



European Journal of Educational Research

Volume 7, Issue 3, 715 -730.

ISSN: 2165-8714

<http://www.eu-jer.com/>

'More than Just Waste Paper' – It Could Be an Indicator of a Stereotypical Image of a Scientist*

Sedat Karacam**

Duzce University, TURKEY

Volkan Bilir

Duzce University, TURKEY

Azize Digilli Baran

Duzce University, TURKEY

Received: June 8, 2018 • Revised: July 16, 2018 • Accepted: July 18, 2018

Abstract: The purpose of this study was to investigate the meanings assigned by pre-service teachers to the wastepaper basket and waste (crumpled) papers in their drawings of a scientist. The study was carried out with 220 pre-service teachers during the 2015-2016 academic years. A phenomenological research method was used. First, the pre-service teachers were administered the 'Draw-A-Scientist Test' in order to identify their images of a scientist and then they were asked to describe and explain the scientist they drew. And a semi-structured interview was performed with the 34 pre-service teachers who included a wastepaper basket and waste paper in their drawings in order to identify the meanings assigned to the wastepaper and wastepaper basket by these teachers. The data were analysed by using content analysis. The results of the analysis showed that with these figures the pre-service teachers revealed their belief that when scientists conduct research, they follow a confirmatory experimental process in a similar manner to the way school science experiments. Based on these results, it can be suggested in the analysis of the drawings that waste paper and wastepaper baskets can be regarded as indicators of the stereotypical image of scientists and of the scientific method they use.

Keywords: Science, science education, image of scientist, draw-a-scientist test.

To cite this article: Karacam, S., Bilir, V., & Digilli Baran, A. (2018). 'More than just waste paper' – It could be an indicator of a stereotypical image of a scientist. *European Journal of Educational Research*, 7(3), 715-730. doi: 10.12973/eu-jer.7.3.715

Introduction

In recent years, it has become one of the fundamental aims of science education to help every individual in the society to become science-literate and as a result to have the cognitive and affective abilities to

- i. interpret the events/situations they encounter from a scientific point of view,
- ii. explain situations and concepts by using them in accordance with their scientific definitions,
- iii. handle problems on a scientific basis and find solutions using scientific methods,
- iv. decide whether a written or oral statement they encounter is scientific or not, and
- v. have the courage to study or make a career in science.

Given the cognitive and affective abilities expected from science-literate individuals, the meanings assigned to concepts such as 'science', 'technology', 'scientific method' and 'scientist' are considered to be significant. Within the scope of these concepts, from a very basic point of view, science-literate individuals need to know what science is and the nature of the science-technology-society relationship. They need to know how science is conducted and who the people are who work in or study science. The images individuals have of these concepts constitute the cornerstone of knowledge regarding science and scientists. Mandler (1992) argues that images are formed at very early ages and by moving through an abstraction process, these images form concepts. A great number of studies have been conducted to determine the images that form the basis of these concepts. In their studies, Kurnaz, Tarakci, Saydam and Pektas (2013) described images of electrification, Kurnaz and Degirmenci (2012) described images of the Sun, the Earth and the Moon, and Kurnaz and Eksi (2015) described student images of solid friction in physics. In addition to these studies, those carried out to determine the images held by individuals of a scientist have an important place in this field and date back to the study carried out by Mead and Metraux in 1957. Using different methods, a large number of studies were conducted in later years based on 'the stereotypical image of a scientist' characterized by Mead and Metraux (1957). Among the most prominent of these was the one carried out by Chambers (1983), in which he developed the 'Draw-A-Scientist Test' (DAST) in order to investigate student perceptions of a scientist. He described the indicators used to assess the pictures drawn by students. Since 1983, many studies have been undertaken within the frame of the

*This paper was presented as oral presentation at the 12th National Science and Mathematics Education Congress in Trabzon, Turkey.

** **Corresponding author:**

Sedat Karacam, Duzce University, Faculty of Education, Duzce-Turkey.
Email: sedatkaracam@duzce.edu.tr

DAST and the indicators of the stereotypical image of the scientist developed by Chambers (1983). Moreover, some studies have investigated indicators other than those described by Chambers, and as a result some additional indicators have been identified. In the pictures drawn by students describing a scientist, however, there are still many elements besides those representing the indicators of the stereotypical scientist. Among these are the crumpled papers randomly thrown around in the room or thrown into a wastepaper basket and a wastepaper basket full of these crumpled papers. This element does not represent any of the indicators noted in the literature. The focus of this study was therefore to investigate the meaning attributed to the crumpled papers and the wastepaper basket full of this waste paper in the pictures drawn by students and to discover whether the waste paper and wastepaper basket represent an indicator of the stereotypical image of the scientist.

A Theoretical Framework

The first study to describe the image of the scientists was carried out by Mead and Metraux in 1957. Based on the writings of the students, the characteristics of stereotypical images of scientists were identified as follows: 'The scientist is a man who usually wears a white coat and glasses and works in a laboratory surrounded by chemical materials and equipment. Some may have a beard... He reads books, takes notes and shouts, "I've found it! I've found it!"' Mead and Metraux (1957) identified this depiction as the stereotypical image of the scientist. Until 1983, a number of studies (Beardslee & O'Dowd, 1961; Krajkovich & Smith, 1982) were conducted to identify the public image of the scientist using Likert-type scales to search for significant differences. However, by employing the theoretical basis provided by Mead and Metraux (1957), these studies were unable to go beyond the investigation of the effects of various factors (gender, educational background, culture, and so forth) on the image of the scientist.














Figure 1. DAST – Example of a drawing (Karacam, 2016b)

Even though the results obtained by Chambers (1983) were very similar to those of the 'first-generation' studies of Mead and Metraux (1957), he made the biggest contribution to this field with the development of the DAST, in which investigators ask students to draw a picture of a scientist on a piece of paper. Using the DAST, Chambers studied the images of a scientist drawn by 4807 primary-school children (kindergarten to grade 5). Consequently, he revealed that the children had drawn a male scientist with a beard and moustache wearing a lab coat and glasses, using technological and scientific instruments and working alone with chemicals and equipment in a closed setting with books and bookshelves, as can be seen in Figure 1.

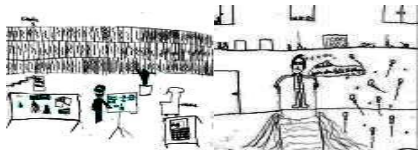



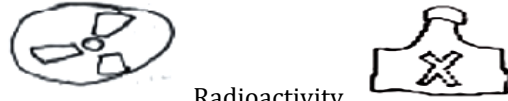




Based upon these findings, Chambers (1983) identified the indicators of the image previously identified as the stereotypical image of a scientist by Mead and Metraux (1957). The seven indicators and figures illustrating them identified by Chambers (1983) are presented in Table 1.

Table 1. Indicators and figures illustrating them in the drawings identified by Chambers (1983)

Indicators	Figures in Drawings
Lab coat	
Eye Glasses	
Facial Hair	
Symbols of Research	   Beaker Flask Test tubes, etc.
Symbols of Knowledge	  Books or annotations Bookcase
Symbols of Technology	  Robot Rocket, etc.
Relevant Captions	 Formulae, symbols, etc. written on the board or paper

As seen in Table 1, Chambers (1983) reported that the lab coat is represented by the figure of the white coat worn by the scientist, glasses by the spectacles, facial hair by a beard and/or a moustache, symbols of knowledge by figures like books or a bookshelf, symbols of research by figures like test tubes and beakers, symbols of technology by figures such as a robot or rocket and relevant captions by figures like equations and chemical formulae written on the board or paper. Subsequently, many studies were carried out on the basis of the DAST and the indicators identified by Chambers were used to analyze the images held by individuals. Later, however, Finson, Beaver and Cramond (1995) developed the Draw-A-Scientist Test-Check list (DAST-C) to facilitate the evaluation of the drawings of scientists by using eight more indicators in addition to the seven indicators identified by Chambers (1983). The indicators added by Finson et al. (1995) and the figures illustrating these indicators are presented in Table 2.

Table 2. Additional indicators and figures illustrating them identified in DAST-C by Finson et al. (1995)

Indicators	Figures in Drawings
Working Indoors	 Study Laboratory
Male (Gender)	 Man
Old/Middle-aged	
Working Alone	
Indicators of Danger	 Radioactivity
Indicators of Secrecy	 Signs and Warnings
Presence of Light Bulbs	
Caucasian	
Mythical Stereotypes	 Dr. Frankenstein

In Table 2, the indicators and figures representing the stereotypical scientist identified by Finson et al. (1995) are presented accordingly, with the indicator of working indoors represented by the figure of a study or laboratory, that of male gender by a man and that of old/middle-aged by an elderly or middle-aged man. The figure of a person alone symbolizes the indicator of working alone, signs for radioactive substances are indicators of danger and warnings or signs such as 'Keep Out' and 'Do Not Enter' indicate secrecy. The presence of light bulbs is depicted by a person with a light bulb lit up over his head, while the indicator of a Caucasian is represented by a human figure with a light-colored face and finally, figures like Dr. Frankenstein symbolize the mythical stereotype of the scientist. In addition to the alternative characteristics identified by Finson et al. (1995), among the indicators of the stereotypical image of the scientist are the elements of the lab coat, eye glasses, beard and/or moustache, symbols of knowledge like books or bookshelves, symbols of research like test tubes and beakers and symbols of technology like batteries and cables. Also included are working in a closed setting such as a laboratory or study with signs of secrecy and danger, working alone,

being a white, elderly or middle-aged male with a light bulb lit up over his head and being a mythical character like Dr. Frankenstein. The indicators identified by Chambers (1983) and Finson et al. (1995) are commonly found in the literature. At a later time, Finson (2003) came up with several additional indicators of the stereotypical image of a scientist. These include hairstyle (bald or unkempt hair), facial expression (smiling or angry), chemical liquids boiling with smoke, bubbles indicating thoughts, and question marks.

Using the DAST introduced by Chambers (1983), a large number of studies have attempted to identify the stereotypical image of the scientist held by the students of diverse grade levels in different countries worldwide (Medina-Jerez, Middleton & Orihuela-Rabaza, 2011; She, 1998). In these studies, the indicators identified by Chambers (1983) and those put forward by Finson et al. (1995) in the DAST-C have been frequently used to evaluate student drawings of a scientist. These studies have revealed that students generally hold the stereotypical image of the scientist. Since 2000, similar studies have been carried out in Turkey. The results of these studies (Karacam, 2016a; Ozgelen, 2012; Turkmen, 2008; Yontar-Togrol, 2000) showed that Turkish students of various grade levels also hold the stereotypical image of the scientist.

Significance of the study

Mead and Metraux were the first to set out to identify the image that individuals have of the scientist and it was suggested in their seminal study in 1957 that individuals in general portrayed the stereotypical image of the scientist identified by Mead and Metraux. Building on the 1983 study of Mead and Metraux, Chambers (1983) developed the DAST to measure the degree of the stereotypical image held by individuals of the scientist and introduced to the field the seven indicators for investigating student perceptions of the scientist. Since 1983, a growing body of studies has been based on the approach developed by Chambers. However, many studies have also been conducted to revise the weaknesses of the theoretical basis formed by the DAST and the seven indicators. Finson et al. (1995) developed the DAST-C, a checklist that includes nine standards or indicators serving as alternatives to evaluate the drawings produced from the DAST. In a similar study conducted by Finson (2003), characteristics such as hairstyle (bald or unkempt hair), facial expression, (smiling or angry), chemical liquids boiling with smoke, bubbles indicating thoughts, and question marks were proposed; however, these were not recognized as stereotypical indicators.

As attested by the literature, many studies have been carried out in various countries using the DAST which have revealed that students from different grade levels hold what is described as the stereotypical image of the scientist. Although carried out in different countries and across different grade levels, these studies produced similar results, which could primarily be attributed to the fact that all utilized the data from the DAST within the scope of the indicators introduced by the DAST-C. In these studies, figures drawn by the students other than those representing the indicators of the DAST-C were disregarded. However, students also drew different objects apart from the figures symbolizing the stereotypical indicators of the DAST-C, such as clocks, table lamps, crumpled papers, and wastepaper baskets overflowing with crumpled papers, as can be seen in Figure 2.



Figure 2. Drawing of a scientist

Students assign meanings to these objects and thus draw them in their pictures because they associate them with the scientist. For that reason, there is a need to analyze the meanings that students assign to objects other than the figures representing the stereotypical indicators of a scientist. The possibility that these objects could be considered as indicators of the stereotypical image of a scientist should be investigated. Accordingly, the present study examined the meanings assigned by pre-service teachers to the waste paper and wastepaper baskets drawn in their pictures of a

scientist and the significance of the waste paper and wastepaper baskets as symbolizing a stereotypical indicator was considered.

Research Question

What is the meaning assigned by pre-service teachers to the waste paper and wastepaper baskets in their drawings of a scientist?

Purpose

The purpose of this study was to investigate the meanings assigned by pre-service teachers to the waste paper and wastepaper baskets in the pictures of a scientist they drew, and to determine the possibility that the figures of waste paper and wastepaper baskets could indicate the stereotypical image of a scientist.

Methodology of Research

Focusing on the meanings assigned by pre-service teachers to the waste paper and wastepaper baskets in the pictures of a scientist they drew, the present study used the phenomenological (qualitative data analysis) research method, which in social sciences, according to Creswell (2013), describes a common meaning held by several individuals of their life experience of a concept or a phenomenon. On the basis of Creswell's perspective, the waste paper and the wastepaper baskets drawn in the pictures of a scientist were identified as the phenomenon and the meanings assigned to this phenomenon were investigated.

Data collection

The research data was collected in the fall of the 2015-2016 academic years. First, pre-service teachers were asked to draw a picture of a working scientist on a piece of paper. The pre-service teachers were told that they were expected to portray the work environment of a scientist, the tools and equipment used while working and the appearance of the scientist. In addition, they were also told that they were free to use crayons and write on their drawings if they wished. They were given one hour of class time (50 minutes) to finish their drawings. In the second lesson, the pre-service teachers were requested to write a description of their scientists on the other side of the paper. The teachers were told that they were expected to give their opinions about the appearance of the scientist, what work was being done in the picture, what equipment was being used and the kind of person the scientist was. They were given another 50 minutes to describe their pictures. Their pictures were then checked for the presence of waste paper and wastepaper baskets and those who included these in their pictures were interviewed semi-structurally two weeks later.

Study sample

The selection of the sample for this study was based on purposeful sampling. According to Entwistle (1997), purposeful sampling methods allow in-depth investigation of given cases. Within the scope of this sampling method, it was ensured that the teachers had not previously taken courses related to history of science and/or scientific research. Therefore, the study included 220 first- and second-year students (pre-service teachers) from the Departments of Psychological Counseling and Guidance Education, Primary School Education and Science Education. Semi-structured interviews were held with the 34 students who had included the figures of wastepaper and wastepaper baskets in their pictures and their data were analyzed.

Data collection instruments

Draw-A-Scientist Test (DAST): This test was used to identify the meanings assigned by the pre-service teachers to the waste paper and wastepaper baskets in their drawings of a scientist. Developed by Chambers (1983), the DAST has been used in many studies (Fung, 2002; Rosenthal, 1993) to identify the image of the scientist held by individuals. In the DAST, students are asked to draw a picture of a scientist and explain/describe the scientist they draw. However, in the 1980s, studies focusing on the reliability of the DAST (Farland & McComas, 2006; Maoldomhnaigh & Hunt, 1988) suggested two ways to increase the reliability of the data obtained from the DAST. The first was to ask students to draw more than one scientist. The other was to use more than one data instrument to identify the image of the scientist held by students. Thus, in more recent studies (Koren & Bar, 2009; Scherz & Oren, 2006) individuals were asked to draw and describe the picture of a scientist, as in the DAST, and then semi-structured interviews were conducted within the scope of their drawings and explanations. In accordance with the current trends in the literature, the present study asked the pre-service teachers to draw a working scientist and explain/describe their drawings in an attempt to explore the meanings assigned to the waste paper and the wastepaper baskets they drew in their pictures. Semi-structured interviews were then conducted with those who drew waste paper and wastepaper baskets in their pictures in order to obtain detailed data about the meanings assigned to the waste paper and wastepaper baskets.

Data analysis

For the analysis of the data, drawings of the teachers, their explanations of the drawings and the data from the interviews were combined and the combination of these three datasets was analyzed via the content analysis technique. This technique was defined by Merriam (1992) as a process in which the data is coded and the categories

describing the basic data properties are generated concurrently; following this process, the meanings in the content are grouped under themes and the relationships between them are described. After completion of the content analysis, three field experts coded the data obtained. This procedure was started once again after every ten students and the assigned codes were reviewed. In this way the consistency of the assigned codes was ensured. At the end of the coding process, the three field experts came together and examined the consistency among the assigned codes. It was seen that all the codes assigned by the three experts were grouped under one theme. The approach developed by Miles and Huberman (1994) was used to calculate the percentage of consistency of the codes assigned by the three experts, and they were found to be 100 percent consistent.

Results

The present study was carried out to investigate the meanings assigned by pre-service teachers to the waste paper and wastepaper baskets they drew in their pictures. The results of the study showed that 34 (15.45%) of 220 pre-service teachers included waste paper and wastepaper baskets in their pictures. The explanations of the 34 teachers who drew waste paper and wastepaper baskets and the data from their semi-structured interviews were analyzed using content analysis and the results indicated that the meanings attributed to the waste paper and wastepaper baskets by the teachers were grouped under one theme, which was identified as 'The Confirmatory Experimental Scientific Method'.

Confirmatory experimental scientific method

The confirmatory experimental method is based on the results of an exploratory study in which experimenters can intelligently propose an experimental hypothesis and conduct an experiment for the purpose of confirming or disproving the hypothesis. Tugce and Esra Almila from the Department of Psychological Counseling and Guidance Education, Aslihan and Ummuhan from the Department of Primary School Education and Nurdane and Meryem from the Department of Science Education were chosen from among the students who emphasized this theme. The drawings of these students, the explanations they made following their drawings and the ideas they shared in their semi-structured interviews are presented below.



Figure 3. Tugce's drawing

Figure 3 presents the scientist drawn by Tugce – a student from the Department of Psychological Counseling and Guidance Education. She drew a male scientist working in the field of genetics and described her drawing, which included a wastepaper basket, as follows: *'The scientist I drew is the kind of person who would prefer to observe and listen to people rather than have a conversation with them. He is very curious and questions almost everything. He loves reading. He likes making observations. He pays attention to things that others do not. Right now, he is examining a living being under the microscope in his study at home. That is, he is conducting studies on genetics. He is writing down what he sees under the microscope. He is trying again and again and taking notes. When he writes better notes, the previous ones go into the wastepaper basket.'*

In the interview with Tugce:

Researcher: *'You interpreted the waste paper in your drawing as "He is writing down what he sees under the microscope. He is trying again and again and taking notes. When he writes better notes, the previous ones go into the wastepaper basket". Could you clarify it a little?'*

Tugce: *'He is working. His wastepaper basket is even a bit overflowing with crumpled papers. He is always trying to find out something by trial and error.'*

Researcher: 'What kind of path is your scientist following with the method you calls trial and error?'

Tugce: 'In the trial and error method, firstly, he makes a hypothesis. He tests his hypothesis by examining things under the microscope. He observes whether his thinking is in the right direction. He starts over again if his ideas do not prove successful. He again puts forward another hypothesis. This is the case with my scientist and he has therefore thrown away the papers. He has worked, worked, and tried hard and his wastepaper basket is overflowing.'

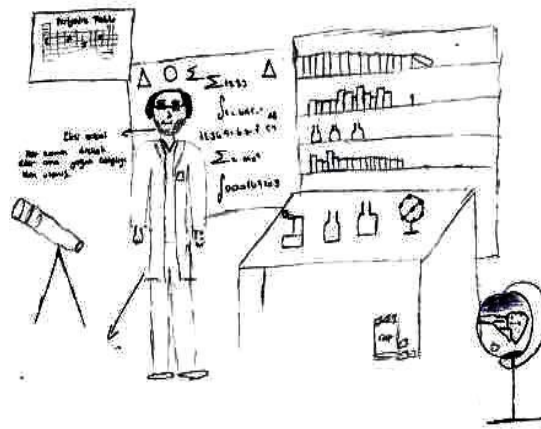


Figure 4. Esra Almila's drawing

Figure 4 presents the scientist drawn by Esra Almila – another student from the Department of Psychological Counseling and Guidance Education. She drew a male scientist working in the field of physics and chemistry and described her drawing and the waste paper and wastepaper basket in her drawing as follows: 'Though the scientist in my picture is almost in his 40s, he is already worn out. He is tired, yet the idea of being a scientist keeps him going. He has lost his hair... due to working hard. He is single, of course. He can't find time to take care of his beard. Fortunately, his hair is gone so he does not need to take care of it. He is wearing a coat, a fundamental requirement of his workplace. He has plenty of books. You need prior knowledge to develop something. Books make it possible. The wastepaper basket is overflowing with failed attempts.'

During the interview with Esra Almila:

Researcher: 'The wastepaper basket is overflowing with...well... they must probably be crumpled papers?'

Esra Almila: 'Yes.'

Researcher: 'After drawing your picture, you interpreted the waste paper and wastepaper basket as "The wastepaper basket is overflowing with failed attempts." What do you mean by failed attempts? Can you explain it a little more?'

Esra Almila: 'The wastepaper basket is the indicator of his unsuccessful experimental trials. After all, an experiment ends after going through several stages. I think it is hard to succeed after one trial. The wastepaper basket and the vast amount of paper in it symbolize the failed attempts.'

The drawing by Nurdane, a student from the Department of Science Education, is given in Figure 5. She drew a male chemist in his thirties, wearing a lab coat and glasses. Nurdane delineated the reason why she drew a wastepaper basket and wastepaper in her picture as follows: 'The scientist I drew is doing experiments in his lab. He never takes off his coat in his lab. The place where he spends most of his time is his library. He learns what he doesn't know by reading. He experiments with what he has learned. He tests to see if it is valid and accurate. He starts over again if it is not. The crumpled papers on the floor are the evidence of his mistakes. He went wrong and then he crumpled and threw the papers away.'

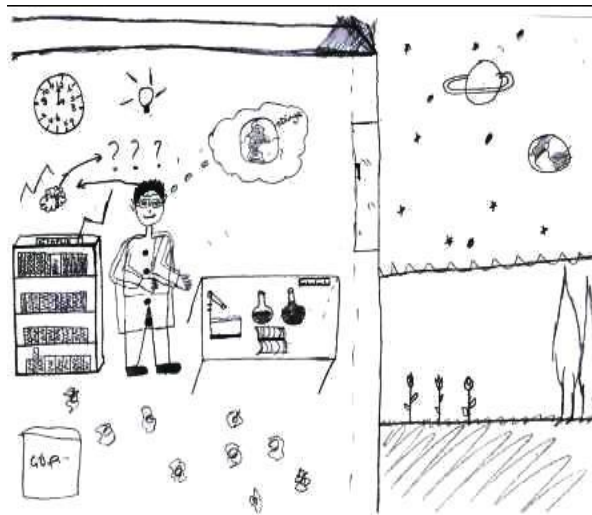


Figure 5. Nurdane's drawing

In the interview with Nurdane about her drawing:

Researcher: 'Why did you draw crumpled papers, Nurdane?'

Nurdane: 'I drew a wastepaper basket, and lots of waste paper. The waste paper shows that the scientist has made many mistakes. He makes more of them. He gets it wrong each time and he therefore wastes tons of paper until he gets a positive result. It is not right to call it a mistake. He has an idea in his mind... he has a sort of theory. He struggles to prove its validity by performing experiments. When the result of his experiment does not support this theory, he crumples the paper and throws it away. It goes on like that until he gets the desired result. That is why I have drawn lots of wastepaper and a wastepaper basket.'

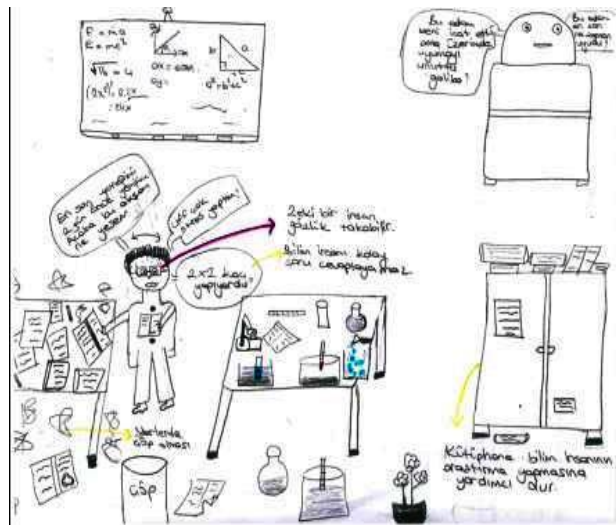


Figure 6. Meryem's drawing

Meryem is another student from the Department of Science Education who included waste paper and a wastepaper basket in her drawing. She drew a scientist and a technician at the same time, working in the fields of biology and chemistry (Fig. 6). Meryem made the following explanation for the waste paper and wastepaper basket: 'The scientist I drew is a 35-year-old man. As he has a very busy schedule, he is the sort of person who hardly sleeps and eats: that is, he doesn't care about his everyday needs. He would rather do experiments and keep busy with something than spend time with his family. He spends so much time on his experiments... time is very important for him. When he does an experiment with an unsatisfactory result, he does not even take the trouble to erase it. He crumples the paper and throws it away and starts over again with a clean paper.'

After making the explanation above about the waste paper and the wastepaper basket that she drew, Meryem shared the following ideas in the interview:

Researcher: 'For the waste paper and wastepaper basket in your picture, you said "When he does an experiment with an unsatisfactory result, he does not even take the trouble to erase it. He throws the paper away and starts over again with a clean paper." Can you please give us a few more details?'

Meryem: 'Well, he does not like some of the studies he conducts. He throws them away. He makes a new beginning... starting with a clean sheet of paper.'

Researcher: 'You say he does not like them. Why not?'

Meryem: 'What I actually mean is that he cannot produce the desired effect. He tests his idea that he had formed prior to the experiment. If he cannot prove his idea, that means he has a negative result. Something is wrong somewhere. For that reason, he needs to take it from the beginning. That is the reason why he crumples and throws away the papers with negative results and starts the experiment over again... with a clean sheet of paper.'



Figure 7. Aslihan's drawing

The picture in Figure 7 was drawn by Aslihan, a student from the Department of Primary School Education. She is one of those who drew some waste paper and a wastepaper basket. Aslihan described the scientist in her drawing as follows: 'Time has worn him out. He has never achieved the position he has dreamt of for so long. However, he has always been determined to prove his theories and make his experiments work at any cost. He has made so many attempts that his wastepaper basket is overflowing with papers. Nevertheless, he has never been able to prove his theory...'

In the interview with Aslihan about her drawing of a scientist:

Researcher: 'Why did you draw a wastepaper basket and waste paper?'

Aslihan: 'I drew them because I wanted to show his trials and errors... and lots of papers resulting from his failed attempts.'

Researcher: 'Can you explain further the trials and errors?'

Aslihan: 'As I mentioned in my explanation, this scientist has read many books. He is developing his theory by reading books. He has to prove his theory by doing experiments. Here, he has performed an experiment yet he could not prove his theory and he therefore threw it into the wastepaper basket. He has started another experiment. It went on like that until he proved it. That is why I called it "trial and error".'



Figure 8. Ummuhan's drawing

Ummuhan is another student from the Department of Primary School Education who drew a wastepaper basket and waste paper in her picture. Her drawing showing a male chemist is presented in Figure 8. Here is how she interpreted the wastepaper basket and waste paper in her drawing: *'With his unkempt hair and beard and wrinkled clothes, Mr. Mahmut is a man in his thirties. As he cannot leave because of working hard, he is using one of the rooms at home to do his experiments. Mr. Mahmut is very keen on working and most of the time he is working non-stop. Recently, he has lost weight, from 80 kg to 65 kg, as he is eating less. He cannot find time for anything but his experiments. He is wearing glasses because he has poor eyesight due to working hard. Rather than writing on a board, he prefers a notebook to take notes about his experiments and he has to tear out and throw away the papers when the result of his experiment is negative.'*

After describing her picture, Ummuhan talked about the wastepaper basket and wastepaper:

Researcher: *'You say that Mr. Mahmut writes in a notebook and tears out and throws away the paper when the result is negative. Can you elucidate what you mean by that?'*

Ummuhan: *'Well Sir, before the experiment, the scientist had prior knowledge regarding the experiment and its result. He had already acquired this knowledge from books. He tries to prove this knowledge by means of the experiment he conducts. If he cannot attain this knowledge at the end of the experiment, then it means he has made a mistake somewhere. Mr. Mahmut tears out and throws the paper in the wastepaper basket when the result is disappointing. Then he starts over again.'*

Tugce and Esra Almila from the Department of Psychological Counseling and Guidance Education, Aslihan and Ummuhan from the Department of Primary School Education and Nurdane and Meryem from the Department of Science Education drew crumpled papers scattered around the floor and a wastepaper basket overflowing with crumpled papers in their pictures of a scientist.

Examination of the reasons why these pre-service teachers drew a wastepaper basket and waste paper, or in other words, analyses of their explanations and their opinions about the meanings that they assigned to the wastepaper basket and the waste paper revealed similarities although the students were enrolled in different departments at the university. The fundamental similarity in the statements of the pre-service teachers was that the wastepaper basket overflowing with crumpled papers symbolized the process of achieving a good (positive) result. According to the pre-service teachers, the good (positive) result was not a product (knowledge) obtained at the end of an experiment or observation, rather it was the idea/knowledge generated by the scientist at the beginning of the experiment. The research undertaken by the scientist prior to the experiment was described as a hypothesis by Tugce, an idea by Meryem, knowledge by Ummuhan and a theory by Aslihan. Before starting the experiment, the scientist created this idea/hypothesis/knowledge/theory by reading books about the experiment he planned to do. The pre-service teachers thought that the scientist conducted the experiments for the purpose of proving the hypothesis he had put forward prior to the experiments. That is, the hypothesis proposed by the scientist prior to the experiments was definitely true and the results of the experiments must not be contradictory. Thus, if the scientist obtained a result different than expected, then the experiment was repeated. The repetition process continued until the hypothesis was proven.

The most important part of the meanings that the pre-service teachers attributed to the waste paper and wastepaper basket is that they regarded the scientific method as a confirmation of the concepts constructed before the experiments. Aslihan and Tugce defined the confirmatory thought process as a trial-and-error scientific method. Oner-Armagan (2015) found similar results for the perception of the experiment as the confirmation of thoughts through trials. Oner-Armagan (2015) concluded that 21 of 50 seventh-grade students associated the concept of science with the concept of experiments, and six of these students associated the concept of experiments with the concept of trials. If we take into consideration that the pre-service teachers regarded the waste paper and wastepaper basket as representing the scientific method of trial and error, we can then define the scientific method as the cognitive strategy of the scientist during the confirmatory process. We therefore ignore the aspect that scientific method is the by the scientists' process of constructing new thoughts through reading existing theories in books. All the meanings attributed by the pre-service teachers to the waste paper and wastepaper basket as the scientific method can be seen in the study of Carey, Evans, Honda, Jay and Unger (1989), which gives a rubric for assessing seventh-grade students' perceptions of the nature of science. Typical answers of the second-year students were 'the scientist is testing an idea', 'the idea is tested to see if it is right', or 'the idea is used to predict the outcome of an experiment', and 'scientists do experiments to test to see if their idea is right.' The idea and experiment are clearly distinguished. 'If the results of the experiment are unexpected, then something requires attention. The scientists might think something went wrong in the way the experiment was conducted, so they go back to fix it, or, they would change their idea.' However, the second-year responses provided no explanation of the constraints for these changes. The views of the second-year students conformed to the confirmatory process. For this reason, the theme was designated as the 'The Confirmatory Experimental Scientific Method'.

Discussion

The present study was carried out to investigate the meanings assigned by pre-service teachers to the wastepaper baskets and waste paper they drew in their pictures of a scientist. Results revealed that the 34 pre-service teachers who included a wastepaper basket and waste paper in their drawings drew these objects to indicate the confirmatory

experimental process although they were enrolled in different departments at the university. In other words, it was seen that by drawing a wastepaper basket and waste paper in their pictures, the pre-service teachers actually implied that scientists use the confirmatory experimental process in their scientific studies. It was found that the pre-service teachers described the stages that a scientist follows while doing scientific research via a confirmatory experimental process, which include

- i. collecting information by reading books about the experiment,
- ii. forming a hypothesis/an idea/knowledge/a theory which is the absolute truth based on the information collected from books,
- iii. doing experiments to prove the hypothesis/idea/knowledge/theory he has formed, and
- iv. repeating the experiment until the hypothesis/idea/knowledge/theory is proven.

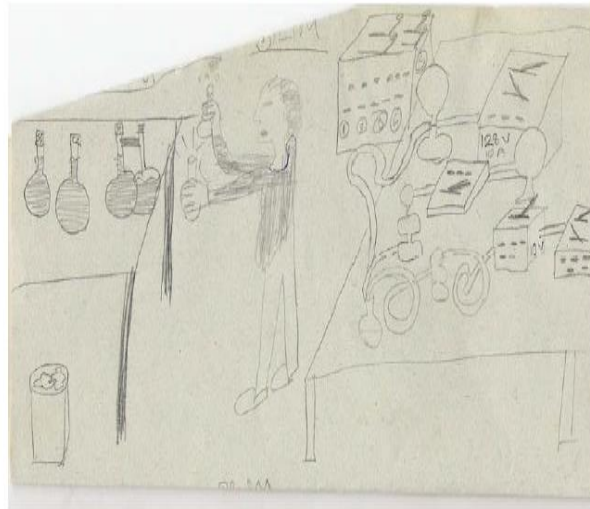


Figure 9. Drawing of a scientist by a student in Ocal's study (2007)

A number of studies in the literature about individual perceptions of the nature of science (Tsai, 1999; Tuken, 2010) have concluded that students have a perception of the confirmatory aspect of scientific experimentation. Tsai (1999) claimed that these perceptions of students about science experiments result from the positivist perspectives of their teachers about the nature of science. However, an analysis of the studies in the literature undertaken to identify the image of a scientist showed that although wastepaper baskets and wastepaper were portrayed in the drawings of a scientist, when evaluating the images of the scientist, researchers disregarded these figures. For instance, a student drew a wastepaper basket full of waste material (as can be seen in Figure 9), yet Ocal (2007) did not take this figure into consideration in his assessment of the drawing. The main reason why studies in the literature disregard the wastepaper baskets and waste paper drawn in the pictures of a scientist is that researchers analyze the pictures or drawings based on the stereotypical indicators identified by Chambers (1983) and Finson et al. (1995). There is no indicator representing the wastepaper basket or waste paper among the stereotypical indicators identified by Chambers (1983) or those added later by Finson et al. (1995). For that reason, researchers only focus on the figures symbolizing the stereotypical image of a scientist, and pay no attention to other figures when analyzing individual drawings.



Figure 10. Busra's drawing

Here, the most important question is 'Can we approach the wastepaper basket and waste paper as an indicator of the stereotypical image of a scientist?' We need to examine the meaning of the word *stereotype* and its use in the literature in order to decide whether to identify the waste (crumpled) paper and the wastepaper basket overflowing with waste paper as an indicator of the stereotypical image of a scientist. In the dictionary developed by the Turkish Language Association (2005), *stereotype* is defined as 'lacking the quality of being original; solid or fixed; a way to repeat what is already known, like a slogan'. As given in the definition, characterizing something as stereotypical requires it to be unoriginal and occur in a way as to repeat what is already known. This definition refers to one-to-one copying of a stereotypical situation or image from any source. Accordingly, it is argued in the literature that the stereotypical image of the scientist is copied from textbooks or written and visual media (Steinke, 2005; Turkmen, 2008). The picture in Figure 10 showing a scientist and a wastepaper basket and some waste paper was drawn by Busra, and she explained why she drew a wastepaper basket and waste paper as follows: '*The waste paper I drew indicates that the scientist is trying to produce something by trial and error. He has tried so many things that the floor is covered with lots of waste papers. He is about to tear his hair out. He has tried and tried yet failed each time. He's become exhausted as he could not prove his theory. Anyway, this is depicted the same way in the cartoons...*'

Busra said that the image of the wastepaper basket and wastepaper is shown in cartoons and she acquired this image from the cartoons. It is possible to see similar caricatures and pictures in various written and visual media. The caricature in Figure 11 and the picture in Figure 12 are examples of this. The figures of wastepaper baskets and waste paper drawn in the pictures of the scientist could be interpreted as representing an indicator of the stereotypical image of a scientist. This is supported by the ideas shared by Busra, the caricatures in the written and visual media, the definition of 'stereotype' provided by the dictionary of the Turkish Language Association and the approach towards the stereotypical scientist in the literature.



Figure 11. Example of a caricature



Figure 12. Example from visual media

The acquisition of the image of the wastepaper basket and waste paper in pictures of scientists by means of the written and visual media seems to be an important reason to identify these figures as an indicator of the stereotypical image of the scientist. Nevertheless, the fact that the frequency of the wastepaper basket and waste paper in the students' drawings of scientists is lower than the frequency of drawings of stereotypical indicators such as a lab coat, a man and glasses might be considered an obstacle in the path of their acceptance as standard indicators. However, the results of previous studies undertaken to investigate the scientist stereotypes (Karacam, 2016b; She, 1998; Turkmen, 2008) showed that the frequency of the *relevant captions* identified by Chambers (1983) as indicators of the stereotypical image of the scientist varied between 7% and 11% in the drawings. The frequency of the indicator represented by the figures of a wastepaper basket and waste paper in this study was found to be 15.45%. Because this frequency percentage is higher than that of the *relevant captions*, there seems to be no reason not to accept them as an indicator of the stereotypical image of the scientist.

Consequently, it might be suggested that the figures of wastepaper baskets and waste paper symbolize a stereotypical indicator as they are consistent with the definition of stereotype and the common approach towards the stereotypical indicators of the scientist in the literature, even though the frequency of these figures is low. When the meanings attributed to waste paper and wastepaper baskets were examined, it was seen that with these figures the pre-service teachers showed that when scientists conduct scientific research, they follow a confirmatory experimental process similar to the methods employed in many science classes. The waste paper and wastepaper baskets in the drawings of the pre-service teachers represent a scientific process that is defined as a scientific method. Thus, it might be asserted that the waste paper and wastepaper basket is a stereotype indicator of the scientific method.

Conclusion and Implications

This study aimed to determine the meanings assigned by pre-service teachers to the waste (crumpled) paper and the wastepaper baskets in their drawings. It was found that with these figures the pre-service teachers showed that when scientists conduct scientific research they follow a confirmatory experimental process similar to that carried out in student science classes. It was concluded that the figures of the wastepaper basket and waste paper represent an indicator of the stereotypical image of the scientist because the images in written and visual media have inspired these figures and thus, they lack originality.

It is noteworthy that triangulation has generally been used to increase the reliability of obtained data, as reported in the existing DAST studies in the literature. In other words, within the DAST, the students were asked to draw a working scientist and explain the drawn scientist. Interviews were then conducted based on the obtained data from these processes. However, the drawings were evaluated through the dimensions of appearance, working environment, gender and knowledge of the scientist, research (chemistry) and technology. Questions related to these dimensions were then used during the interviews, regardless of the use of the triangulation method in these studies. Hence, considering waste paper and wastepaper baskets as an indicator for a stereotypical scientist image may allow the researchers to interpret the data obtained from DAST in detail. It can be claimed that as a result of the detailed interpretation, the findings will be more reliable and thereby positively affecting the validity of DAST. Although the results of this study, which included 220 pre-service teachers, suggested that the wastepaper basket and waste paper in the drawings of a scientist could be an indicator of method, this perception needs to be tested across different grade levels and population sizes. Moreover, there are a few unchallenged points within the study. One of these is that since both the waste paper and wastepaper baskets appear in the drawings at the same time, we cannot know whether or not the students had a perception of any of them as a scientific method. The second point is whether the students who did not draw waste paper and wastepaper baskets had the aforementioned indicator of a scientific method. According to the studies in the literature, even if the student does not draw a lab coat, we cannot make an inference that the student does not hold this kind of image; however, this lab coat image can be thought of as a less dominant image than one drawn. For this reason, we cannot claim that the students who did not draw waste paper or wastepaper baskets did not hold such indicators of scientific method. However, as mentioned above, we can view this type of indicator as less dominant. In this regard, the scientific method used by the scientist in these student images should be questioned. Future studies taking this point into consideration will allow this uncertainty to be resolved.

In addition, there are figures like a clock that are disregarded because they do not represent the stereotypical image of a scientist despite their presence not only in this study but also in a number of studies in the literature. Therefore, there is a need for further research to assess whether these figures and the meanings attributed to them are an indicator of the stereotypical scientist. Findings obtained from studies investigating the scientist images held by individuals will make it possible to analyze the drawings in more detail.

References

- Beardslee, D. C., & O'Dowd, D. D. (1961). The college-student image of the scientist. *Science*, 133(3457), 997–1001.
- Carey, S., Evans, R., Honda, M., Jay, E., & Unger, C. (1989). An experiment is when you try it and see if it works: A study of grade 7 students' understanding of the construction of scientific knowledge. *International Journal of Science Education [Special issue]*, 11, 514–529.
- Chambers, D. W. (1983). Stereotypic images of the scientist: The A-Draw-A-Scientist Test. *Science Education*, 67(2), 255–265.
- Creswell, J. (2013). *Qualitative inquiry and research design: Choosing among five approaches*. London, UK: SAGE Publications.
- Entwistle, N. (1997). Introduction: Phenomenography in higher education. *Higher Education Research & Development*, 16(2), 127–134.
- Farland, D., & McComas, W. (2006). *Deconstructing the DAST: Development of a valid and reliable tool for assessing students' perceptions of scientists*. Paper presented at the Association of Science Teacher Education Conference, Clearwater, FL.
- Finson, K. D., Beaver, J. B., & Cramond, B. L. (1995). Development and field tests of a checklist for the Draw-A-Scientist Test. *School Science and Mathematics*, 95(4), 195–205.
- Finson, K. D. (2003). Applicability of the DAST-C to the images of scientists drawn by students of different racial groups. *Journal of Elementary Science Education*, 15(1), 15–26.
- Fung, Y. Y. H. (2002). A comparative study of primary and secondary school students' images of scientists. *Research in Science & Technological Education*, 20(2), 199–213.
- Karacam, S. (2016a). Scientist-image stereotypes: The relationships among their indicators. *Educational Sciences: Theory & Practice*, 16(3), 1027–1049.
- Karacam, S. (2016b). Investigating how the biographies of today's scientists affect 8th graders' scientist image. *Eurasia Journal of Mathematics, Science & Technology Education*, 12(8), 1971–1995.
- Koren, P., & Bar, V. (2009). Pupils' image of 'the scientist' among two communities in Israel: A comparative study. *International Journal of Science Education*, 31(18), 2485–2509.
- Krajcovich, J. G., & Smith, J. K. (1982). The development of the image of science and scientists scale. *Journal of Research in Science Teaching*, 19, 39–44.
- Kurnaz, M. A., Tarakci, F., Saydam, A., & Pektas, M. (2013). Elektriklenme, yildirim ve simsek ile ilgili ogrenci zihinsel modellerinin incelenmesi [An analysis of high school students' mental models of electrification, thunder and lightning]. *Usak University Journal of Social Sciences*, 6(4), 33–51.
- Kurnaz, M. A., & Degirmenci, A. (2012). 7. Sınıf ogrencilerinin güneş, dünya ve ay ile ilgili zihinsel modelleri [Mental models of 7th grade students on the Sun, Earth and Moon]. *Elementary Education Online*, 11(1), 137–150.
- Kurnaz, M. A., & Eksi, C. (2015). An analysis of high school students' mental models of solid friction in physics. *Educational Sciences: Theory & Practice*, 15(3), 787–795.
- Mandler, J. M. (1992). How to build a baby: II. Conceptual primitives. *Psychological Review*, 99, 587–604.
- Maoldomhnaigh, M., & Hunt, A. (1988). Some factors affecting the image of the scientist drawn by older primary school pupils. *Research in Science & Technological Education*, 6, 159–166.
- Mead, M., & Metraux, R. (1957). Images of the scientists among high-school students. *Science*, 126, 384–390.
- Medina-Jerez, W., Middleton, K. V., & Orihuela-Rabaza, W. (2011). Using the DAST-C to explore Colombian and Bolivian students' images of a scientist. *International Journal of Science and Mathematics Education*, 9(3), 657–690.
- Merriam, S. (1992). *Qualitative research and case study applications in education*. San Francisco, CA: Jossey-Bass.
- Miles, M. B., & Huberman, A. M. (1994). *Qualitative Data Analysis*. Thousand Oaks, CA: SAGE Publications.
- Ocal, E. (2007). *Ilkogretim 6, 7, 8. sınıf öğrencilerinin bilim insanı hakkındaki imaj ve görüşlerinin belirlenmesi* [Determination of the image and opinions of 6th, 7th and 8th grade primary education students about scientists] (Unpublished master's thesis). Gazi University Institute of Educational Sciences, Ankara, Turkey.
- Oner-Armagan, F. (2015). Cognitive structures of elementary school students: What is science? *European Journal of Physics Education*, 6(2), 54–73.

- Ozgelten, S. (2012). Turkish young children's views on science and the scientist. *Educational Sciences: Theory & Practice [Special issue]*, 12, 3211–3225.
- Rosenthal, D. B. (1993). Images of scientists: A comparison of biology and liberal studies majors. *School Science and Mathematics*, 93(4), 212–216.
- Scherz, Z., & Oren, M. (2006). How to change students' images of science and technology. *Science Education*, 90(6), 965–985.
- She, H. (1998). Gender and grade level differences in Taiwan students' stereotypes of science and scientists. *Research in Science & Technological Education*, 16(2), 125–135.
- Steinke, J. (2005). Cultural representations of gender and science: Portrayals of female scientists and engineers in popular films. *Science Communication*, 27, 27–63.
- Tsai, C. C. (1999). "Laboratory exercises help me memorize the scientific truths": A study of eighth graders' scientific epistemological views and learning in laboratory activities. *Science Education*, 83(6), 671.
- Tuken, G. (2010). *Kentlerde ve kırsal kesimde öğrenim gören öğrencilerin bilimsel epistemolojik inanclarinin belirlenmesi* [Determining scientific epistemological beliefs of students in urban and rural places] (Unpublished master's thesis). Osmangazi University Graduate School of Natural and Applied Sciences, Eskişehir, Turkey.
- Turkish Language Association (2005). *Türkçe sozluk* [Turkish dictionary]. Ankara, Turkey: Turkish Language Society.
- Turkmen, H. (2008). Turkish primary students' perceptions about scientists and what factors affect the image of the scientists. *Eurasia Journal of Mathematics, Science & Technology Education*, 4(1), 55–61.
- Yontar-Togrol, A. (2000). Öğrencilerin bilim insanı ile ilgili imgeleri [Student images of the scientist]. *Education and Science*, 25(118), 49–57.