

## SECONDARY SCHOOL STUDENTS' PERCEPTIONS ABOUT SCIENTIST: METAPHORICAL ANALYSIS

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### Abstract

*The current study aimed to examine secondary school student's perceptions about scientists using metaphors. A total of 220 students from 6<sup>th</sup> and 8<sup>th</sup> grades of a secondary school in one of the central districts of Ankara province participated in the study. All students attending the specified classes took part in the study, therefore no sampling was required. The study was conducted in the fall semester of 2012-2013 academic year. Metaphor technique was utilized in the study to identify student perceptions regarding scientists and students were asked to fill in the blanks provided in the following sentence: "A scientist is like a.....because.....". Data obtained from the study were coded by three coders and inter-rater reliability was found to be 0,94, 0,95 and 0,97. At the end of the study a conceptual framework composed of 3 main categories, 6 sub categories and 23 codes representing student perceptions was obtained. Conceptual framework pointed to the fact that student perceptions regarding scientists had a highly complex structure. The conceptual framework is expected to direct future studies in the field in analyzing and interpreting student perceptions. Based on the findings, it is identified that metaphors can be used as alternative data collection tools in identifying student perceptions of scientists.*

**Key Words:** Science Education, Metaphors, Perception of Scientist.

## ORTAOKUL ÖĞRENCİLERİNİN BİLİM İNSANI ALGILARI: METAFORİK ANALİZ

### Özet

*Bu çalışmanın amacı ortaokul öğrencilerinin bilim insanı algılarını incelemektir. Araştırmaya Ankara'da bir ortaokulda öğrenim gören 220 altı ve sekizinci sınıf öğrencisi katılmıştır. Okulda öğrenim gören tüm altı ve sekizinci sınıfta öğrenim gören öğrenciler araştırma kapsamına alınmıştır. Araştırmada uygulama 2012-2013 öğretim yılında yapılmıştır. Uygulamada öğrencilerin bilim insanına yönelik algılarını belirlemek için metaphor tekniği kullanılmıştır. Bu kapsamda öğrencilerin "Bilim insanı ..... gibidir. Çünkü....." ifadesindeki boşlukları doldurarak bilim insanı kavramını mecazlayarak açıklamaları istenmiştir. Uygulama sonucu elde edilen veriler üç kodlayıcı tarafından ayrı ayrı kodlanmıştır. Kodlayıcıların verdiği kodların 94%, 95% ve 97% oranında tutarlı olduğu görülmüştür. Araştırma sonucunda öğrencilerin bilim insanına yönelik algılarının 3 temel kategori, 6 alt kategori ve 23 kod altında toplandığı bulunmuştur. Bu çerçevede öğrencilerin bilim insanına yönelik algılarının çok kompleks olduğu ve metaphor tekniğinin bu alanda alternatif bir veri toplama aracı olabileceği sonucuna ulaşılmıştır.*

**Anahtar Kelimeler:** Fen Eğitimi, Metaforlar, Bilim İnsanı Algısı.

## Giriş

Development of scientific activities and rate of sharing their results with the others has increased along with the advances in technology. Today, science can reach the farthest corners of the world and individuals from many different cultures can present their scientific activities. This fact leads to positions in which various scientific truths can be expressed and individuals need to use decision making skills. Scientists are not independent of this process because at the end of the decision making process individuals classify scientists as “the ones who tell the truth and the ones who don’t”. As a result, based on the framework of the positivist philosophy; there are distortions in individuals’ beliefs about the image of scientists as “individuals who tell the truth” (Lederman, 1999). These distortions first started in countries that are advanced in the fields of science and technology. For instance, while the image of scientists as altruistic and notable individuals who strive to serve their developed or developing countries is dominant in Sjøberg’s (2002) study, in highly developed countries the mad scientist image is observed which portrays scientists as individuals who conduct studies to harm humanity or the environment. Various studies in literature (Flick, 1990; Boylan, Hill, Wallace and Wheeler, 1992) suggest that these types of negative perceptions negatively affect tendencies for future careers in science. Therefore, studies are needed in order to effectively interpret individuals’ perceptions about scientists and to support the positive development of these perceptions so that the future of scientific endeavors can be established on strong foundations in undeveloped or developing countries like Turkey.

### ***Measuring Students’ Perceptions About Scientist***

The first study regarding the identification of perceptions about scientists was conducted by Mead and Metraux (1957). Researchers asked 35.000 high school students to write about scientists. Research results showed that individuals defined scientists in general in the following statements identified as stereotypes by the researchers:

*The scientist is a man who wears a white coat and works in a laboratory. He is elderly or middle aged and wears glasses . . . he may wear a beard. . . he is surrounded by equipment: test tubes, bunsen burners, flasks and bottles, a jungle gym of blown glass tubes and weird machines with dials . . . he writes neatly in black notebooks . . . One day he may straighten up and shout: “I’ve found it! I’ve found it!”. . . Through his work people will have new and better products. . . he has to keep dangerous secrets . . . his work may be dangerous . . . he is always reading a book (p. 386).*

Dorkins (1977) who utilized the same data collection tool as Mead and Metraux (1957) asserted that 1200 college students perceived scientists as cold and mysterious individuals who lived in their own worlds.

Studies to identify perceptions about scientists that started with Mead and Metraux's (1957) research can be examined in two generations as regards to the data collection tools used in the studies. Some of the studies conducted in the first generation used Likert type conceptual differences or classification scales, some used "Draw-A-Scientist-Test (DAST)", some used interviews, whereas others utilized questionnaires composed of open-ended questions and some preferred word association tests (WAT). It is notable that studies in this generation used a single data collection tool to identify individuals' perceptions about scientists. The dimension defined below of studies is presented at Figure 1 (p...).

#### ***Studies Using Single Data Collection Tool to Examine Students' Perceptions About Scientist***

Likert type scales or classification scales were used in the first group studies (Beardslee and O'dowd, 1961; Krajcovich and Smith, 1982). The first study in this group was undertaken by Beardslee and O'dowd (1961) using conceptual differences scale. Beardslee and O'dowd (1961) asserted that college students perceived scientists as smart, hardworking and asocial in general. This study was followed by Krajcovich and Smith's (1982) study which utilized a Likert type scale. In these studies, stereotypical perceptions of individuals about scientists found in literature were written in the format of scale items and Likert, conceptual differences or classification type scales were developed. Therefore, results of the studies usually supported the findings in the literature about the stereotypical perceptions about scientists. Examination of study results show that these scales did not allow the presentation of perceptions previously unidentified in the literature. Data obtained from these scales only suggest that individuals' perceptions about scientists are at the stereotypical level.

Perceptions about scientists were assessed with the help of questionnaires composed of open-ended questions in another group of studies undertaken in the first generation (Rampal, 1992; Petkova and Boyadjieva, 1994; Ruão, Neves, Botelho and Nogueira, 2012). Petkova and Boyadjieva (1994) identified that students perceived scientists as smart, hardworking, noble, outspoken, objective, able to make independent decisions, honest and faithful to science. Rampal (1992) found that teachers thought of scientists as males who were smart, generally absent-minded, unemotional and antisocial, with white coat, wearing glasses and no hair. Ruão et al. (2012) found that the majority of students emphasized in their image of scientists the following conceptual categories "Scientists develop interesting activities", "Scientists invent new things" and "Scientists help people".

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Another group of students emphasized the following conceptual categories “Scientists make a lot of money”, “Scientist have boring jobs” and “Scientists spend much time in library”.

Individuals’ image of scientist was identified with the help of interview technique in the third group of the first generation studies (Palmer, 1997; Parsons, 1997; Guler and Akman, 2006). As a result of interviews with 20 African American students, Parsons (1997) found that students perceived scientists as individuals who are industrious, dedicated to work, intelligent and lonely. Guler and Akman (2006) identified that 6 year old students perceived scientists as individuals working in closed spaces full of books and lab tools and who have lab coats, glasses, mustachios and disheveled hair.

WAT was used in another group of the first generation studies (Bovina and Dragul'skaia, 2008; Dikmenli, 2010) to identify student conceptualization of scientists. Bovina and Dragul'skaia (2008) conducted the first study in this group. In the study, humanities students defined scientists by reference to high mental abilities, competence, social status and social recognition. Natural sciences students referred to the scientist’s competence, special abilities (talents), absorption in scientific activity and their social status. Only four elements of the nuclei of the representations coincided: intelligent, educated, old, and intellectual. Dikmenli (2010) asserted that biology teachers’ perceptions about scientists were classified under six conceptual categories. The first conceptual category was defined as scientists’ personal characteristics and it was observed that teacher candidates emphasized this category the most. The majority of teachers who emphasized this category focused on positive images of scientists as intelligent, curious, industrious, objective and able to produce thought. Some of the teacher candidates emphasized negative characteristics of scientists as workaholic, thoughtless, asocial, mad and selfish. The second conceptual category was defined as the activities of scientists by the researchers. The majority of teacher candidates that focused on this category emphasized key terms such as discovery, observation, research and service to society whereas a small number of teacher candidates emphasized doing experiments, producing technology and working on science. Researchers identified the third category as the names of scientists, the fourth category as the scientists’ work environment and the fifth category as the technological advances. The last category is scientists’ physical appearance. Teacher candidates who focused on this category presented their image of scientists as elderly and bald individuals who wear glasses and lab coats. In the light of these findings, it is stated that conceptualizations of teacher candidates from Dikmen about scientists are rather limited and superficial.

In another group of studies in the first generation (Chambers, 1983; Rosenthal, 1993; She, 1995; Finson, Beaver and Cramond, 1995; Fung, 2002) “Draw

A Scientist Test (DAST)" was used to identify individuals' image of scientists. Studies in this group constitute the largest part of the research undertaken to identify individuals' image of scientists. The first study in this group was done by Chambers (1983). Chambers (1983), who reasoned that it would be difficult to express perceptions with written expression technique, created DAST. The researcher also prepared a control list to ensure the analysis of the data obtained from DAST. In his study, Chambers (1983) described the scientist images of 4807 primary school students (preschool-5th grade) from their drawings. Research results showed that in general, students perceived scientists as males with beards or mustaches who wear lab coats and glasses, use technological devices and work alone in environments equipped with chemical substances and tools and adorned with knowledge symbols such as books and libraries. Finson et al. (1995) extended the content of the control list developed by Chambers (1983) is presented that DAST-C. Researchers aimed to make statistical analyses by scoring the dimensions regarding students' drawings of scientists with the extended control list. The control list included many stereotypical characteristics of scientists such as gender, work environment, mythical images, danger or privacy marks and lab work.

Various negative viewpoints were voiced at the end of late '80s about the reliability of data obtained from DAST. These views can be examined under two headings: DAST instructions and the fact that DAST directs students to draw a single scientist. Maoldomhnaigh and Hunt (1988) and Farland and McComas (2006) proposed that students should be asked to draw more than one scientist in order to increase reliability of data obtained from DAST. Maoldomhnaigh and Hunt (1988) stated that different results may be obtained when DAST is implemented in different time frames since meanings attached to the image of scientists can differ for students when DAST is implemented at different times. Farland and McComas (2006) conducted DAST three times to identify student images on scientists and defined their technique as extended DAST (E-DAST). According to researchers, the reason for reapplication is to increase reliability of data obtained from DAST.

Symington and Spurling (1990) and Maoldomhnaigh and Mhaolain (1990) proposed changing the presentation of DAST instructions to increase data reliability. Symington and Spurling (1990) presented DAST-R (Draw-A-Scientist-Test-Revised) approach. The most important difference of this approach from the general DAST applications is the way of presenting the expectations from the drawing. Researchers used the following revised prompt when they asked students to draw about scientists: "Do a drawing which tells what you know about scientists and their work". Researches stated that there were differences between data obtained from both approaches when they compared DAST and DAST-R applications.

***Studies Using More Than One Data Collection Tool to Examine Students' Perceptions About Scientist***

In this group, several of the following techniques (DAST, open-ended questionnaires, Likert type scales and interview techniques) were used to identify individuals' conceptualizations and visual images of scientists. The instruction for DAST in this generation was changed to "draw a scientist who is working".

In their studies Mason, Kahle and Gardner (1991), Jackson (1992), Boylan et al. (1992), Monhart (2003) and Samaras, Bonoti and Christidou (2012) used DAST and interview techniques to identify students' image of scientists. Results shows that in general students perceived scientists as white males with glasses and lab coats working in laboratories surrounded with lab materials such as Bunsen burners and volumetric flasks. Results of studies undertaken by Mason et al. (1991) and Monhardt (2003) showed differences from this tendency. It was found by Mason et al. (1991) that the majority of high school students perceived scientists as bad characters taking part in violent activities and another group of students were found to perceive scientists as individuals with weird appearances. Monhardt (2003) found that instead of perceiving scientists as individuals with glasses and lab coats working in laboratories, students drew them as individuals working in natural environments about animals, food and nature. Jackson (1992) and Boylan et al. (1992) suggested that interview technique provided more efficient data compared to DAST. Samaras et al. (2012) extended this statement and found that results obtained from DAST and interviews were different and the results obtained from interviews about the personality of scientists and their work were complex than the results obtained from DAST. Based on research findings, researchers suggested that DAST provided data only about the appearances of the scientists and their work environments whereas interviews presented the understanding about scientists in the students' conceptual frameworks.

Bowtell (1996), Scherz and Oren (2006) and Koren and Bar (2009) used DAST and an open-ended questionnaire to determine students' image of scientists and interviewed students about their drawings. Research identified that students generally drew male scientists who worked with chemical substances and materials. Bowtell (1996) stated that students whom participated in the study had negative and stereotypical scientist images and that negative elements increased as level of education increased. Different from Bowtell's (1996) findings, Koren and Bar (2009) found that Arabic speaking students drew Islamic scientists due to their different ethnic origins. Students who spoke Hebrew perceived scientists as individuals helping humanity whereas students who spoke Arabic perceived scientists as prestigious persons, who made discoveries, helped their own community and earned money.

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Barman, Ostlund, Gatto and Halferty (1997), Rodari (2007) and Akcay (2011) implemented DAST to identify students' scientist perceptions and later asked the students to write the scientist in their drawings. Similar to previous results, research results showed that students perceived scientists as male with lab coats working alone in laboratory etc. Akcay (2011) identified that students perceive scientists as objective, independent, hardworking, determined, intelligent and curious persons with large brain power, who help society and humanity, create objects and make discoveries, know about everything and can make mistakes. When student perceptions were compared in the study, it was found that high school students' perceptions regarding scientists were more positive. It was identified that compared to primary school students, high school students emphasized the curiosity, determination, industriousness, objectivity, independence, openness to criticism characteristics of scientists as well as their thinking abilities and possibility of their making errors.

In their study, Farland (2003) and Milford and Tippett (2013) examined students' perception of scientists by using DAST and a questionnaire composed of open-ended questions. Research results showed that the majority of students perceived scientists as bald and elderly men with glasses. Analysis of data obtained from open-ended questions showed that students perceived scientists as intelligent, curious, industrious, productive, inventor, researcher, expert, patient, determined, happy, successful, self-confident individuals who enlighten people with their work, make their lives easier, work according to plans and programs and have titles and fame.

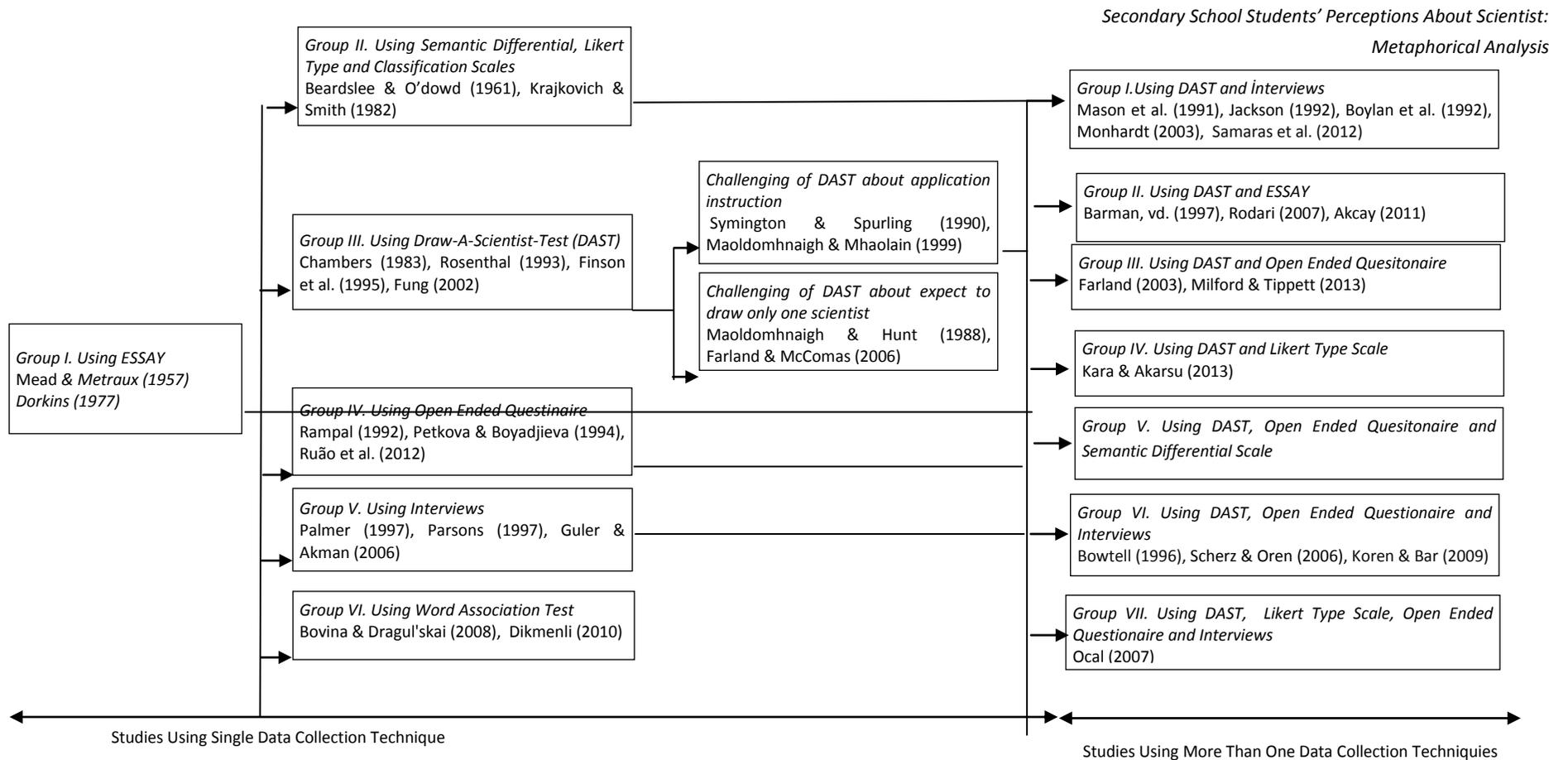
In their study Song and Kim (1999) and Demirbas (2009) examined the image of scientists held by students by using DAST, conceptual differences scale and a questionnaire composed of open-ended questions. It was found that the most emphasized characteristics of scientists were industriousness, creativeness and attentiveness. Related to student perception of scientists, teacher candidates generally perceived scientists as middle aged males with glasses and lab coats who work in the laboratory, do experiments, think or do research alone. Song and Kim (1999) found that students were affected by scientists' cognitions and high IQ levels rather than their affective or ethical characteristics. Researchers also identified that age and gender affect individuals' image of scientists.

Ocal (2007) investigated student views about scientists by implementing DAST, a Likert type scale and another questionnaire composed of open-ended questions along with interviews. Study results presented that students in general perceived scientists as persons with glasses and lab coats who worked in a laboratory. It was also identified that students believed scientists undertook activities for the benefit of society, were creative and produced knowledge.

Kara and Akarsu (2013) researched the ideas of primary level students about scientists by utilizing DAST and a Likert type scale. Research results showed that

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students had clichés about scientists such as: male, wears glasses and lab coats, workaholic and dedicated to work. It was also found that students believed scientists strived to develop scientific knowledge and worked for the benefit of humanity.



### ***The Importance of the Current Study in Literature***

As Figure 1 shows, the first study conducted by Mead and Meatraux (1957) on identification of perceptions about scientists in the literature depicted individuals' scientist images with qualitative research techniques. Likert type, Semantic Differential and Classification Scales and DAST were developed in studies undertaken until the late '80s based on the findings of previous studies. These studies examined the level of stereotypical perceptions about scientists in the framework of quantitative data obtained from scales and DAST and based on variables such as gender and level of education.

At the end of the '80s, researches preferred interviews, open-ended questionnaires and WAT methods with the increase of the effects of qualitative research techniques in the scientific world. Regardless of the differentiation between qualitative and quantitative, these studies undertaken to identify individuals' perceptions about scientists by using a single techniques such as essays, WAT, interviews and DAST were defined as first generation studies.

Beginning of discussions in late '80s and early '90s towards the reliability of data obtained from DAST and presentation of perceptions identified as stereotypes in the studies since 1957 directed researchers to implement different data collection tools together. It is noted that several of the following techniques were together used in these group of studies called the second generation: semantic differential, classification and Likert Type Scales, essay, open ended questionnaire, interviews and DAST. Student perceptions about scientists and the effect of variables such as culture, gender, level of education, socio-economic level on these perceptions have been examined in recent years based on qualitative and quantitative data obtained from various data collection tools. However, the obtained results are still similar to those of previous studies.

The main reason for obtaining similar results may be related to the use of techniques in the field such as semantic differential, classification and Likert type Scales, essay, interviews, open ended questionnaires and DAST. A different approach in the field was presented by Bovina and Dragul'skaia (2008) and Dikmenli (2010) who used WAT as data collection tool. Therefore, the question "whether different dimensions of individual perceptions about scientists can be obtained with the use of different data collection tools" should be addressed. In this context, the current study based on metaphor method as a different method from the studies in literature basically sought to answer the following question: What are secondary school students' perceptions about scientists?. In other words, secondary school students' perceptions about scientists will be examined by using the metaphor method. The negative and positive aspects of participating secondary school students' perceptions about scientists will be discussed based on the obtained description. In this sense, the current study is expected to generate a framework towards interpreting secondary school students' perceptions about scientists and enlighten the way to find what can be done to positively develop

these perceptions. The study will also be instrumental in making decisions about the usability of metaphors as alternative methods in identification of perceptions about scientists. In this context, the study is expected to direct future studies in the field.

### **Methods**

Current study undertaken to identify secondary school 6<sup>th</sup> and 8<sup>th</sup> graders' perceptions about scientists was based on phenomenological research approach which is one of the qualitative research techniques (Creswell, 2013). According to Creswell (2013), the common meaning of a "lived experience" of a phenomenon or a concept experienced by a group of individuals is described in phenomenological research approach. The main aim of phenomenological research is to reduce individual experiences about a phenomenon or concept to explanations of universal quality. In other words, the aim is to understand the nature of objects or concepts. Researchers in phenomenological studies collect data about individuals' experiences regarding a phenomenon or a concept and present a holistic description that summarizes the essence of all individuals' experiences (Creswell, 2013). Based on this outlook, current study aimed to define 6<sup>th</sup> and 8<sup>th</sup> graders' perceptions about scientists with the use of phenomenological research approach.

### **Participants**

A total of 191 students attending 6<sup>th</sup> and 8<sup>th</sup> grades of a secondary school in the province of Ankara participated in the study in 2012-2013 academic year. In the study purposeful sampling strategy was used in participant selection process (Creswell, 2013). The mission of constructing perceptions towards science and scientists in Turkey has always been in the realm of science lessons. Science classes are provided starting in the 3<sup>rd</sup> grade. Science classes are taught by the classroom teachers in primary school 3<sup>rd</sup> and 4<sup>th</sup> grades and by Science and Technology branch teachers in 5<sup>th</sup>-8<sup>th</sup> grades. Chambers (1983) asserted that cliché images about scientists are formed by 5<sup>th</sup> grade. The study consisted of secondary school 6<sup>th</sup> and 8<sup>th</sup> grade students since science lessons are taught by branch teachers through 5<sup>th</sup> grade to 8<sup>th</sup> grades and cliché images about scientists are already formed by Grade 5. All students attending 6<sup>th</sup> and 8<sup>th</sup> grades participated in the study. 12 students were left out of the analysis unit since the metaphoric structures they used were not suitable and they left blanks spaces. Therefore, data from 179 (6<sup>th</sup> grade=78, 8<sup>th</sup> grade=101) students were analyzed. Table 1 presents the distribution of students according to gender and class.

**Table 1.** Frequencies and percentage distributions of participants' gender and grade

Grade	Male		Female		Total	
	F	%	f	%	f	%
6 <sup>th</sup>	49	25,1	44	23,0	92	48,1
8 <sup>th</sup>	47	24,6	52	27,3	99	51,9
<b>Total</b>	<b>95</b>	<b>49,7</b>	<b>96</b>	<b>50,3</b>	<b>191</b>	<b>100</b>

### ***Instruments***

Metaphor technique was used in the current study to identify student perceptions about scientists. Until 1980 Metaphors are generally perceived as a linguistic analogy approach used in the literature and the concept of metaphor is dealt within literature and linguistic studies to be considered as the art of speech. Especially the concept of metaphor has gained a different dimension especially with a "Contemporary Theory of Metaphor" put forward by Lakoff and Johnson (1980). Lakoff (1993) asserted that metaphor is not a tool to provide make sense of concept through the poetic and storical way. According to Lakoff, metaphors exhibit individuals' thoughts relevant to target concept. Cerit (2006) states that metaphors are tools used by human beings in describing how they see life, environment, events and objects by using different similes. Group (2007) and Schmitt (2005) explained metaphor and its administrations in educational studies. In this sense, metaphor technique has been used in various studies in the field of educational sciences for many years to present the transformations in classrooms, to examine the beliefs that are formed and to increase awareness about theoretical assumptions (Guerrero and Villamil, 2002). Metaphors have been used in various studies (Adıguzel, 2009; Balcı, 1999; Cerit, 2006; Guner, 2013; Becerikli, 1999) in literature to identify perceptions of stakeholders about various teaching methods, concept of inspectors, guidance teachers, science and technology teachers, educational technologies etc. In this study, metaphors were presented to the students in the following format consistent with this category: "A scientist is like a.....because.....".

### ***Data Analysis***

In the current study, metaphors formed by secondary school students about the concept of scientists were analyzed by using the model proposed by Miles and Huberman (1994). Process of analysis in this model is composed of three basic components which are data reduction, data display and drawing conclusions. According to Miles and Huberman, data reduction starts with removal of inappropriate and invalid data from the data set and continues until the end of the analysis process. Main purpose of this component is to reduce data without losing crucial information. Themes,

clusters and patterns are identified and noted towards the midpoint of analysis process. The second component is implemented simultaneously while the coding is ongoing in the first process. The second component includes the display of data with various tools such as concept tree, Venn diagram and graphics. (Miles and Huberman, 1994). Results are interpreted and their reliability is tested in the last component (Miles and Huberman, 1994). In line with this process, current study first reviewed the metaphors to sort out data not suitable for metaphorical structures or left blank. In the second phase, data were coded by taking into consideration the identified codes and categories about scientists in literature. Students were given the codes in  $S_{order}$ . In the third phase, the categories were defined according to student statements and relational patterns between categories and codes were identified. Reliability and validity were reviewed in the fourth phase. For reliability, consistency of codes assigned by coders was investigated. Codes assigned by three separate coders were evaluated by an expert in the field. The evaluation showed that in the data set of 179, 11 of the codes assigned by coder one and two, 8 of the codes assigned by coder one and three and 5 of the codes assigned by coder two and three were different from one another. An approach defined by Miles and Huberman (1994) was used to calculate consistency in coding. In this approach, consistency is calculated by using the following formula:  $\text{agreement between coders} = \frac{\text{number of agreed codes}}{\text{number of agreed codes} + \text{number of disagreed codes}}$ . Consistency coefficient between the first and the second coders in the current study was found to be  $r = \frac{168}{168+11} = 0,94$ . Consistency coefficient between the first and the third coders was  $r = \frac{171}{171+8} = 0,95$  and between the second and the third coders was calculated to be  $r = \frac{174}{173+5} = 0,97$ . According to Miles and Huberman (1994), study results are reliable when consistency is 90% or above.

### **Findings**

Study results showed that participants generated 179 valid metaphors about scientists. It was identified that participants defined scientists in their metaphors by using 80 different concepts. Examination of these concepts in terms of frequency of use in metaphors indicate that students used the concepts of the sun ( $f=17, \%9,5$ ), teacher ( $f=14, \%7,8$ ), computer ( $f=12, \%6,7$ ), book ( $f=12, \%6,7$ ), lamp ( $f=8, \%4,5$ ), brain ( $f=7, \%3,9$ ), library ( $f=6, \%3,4$ ), ant ( $f=5, \%2,8$ ), light ( $f=4, \%2,2$ ) and machine ( $f=4, \%2,2$ ) the most. Figure 2 presents the frequencies and percentage distributions of the categories obtained as a result of the analysis of metaphors about scientists.

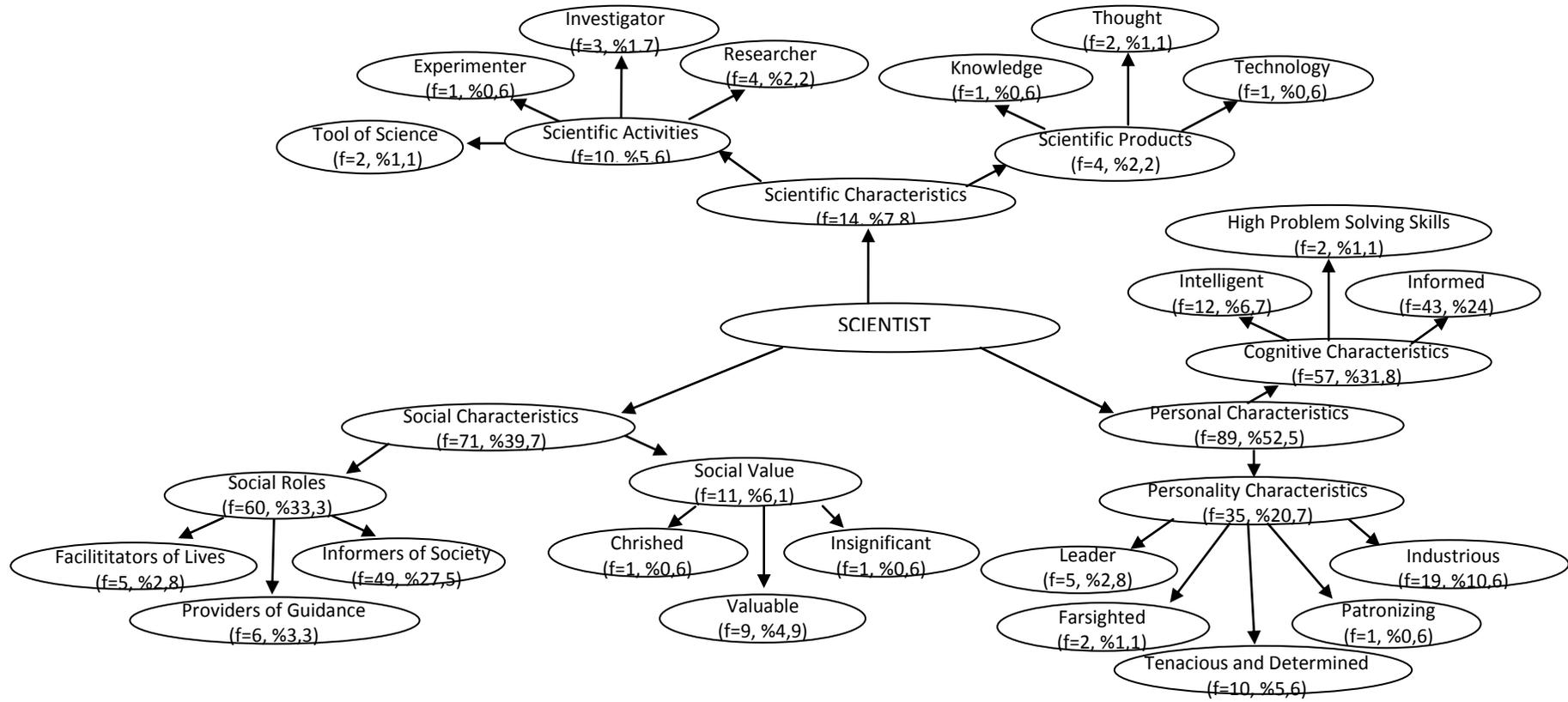


Figure 2: Conceptual Categories of Students' Perceptions About Concept of Scientist

### **Main and Sub-Categories Relevant to Students' Perceptions About Scientist**

Figure 2 shows that students have scientist images that include the main categories of social, personal and scientific characteristics. It was identified that 52.5% of the students emphasized the personal characteristics of scientists, 39.7% focused on their social characteristics and 7.8% stressed their scientific characteristics. Students mostly focused on personal characteristics of scientists and the scientific characteristics category displayed very low frequencies. In this sense, it can be suggested that secondary school students have a tendency to attribute meaning to scientists' personal characteristics.

#### **Main Category 1: Social Characteristics of Scientists**

Figure 2 shows that perceptions of students who emphasized scientists' social characteristics are collected under two sub categories: *social roles of scientists* and *social value of scientists*. It was found that 33.3% of the participating students (f=60) emphasized social roles of scientists whereas 6.1% (f=11) emphasized social value of scientists. The majority of students emphasized the sub category of social roles of scientists however they did not have high levels of awareness about scientists' social values.

##### *Sub-Category 1: Social Roles of Scientists*

As the figure shows, expressions of students who emphasized the sub category of social roles of scientists are combined under three codes: informing society, facilitating the lives of others and providing guidance. It was found that 27.5% of the students (f=49) emphasized the code of informing society, 3,3% (f=6) focused on their guidance roles and 2,8% (f=5) stressed the code of facilitating the lives of others.

##### *Code 1: Scientists as Informers of Society*

The high frequency metaphors used by 49 students who emphasized that the roles of scientists included informing the society can be listed as: the sun (f=15), lamp (f=8), teacher (f=5), book (f=5), light (f=4), library (f=2) and the moon (f=2). In addition to these metaphors, single students used the following metaphors to define scientists: tree, fire, computer, flower, electric wire, treasure, hope and transmitter.

S<sub>41</sub> who used the concept of sun to form a metaphor stated that: "A scientist is like the sun because he enlightens us by utilizing his intelligence and mastership". S<sub>2</sub> who also used the concept of sun formed a metaphor expressing that "A scientist is like the sun because he enlightens everyone". S<sub>22</sub> who selected the concept of lamp defined scientists with the following metaphor: "A scientist is like a lamp because he enlightens everyone with his knowledge. S<sub>7</sub> who used the concept of lamp expressed his/her views in the following manner: "A scientist is like a lamp because he radiates light as the lamp". S<sub>88</sub> ho used the concept of light formed the following metaphor: "A scientist is like the light because he enlightens us".

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S<sub>67</sub> who formed a metaphor by using the concept of book stated that “A scientist is like a book because books provide information”. S<sub>17</sub> who also used the concept of book formed the metaphor in the following sentence: “A scientist is like a book because you can get information whenever you want”. S<sub>63</sub> who used the concept of library stated that “A scientist is like a library because he always provides us with knowledge”. S<sub>88</sub> who used the same concept used the statement that “A scientist is like a library because when you open his door, he provides us with the whole knowledge”. S<sub>68</sub> who used the concept of tree formed his/her metaphor as “A scientist is like a tree because he provides information to the individuals who have an insatiable desire for knowledge”. S<sub>48</sub> who expressed his/her views by using the concept of transmitter stated that “A scientist is like a transmitter because he always transmits knowledge”.

Examination of metaphors presented previously point to the fact that students emphasize their perceptions that focus on scientists’ informing and enlightening the society. Concepts of the sun, lamp and light in the metaphors used by S<sub>41</sub>, S<sub>2</sub>, S<sub>7</sub>, S<sub>22</sub>, S<sub>68</sub> and S<sub>88</sub> emphasize achievement of knowledge by scientists as a result of their research and sharing this knowledge with the society. In other words, it is seen that scientists are regarded as resources that inform society. S<sub>48</sub>, S<sub>67</sub>, S<sub>17</sub>, S<sub>63</sub> and S<sub>88</sub> who defined scientists in association with concepts such as books, library, electric wire and transmitter approach scientists as tools that carry knowledge to society. In this sense, this category coded scientists as informers of society.

#### *Code 2: Scientists as Providers of Guidance*

6 students who defined the role of scientists as providers of guidance used the concepts of signboard, teacher, life coach, the North Star and the moon.

S<sub>39</sub> who used the concept of North Star in his/her metaphor stated: “A scientist is like the North Star because he shows us the way”. The metaphor of S<sub>36</sub> who used the concept of life coach expressed that “A scientist is like a life coach because he guides us throughout life with his discoveries”. S<sub>12</sub> used the concept of teacher in his/her metaphor which stated: “A scientist is like a teacher because the knowledge he provides guides our lives”. S<sub>132</sub> who used the concept of signboard in his/her metaphor stated that “A scientist is like a signboard because he shows us the way about science”.

When the metaphors presented above is examined, it is observed that students associate scientists with guidance with the use of concepts such as the North Star, life coach, teacher and signboard. In that sense, this code was defined as “scientists as providers of guidance” based on the emphasis on their guidance roles.

#### *Code 3: Scientists as the Facilitators of Others’ Lives*

It was identified that five students who emphasized the role of scientists as facilitators of others’ lives used the concepts of “mother, chef, government, user

manual and magnifying glass in their metaphors. The metaphors formed by students are presented below:

S<sub>14</sub> who used the concept of government in his/her metaphor stated “A scientist is like the government because he meets the needs of people by discovering things and makes their lives easier”. S<sub>95</sub> used the concept of chef in the metaphor which stated that “A scientist is like a chef because he facilitates the lives of others with the food he cooks”. The metaphor of S<sub>16</sub> who used user manual as a concept expressed that “A scientist is like a user manual because he works to facilitate our lives”. The concept of magnifying glass was used in the metaphor of S<sub>4</sub> “A scientist is like a magnifying glass because he is there when you need it to make it easier for me to examine the object”. S<sub>146</sub> who formed a metaphor with the concept of mother stated that “A scientist is like a mother because he helps us live comfortable lives by providing our needs”.

Metaphors presented above show that students associate the concepts of government, chef, user manual, magnifying glass and mother with the role of scientists as facilitators of lives. This outlook presents that students perceive scientists as individuals who makes the lives of others easier by providing the needs of society. Therefore the code was identified as “scientists as facilitators of others’ lives”.

#### *Sub-Category 2: Social Value of Scientists*

6,1% of the participating students (f=11) emphasized the sub category about the social value of scientists. 9 of these students (4,9%) focused on code “scientist as a valuable person”, 1 (0,6%) emphasized the code “scientist as a cherished person” and another student 0,6 % focused on the code of “scientist as an insignificant person”. When student perceptions regarding the social values of scientists were examined, it was seen that students had positive images in general.

#### *Code 1: Scientist as a Valuable Person*

3 of the students who emphasized the code of scientists as a valuable person used the concepts of diamond and gold in their metaphors and one student selected the concepts of mine, jewelry and emerald. Student metaphors are presented below:

S<sub>95</sub> who used the concept of diamond in the metaphor stated that “A scientist is like diamond because he facilitates our lives with his discoveries”. S<sub>64</sub> who associated scientists with diamonds stated that “A scientist is like a diamond because he is valuable for providing us information”. S<sub>66</sub> who used the concept of gold in the metaphor expressed his/her ideas as “A scientist is like gold because he is very valuable for us”. S<sub>73</sub> who used the concept of jewelry expressed his/her ideas in the following metaphor: “A scientist is like jewelry because he is very valuable”. The metaphor of S<sub>145</sub> who associated scientists with mines stated that “A scientist is like a mine because he is hard to find and very valuable”. The metaphor

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of S<sub>121</sub> who used the concept of emerald expressed the ideas of the student as follows: “A scientist is like emerald because he is very valuable”.

The metaphors presented above emphasize those students associate the concept of scientist with several ores based on the value. It was identified that S<sub>66</sub>, S<sub>73</sub> and S<sub>121</sub> emphasize the value of scientists without mentioning any of their functions. S<sub>95</sub> and S<sub>66</sub> stated the value of scientists in relation to the products and the social benefits of these products. S<sub>95</sub> focused on the aspect of provision of information and S<sub>66</sub> mentioned facilitating human life by making discoveries. Students were found to emphasize the fact that scientists are valuable since they are few in number. In this sense, this code was identified as “scientist as a valuable person”.

#### *Code 2: Scientist as a Cherished Person*

It was identified that the student who emphasized the code of “: scientist as a cherished person used the concept of chocolate in his/her metaphor. S<sub>19</sub>’s metaphor stated that “A scientist is like chocolate because he is loved very much”. As seen in the metaphor, the student associated the concepts of scientist and chocolate based on their popularity. Therefore, it was decided that student defined scientists as cherished persons and the code was titled as “scientist as a cherished person”.

#### *Code 3: Scientist as an Insignificant Person*

One student emphasized the code of scientist as an insignificant person by using the concept of washed out bill in the metaphor. S<sub>89</sub>’s metaphor stated that “A scientist is like a washed out bill because the writings on it cannot be read which makes him insignificant”. It was observed that the student define scientists as insignificant because they cannot be understood by people. In this context, the code was defined as “scientist as an insignificant person”.

### **Main Category 2: Personal Characteristics of Scientists**

89 of the participating students (52,5%) focused on personal aspects of scientists in their metaphors. These metaphors were classified under personal characteristics and cognitive characteristics. 57 students in the study (31,8%) emphasized the cognitive features of scientists whereas 35 students (20,7%) focused on personal characteristics sub category. Codes under these categories are defined below.

#### **Sub-Category 1: Cognitive Characteristics of Scientists**

Examination of student metaphors about the cognitive characteristics of scientists show that 43 students (24%) perceived scientists as informed, 12 students (6,7%) as intelligent and 2 students (1,1%) as individuals with high problem solving skills. The majority of students who emphasized scientists’ cognitive skills focused on the code of being informed individuals.

#### Code 1: Scientist as an Informed Person

It was found that students who perceived scientists as informed persons used the following concepts in their metaphors: computer (f=7), book (f=7), teacher (f=6), library (f=4), dictionary (f=3), encyclopedia (f=3), brain (f=3), cabinet (f=2), cube of knowledge (f=2) and internet (f=2). It was also identified that the each of concepts of ocean, space, puzzle and universe were used by one student. The metaphors of the students are presented below.

S<sub>91</sub> who used the concept of computer in his/her metaphor stated that: "A scientist is like a computer because he knows everything". S<sub>35</sub>, another student who used the concept of computers formed the following metaphor: "A scientist is like a computer because he is highly informed". S<sub>99</sub> who used the concept of internet formed the following metaphor: "A scientist is like internet because he has all the information". Another student (S<sub>157</sub>) who associated scientists with the internet stated that "A scientist is like internet because he has a lot of knowledge in his mind". S<sub>32</sub> associated scientists with teachers in his/her metaphor: "A scientist is like a teacher because the information in books is registered in his brain".

S<sub>4</sub> used the concept of book in the following metaphor: "A scientist is like a book because he is highly informed". S<sub>10</sub> who used the concept of dictionary stated his view in the following metaphor: "A scientist is like a dictionary because he is highly informed." S<sub>24</sub> who defined scientists by associating them with the concept of encyclopedia formed the following metaphor: "A scientist is like an encyclopedia because he knows everything about medicine".

S<sub>30</sub> who used the concept of brains stated that "A scientist is like the brain because he possesses all information". S<sub>39</sub>, another student who used the concept of brains stated that "A scientist is like the brain because he knows everything". S<sub>75</sub> who used the concept of library stated his/her view in the following metaphor: "A scientist is like a library because he is full of information". S<sub>83</sub> who defined the concept of scientist by associating the term with cabinet formed the following metaphor: "A scientist is like a cabinet because he is filled with information". S<sub>3</sub> who explained the concept of scientist with the concept of puzzle stated that "A scientist is like a puzzle because he has a lot of information". The metaphor formed by S<sub>67</sub> who associated scientists with the ocean was "A scientist is like the ocean because he is filled with different sorts of information".

S<sub>69</sub> likened the scientists to the universe and formed the following metaphor: "A scientist is like the universe because he has infinite knowledge". S<sub>56</sub> who used the concept of space in the metaphor stated that: "A scientist is like the space because his knowledge is limitless like the space".

The above metaphors created by students to define scientists show that S<sub>91</sub>, S<sub>35</sub>, S<sub>99</sub>, S<sub>157</sub>, and S<sub>67</sub> used the concepts of computer, internet, teacher, book, dictionary, encyclopedia, library, brain, cabinet, puzzle and ocean by associating

the concepts with objects or individuals that store things such as knowledge. In other words, students defined scientists as individuals full of knowledge. Although no expressions were included in some student metaphors regarding storage capacity, it was observed that the concepts they used had limitations. A different approach was observed in the metaphors created by S<sub>69</sub> and S<sub>56</sub> which included expressions about the width and infiniteness of scientists' knowledge. These students claimed in their metaphors that scientists have infinite and limitless knowledge. In that context and based on student metaphors, the specific code was defined as "scientist as an informed person".

#### Code 2: Scientist as an Intelligent Person

The metaphors created by 12 students who emphasized the code of scientist as an intelligent person included the concepts of a brain box (f=5) and computers (f=2). In addition to these concepts, search engine, brain, crow, teacher and robot concepts were also used by one student each in metaphors to define scientists.

S<sub>49</sub> who used the concept of a brain box in their metaphors stated that "A scientist is like a brain box because he is very intelligent". S<sub>28</sub> who defined scientists by associating the term with the concept of computers formed the following metaphor "A scientist is like a computer because he is very intelligent". S<sub>42</sub> who associated scientists with search engine formed the following metaphor: "A scientist is like the search engine because he is very intelligent". S<sub>93</sub> used the concept of brain in his/her metaphor: "A scientist is like the brain because he is very intelligent".

It was observed that students who emphasized the code of scientists as an intelligent person associate the concept of scientists with a brain box, computer, search engine and brain in terms of intelligence. In this sense, the code was defined as "scientist as an intelligent person".

#### Code 3: Scientist as a Person with High Problem Solving Skills

The metaphors formed by two students by using the concepts of calculator and teacher were found to emphasize the code of scientist as a person with high problem solving skills.

S<sub>51</sub> who used the concept of calculator in the metaphor stated that "A scientist is like a calculator because he solves all problems". S<sub>144</sub> who used the concept of teacher stated his/her idea with the following metaphor: "A scientist is like a teacher because he produces solutions to all problems".

Examination of student metaphors shows that S<sub>51</sub> and S<sub>144</sub> formed their metaphors by associating the concept of calculator and teacher with scientists in terms of solving problems. In that respect, the code was named "scientist as a person with high problem solving skills".

#### Sub-Category 2: Personality Characteristics of Scientists

35 (20.7%) students emphasized "scientists' personality characteristics" sub category. 19 of these students (10.6%) perceived scientists as industrious persons, 10 (5.6%) as tenacious and determined persons, 5 (2.8%) as leaders, 2 (1.1%) as farsighted individuals and 1 (0.6%) as patronizing persons. In the light of these findings, the majority of the students emphasized industriousness, tenacity and determination of scientists.

##### Code 1: Scientist as an Industrious Person

19 (10.6%) students who perceived scientists as industrious individuals used the concept of ants, 4 used the concept of machines, 3 used bees, 2 used brain and 2 used the concept of the earth. In addition to these students, motor, organ, clock and time bomb were concepts used by one student each in their metaphors.

S<sub>44</sub> who used the concept of ant in his/her metaphor stated that: "A scientist is like an ant because he works all the time". In his/her metaphor, S<sub>166</sub> stated "A scientist is like an ant because he is very industrious". S<sub>101</sub> who associated the concept of scientists with the concept of bees formed the following metaphor: "A scientist is like the bee because he always works and makes efforts". Another student (S<sub>122</sub>) who formed associations with bees formed the metaphor that stated: "A scientist is like the bee because he works very hard".

S<sub>76</sub> who associated the concept of scientists with the concept of machine formed the following metaphor: "A scientist is like a machine because he works without getting tired".

S<sub>21</sub> using the concept of the earth stated that "A scientist is like the earth because he never stops". S<sub>48</sub> who defined the concept with the concept of brain stated that: "A scientist is like the brain because he works even in his sleep". S<sub>168</sub> who made use of the concept of organs formed the following metaphor: "A scientist is like our organs because he always works". S<sub>26</sub> used the concept of clock in his/her metaphor which stated that "A scientist is like a clock because he works nonstop".

Examination of metaphors formed by students show that some students associated scientists with the concepts of machines, ants and bees since these elements are socially recognized with their industriousness and students likened scientists to these concepts based on the industriousness of scientists. In other words, the metaphors formed to emphasize industriousness with the help of concepts such as machine, bee and ant are metaphors widely used in society. Some students defined scientists by likening them to non-stop mechanisms such as brain, organs, the earth and the clock or to a part of these mechanisms. As a result it was identified that students perceived scientists as individuals who work nonstop and the code was titled "scientist as an industrious person".

#### Code 2: Scientist as a Tenacious and Determined Person

The students who emphasized the code “scientists as tenacious and determined individuals” used monster, archeologist, brain, lighter, iron, ray (beam), turtle, fighter and water concepts in their metaphors. Student metaphors are presented below:

S<sub>34</sub> who associated scientists with archeologists stated that “A scientist is like an archeologist because he extracts everything from depths without getting tired”. S<sub>40</sub> who defined scientists with the concept of fighter formed the following metaphor: “A scientist is like a fighter because he always succeeds in all the wars with his tenacity”. S<sub>22</sub> who defined scientists with the concept of rays stated in his/her metaphor that “A scientist is like a ray because he focuses on a point and he gets there”. S<sub>5</sub> who used the concept of monster to define scientists stated that “A scientist is like a monster because he accomplishes what he sets out to do.”

S<sub>107</sub> who utilized the concept of iron defined scientists with the following metaphor: “A scientist is like iron because he never bends against all negative conditions”. S<sub>72</sub> used the concept of river to define scientists and formed the following metaphor: “A scientist is like a river because he never strays from his path against all odds and reaches the sea”. S<sub>96</sub> used the concept of turtle and formed the metaphor that stated “A scientist is like a turtle because he never gives up even though he may be slow”.

Examination of student metaphors presents that students who used the concepts of archeologist, fighter, lighter and ray to define scientists associate them with these concepts in terms of focusing on and achieving a goal with tenacity and determination. In other words, students asserted in their metaphors that even though it is difficult, scientists achieve their goals with the help of tenacity and determination. Students who used the concepts of iron and river in their metaphors had a different approach. These students associated scientists with iron and river concepts since they believed scientists would not give up due to their tenacity and determination. The student who defined scientists by associating them with the concept of turtle presented scientists as individuals who would not abandon their tasks due to tenacity and determination even though they may have negative traits (like slowness). Although the approaches were different in the metaphors, it was seen that the common theme was the tenacity and determination of scientists. In that context, the code was titled “scientist as a tenacious and determined person”.

#### Code 3: Scientist as a Leader

Students who emphasized the code of scientist as a leader used the following concepts in their metaphors: pair of scissors, army commander, the sun, flag and lion. S<sub>8</sub> who associated the concept of scientists with the concept of scissors formed the following metaphor: “A scientist is like a pair of scissors

because he is sharp, he stands out with his leadership". S<sub>83</sub> who used the concept of army commander formed the metaphor that stated "A scientist is like an army commander because he leads us to learn science". S<sub>74</sub> used the concept of flag in his/her metaphor "A scientist is like a flag because he leads the society". S<sub>52</sub> used the concept of the sun and formed the following metaphor "A scientist is like the sun because he shines with his brightness wherever he goes". S<sub>115</sub> who used the concept of lion in the metaphor stated that "A scientist is like a lion because he leads people around him".

Examination of student metaphors shows that scientists are perceived with their leadership skills in the metaphors formed by using the concepts of the sun and scissors. Students who used concepts such as army commander, flag and lion in their metaphors emphasized that scientists led the people around them with their leadership. In this context, this code was named "scientist as a leader".

#### Code 4: Scientist as a Farsighted Person

Students who perceived scientists as farsighted individuals used the sun and ant concepts in their metaphors. S<sub>23</sub> who used the concept of the sun to define scientists formed the following metaphor: "A scientist is like the sun because he sees ahead with his light. S<sub>148</sub> who defined scientists by associating them with the concept of ants formed the following metaphor: "A scientist is like an ant because he plans for the winter during the summer".

Both students were found to emphasize the farsightedness of scientists in their metaphors. In this respect, this code was titled "scientist as a farsighted person".

#### Code 5: Scientist as a Patronizing Person

It was found that the student who perceived scientists as patronizing used the concept of godfather in his/her metaphor. S<sub>45</sub> formed the following metaphor: "A scientist is like the godfather because he is domineering". As can be seen from the metaphor formed by the student, the student associated scientists and godfathers in the sense that they expect their orders to be fulfilled and they insist on that. In other words, the students emphasized the fact that scientists insist on some ideas they regard as accurate and they don't accept that they may be wrong. Therefore, the code in the study was titled "scientist as a patronizing person".

### ***Main Category 3: Scientific Characteristics of Scientists***

14 of the participating students (7,8%) emphasized the category of scientific characteristics of scientists. 10 of these students (5.6%) focused on scientific activities whereas 4 (2.2%) emphasized scientific products sub categories.

#### Sub-Category 1: Scientific Activities of Scientists

The metaphors of students emphasizing the sub category of scientific activities of scientists were collected under the following codes: scientist as an

investigator (f=3), scientist as a researcher (f=4), scientist as tool of science (f=2) and scientist as an experimenter.

Code 1: Scientist as a Researcher

The metaphors of students emphasizing scientists as researchers used the concept of computers (2 students) and magnet (1 student) and student (1 student). S<sub>6</sub> and S<sub>156</sub> who used the concept of computers in their metaphors stated that “A scientist is like a computer because he does research”. S<sub>141</sub> who defined scientists with the concept of student stated “A scientist is like a student because he searches everything he is curious about”. S<sub>17</sub> defined scientists by using the concept of magnets and expressed his/her ideas in the following metaphor: “A scientist is like a magnet because he searches for and finds information”.

Examination of metaphors shows that students associate scientists with the concepts of computers, students and magnets in terms of research characteristics. Based on this association, the code was named “scientist as a researcher”.

Code 2: Scientist as an Investigator

It was determined that students who emphasized the role of scientists as investigators used the following concepts in their metaphors: detective (f=2) and telescope (f=1). S<sub>13</sub> and S<sub>25</sub> who used the concept of detective formed their metaphors as follows: “A scientist is like a detective because he investigates everything”. S<sub>103</sub> who associated the concept of scientists with the concept of telescope formed the following metaphor: “A scientist is like a telescope because he examines everything in detail”.

Examination of the metaphors which used telescope and detective concepts shows the main theme as the process of investigation. Thus, this code was named “scientist as an investigator”.

Code 3: Scientist as a Tool of Science

Students who emphasized the code of scientist as a tool of science used the concepts of spoon and key in their metaphors. S<sub>87</sub> who used the concept of key formed the following metaphor: “A scientist is like a key because only he can open the door of science”. S<sub>3</sub> who used the concept of spoon in his/her metaphor stated that “A scientist is like a spoon because he is a tool of science”.

Examination of student metaphors shows that students associated the concept of scientist with the concepts of spoon and key since they see them as the vehicle to do and start something. In this respect, the identified code was named “scientist as a tool of science”.

Code 4: Scientist as an Experimenter

The student who perceived scientists as experimenters used the concept of monkey in his/her metaphor. The student’s (S<sub>16</sub>) metaphor stated that “A scientist is like a monkey because he jumps from experiment to experiment”.

Examination of the student's metaphor shows his/her perception of scientists as individuals who are constantly busy with experiments. Therefore, this code was identified and named "scientist as an experimenter".

#### Sub-Category 2: Scientific Products of Scientists

It was identified that two of the students who emphasized the sub category of "scientific products of scientists" perceived scientists as producers of thought, one student as discoverer of technology and one student as producers of knowledge. These codes are examined in more detail below.

##### Code 1: Scientist as a Person Who Produces Thought

Two students participating in the study used the concepts of highway and sky in their metaphors to emphasize the code "scientist as a person who produces thought". S<sub>151</sub> who used the concept of highway formed the following metaphor: "A scientist is like the highway because he has many thoughts going around in his head". S<sub>73</sub> who used the concept of sky in the metaphor expressed that "A scientist is like the sky because he produces as many thoughts as there are in the sky".

Examination of students' metaphors shows that students mention the density of thoughts produces by the scientists in their metaphors. Thus, this code in the current study was named "scientist as a person who produces thought".

##### Code 2: Scientist as a Person Who Produces Knowledge

One student in the study perceived scientists as individuals producing knowledge and used the concept of transformation box in his/her metaphor. The metaphor of the student (S<sub>19</sub>) stated "A scientist is like a transformation box because he takes knowledge, transforms it and presents as new knowledge".

Examination of the student's metaphor shows his/her perception of scientists as tools that produce new knowledge by using prior information. Thus, this code was titled "scientist as a person who produces knowledge".

##### Code 3: Scientist as a Person Who Discovers Technology

It was identified that one student (S<sub>94</sub>) who perceived scientists as producers of technology used the concept of gold detector in the following metaphor: "A scientist is like a transformation box because he finds the technology".

As can be detected from the metaphor, the student perceived scientists as discoverers of technology. Therefore, this code was identified as "scientist as a person who discovers technology".

### **Discussion**

#### ***What Are Secondary School Students' Perceptions About Scientists?***

Conceptual framework presented in Table 2 regarding the student perceptions about scientists was created as a result of data analysis. The conceptual framework shows that students' image of scientists are rather complex.

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Similarly, Finson (2009) proposed that scientist images are related to multi-dimensional and sophisticated concepts that are internalized in the minds of individuals. Examination of the framework displays that the scientist images of students are collected under three main categories: social characteristics of scientists, personal characteristics of scientists and scientific characteristics of scientists. It was also determined that perceptions were classified under 6 sub categories under the main categories as well. It was found that perceptions of students emphasizing the Social Characteristics of Scientists mostly congested around the themes of Social Roles of Scientists and Social Value of Scientists while perceptions of students emphasizing the Personal Characteristics of Scientists congested around the themes of Cognitive Characteristics of Scientists and Personality Characteristics of Scientists and perceptions of students emphasizing the Scientific Characteristics of Scientists congested around the themes of Scientific Activities of Scientists and Scientific Products of Scientists. Examination of the codes under sub categories presents that students perceive scientists as intelligent, informed, industrious, tenacious and determined, a leader, farsighted, with high problem solving skills, investigator, researcher, experimenter, producer of information, thought and technology, valuable and cherished, informer of society, facilitator of others' lives and a guide. The sub categories and codes in the conceptual framework obtained at the end of the study are supported by the results of many studies (Song and Kim, 1999; Koren and Bar, 2009; Dikmenli, 2010; Ruão et al., 2012) in the literature.

Investigation of studies that support the current findings shows that the cited studies follow different approaches in analyzing students' perceptions of scientists. Majority of these studies (Petkova and Boyadjieva, 1994; Song and Kim, 1999; Koren and Bar, 2009) used questionnaires composed of open-ended questions to determine students' perceptions of scientists and student perceptions were described without using categories. In other words, data in many of these studies were not analyzed for content and only analyzed descriptively and codes regarding scientist images were defined. Codes obtained as a result of the current study such as intelligent, informed, leader, industrious, tenacious and determined, with high problem solving skills, facilitator of social life and guide were also obtained in many of these studies. Two studies in the literature undertaken to define students' image of scientists (Dikmenli, 2010; Ruão et al., 2012) are similar to the current study in terms of data analysis although they used different data collection tools. These studies also analyzed the findings by categorizing student perceptions about scientists. Codes and sub categories for these codes obtained in the current study such as intelligent, informed, leader, industrious, tenacious and determined, with high problem solving skills, facilitator of social life and guide were also obtained by these studies mentioned above.

***Can Metaphors be Applied to Determine Perceptions of Individuals About Scientist as a Data Collection Technique?***

It is possible to observe different emphasis between the results of the current study and the results of previous studies in the literature. For instance, Nuhoglu and Afacan (2011) found different results for the perceptions of primary education 4th, 5th and 6th graders about scientists regarding personal characteristics of scientists such as courage, tolerance, being prejudiced, nervousness, selfishness, indetermination, untidiness, inconsistency, innovativeness, tidiness, curiosity, having high imagination and concentration levels, ability to propose different solutions to problems, ability to compare events, ability to think critically and awareness of problems around them. Dikmenli's (2010) study defined additional categories to the categories obtained in the current study such as the names of scientists, working environment of scientists, technological advances and physical appearance of scientists. Here, the following questions arise: Should we think that perceptions of the students in the current study are superficial compared with the other results obtained in the literature? Or have some of the limitations of the metaphor method limited us from obtaining data? The most fundamental difference between the studies in the literature and the current study is the data collection tool used in the current study. Studies in the literature utilized questionnaires composed of open-ended questions and word association tests. Students may present many of the concepts in their conceptual networks related to scientists in the questionnaires composed of open-ended questions and word association tests. To the contrary, students in the metaphor method associate the concept of scientist with the closest concept in their conceptual networks. In other words, while open-ended questionnaires and word association tests allow the detection of perceptions from student statements regarding various aspects of scientists, metaphor method identifies perceptions regarding only one aspect of scientists. Therefore, although the metaphor method allows ease in implementation and analysis and provides valid data, it may be necessary to have a large working group in this technique. The need is evident for future studies that use metaphor method with larger research groups to identify student perceptions about scientists. Such studies will help enlighten whether metaphor method will provide data regarding various categories such as the appearance of scientists and the working environment.

***Are Students' Perceptions About Scientist Positive?***

Since students mostly emphasized the personal and social characteristics of scientists and used positive statements, it can be argued that participating students had positive perceptions about scientists. Similarly, literature states that students have positive perceptions about scientists based on various studies (Sjøberg, 2002; Ruão et al., 2012) that identified student emphasis on personal and social characteristics of scientists. Song and Kim (1999) identified that students generally

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focused on personal characteristics of scientists. Researchers posited that student perceptions were positive but their awareness levels should be raised regarding the social and environmental roles of scientists. Similarly, Rodari (2007) expressed that students need to learn about the place and role of scientists in the society and their characteristics rather than regarding them as holy to encourage opting for careers in science. Rodari's (2007) expressions about consecration are best explained by the work of Anderson (2006). As a result of the study conducted on secondary school students in Ghana, Anderson (2006) identified that students perceived scientists as individuals who helped poor persons who could not benefit from social rights. In another study, students expressed their perceptions of scientists as the slave of humanity and the hero of the society. It was found that scientific characteristics of scientists were not highly emphasized. Can we state that students' scientist images were positive although their awareness levels regarding the scientific aspects of scientists were low?

Developing naive perceptions will positively affect student tendencies to have careers in science (Flick, 1990). Therefore teachers, scientists and policy makers need to take steps to positively develop students' scientist images. To achieve this mission, teachers should utilize hands on science activities more, and provide their students with opportunities to participate in science camps that allow working with scientists doing research. Similarly, Buldu (2006) suggests inviting scientists to the science classroom, using more hands on science activities and bringing more scientific books to the teaching environment in order to positively affect students' scientist images. Scientists and policy makers should also undertake activities to ensure the accessibility of science by everyone. Morin (1994) states that an average citizen has difficulties in understanding scientific rules, methods, rituals and the language of science since science is approached as a process organized by a specific elite group for many years (Cited by Ruão et al., 2012). Morin believes that science or scientist image of the average student or the public who are distant from scientific studies is based on irrational foundations and these groups regard scientists as heroes, wonder men or wizards. In that sense, policy makers and scientists need to open the doors of scientific activities to average public and publish their work in an intelligible language for the masses.

#### **Conclusion and Implication**

Conceptual framework in Figure 2 that presents student perceptions about scientists was created as a result of the study undertaken secondary school students' scientist images. This framework is believed to direct the interpretation of student perceptions about scientists in the future. However, comparison of the content of the conceptual framework with the results of previous studies shows that some categories are missing in the framework such as the physical appearance and work environment of scientists. It is believed that lack of such categories is based on the number of participants, level of education and the metaphor method. Data included in the basis of the conceptual framework were collected with the

metaphor method which can be regarded as an alternative technique to identify individuals' scientist images due to the ease of the method both in implementation and in analysis. However, students can present only one perception in one metaphor sentence in this method. Therefore, the sample should be large in studies that use metaphor technique and students should be asked to create more than one metaphor. Also, undertaking similar research in larger groups composed of individuals from various educational levels will allow us to decide whether this framework helps interpreting different perceptions towards scientists.

Study results show that students mostly emphasized the personal and social characteristics of scientists, focused on their scientific characteristics the least and generally used positive statements in their metaphors. Similar studies in literature regarded students as ordinary individuals and presented positive perceptions. If we regard students as individuals who will have future science careers, we cannot claim that they have positive perceptions since they rarely emphasized scientific characteristics of scientists in the current study. So, student perceptions about scientists were defined as naïve in the current study. It is believed that studies in the future should take into consideration the emphasis on scientific characteristics of scientists while evaluating the student perceptions.

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