

Investigation of the Secondary School Students' Images of Scientists *

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Abstract

The overall purpose of this study is to explore secondary school students' images of scientists. In addition to this comprehensive purpose, it is also investigated that if these students' current images of scientists and those in which they see themselves as a scientist in the near future are consistent or not. The study was designed in line with the case study research in a qualitatively manner. The working group is of totally 175 (95 boys, 81 girls) secondary school students enrolled in the fifth, sixth, seventh and eighth grade of a public school located in the province of Adiyaman. Data were collected through drawings during the drawing activity and interviews conducted with the selected drawings' owners in order to explore images of scientists. Elements take place in the drawings which are investigated by two of science education expert and one of art expert were analyzed in accordance with certain categories appearing in the related literature. Furthermore, fifteen pictures among others were randomly selected and their owners were asked to imagine themselves as a scientist in the near future and consequently depict and draw on a paper their imagination. For further information, interviews were carried out to determine the differences between the first drawings and the second ones. It is concluded that 68% of secondary school students draw a natural scientist or scientists, 2,28% of those draw a social scientist or scientists and finally the rest draw no scientist. The rate of drawings including only one scientist is %66,85 while the rate of drawings possess more than two scientists %4,57. On the other hand, the rest of the drawings are without any scientist. There is no obvious difference in all categories selected in the context of the study according to grade level and gender. The study revealed the possibility of the fact that secondary school students' images of scientist are substantially formed by the content of prevailing mainbooks and workbooks including activities in the classrooms. When talking about scientists, the majority of the students depict a nature scientist who works more often in the laboratory, especially male and bespectacled. In addition, students mostly consider people as a scientist who work in the field of natural sciences. Consequently, doing science is an individual effort in an indoor environment rather than a set of group activity. Finally, data from interviews show that most of the students have a dream of being scientist in their future careers.

Key words: Nature of Science, Images of Scientists, Drawing Technique

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Introduction

The concept of scientific literacy has increased its importance especially since the final years of 1950s by making nature of science more researchable (Lederman, 2006). One of the prominent rationales of these terms is the fact that nature of science is a vital prerequisite of scientific literacy acquisition (AAAS, 1990, 1993, NRC, 1996; NSTA, 1982, Lederman, 2006). Because of different explanations derived from various perspectives, there is no mutually accepted description of nature of science. However, there are certain points on which experts studying in the related field agreed. These points given below highlight the meaning of nature of science:

- Imagination and creativity in science
- Social and cultural effects in the development process of scientific knowledge
- Tentativeness of scientific knowledge
- Subjective, objective and theory-laden nature of scientific knowledge (Osborne, 2003; Lederman, 2006).

As pointed out in the findings of earlier research, both students and teachers generally have insufficient or naive understandings of nature of science (Lederman, 2006). Therefore, it is getting more and more important to view educational settings such as teaching programmes because of their possible effects on students' images of scientists and perceptions on nature of science. By the way, improving students' understandings of nature of science make them more informed and facilitate the learning of science content (Driver, Leach, Millar & Scott, 1996). There is a lot of controversy over the relationship and differences between science and nature of science. It doesn't exist any mutually accepted description of nature of science (Abd-El Khalick & Lederman, 2000; Lederman, 2006). Accordingly, it reveals the importance of fundamental paradigm on how to teach nature of science. Because science develops with the improvements in the fields of history of science, philosophy of science and sociology of science disciplines deal systematically with science and scientific entrepreneurship (Abd-El Khalick & Lederman, 2000). Referring to the impossibility of reaching a mutually accepted description of both scientific literacy and nature of science, Laugksch (2000) states that expected outcomes from science education are formed along with the expectations of different occupational groups and stakeholders by approaching the issue using the term of "*Interest Groups*". Nature of science is generally considered as a complex construct consisting of both the epistemology and sociology of science and a way of knowing including certain values and beliefs inherent to scientific knowledge (Lederman, 1992,2006).

Despite there are science teaching programmes prepared with regard to contemporary approaches, they are more often unable to prevent students' from having misconceptions regarding nature of science. These misconceptions are particularly unrealistic views that are initially gender-based, that is, consisting of scientists' activities and beliefs connected with scientist are male (Newton&Newton, 1998; Korkmaz&Kavak, 2010).

In Turkey, teaching of nature of science, in other words, content knowledge of nature of science has been taught predominantly through textbooks. These textbooks fail to fulfil the aim of getting students more informed in terms of nature of science. Moreover, most of the teachers don't have enough competencies including insufficient or naive beliefs of nature of science so that students are getting more prone to develop misconceptions by teaching of these incompetent teachers.

With some promising results reached in the practical nature of science research at the higher education level in the last several years, however, it has been barely made sense the fact that some students who famish equal opportunities against other students in the process of learning of science and nature of science content, relatively. Nevertheless, it is essential to mention about certain problems due to the nature of the issue comprises nature of science. Nature of science refer to a complex and hybrid field possessing blending aspects of history of science, philosophy of science and sociology (McComas&Almazroa, 1998). Therefore, it could be generalized that understandings of nature of science develops over time and make sense of it with fortifying the relationship between the

aspects given above. Accordingly, teaching of nature of science should be given permanently, in other words, should be facilitated from primary school level to higher education level.

In the related literature, it is a common interpretation that students imagine a laboratory when they are asked to depict scientists and their working environments. This perception make students think about science as if it should be necessarily carried out in the indoor areas. Drawings with introvert and unsocial scientists working alone in a laboratory are main descriptions on images of scientists. On the other hand, students mostly regard scientists working in the field of natural sciences as a scientist rather than the others working in social sciences. Scientists appearance and materials, equipments they use are also striking. Scientists are generally perceived as male, bespectacled, wearing a white lab coat and having strange beard and hair (Newton&Newton, 1998). This perception reflects the fact that students tend not to see scientists as anyone living in his/her daily life.

The overall purpose of this study is to explore secondary school students' images of the scientist. In addition to this comprehensive purpose, it is also investigated that if these students' current images of scientist and those in which they see themselves as a scientist in the near future are consistent or not. Referring to the lack of research on related issue, Zhai et al. (2014) point out in their study that students from fourth grade level perceive science as carrying studies at first hand, doing science by teachers lectures, doing science by using textbooks and finally doing science in the context of social process. In addition, students who are exposed to experiments see themselves as a scientist more often compared to others.

Method

Data Collection

Data were collected through students' drawings in order to discern images of scientists (Buldu 2006). Elements take place in the drawings which are investigated by two of science education expert and one of art expert were analyzed in accordance with certain categories appearing in the related literature. Furthermore, fifteen pictures among others were randomly selected and their owners were asked to imagine themselves as a scientist in the near future and consequently depict and draw on a paper their imagination. For further information, interviews were carried out to determine the differences between the first drawings and the second ones. The study was designed in line with the case study research in a qualitatively manner. The working group consists of totally 175 (95 boys, 81 girls) secondary school students from the fifth, sixth, seventh and eighth grade of a public school located in the province of Adiyaman.

Analysis of Data

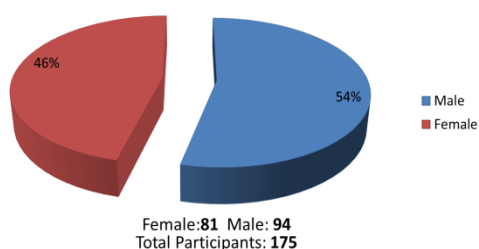


Figure 1: The Distribution of Participants by Gender

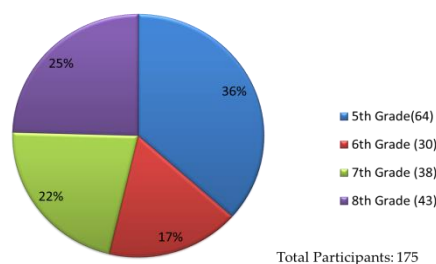


Figure 2: The Distributions of Participants' Grades and Frequencies

As given above, in Figure 1, participants consist of 46% female and 54% male. Figure 2 shows the distribution of participants by grade as 36% of 5th, 17% of 6th, 22% of 7th and 25% of 8th, relatively.

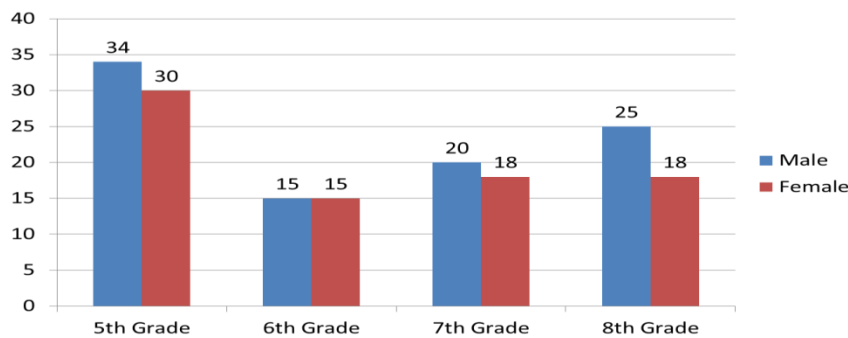


Figure 3: The distribution of participants by gender and grade

Figure 3 includes 34 male and 30 female from 5th grade, 15 male and 15 female from 6th grade, 20 male and 18 female from 7th grade and finally 25 male and 18 female from 8th grade.

Findings

Data collected from drawings show that 68% of secondary school students draw a natural scientist or scientists, 2,28% of those draw a social scientist or scientists and finally the rest draw no scientist (Figure 5).

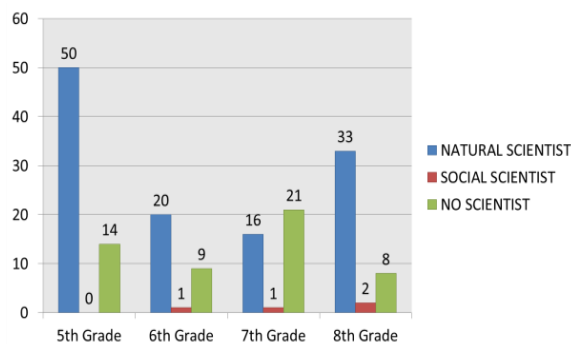


Figure 4: The distribution of participants drew

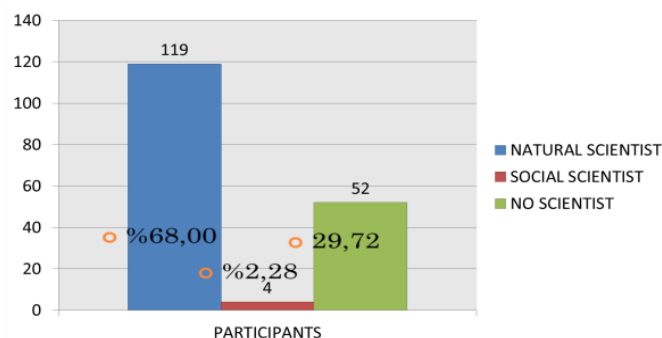


Figure 5: Total distribution of participants drew natural/social scientists or no scientists

In Figure 4, there are 50, 20, 16 and 33 participants drawing natural scientists. Instead, there exist 0, 1, 1 and 2 participants drawing social scientists. Also 14, 9, 21 and 8 participants with no scientist in their drawings in 5th, 6th, 7th and 8th grade, relatively. The rate of drawings including only one scientist is %66,85 while the rate of drawings possess more than two scientists %4,57.

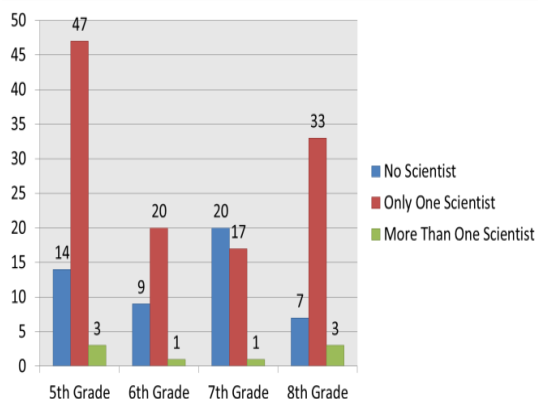


Figure 6: The Distribution of Participants Drew Drawings Scientist/Scientists by Grade

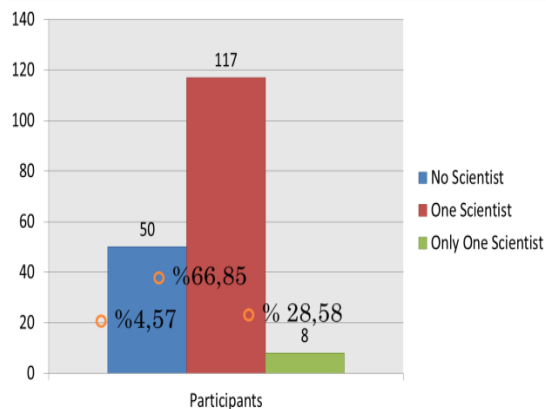


Figure 7: The Total Distribution of Participants With Scientists and No Scientist

The distribution of participants (Figure 6) is given according to drawings with only one scientist, more than one scientist and no scientist. Accordingly, there are 47, 20, 17 and 33 participants drawing only one scientist; 3, 1, 1 and 3 participants drawing more than one and finally 14, 9, 20 and 7 participants drawing no scientist by 5th, 6th, 7th and 8th grades, relatively.

Table 1: *Secondary School Students' Images of Scientists*

Thema 1: Images of Scientists

Codes

Selected Statements

1. Scientist is one who invents something.	"A scientist do experiments and invents"
2. Scientist is one who produces useful works for the future.	"Scientists have contributions for humanity." "Scientists are a people who shed light on the lifes of next generations with their ideas, studies and inventions."
3. Scientist has superior properties.	"Scientists are self-confident, smart, modest and emphatic."
4. Scientist devotes his/her life to science.	"Scientists are tolerant, devoted to science, stood up against all obstacles with their honest personalities."

Analyzing Table 1 given below, students current images of scientists were categorized within four codes. That is, scientist is one who invents something, deals with useful activities, has superior features and devotes himself/herself to doing science according to students' images of scientists. In addition, students tend to show no negative feature or characteristics scientists possess.

When students' current images of scientists, it is seen that there exist four codes. These codes are categorized in the study as "Scientist is one who invents something", "Scientist is one who produces useful works for the future", "Scientist has superior properties" and "Scientist devotes his/her life to science. Looking at these codes, there is a tendency not to refer any negative attribute to scientists. This view is stated by students as follow:

"Scientists are a people who shed light on the lifes of next generations with their ideas, studies and inventions."

"Scientists are tolerant, devoted to science, stood up against all obstacles with their honest personalities."

After the analysis of the images of scientists regarding students' views on how to see themselves in the future, there exist totally four codes as follow: a) the opinion of scientific entrepreneurship should be product-based, b) personal characteristics of scientists, c) the universality of scientific entrepreneurship and d) the effects of science on social life. These codes and related statements are given in Table 2 as well.

Table 2: The Images of Scientists Regarding Students' Views on How to See Themselves in the Future

Thema 2: Students' Images of Scientists in the Future	
Codes	Selected Statements
1. The opinion of scientific entrepreneurship should be product-based (invention, discovery, etc.)	I would like to see myself as the person who invents the most beneficial and durable gadgets.
2. Personal characteristics of scientists (self-confidence, intelligence, recognition, working independently, etc.)	"Scientist likes carrying out research and discovers new things". "I drew a scientist applauded by everyone". "Scientist is one who is well-known, smart and courageous"
3. The universality of scientific entrepreneurship	In my picture, I wanted to tell about people from all over the world with similar aims and their inventions.
4. The effects of science on social life	"Scientist is a person who lives in welfare and serenity stem from science learning among experiments as well as having a social life. I'd like to be a pediatricist. I'm so interested in dealing with diseases children exposed to. Because they often get sick from the very early years of their lives. This makes me unhappy. I promised I would be a pediatricist and do my best to heal them."

Table 3. *The Comparison of Student's Current Images of Scientists and Those in Which They See Themselves As a Scientist in the Future*

Thema 2: The Comparison of Pre and Post Images of Scientists			
1. Drawing Content and Interview Form		2. Drawing Content and Interview Form	
Codes	Selected Statements	Codes	Selected Statements
1. Scientists have universal purposes.	I drew a woman in my first picture. This woman was a scientist. The sea I drew behind the woman refers to the unlimited nature of science as sea.	1. Science as specific to a particular discipline	"Scientists are people who work in certain disciplines."
2. Scientists deal with inventions.	"If I was a scientist, I'd fly with my rocket." "Scientists are smart and invent new things."	2. Decision-making independently	"I invented a machine that works through the energy of fotons."
		3. Creativity	"I tried to show that everything could be succeed." "In my second drawing, I drew myself with my dreams." "I invented a machine working by fotons. I am turning a rainbow to show my delight while travelling in the picture with the purpose of sending anyone else to experience in the pictures they choose."
		4. The value of science	"I want to show the value of science appreciated by people." "I compared money and science. Science surpassed money at the end."
		5. The tentaniveness of scientific knowledge	"We could make mistakes while doing research. But the important thing is here to find out the mistake and eliminate it."
		6. Obstacles encountered by scientists	"I mentioned about challenges Galileo encountered and his efforts to explain phenomenon in the search of reality." "People advise others that science doesn't make money so people should get a job and make money."

The comparison of pre-post images of scientists is given in Tablo 3. These images are tried to be revealed by first drawings and interview forms. Two codes are extracted from first drawings and six codes from second drawings. Some of the statements under these codes are given in Table 3 as well as codes.

Discussion, Result and Recommendations

Scientists are generally perceived as male, bespectacled, wearing a white lab coat. Students mostly regard scientists working in the field of natural sciences as a scientist rather than the others working in social sciences. In addition, they think about science as if it should be necessarily carried out in the indoor areas. Another remarkable finding in the study is that there is no fifth grade student who try to draw any social scientist.

When first and second pictures compared, one of the most striking finding is that codes in the first pictures are highly pointed in the literature. Notwithstanding, it is explored that codes in the second pictures have more and various codes compared to first pictures. In other words, it is stated by students that scientists have universal purposes and deal with inventions in the first pictures, instead, scientists have limited research issues, have the ability of independently decision-making, creative and stand up against obstacles in the second pictures. Finally, they mention about the value of science and tentativeness of scientific knowledge in the context of science and scientific knowledge.

To sum up, findings inferred from drawings show that almost every student keen on being a scientist in the future. But, some of them answered negatively to the question of “Would you like to be a scientist in the future?” during the interviews. This finding refers to a conflict between the findings from drawings and interviews. Similarly, Zhai et al. (2014) in their study point out that some students don't imagine themselves as a scientist on account to the fact that scientists do dangerous experiments by themselves. Students explaining this view, specify that there is no need to listen to the teacher and textbooks are enough to improve themselves. Despite that, there is no considerable body of evidence to claim any correlation between their images of scientists and career plans (Baldu 2006). From all these findings and interpretations, it could be concluded that students have decent beliefs to achieve their dreams on being a scientist. Alike, it could be generalized that cultural environments in which students live has a prominent effect on the construction process of students' views.

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Selected Drawings

