict experiment results. Solomon et al. (1996) conducted a study that yielded similar results. In this study, more than half of the participants claimed that scientists make predictions about the results of experiments.

The fourth question, which pertained to gifted students' perceptions of the scientific method, inquired whether the ideas of scientists influenced the experiment results or not. The research revealed that gifted students held varying opinions regarding the influence of scientists' ideas on experiment results. In this regard, 28 of the students believed that the ideas of scientists influenced the results of experiments, whereas 28 of the students held the opposite opinion. Examining this situation through the lens of science reveals that scientists' approaches shape scientific knowledge. In particular, the creativity and imagination of scientists are considered important factors here (Lederman et al., 2002). Scientists direct their work with creativity and imagination in all processes of scientific knowledge production (Akerson & Donnelly, 2010). In this context, we can consider the view that scientists' ideas influence scientific knowledge as a more accurate approach to understanding the nature of science.

In the study, the reasons behind the change of some theories were examined as the fifth reason related to the perceptions of gifted students about the scientific method. The research revealed that gifted students primarily attributed the change in some scientific theories to the availability of more advanced technology. In addition, some students stated that scientists can make mistakes, that researchers now apply different methods, and that more evidence can be obtained. As knowledge in a field advances, new insights and evidence may require changes to existing theories to better align with empirical data and observations (Spirtes et al., 1993). On the other hand, practical considerations, such as the application of theories in real-world scenarios, may lead to changes to improve the utility and effectiveness of theoretical frameworks (Wiland, 2002). This suggests that technological developments, in particular, may lead to changes in some theories and the use of different methods.

Finally, the study analyzed gifted students' perceptions of the scientific method and how they would respond if faced with a choice between two theories. The study revealed that gifted students typically choose the theory closer to the truth when faced with a choice between two theories. Students followed suit, stating that they would opt for the theory that is more practical in daily life, widely accepted by scientists, and incorporates advanced technology. Given the nature of science, selecting the correct theory among the two would be a more accurate approach. On the other hand, since science serves the purpose of facilitating people's lives and is fed by technological developments, it is thought that gifted students choose these criteria in theory selection. However, this view is also acceptable in terms of the nature of science, given that the general acceptance of authorities shapes scientific knowledge (Muşlu, 2008).

The present study endeavors to evaluate the Nature of Science (NOS) among gifted students, and the findings reveal that these students tend to express opinions that align with the NOS. However, it is noteworthy that gifted students also present views that contradict the nature of science, particularly on scientific knowledge, which can be influenced by the views of scientists and the basis of scientific knowledge. Consequently, experts believe that it is imperative to introduce various activities aimed at enhancing the students' assessment of the NOS. Nevertheless, given that the study is limited to the study group, additional studies on NOS evaluations of gifted students are warranted. Studies conducted on different samples could examine the NOS evaluations of gifted students, thereby boosting their transferability.

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