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The effect of informal and formal interaction between scientists and children at a science camp on their images of scientists

Gulsen Leblebicioglu, Duygu Metin, Esra Yardimci, Pinar Seda Cetin
Abant Izzet Baysal University, Turkey

Abstract
A number of studies have already investigated children's stereotypical images of scientists as being male, old, bald, wearing eyeglasses, working in laboratories, and so forth. There have also been some interventions to impose more realistic images of scientists. In this study, a science camp was conducted in Turkey with a team of scientists consisting of elementary science education researchers. They interacted with the children throughout the camp both formally and informally. Twenty-four 6th and 7th grade students participated to the science camp. The science camp was conducted near a forest and big lake, and lasted ten days in July, 2008. The main goal of the science camp program was to introduce the nature of science and scientists. In one session of the science camp, the children's images of scientists were made explicit through analysis and discussion of their drawings of a scientist, and challenged by introducing them to three non-stereotypical scientists. The camp team consisting of scientists worked and stayed with the children throughout the science camp. Thus, they interacted with the children in formal and informal ways. The change in the children's images of scientists was researched by applying the Draw a Scientist Test (DAST) (Chambers, 1983) as pre- and post-test. Additionally, all the children were interviewed about their drawings. The only stereotypical images found in the pre-test were being male and slightly older. However, almost equal numbers of male and female scientists were drawn in the post-test, and most of them were middle aged or young. Other stereotypical images of scientists emerged less in the pre-test and decreased in the post-test. In conclusion, the science camp helped the children to realize the human nature of scientists.

Keywords: Draw a scientist test (DAST), stereotypical images of scientists, informal learning environments, science camp

Introduction

Investigating children's images of scientists has been an important issue for science educators (e.g. Cakmakci, Tosun, Turgut, Orenler, Sengul, & Top, 2011; Turkmen, 2008; Kaya, Dogan, & Ocal, 2008; Yvonne, 2002; Song & Kim, 1999). The reason for this interest is the increasing recognition in the science education community that children's images of scientists affects their attitudes toward science and their interest in scientific careers (She, 1998; Boylan, Hill, Walace, & Wheeler, 1992). Since scientific and technological developments are important for all countries and continuing human support is a reality, examining children's images of scientists and helping them to develop more realistic images is extremely crucial in attracting their interest in science.

Various research studies have been conducted to investigate children's images of scientists. These research studies reported that children have stereotypical images of scientists (e.g. Yvonne, 2002; Barman, Ostlund, Gatto, & Halferty, 1997; Finson, Beaver, & Cramond, 1995; Huber & Burton, 1995; She, 1995). The most common stereotypical images of scientists reported in the literature were male, old, wearing eyeglasses, bald, working in a laboratory wearing their laboratory coats. Moreover, secretly doing insane and dangerous things with chemicals in laboratories were also reported as stereotypical images of scientists (Finson, 2003).

The Draw a Scientist Test (DAST) developed by Chamber's (1983) was used to elicit children's images of scientists in most of the studies. Chambers reported seven elements of stereotypical images of scientists such as laboratory coats, eyeglasses, facial hair, symbols of research, symbols of knowledge, technology, and relevant captions. Since DAST is easy to apply and widely used, Finson et al. (1995) developed a checklist, DAST-C, to make it more reliably scored by different researchers. Finson (2003) applied DAST-C with children from different ethnic backgrounds to analyze the validity of DAST-C for diverse populations and reported it to be valid.

Although there has been extensive research into students' images of scientists in western countries, similar research studies have only been conducted in recent years in Turkey (Cakmakci et al., 2011; Akcay, 2011; Korkmaz & Kavak, 2010; Turkmen, 2008; Kaya et al., 2008; Buldu, 2006; Togrol Yontar, 2000). In the Turkish context, some studies (Cakmakci et al., 2011; Korkmaz & Kavak, 2010; Kaya et al., 2008; Togrol Yontar, 2000) provided results in parallel with western DAST studies in which children were found to have stereotypical images about scientists. On the other hand, in others, some stereotypical images of scientists such as having eyeglasses, facial hair, wild hair, wearing laboratory coats, doing dangerous and secret things emerged less than those reported in western cultures (Akcay, 2011; Turkmen, 2008; Buldu, 2006). The results of the studies conducted by Akcay (2011), Turkmen (2008) and Buldu (2006) indicated that stereotypical images of the scientists among Turkish children are slightly less than the ones revealed in western studies. An investigation conducted by Sjoberg (2000) corroborated this finding. Sjoberg reported that the image of science and scientists is more positive among students in undeveloped and developing countries than in developed countries. Similarly, Song & Kim (1999) reported that Korean children had less stereotypical images of scientists than in western studies.

Most of the DAST research studies have already investigated children's images of scientists by large scale applications of DAST, and have well documented the stereotypical images of scientists held by children (e.g. Schibeci, 2006; Yvonne, 2002; Barman et al., 1997; Finson, et al. 1995; Huber & Burton, 1995; She, 1995; Schibeci & Sorensen, 1983). Toward this end, the question arising is "How can we help children to develop more realistic images of scientists". However, intervention studies have been scarce (Cakmakci et al., 2011; Finson, 2002). One such study was a residential program in which university scientists came to the classrooms to interact with the students (Flick, 1990). The program was found to be effective in developing students' images of scientists as a children's role model.

The effects of hands on science activities on children's images of scientists have also been researched. Huber & Burton (1995) investigated the effect of a teacher training program based on hands on science experiments on their students' images of scientists. They applied DAST twice with a three month interval in some of the teacher trainees' classrooms. They found that while boys had more stereotypical images of scientists than girls, they developed more positive images than girls. Another study into the effectiveness of teaching science by hands-on science activities on children's images of scientists was an eight-week long intervention conducted in Australia by Jane, Fleer, & Gipps (2007). They applied a teaching unit at primary schools which basically consisted of hands-on science activities with small groups of children. They concluded that the teaching sequence of such activities provided by the pre-service teachers encouraged changes in the children's views of scientists.

Another interesting intervention to change students' images of science and technology was conducted by Scherz & Oren (2006). They included an investigation aspect in a science and technology program which included weekly student visits to research centers and technological sites. They reported that the program developed the students' images of science and technology. A somewhat similar study (Farland-Smith, 2006) in which female students worked side by side with scientists for a number of days in laboratories and field exercises resulted in a keen appreciation of the sciences among the majority of participants, and both a heightened and broadened awareness of science as a human endeavour.

In contrast to the above findings, Simonneaux, Albe, Ducamp, & Simonneaux (2005) designed a teaching intervention in which scientists held a series of three lectures on socio-scientific issues to high school students with a debate addressing students' perceptions of science and scientists directly following each lecture. They reported that the intervention had little effect on students' perceptions of science and scientists.

More recently in Turkey, Cakmakci et al (2011) conducted a quasi-experimental study into the effectiveness of evidence-informed instruction in promoting an inclusive image of scientists among students through a quasi-experimental study. They report that students following evidence-informed instruction had significant gains in the post-test regarding their images of scientists, compared to students receiving traditional instruction. After evidence-informed instruction, many students started to view scientists as realistic people rather than as extraordinary people or mythical creatures.

Rationale of the study

More interventions are needed in order to find ways to introduce scientists better and help children to develop more realistic images of scientists. All previous interventions except for those of Scherz & Oren (2006) and Farland-Smith (2006) studies were conducted in classrooms, which are formal learning environments. In both studies, the students had close contact with scientists at research institutes and they both reported positive changes in students' stereotypical images of scientists. Informal interaction can occur in various settings. For example, camp environments can provide many opportunities for participants' interaction. Science camps with science educators can bring scientists and children together and support their formal and informal interaction. Regarding informal education, Schibeci (1989) stated that factors outside schools had a strong influence on students' educational outcomes, perhaps strong enough to swamp the effects of variations in education practices. Informal science education has become popular in recent years in order to take advantage of outside school effect in the education of children. Residential camps such as science camps are common in most of western countries and getting popular in the country that the study was conducted.

Science camps were conducted for various purposes such as developing students' interest and perceived abilities in science (Markowitz , 2004), perceived knowledge and skills (Knox, Moynihan, & Markowitz, 2003), and scientific literacy (Foster & Shiel Rolle, 2011).

Method

The aim of this study was to find out the influence of a science camp during which children interacted with scientists formally and informally and met with non-stereotypical scientists on children's images of scientists. Thus, the methodology of the study included formal and informal interaction of children with scientists, addressing children's stereotypical images of scientists directly based on first hand data from their own drawings, and extending their views of science and scientists by bringing them together with non-stereotypical scientists. Direct interventions which encouraged actual meetings and working together between practicing scientists were suggested by some of other researchers (Farland-Smith, 2006; Scherz & Oren, 2006; Finson, 2003; Song & Kim, 1999; Finson et al., 1995; Flick, 1990). In order to determine the effect of the methodology applied at the science camp on children's images of scientists, DAST (Chambers, 1983) was applied as pre-test at the beginning and post-test at the end of the camp. The descriptive analysis and comparison of the children's DAST drawings at the beginning and end of the science camp are presented in this paper.

Participants

The sample of this study included 24 6^{th} and 7^{th} graders who were 12 or 13 year-olds. Eleven of them were female and thirteen of them were male. The children were from ten different elementary schools. They participated in the science camp voluntarily. In instances where there were too many applications from the same school, science teachers' suggestions regarding children's interest in nature and science were considered in selecting the children.

Treatment

The residential science camp was held at a village hotel and lasted ten days in July, 2008. The children stayed in houses in groups of four or five. At least one science team member stayed in each house in order to interact with them. The science camp team consisted of seven science educators. Three were associate or assistant professors, four were post-graduate students. They were introduced to the children as scientists. They were in close contact with the participating children, guiding their inquiry, and helping them do activities throughout the camp. There were also six other scientists attending single sessions. Two professors of biology and chemistry, and one associate professor of mathematics education. Three scientists attended the 'who are scientists? ' session to represent non-stereotypical scientists. They left the camp after they had completed their session.

The detailed science camp program is given in Table 1. The main goal of the science camp program was to introduce the nature of science by means of explicit nature of science activities and guided-inquiry. The children's conceptions of scientists were very much related to their conception of science, and thus the researchers decided to follow the children's conception of scientists by applying DAST at the beginning and end of the science camp.

Intervention

In addition to informal interaction between the scientists who were science advisors and the participating children, there was a special session for the discussion of the children's conceptions of scientists and introducing them to non-stereotypical scientists. The special session for scientists was named 'who are scientists?' and conducted on the third day of the science camp. This special session consisted of two different parts. The first part started with analysis of the children's DAST drawings that they had drawn on the previous day. Analysis of the pictures was done together with the children as an activity guided by a science educator. The children were returned their DAST drawings and asked to raise their hands if the characteristics given by the science educator were present on their drawing. The science educator counted raised hands and noted on a white-board. In this way, data were generated collaboratively. Then, the children were asked what they would infer based on the data from their drawings. During the interpretation of the data, the science educator made the stereotypical images explicit and asked the children to discuss why they thought of scientists in this way. Scientists' pictures in textbooks and scientists in movies were frequently offered by children as a source for their stereotypical images of scientists.

After a brief discussion about children's drawings, second part of the special session began. In the second part, a couple who were both physicists and a female psychologist were invited to the session to talk about how they work and live. Interestingly, the physicist couple met in a physics laboratory when they were working on the same research team, married each other, and they were still working together in their research studies. They had two children. Thus, the children learned about their non-stereotypical life through questioning them in an informal manner. The husband was also talented in drawing cartoons and he drew a few cartoons for children on the board. The female psychologist particularly talked about her laboratory, which contained an observation room, and her experiments on children's social development. Her laboratory was a lot different from the laboratories that were drawn by children.

In addition to this activity, the science advisors managed most of the science camp sessions and guided a small group of children throughout their inquiry process. Thus, there were many formal interactions between scientists and children in these sessions.

Informal interactions between scientists and children occurred in many instances while living together for ten days. Each science advisor stayed at the same room with three children, they ate, talked, and played together throughout the science camp.

Data Collection

In order to determine the effect of the methodology applied at the science camp on the children's images of scientists, DAST (Chambers, 1983) was applied as a pre-test at the beginning and post-test at the end of the camp. It is a widely used tool, because drawing allows respondents to express their inner feelings which could rarely be expressed otherwise (Song & Kim, 1999). The children were simply asked to draw a scientist on a piece of A-4 paper provided. DAST was applied in one session and all children drew their scientists at the same time.

Although DAST is one of the most used and practical instrument to determine children's images of scientist, it also has some drawbacks. Interpretation of children's drawings by an outsider would be problematic. Therefore, it was supported by short individual interviews on their DAST drawing.

Since there is a caution suggested in interpreting children's DAST drawings (e.g. Cakmakci et al., 2011; Losh, Wilke, & Pop, 2008; Newton & Newton, 1998), short individual semi-structured interviews were conducted with each child on their picture to clarify the uncertain symbols and images. Interviews were conducted by the science camp team. They were present in different corners of the room. When the children completed their drawing, they went to one of the science educators and were shortly interviewed on their picture. The science educator asked the child to explain his/her drawing and asked about the symbols that could not be understood. The interviewer took interview notes on the child's drawing. Each science educator interviewed three or four children.

Data Analysis

Although a raw analysis of the children's drawings were done altogether in the 'who are scientists?' session, these results were not used. Later, the data were recoded by one of the researchers. The reason for coding the data by one researcher is as follows. Since each interviewer noted what each symbol was on each child's DAST drawing, less retained for interpreting DAST drawings. Most of the symbols in DAST drawings were self-reported by the children and thus would not make any difference if it were coded by another coder.

DAST-C (Finson, 2003) was used as a coding scheme in order to provide comparable results with previous studies. DAST-C checklist was also validated for using with diverse populations (Finson, 2003). Finson organized the codes according to three subscales. The first scale consists of seven elements of stereotypical images of scientists reported by Chambers (1983). The second subscale consists of the elements of stereotypical images of scientists that Finson needed to add to Chamber's seven indicators. Third subscale includes other elements of images of scientists not necessarily stereotypical, but needed to be considered in Finson's study. The symbols emerged in this study was added as a fourth subscale.

The study was a qualitative and descriptive exploration of the change in children's image of scientists throughout the science camp. The symbols in the children's DAST drawings were coded, and then frequency and percentage of each code was determined. They were tabulated in separate tables for each subscale and interpreted.

Results and Interpretation

Although 24 children participated in the science camp, 19 children drew a scientist in both the pre- and post-tests. 19 children drew 25 scientists in the pre-test and 32 scientists in the post-test, although they were instructed to 'draw a scientist'. Thus, the percentages of each symbol in both the pre- and post-test were calculated as 25 and 32 respectively. The data for the first subscale are summarized in Table 2.

The laboratory coat is the symbol of scientists in DAST studies in western countries, but it could not be considered as a stereotypical image of scientists for the children in the current study. The laboratory coat was present at a frequency of 20% in the pre-test and 9% in the post-test. Eyeglasses and facial hair were more frequent than the laboratory coat in both pre- and post-test. The frequency of eyeglasses and facial hair were both 44% in the pre-test and their frequencies decreased to 31% and 25% respectively.

There were symbols around the scientist(s) in the children's drawings such as symbols of research, knowledge, technology, and captions. The results revealed that symbols of research such as laboratory items were not high; 28% in the pre-test and 19% in the post-test. Volumetric flasks filled with liquids were the most common research symbol. Knowledge symbols were present at a frequency of 64% in the pre-test and increased to 69% in the post-test. Books were the most common knowledge symbols in the children's DAST. Symbols of technology were the most common type of symbols in children's DAST in the pre-test (80%), but decreased to 34% in the post-test. Though children drew a wide variety of technologies, computers, head lights, and magnifying glasses were the most frequent ones.

Table 1. The Science Camp Program

Hours	1st day	2nd day	3rd day	4th day	5th day	6th day	7th day	8th day	9th day	10th day
Morning Sessions (9am-13pm)		**What is science? Pre-test (Draw a Scientist Test (DAST) and VNOS D questionnaire application. Water Machine activity)**	**Who are scientists? (DAST analysis and meeting with non-stereotypical scientists)**	Research I (Teaching variables and their control on Pendulum)	What and how to search? (Deciding a research question at nature and developing methodology)	Science center visit at the capital city	Doing research I (Conducting their research at nature with their science advisor)	Doing research II Conducting their research at nature with their science advisor)	What did we find? (Preparing posters about their research)	Preparing for Parents
Afternoon Sessions (3 pm-7pm)	Coming to the camp	Mathematics at Nature (Fibonacci numbers, Golden Spiral)	Nature Walk (Observations at many stations such as trees, plants, and ants. Modeling a water shed)	Science, Nature and Art (Face mask, Marbling Art, Leonardo da Vinci and Beethoven, four season symphony)	Ecosystems around the camp (Visiting lake, puddle, stream, forest and teaching ecology)		Environmental Pollution (Chemicals at home, chemical pollution in the environment)	Ecology games (Habitat games) NOS (Tricky Tracks, The Cube)	Creative Painting (Painting a T-Shirt)	Poster Presentation to parents Certification
Evening Sessions (8pm-11pm)	Welcome party	NOS (Real Science, Real Fossils) Evaluation Getting rest	NOS (Young or Old? and The Whole Picture) Evaluation Getting rest	What and how to search? (Forming project groups and thinking about a research question at nature) Evaluation Getting rest	Research II (Making fastest rocket with balloon. Testing and controlling variables) Evaluation Getting rest		Research III (Earthquake and global warming activity. Drawing graphs) Evaluation Space Observation I (Observing the Moon and Jupiter)	Evaluation Space Observation II (Observing constellations)	**Overall Evaluation Post-test (Draw a Scientist Test (DAST) and VNOS D questionnaire application.) Party**	

Table 2. Percentages of symbols in first subscale in DAST -C

Symbols	Pre-test n (%)	Post-test n (%)
Laboratory coat	5 (20)	3 (9)
Eyeglasses	11 (44)	10 (31)
Facial hair	11 (44)	8 (25)
Symbols of research (volumetric flask, test tubes, atom model, Bunsen burner, glass pipe, bones)	7 (28)	6 (19)
Symbols of knowledge (books, chalkboard, charts/posters, clipboards, pens in pocket, bookshelves, library, science center)	16 (64)	22 (69)
Symbols of technology (computers, head-light, magnifying glass, stetescope, rocket, microscopes, telescope, Internet, binoculars, walkie-talkie, repair tool, calculator, telephone, space vehicle, walkman)	20 (80)	11 (34)
Relevant captions	8 (32)	0 (0)

Relevant captions occurred at a frequency of 32% in the pre-test, but completely disappeared in the post-test. Most of the captions were the name of the scientist or some information about the scientist's age.

Table 3 represents additional elements of stereotypical images of scientists found in the Finson (2003) study. Being male was the most common stereotypical image in the children's drawings in this study. At the beginning of the science camp, the percentage of male scientists was 84% whereas that of female scientists was only 12%. After the camp, this stereotypical image was changed into ideal image of scientists that they could be male or female with almost equal opportunities (50%). All of the female scientists in the pre-test were drawn by girls, but it was striking that three boys and six girls drew female scientists in the post-test.

Table 3. Percentages of symbols in second subscale in DAST-C

Symbols	Pre-test n (%)	Post-test n (%)
Gender		
Male	21 (84)	16 (50)
Female	3 (12)	15 (47)
Gender not indicated	1 (4)	1 (3)
Age		
Old	10 (40)	2 (6)
Middle Aged	9 (36)	14 (44)
Young	5 (20)	14 (44)
Age could not be determined	1 (4)	2 (6)
Scientists doing work at the laboratory	1 (4)	1 (3)
Scientists doing work at the nature	2 (8)	2 (6)
Presence of light bulb	2 (8)	1 (3)
Indication of danger	0 (0)	0 (0)
Mythic Stereotypes	0 (0)	0 (0)
Indication of secrecy	0 (0)	0 (0)

Most of the scientists were old (40%) or middle aged (36%) in the pre-test; whereas the frequency of old scientists decreased to 6% in the post-test. Most of the scientists in the post-test were young (44%) or middle-aged (44%). Being middle aged or old was the second stereotypical image that emerged in this study. However, this stereotypical image changed positively toward younger scientists throughout the science camp.

Stereotypical images of scientists drawn as they worked in laboratories were rare in this study; 4% in the pre-test and 3% in the post-test. Similarly, scientists drawn as working in external environments were only 8% in the pre-test and 6% in the post-test. Most of the scientists were drawn passive; they were not drawn as doing something. Some symbols of research, knowledge, and technology or other symbols were drawn around the scientist. An example of children’s such drawings and one example from drawings which shows scientists doing work is represented in Figure 1 for comparison.

Figure 1. Passive scientist drawing (on the left) and active scientist drawing (on the right) in the pre-test

Indication of danger and secrecy and mythical images were reported to be stereotypical images in previous studies (e.g. Finson, 2003). Interestingly, such images did not emerge in this study.

There were other elements in the children’s drawings which are not necessarily stereotypical, but should be considered (Finson, 2003). Table 4 presents these symbols.

The appearance of the scientists was mostly casual in the pre-test (80%) and even some of the scientists were drawn as wearing neckties, which is the symbol of formality. Although its appearance decreased to 44% in the post-test, it was still the most common figure for the appearance of the scientist. The laboratory coat which is the symbol of scientists in western studies was not common in the children’s drawings in this study. Surprisingly, sportive clothing (25%) and even dresses (9%) emerged in children drawings in the post-test. These two aspects were added to Finson (2003) DAST-C checklist.

Table 4. Percentages of symbols in third subscale in DAST-C

Symbols	Pre-test n (%)	Post-test n (%)
Outlook of the scientist		
Casual clothing	20 (80)	14 (44)
Necktie	6 (24)	3 (9)
Laboratory coat	5 (20)	3 (9)
Sportive clothing	0 (0)	8 (25)
Dress/Skirt	0 (0)	3 (9)
Hair style		
Neat	17 (68)	28 (88)
Untidy	5 (20)	2 (6)
Bald	3 (12)	2 (6)
Facial expression		
Smiling	16 (64)	19 (59)
Neutral	7 (28)	8 (25)
Frowning	0 (0)	1 (3)
Wild	1 (4)	2 (6)
Type of scientist		
Chemist	1 (4)	0 (0)
Biologist	1 (4)	2 (6)
Physicist	0 (0)	0 (0)
Indeterminate	23 (92)	30 (94)

Regarding hair style, untidy hair (20%) and baldness (12%) were not common in children's drawings in the pre-test. At the beginning, most of the scientists were drawn with neat hair (68%). In the post-test, neat hair increased to 88% whereas untidy and baldness decreased to 6%. Frowning or wild looks were again rare in this study. On the other hand, smiling face was common (64% in the pre-test and 59% in the post-test) in the children's drawings. Neutral facial expression was the next in the drawings with 28% in the pre-test and 25% in the post-test.

In this study, it was difficult to decide which type of scientist was in the drawing, because there were not many reliable clues around the scientist in the drawings. In the pre-test, the type of the scientist was not clearly understood in 92% of the drawings. Similarly, it was 94% in the post-test. The number of drawings in which the type of the scientist was clear was only two in the pre-test; one of them was a chemist and the other one a biologist. There were only two biologists in the post-test.

Up to this point, all symbols were the ones included in DAST-C developed by Finson (2003). There were other additional symbols in the children's drawings that should be considered in order to understand the children's images of scientists in the present study. Such additional symbols are presented in Table 5.

The most original finding in this study was the indication of scientist's hobbies and phobias in the drawings in the post-test whereas there were no related symbols in the pre-test. In the post-test, hobbies were indicated for 41% of the scientists by drawing them as they were playing basketball, volleyball, or listening to the music with a walkman, etc. as can be seen in Figure 2. Phobia was indicated for one male scientist by a note next to the picture; 'he is scared of the dark.'

Table 5. Percentages of symbols in fourth subscale added to DAST-C

Symbols	**Pre-test n (%)**	**Post-test n (%)**
Hobbies (Playing volleyball, playing basketball, going to the cinema, weightlifting, having picnic, reading book, listening to music)	0 (0)	13 (41)
Phobia (darkness)	0 (0)	1 (3)
Context of the scientist		
In the laboratory	6 (24)	8 (25)
At the outside	3 (12)	10 (31)
In the classroom	0 (0)	1 (3)
In the library	2 (8)	3 (9)
Undefined Context	14 (56)	10 (31)
Additional Surrounding Symbols		
Bubbling Liquids	4 (16)	0 (0)
Smoke/steam	3 (12)	1 (3)
Bulb	2 (8)	1 (3)
Question mark	3 (12)	2 (6)
Thinking balloons	12 (48)	6 (19)
Notes on the picture	10 (40)	9 (28)

Figure 2. Hobbies of scientists (playing basketball and listening to music) in the post-test.

As it was stated earlier, it was difficult to decide what type of scientist had been drawn, because there were not enough symbols around the scientist which clearly related to a subject area. Thus, we coded the context of the scientist drawn to help the reader to understand children’s drawings. Approximately one quarter of the scientists were drawn as if they were in the laboratory, but they were not well equipped laboratories as it is evident in Figure 3a. Only three scientists (12%) were drawn outside in the pre-test as they were doing observations in nature with a magnifying glass (Fig 3b). The number of scientists drawn outside increased to 10 (31%) in the post-test. Two scientists (8%) in the pre-test and three scientists (9%) in the post-test were drawn in the library. Books and bookshelves filled with books were the most common symbols drawn around scientists, but these scientists were specifically drawn in or in front of a library (Fig. 3c). There was only one scientist teaching at the blackboard in a classroom in the post-test (Fig 3d). On the other hand, 56% of the drawings in the pre-test and 31% of the drawings in the post-test did not clearly indicate the context of the scientist.

3.a. Scientist in the lab (pre-test)

3.b. Scientist outside (pre-test)

3.c. Scientist (on the right) in front of the library (pre-test)

3.d. Scientists teaching in the classroom (post-test)

Figure 3. Context of the scientists in the children's drawings.

Bubbling liquids and smoke were observed in some of the drawings at a percentage of 16 and 12 respectively in the pre-test. However, bubbling liquids disappeared and smoke was observed in only one drawing (3%) in the post-test. Light bulbs and question marks were also observed, but they were rare in the drawings. Three question marks and two bulbs were found in the pre-test, and two question marks and one bulb were found in the post-test.

In addition to these symbols, there were both thought and speech balloons which contains writing or symbols (48% in the pre-test and 19% in the post-test). The children using these symbols indicated that the scientists think a lot and their minds are full of questions about their work. One of these scientists is shown in Figure 4.

Figure 4. Thought balloons indicating a busy mind in the children drawings (pre-test)

A last striking finding was that one child drew a scientist in the post-test and wrote 'I am a scientist' under the drawing as in Figure 5. This child could have internalized the concept of being a scientist at the camp and felt himself to be a scientist at the end of the camp. However, as it was evident from the figure, he did not draw any other symbol to indicate clues about the scientist such as his subject area or context.

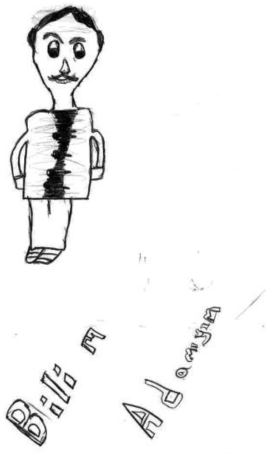

Figure 5. The child who indicated that the scientist was himself in the post-test.

Discussion

The purpose of the study was to determine the change in the children's images of scientists throughout the science camp at which they interacted with scientists both formally and informally and met with non-stereotypical scientists. The results of the study revealed that the children came to the science camp without any extensive stereotypical images about scientists other than being male and being middle aged or old, and they left the camp with even more humane images of scientists of any gender and age.

Other stereotypical images found in western studies (e.g. Barman et. al, 1997; Finson, et al. 1995; Huber & Burton, 1995) such as having eye glasses, a laboratory coat, and crazy hair, etc. were not common in this study. Moreover, stereotypical images such as working in the laboratory and laboratory items around the scientists were again less than the ones in western studies (e.g. Barman et al., 1997). One reason for less laboratory related scientist image in this study could be that the children do not learn science in school science laboratories. Classical science laboratories with benches are not common in Turkish elementary schools.

It was interesting that symbols of knowledge and technology were more common than the research symbols in the pre-test. Knowledge symbols increased in the post-test whereas technology and research symbols decreased. It seems that the children in our study symbolized scientists with books which would indicate that they thought scientist as knowledgeable people who read a lot, and thus wear eye-glasses.

The children in this study had only stereotypical images about scientists regarding their gender and age at the beginning of the science camp. Old or middle-aged male scientists were common in their drawings in the pre-test. These figures decreased in the post-test and they drew more female and younger scientists. The reason for this change could be the science team. The average age of the team was about 32, which would be considered as middle aged for scientists. In the special session, all three scientists were middle-aged. The number of females (5) was also higher than that of males (2) in the team. The female scientists that the children interacted at the science camp could have challenged their stereotypical idea that scientists are usually male.

The finding of Turkish children having less stereotypical images of scientists than their counterparts in western countries was also reported by Akcay (2001), Turkmen (2008), and Buldu (2006) studies. Students in developed countries could have been more exposed to scientific environments through media and or literature and thus they could be exposed to more stereotypical images of scientists than their peers in Turkey.

The number of scientists drawn by 19 children increased from 25 to 32 in the post-test. However, this does not indicate increased collaboration among scientists. Short interviews revealed that the children expressed their different ideas about scientists by drawing one scientist for each idea at different places on the paper.

The most original finding of this study was the emergence of the hobbies and phobia of scientists on the children's drawings at the end of the camp. The emergence of hobbies and phobia indicates that children noticed human nature of scientists better at the science camp. This positive change in children's conception of scientists is valuable, because cold face of science and scientists would change if children see scientists as ordinary people. This aspect was also pointed out by Barman et al.(1997) by stating the need for broadening children's ideas about scientists on a more personal level and help them gain an appreciation for the personalities of scientists as 'real people'.

Conclusion and Recommendations

In summary, the changes from pre- to post-test indicated that the children's stereotypical images of scientists did not exist to a great extent as has been reported in western studies. In fact, they even decreased after the camp, and humanistic images of scientists increased at the end of the science camp. The duration of the camp was ten days, which was not a particularly long time. Despite its short duration, its positive effect in changing stereotypical images into more human-like images was evident in this study. Almost all of the previous interventions included scientists interacting with children in a formal environment or learning about scientists from the history of science. Informal interactions could be added in order to show the more human nature of scientists. In Song & Kim's (1999) study, the children reported that they were generally more attracted by the personal and particularly the affective character and social contributions of the scientists, and not so affected by their intellectual talent and scientific achievements. They concluded that children generally come to see scientists as individual people and are moved by their personal and humane attractions. This study proved the effectiveness of introducing scientists by their personal life and humane character (affective) in addition to their scientific abilities and scientific studies (cognitive) to improve image of scientists.

Printed and visual media were found to be main sources for children's images of scientists (e.g. Buldu, 2006; Togrol Yontar, 2000). Stereotypical images of scientists were mostly included in movies, cartoons, newspapers, and science journals. Media effect would be used for introducing scientist in both cognitive and affective aspects. Scientists' personal life and humane character could be indicated in the movies and documentary films about scientists or scientific inventions could also be extended to include the scientists' humane character.

In addition to media, stereotypical images of scientists should be a concern for all scientists, not for only science educators. If more children choose science careers, all areas of science would get more human support. For this reason, it is a social responsibility of scientists to interact with children and express themselves as normal. Without any doubt, there is ample evidence that children's images of scientists affect their attitudes toward science (She, 1998; Boylan et al., 1992). Science educators have already determined children's attitudes toward science being low in some areas and trying to find ways of increasing children's attitudes toward science by means of contemporary curricula and some other interventions as the one in this study. Scientists and teachers could provide many opportunities to fill the gap between scientists and children in both formal and informal environments.

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