# How did a science camp affect children's conceptions of science?[1]

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## Contents



## Abstract

Science explores nature and the most authentic way of introducing science is creating learning environments in the nature and let children make their own

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discoveries in the nature as real scientists. Science camps would be an opportunity for this kind of science education. This study introduces a science camp and reports findings regarding its effectiveness on children's conception of science.

The science camp was conducted at a holiday village which was located near a forest and lasted ten days between July, 4-13, 2008. The participants were 24 children (11 girls and 13 boys) who were at 6th and 7th grades. The science camp team mainly consisted of elementary science educators and the children interacted with them throughout the science camp.

First three days of the science camp program was aimed at developing background for inquiry and collaboration skills. In the following days, the students conducted guided-inquiry in small groups on a research question that they asked about the nature. Then, each group prepared a poster and presented it to their families on the last day of the science camp. Explicit NOS activities were also done throughout the science camp program. VNOS D was applied as pre- and post-test in order to determine the effectiveness of the science camp in introducing science and its specific aspects. Only data from two questions of the VNOS D which were about science and its distinguishing features from other areas were reported in this paper to investigate children's ideas about science in general.

The results showed that science camp program improved children's conceptions of science to a more scientific perspective. They learned more about scientific processes such as data, measuring, and interpreting. Some of them progressed more and provided more detailed expressions while defining science. Most of them had already perceived both the process and product of science, but their understanding of the process of science was detailed at the end of the science camp.

**Keywords**: Conception of science, science camp, guided-inquiry, nature of science

# Introduction

Achieving scientific literacy has been stated as the most permanent and desirable intent of science education. Scientifically literate individuals not only understand and use scientific process skills, but also make sense of the epistemological values behind these scientific processes, hence nature of science (NOS). Epistemological values of science refers to some underlying assumptions which provide opportunities for deep understanding about what science is, how science is done,

what the process of doing science is, what are the criteria to be accepted as scientific as well as understanding scientific content knowledge. Thus, the ability to comprehend science with its underlying assumptions in its inherent nature is the main and permanent requirement of being scientific literate.

Although there have been no common conception about NOS among science educators and philosophers of science (Abd-El-Khalick, Bell, and Lederman, 1998), NOS can be defined as values and beliefs inherent to scientific knowledge, and philosophical underpinnings of scientific activities (Lederman, 1992; Lederman, 2007). Thus, the NOS is very complex epistemological and constantly developing issue about science. However, there are some particular aspects of NOS that are seen comprehensible for elementary students (Akerson & Abd-El-Khalick, 2005; Lederman, 2007). These aspects of NOS corresponding to elementary level are related to understanding such as scientific knowledge is subject to change (tentative), is based on evidence and data derived from observation of the natural world (empirically based), is subjective or theory laden (influenced by the socio-cultural context scientists came from and scientist's theoretical background), requires and involves creativity and imagination when it is necessary, and is embedded in social and cultural context where it is constructed (Lederman, 2007; Khishfe, 2008). Accordingly, understanding of these aspects of NOS is parallel to comprehending what science is. Thus, in the case of science education, detecting students' existing conceptions of science provides meaningful clue for science educators in order to design appropriate instruction for their students.

Previously, science educators interested in searching children's definitions of science in 1990's and have shifted toward understanding NOS in recent years. This orientation toward NOS facilitates the understanding of science in a more holistic manner and also provides opportunities for students to understand the relationships between aspects of science which seem to be separate and independent from each other. Indeed, NOS is more general than definition of science since it reflects multidimensional structure of science including epistemological, philosophical, historical, social, and cultural perspectives.

However, the consistent and well-documented evidence regarding students' understanding of NOS have shown that students have inadequate and inappropriate understanding about NOS regardless of their grade levels (Lederman, 1992; Lederman, 2007). Additionally, there are some studies which directly focused on students' specific definitions of science. This type of studies provides information

about students' explanations of science in general perspective and facilitates the understanding what science corresponds to in their minds. Likewise, Kang, Scharmann and Noh (2005) stated that investigating and knowing what students think science is, therefore, will help us gain a more comprehensive understanding of students' views of NOS.

Most of the studies in the literature regarding children's conceptions of science focused generally on determining children's existing ideas about science. The participants of these studies ranged from 4th to 12th grades. BouJaoude and Abd-El Khalick (1995) searched Lebanese middle school students' definitions of science and perception of its purpose and usage by applying questionnaire and semi-structured interviews with 80 middle school students from two private and two public schools. Two of their questions were about students' definition of science and its purpose. Most of the students' definitions stressed science as school related activities. For example, sixty-four of them defined science as 'subject that gives information about humans, animals, plants, earth, the sky, and the stars. Thirty-five percent of them defined science as 'subject matter divided into other subjects such as physics, chemistry, and biology'. Eighteen percent of them defined science 'as a method of doing things' and 'a school subject to teach new things'. Sixteen percent of them defined science as 'a subject that enlightens and gives the truth about nature'. Ten percent of them defined science as 'a subject we studied in class'. Regarding purpose of science, they reported that students stated six main purposes of science (in the order of decreasing in frequency) as academic preparation, preparation for future carriers, achieving higher social status, helping people solve everyday problems, discovering new things, helping people to appreciate and understand nature. They concluded that Lebanese middle school students, like middle school students in the U.S., seem to have a restricted view of science. Most of them defined science as academic subject and perceived its purpose as preparation for higher grades, higher studies and carriers.

Likewise, Kang, Scharmann and Noh (2005) in their cross-age study, examined students' views on five constructs concerning purpose of science, definition of scientific theory, nature of models, tentativeness of scientific theory, and origin of scientific theory. They found the majority of students, regardless of their grade level, thought that science is an activity concerned with making the world a better place to live in. Additionally, particular percent of the students selected item stated that science makes new discoveries and adds them to the knowledge of the nature.

The result of this study also showed that there were no clear differences in the distributions of 6th, 8th, and 10th graders' views of science.

In other study, Sutherland and Dennick (2002) investigated the influence of students' different world-views associated with their cultural background on their perceptions of science. They used both qualitative (open-ended questions and interviews) and quantitative (a Likert-scale questionnaire) instruments to explore students' views of science. Thirty-six 7th grade Euro-Canadian and 72 7th grade Cree students participated to the study. In accordance with the other studies, the result of this study showed that most of the students regardless of their background considered science as a body of knowledge. Similarly, most of the students of both groups thought that the main purpose of doing experiment in science was finding out and figuring out something.

Another similar study seeking change in children's conception of science through school years was conducted in Australia by Stein & McRobbie (1997). They applied a phenomenological study with 151 students at grade 4, 7, 9, and 11-12. They raised six categories to organize students' conception of science into six categories and compare students' conception at different grades to find out the change in students' conceptions throughout schooling. Grade 7 data were comparable to this study. Seventh graders defined science as what is done or learnt at school (Category 1, 60%), a consumable product (Category 1, 60%), a study of the world (Category 3, 70%), a process (Category 4, 58%), a dynamic knowledge (Category 5, 0%), and being influenced by social context (Category 6, 0%). They interpreted categories 1-3 to be related to self and categories 4-6 as categories as more general and detached to self. The researchers stated that categories 5 (science is a dynamic knowledge) and category 6 (science is influenced by social context) were more complex level than categories 1, 2, 3, and 4, because category 5 and 6 were multidimensional and pointed out that aspects of influences, changeability, and progress. Maybe because of that, students from the younger grades (4th and 7th) did not propose such ideas. This category represented students' ideas from upper grades (9th and 11th).

There were also some studies which concentrated on change in students' conception of science as a result of intervention. Carey, Evans, Honda, Jay, and Unger (1989) studied whether there were change in 76 7th grade students' understanding of the nature and purpose of scientific inquiry as a result of three-week NOS unit intervention. They conducted half-hour clinical interviews

with students to explore their understanding about the nature of scientific knowledge and inquiry. Researchers reported that students were not able to efficiently articulate the purpose of science in their initial understandings. Students who participated to this study thought that the goal of science was to discover new things, to find new cures for diseases. They also thought that scientists make research in order to discover facts about nature by making observation and trying things out. Additionally, according to these students scientific knowledge is a faithful copy of the world. As a result of short classroom-based intervention, researchers found statistical significant intervention impact on the students' understanding. Over half of the students realized the main role of experiment in science as test of scientific ideas. They also realized that scientific activities are guided by particular ideas and questions.

Studies in Turkey were scarce. Recent studies on NOS provided some insights about children's definitions of science, because instruments widely used in NOS research includes an item asking what science is. Celikdemir (2006) studied 1026 6th and 923 8th graders through a written instrument. One of the questions was related to students' definition of science. One of them was stated to be taken from VOSTS (Aikenhead, Fleming and Ryan, 1987) and asking directly what science is and providing 10 options. Their results reported as grand totals of both 6th and 8th graders were summarized here, since we thought that grand totals were comparable to our study which includes children from 6th and 7th grades. According to their results, definition of science as exploring the unknown and discovering new things about our world and universe (alternative C) was the most common chosen option among students (24.5%). Definition of science indicating the social aspect of science as finding and using knowledge to make the world a better place to live in (alternative F) received 17.1% of the responses. Third common response was definition of science as a study of fields such as biology, chemistry, and physics (alternative A) (15.6%). Fourth common response was the definition of science as a body of knowledge such as principles, laws and theories, which explain the world around us (alternative B) (12.9%). Technology-based definition of science as inventing or designing things (alternative E) was chosen by 10.9% of the students. It was interesting that definition of science as carrying out experiments to solve problems of interest about the world around us (alternative D) was less common (6.5%) among student responses. Similarly, 6.4% of the students defined science as an organization of people (called scientists) who have ideas and techniques for discovering new knowledge (alternative G). Other three options were scarce. They

concluded that most of the students had contemporarily accepted view on the definition of science which defines science as investigating new things and explaining the working of the world.

A similar study was performed by Doğan Bora (2005) with 10th grade students and their teachers. The Views on Science-Technology-Society (VOSTS) questionnaire (Aikenhead, Fleming and Ryan, 1987) and interviews were conducted in this study. The result of the study revealed that 10th grade students had traditional views about science. Similar to other result, most of the students selected the VOSTS item which expresses science as finding and using knowledge to make the world a better place to live in. They also defined science as exploring new things.

Accordingly, the result of these studies showed that students' conception of science were diverse, nevertheless, they do not have desirable understanding about science regardless of their grade levels. In general, they considered science either as 'exploring the unknown and discovering new things about our world and universe' or as subject that gives information about our world and universe. Thus, students were not able to clearly articulate science as a process by which scientists have an attempt for conceptualizing our world and universe in general and making meaning about their dynamics.

## Rationale for the Study

Previous studies were mainly concentrated on determining children's conception of science and pointed out that children had a restricted view of science. Several interventions would be done to better introduce science and help children to extend their conception of science which was mostly related to school activities. Lederman (2007) pointed out that using context of scientific inquiry and activities which provide opportunity for students to replicate scientific inquiry in appropriate conditions is the best way to teach NOS. Science camps are such an intervention in which children could conduct their scientific research while they were reasoning about science and its epistemological aspects. Actually, science camps are common in especially the U. S. Simple search on WWW results in enormous number of science camps. A quick examination of the science camp programs indicated that their programs usually consisted of hands-on science activities, field trips, and technological inventions. Such programs provide learning opportunities outside of school, but they are not specifically designed for introducing several aspects of science.

In contrast to their common application, research on science camps is really scarce. We could locate only one research study in which a science camp was conducted with a group of Taiwanese gifted middle school students (Liu & Lederman, 2002). The aim was to introduce NOS. They applied explicit inquiry and some NOS activities were done at the science camp. VNOS D was applied and students were interviewed on their responses to determine the change in their NOS views. They did not find any change in students' understanding of NOS from pre- to post-test, but the students were already well on the pre-test. Ceiling effect and short period of instruction were two possible reasons proposed by the authors for no change from pre- to post-test.

We believe that science camps deserve more research attention to clarify their effectiveness in introducing science. Thus, it was worthwhile to design and implement a science camp in order to introduce science to the children in a more holistic perspective. The present study aimed at searching the effectiveness of a science camp program which aimed at introducing science by using inquiry and explicit NOS activities on children's understanding of science.

# Method

This research was implemented in accordance with Three in One: Nature, Science and Children Summer Science Camp Project which was supported by Science and Society Department of Scientific and Technological Research Council of Turkey (STRCT). The Science Camp Project consisted of two terms. The data in this research were obtained by the children who participated in the second term of the project between July, 4-13, 2008.

*Participants*

The participants were 24 children who were at 6th and 7th grades. There were 11 girls and 13 boys. Thirteen of them were at 6th grade and eleven of them were at 7th grade. Children were selected from ten different elementary schools in the city. Science teachers' suggestions were considered in selecting the children. The only criterion was the children's interest in science. Although the children were selected, participation was their voluntary choice.

*Design of Research*

In this study, the effectiveness of science camp program on children's views of science was investigated by qualitative research (Denzin & Lincoln, 2000). The science camp program was developed by the researchers and included explicit NOS activities in addition to children's guided inquiry at the nature. VNOS D questionnaire and semi-structured interviews on the questionnaire was applied at the beginning and at the end of the science camp. Interpretative analysis (LeCompte & Preissle, 1993) was applied in the analysis of the data. Pre- and post-test results were compared and interpreted to find out the changes in children's views about science.

*Instruction*

The science camp was conducted by a team which included science, mathematics, and art educators. The science camp was carried out at a holiday village which was located near a forest and lasted ten days. The purpose of the science camp was to introduce science to the children in general and to teach some NOS aspects. Due to the research showing the effectiveness of explicit NOS instruction (Abd-El-Khalick & Lederman, 2000), explicit and guided-inquiry approach (Khishfe, 2008) and several explicit NOS activities (Lederman & Abd-El-Khalick, 1998) were used in order to introduce science to the children. Research studies have consistently shown that explicit approach is more effective than implicit approach in teaching NOS (Abd-El-Khalick & Lederman, 2000; Khishfe & Abd-El-Khalick, 2002; Khishfe, 2008). There were also lots of different and enjoyable activities in the science camp program. The activities could be grouped in four categories.

1. Explicit NOS activities: The explicit NOS activities were Black Box, Real Fossils, Real Science, Young Woman or Old Woman, The Hole Picture, Tricky Tracks and The Cube (Lederman and Abd-El-Khalick, 1998). These were most commonly used activities in related literature regarding NOS instruction. In addition to these activities, three activities, Modeling the Bottom of a Puddle, Modeling Earthquake Data and Global Warming, were developed by the researchers to introduce scientific modeling and scientific research process. During these activities explicit-reflective approach was used in accordance with general approach of science camp. This reflective approach was used in some other studies to help children discuss and deepen their understanding of NOS (Akerson, Abd-El-Khalick, & Lederman, 2000) by articulating their understanding in interactive period. For this reason, during and especially at the end of each activity, target aspects of

NOS were discussed explicitly and children were provided opportunities to express their understanding about activities during debrief discussion period conducted just after the activities. Furthermore, these activities facilitated children's motivation during the activities because of inherently mysterious nature of the activities.

2. Guided inquiry: Second kind of activities was related to the scientific process. Firstly, background training for conducting inquiry was done in two research workshops. Then, they formed their research groups and planned a two-day long inquiry at the nature. They conducted their inquiry, collected data and interpreted it. In the end, they summarized their inquiry on a poster and presented them to their parents. The purpose of this kind of activities was to teach scientific inquiry to the children in its natural setting by replicating the scientific process. In these activities, children could understand how science is done and how scientists work. The children worked in groups of three during these activities. Each group was guided by a supervisor who was expert in science education. Six supervisors who were mostly science educators at the university guided the children's inquiry process. With the help of their supervisors, the children could make sense of scientific inquiry process which they engaged in. The supervisors asked group members to find a research question which would be applied at the nature in two days. Then the supervisors guided them in developing their research. Then, they applied their inquiry at the nature. The supervisors worked with their groups in close contact and facilitated their understanding of science by probing their thinking what they were doing and how it was done by scientists. Since they worked in a group, they also had opportunity to discuss their process with their group members. Furthermore, since all the activities conducted in a specific order during the science camp, the children had also opportunity to articulate and transfer their understanding acquired in one activity into another activity. Reflective approach was also used in this kind of activities as it was in the explicit NOS activities.

3. Activities by which science is related to other areas: This kind of activities aimed at introducing some subjects at the nature such as mathematics and art, and environmental awareness. Funny Math, Observation Stations in Nature, Eco-systems in Our Camp, Environmental Pollution, Space Observation, and Habitat Game were conducted to attain this purpose.

4. Other activities: These activities aimed at improving children's abilities in social communication and art practice. In order to implement this purpose, Science and Art Workshop and Creativity Workshop were conducted and children went to a science center in the capital city of Turkey.

*Collecting Data*

*Questionnaire.* Views of the Nature of Science Version D (VNOS-D) questionnaire (Lederman & Khishfe, 2002) was applied as pre- and post-test in order to determine the effectiveness of the science camp in introducing science in general and teaching some NOS aspects. The questionnaire includes seven open-ended questions. Some of the questions are generic and some of them are content-embedded (Khishfe, 2008). All the items included in questionnaire aimed at questioning target aspects of NOS such as empirical, tentative, subjective NOS, role of imagination and creativity, and difference between observation and inference. Although the children's responses to all the questionnaire items reflected their understanding about science in a specific way related to target aspects of NOS, first two items of the questionnaire provided opportunity for researchers to identify children's understanding of science in a more general way. These two questions facilitated understanding what science corresponds to in children's mind and how they make sense of science. Thus, these two items of the VNOS-D questionnaire which were about science and its distinguishing features from other areas were analyzed to investigate children's ideas about science in the present study. Although all the responses of children were examined, present study included especially the data which were obtained from first two questions in VNOS-D. Other questions were specifically related to the tentative nature of scientific knowledge, the use of imagination and creativity in science, and scientific model.

*Interviews.* Individual semi-structured interviews were conducted just after pre- and post-test applications to understand children's views about science better. The interviews were conducted by the researchers, and children were provided their questionnaires and asked to explain their answers. Each interview lasted 30 minutes on average. All interviews were audio-taped and transcribed verbatim for analysis.

*Analysis of Data*

Large amounts of qualitative data were obtained from both pre and post questionnaires and interviews. In order to facilitate analysis of data, a qualitative

data analysis package program was used. The data were analyzed by interpretive analysis (LeCompte ve Preissle, 1993). The data were coded by first researcher and checked by second researcher. The different ideas about the codes were negotiated and a consensus was reached. Then, two researchers classified the codes into categories inductively until they satisfied that the data were organized for interpretation. After that, they interpret children's conception of science at the beginning and end of the science camp, and compared these interpretations to find out the change in children's conception of science.

# Results and Interpretation

In accordance with the aim of the present study, children's ideas about science were investigated both at the beginning and at the end of the science camp. The coding scheme emerged during the qualitative analysis was presented in Table 1. The names in the quotes are pseudonyms. The number in parentheses corresponds to frequency of the related code.

*At the Beginning of the Science Camp*

They defined science mainly as doing inquiry, experiments, and observation. Next, its purpose and its benefits to the society were indicated in their definitions of science. They also indicated scope of science, its relationship with technology, and being endless in their definitions.

There were three basic conceptions of science among children. Four children stated only that science is knowledge. Scientific knowledge is the product of the scientific process. Thus, such ideas about science were categorized as "only product of science". On the other hand, five children stated only the process of science in their definitions and were classified as "only process of science". Fifteen children were close to ideal conception of science which includes both process and product of science. Such ideas were classified as "both process and product of science". These three conceptions of science were elaborated in more detail in the following paragraphs.

Children who indicated only product of science defined science as knowledge, finding results, and developing knowledge. But these children did not describe how these knowledge or results were obtained as it is evident in the following quotes.

*Science is knowledge. (Zeynep)*

*Science is the most improved and the most accurate knowledge about every subject. (Zehra)*

The children who indicated only the process of science (5) used such concepts as inquiry, experiment, and observation in their definitions of science. Inquiry (5) was stated by all children in this group and then followed by experiment (3), observation (2), and investigation (2). These were grouped under experimental processes, because these are scientific processes applied in doing science. It was noticed that children were aware of that science is done by inquiry and experiment, but they could not further articulate what inquiry is or why experiments are done. The researchers inferred that they used these processes as general terms rather than functional processes in science. In addition, they used them in order as it can be seen from the following quote:

*Science is done with inquiry and experiment. I don't think that science is done without inquiry. (Begum)*

In the quote, inquiry and experiment was used but there was not any further expression to show that the child really understood these processes. Similarly, another child defined science as follows:

*In science, we do inquiry and observation in every subject and in any way.(Arda)*

Arda indicated that science is done through inquiry and observation, but there was not again any further explanation of how inquiry is done. In addition, these two children used observation and experiment independent from inquiry such as they stated with such phrases 'inquiry and experiment' or 'inquiry and observation'. They did not indicate experiment and observation as a part of the inquiry. Such results indicated that children had some basic understanding of the scientific process as doing inquiry, but their understanding was superficial. Some of them did not even consider inquiry as an experimental process. For example, the same child (Arda) articulated what s/he meant by inquiry as in the following quote from the interview:

*Interviewer (I): (reads his answer on the questionnaire: you wrote that science does inquiry and investigation.) What does science investigate?*

*Child (C): It investigates space, structure of matter, underground resources.*
*I: How is inquiry done in science?*
*C: It breaks it into its parts. (indicating misunderstanding)*
*I: Think yourself as a scientist. You want to do inquiry. How do you do that?*
*C: First of all, I collect knowledge about that subject. I evaluate them and complete its missing parts.*
*S: How do you complete the missing parts?*
*C: By searching the Internet and encyclopaedias. (Arda)*

Arda was again using two terms inquiry and investigation in sequence in defining science. But, probe questions about inquiry emerged that he meant searching knowledge from different sources rather than experimental inquiry.

In summary, definitions grouped under only process of science category included such terms inquiry, experiment, observation, and investigation. But, the meaning attached to them was mostly process of searching knowledge from written materials rather than process of searching unknowns and producing knowledge.

**Table 1.** Categorization of the data about the children's conceptions of science at the beginning and end of the science camp

| | | | | |
|---|---|---|---|---|
| **Science** | Only product of science (4) **(1)** | Knowledge (3), Invention (1) **(1)** | | |
| | Only process of science (5) **(5)** | Superficial (5) **(4)** | Experimental process | Inquiry (5) **(3),** Experiment (3) **(2)** Observation (2) **(3),** Investigation (2) **Data collection (3), Interpretation (2)** |
| | | **Detailed (1)** | **Experimental process** | **Inquiry (1), Experiment (1) Data collection (3), Prediction (1)** |
| | Both product and process of science (15)**(18)** | Superficial (15) **(8)** | Product of Science (Scientific knowledge) | Finding result(6) **(3)** Producing knowledge from experiment (5) Developing knowledge (4) **(3)** **The group of knowledge (2)** |
| | | | Process of Science (Scientific process) | Inquiry (15) **(8),** Experiment (10) **(7)** Observation (4) **(5),** |

| | | | | |
|---|---|---|---|---|
| | | | | Interpretation (1) **(2)**<br>**Measurement (1), Data collection (4)** |
| | | **Detailed (10)** | **Product of Science (Scientific knowledge)** | **Finding result(3), Developing knowledge (3) The group of knowledge (1)** |
| | | | **Process of Science (Scientific process)** | **Data collection (10), Inquiry (9), Observation (7) Experiment (5), Investigation (4), Interpretation (3), Prediction (3), Measurement (2)** |
| | Purpose of science | Finding unknown (7) **(7)**<br>Making invention (6) **(3)**<br>Developing ideas (1), Taking patent (1) | | |
| | Benefits to the society | Makes life easier (7), Enlightens society (1)<br>Provides knowledge to people (3)<br>Studies for welfare of people (3) | | |
| | Relationship with technology | Uses technology (3) **(1)**<br>Confusion with technology (5) **(1)** | | |
| | As a school subject | Related to science course (4) | | |
| | Endlessness of science | Proceeds (4), Endless (1), Not limited (1) | | |
| | Scope of science | Particular areas | Nature (10) **(4),**<br>Space (3)<br>Living things (3) **(1)**<br>Elements and molecules (2)<br>Underground resources (1) | |
| | | All areas | Comprehends other areas (10) **(18)** | |
| | **Emotional aspect of science** | **Requires patience and respect (2)**<br>**Includes things that are hard to think (1)**<br>**Requires effort(1)** | | |

*Note: Unbolded numbers in parentheses are frequency of the codes at the beginning of the science camp and the bolded ones are frequencies at the end of the science camp.*

Majority of the children (15) described science by indicating both process and product of science. These children indicated that science includes inquiry, experiment, and observation by which scientists produce knowledge. But, as it can be seen below, these children's descriptions of science were also superficial.

> *In my opinion, science is related to space, research, and so on. I think science produces knowledge by doing inquiry and investigation. We get results about any subject by doing inquiry and investigation in science. (Yonca)*

Yonca indicated that 'results about any object' (product) were obtained by 'doing inquiry and investigation' (process). This definition of science was more accepted to be more comprehensive than the ones by stating only 'science is done by doing inquiry and experiment' (process), because it indicates a sense of understanding of the aim of doing inquiry. Another child with similar ideas defined science as follows:

> *Science requires inquiry. It would be necessary to do inquiry in a best way and find correct result. (Ali)*

Ali stated that science requires inquiry (process) and finds correct results (product). But, further detail about inquiry was again missing. These two children were typical examples for the children who indicated both the process and product of science. They realized that inquiry, experiments, and observations are conducted in science and some results and knowledge are obtained from these inquiry, experiments, and observations. Their level of detail of the process of science in their definitions was similar to the children indicating only the process of science as being superficial and limited. They similarly used inquiry (15), experiment (10), observation (4), investigation (3), and interpretation (1) in order in their definitions of science. They indicated product of science in their definitions such as 'finding results' (6), 'produces knowledge from experiments' (5), and 'developing knowledge' (4).

Some of the children indicating both the process and product of science articulated what they mean by inquiry in their definition. They, similar to the ones indicated only the process of science, explained inquiry as searching knowledge from books, encyclopedia, and the Internet.

> *We should do inquiry in order to do science. We might do inquiry alone or as a group by visiting the surrounding or the Internet. (Dincer)*

> *We do inquiry by ourselves. If we did not use encyclopedia, search knowledge from journals and just search the Internet, we would do little inquiry. But, if we search all of them, we would do more inquiry. (Buket)*

As it was evident from the two quotes, children were more familiar with searching knowledge from books than searching an event through observations and experiments.

In some of the definitions, science was related to technology. But, it was seen that some of the children (8) confused science with technology and used them as synonyms.

> *Science is technology. (Begum)*

> *Science is technology, invention, making life easier, and patent. (Ahmet)*

There were also some additional expressions in children's definitions of science. Most of them were related to the purpose of science. They mainly stated the purpose of science as finding unknowns (7) and inventing (6). Developing ideas was stated by only one child. Taking patent was mentioned by one child. Confusion with technology was also evident in this category, because children who confused science with technology stated its purpose as inventing new technologies and taking patent.

> *Science means doing new inventions. Science is invention of technology and patent. Science is done in order to make the life easier and accelerate people's work. (Ahmet)*

Another common aspect of science indicated in their definitions of science was its benefits to the society. They indicated this aspect by such phrases as makes life

easier (7), provides knowledge for people (3), works for welfare of the society (3), and enlightens the society (1).

> *Lots of technological equipments are produced through science. So science makes our life easier. Science provides knowledge about diversity of animals and flowers which lived on earth at earlier times. (Funda)*

> *We must consider science as important as developed countries. If we don't do it, we will drop back and become illiterate society. As long as people consider science as important, they improved themselves. (Omer)*

Children mostly indicated scope of science in their descriptions of science. Some children stated that science works on such areas as nature (10), living things (3), space (3), elements and molecules (2), and underground resources (1). On the other hand, some of them indicated that science is done in every area or comprehends other areas (10).

> *Science is diagnosis of people about the structure and living conditions of living things by observing and doing experiments with different equipments .(Arda)*

> *Science can be related to every field; space, sky, trees, flowers, and insects and science does inquiry about all of these fields. (Zehra)*

A few children stated the endless nature of science by stating that science always proceeds.

> *Science is a field which finds new findings. Science is instructive and always proceeds. (Funda)*

> *Science is endless. As you search a subject more and more, there will always be more detail. Thus science will not end. (Mehmet)*

In summary, it could be said that children's opinions about science and its features were superficial and limited before the science camp. Children had basic insights about science since they used inquiry, experiment and observation in their descriptions of science. But, they did not talk much about the functions of these processes in science. Some of them confused science with technology. The children mostly indicated the purpose of science and its benefits to the society in their

definitions of science. Positively, children recognized science as a comprehensive field which studies nature, space, and living things.

*At the End of the Science Camp*

The categories emerged from the data were generally similar to the ones at the beginning of the science camp. But, there were also differences. The children did not indicate that science is a school subject and benefits of science to the society in their definitions of science at the end of the science camp. On the other hand, they provided more detailed definitions of the process of science. In addition to this addition and disappearance of some categories, there were also qualitative differences in each category from beginning to end of the science camp.

At the end of the science camp, there was not any child left who stated that science is only a body of knowledge (product of science). Only five children indicated only the process of science. Most of these children (4) stated superficial definition of the process of science as it was evident in the following quotes.

> *Science is all of inquires and experiments done in every subject. It might be in a new subject or reinterpreting previous inquiries.(Akın)*

> *Science is doing observation, experiment, inquiry, using creativity and imagination, and collecting data. (Ahmet)*

These children still used inquiry (3), experiment (2), and observation (3) with next to each other without relating them to each other. New processes such as data collection (3) and interpretation (2) were just added to their list of processes without any attachment to inquiry or experiment. For example, Ahmet started his definition with observation, but used collecting data in the end of his definition. This indicated that they learned about new scientific processes at the science camp, but they did not understand their connectedness and function in a scientific inquiry.

There was only one child with detailed expression in only process of science category. S/he expressed that data are collected in inquiry and predictions are made based on data.

> *There is inquiry in science and data are collected in inquiry studies. In this camp, we did a lot of activities. Sometimes we collected our data*

*ourselves; sometimes you gave us data. We tried to predict what we search depending on these data. (Murat)*

The same child defined science at the beginning of the science camp as "scientists doing inquiry or invent an equipment". The quote indicated that s/he knew the inquiry process a little bit more than the beginning of the science camp. S/he started to learn some processes of inquiry at the end of the science camp such as data collection and prediction. Moreover, s/he used these processes with their functions in research. For example, s/he stated that they "made prediction based on data" rather than saying just "made prediction". But this child was still far behind full conception of science.

Similar to beginning of the science camp, majority of the children (18) indicated both process and product of science. Only three children were added to this category at the end of the science camp. But, the real development in their definitions was the emergence of more detailed explanations of the process of science. Some of the children's definitions of the process of science were detailed (10) whereas some of them were still superficial (8).

Superficial definitions indicating both process and product of science included such experimental processes as inquiry (8), experiment (7), observation (5), collecting data (4), interpretation (2), and measurement (1). Collecting data and measurement were emerged only at the end of the science camp. These children, similar to the beginning of the science camp, listed scientific processes next to each other without relating them to each other. Their use of scientific processes was sometimes wrong or meaningless.

*I: What is science?*
*C: Science is a semi-real subject which is done by collecting data, using imagination, and interpretation.*
*I: What do you mean by semi-real subject?*
*C: If we did not have all of the data, we cannot know if it (scientific knowledge) is certain. ....*
*I: Did you do science at this camp?*
*C: Yes*
*I: How did you do science at this camp?*
*C: I did science by doing inquiry. For example, we did inquiry on insects and there were science in each activity at the science camp. We added*

*interpretation and imagination if we did not know it. We used all of the things, data. For this reason, I thought I did science at this camp. (Funda)*

Funda stated that she did science by doing inquiry, but she did not detail what she did in the inquiry; she just repeated she did inquiry on insects. She presented misunderstanding of interpretation and the use of imagination as processes done if we do not know something. She called data as things first and then remembered and used data. In summary, this child's definition was not a meaningful and concise definition, it just a collection of scientific processes and did not indicate a coherent conception of science. Another exemplary quote was the following:

*I: (reads her definition of science on the questionnaire) science is the results that scientists reach by doing inquiry, experiments, and by using imagination and creativity. What else do you think when I say science?*
*C: Black-box activity came to my mind when I think about science. It was fun. We did scientific model as a scientist.*
*I: How did you do science in this activity?*
*C: First, we collected our data. Then, we planned what we could do based on these data. We planned what was its inside. We reached a result after our plan and we presented it to you and our friends.*
*I: What else do you think about how science is done?*
*C: By collecting knowledge from different resources, collecting data, doing inquiry, doing experiments. In the end, we added our interpretation by using imagination and creativity. (Buket)*

Buket listed inquiry, experiments, using imagination and creativity in defining the process without any connectedness to each other, and indicated the product of scientific process as reaching results. She remembered black-box (water machine) activity as an example of science and stated that they developed scientific model. But, when the interviewer asked how she did science in this activity, she stated that they collected data at first. Then, she did not use scientific model, but called it as 'plan' or 'result reached after their plan'. When the interviewer asked with general terms how science is done, she listed the scientific processes similar to her first definition at the beginning of the interview. This indicated that she did not connect these processes, for example she did not say 'collecting data in their experiment or inquiry', and instead she said 'science is done by collecting data, doing inquiry, doing experiments' as separate processes. Other children's definitions in this category had similar properties. The researchers thought that although their list of

processes in their definitions of science enriched and they realized the importance of data, their definitions were still superficial and lacks clear indication of the scientific process. They stated the product of science as getting knowledge (3), finding results (3), and being a group of knowledge (2).

There were some other children (10) who provided detailed explanations of the scientific process and its product. All of these children used collection of data in their definitions of science and sometimes indicated the importance of the amount of data in the scientific process. They also used inquiry (9), observation (7), experiment (5), investigation (4), interpretation (3), prediction (3), and measurement (2) in their definitions of science. Their use of these processes was mostly correct and they also indicated the function of these processes in doing science. The quotation below provides a good example of such children.

> *I don't know the definition of science. I mean it seems complex to me. It might be something like that. Science is collecting data, using imagination and interpretation when the data is limited…For example, there was a black box activity and there were something in this black box. We could not see inside of this box. Scientists also could not see. We could not see, but we imagined its inside. There was only a funnel and a short hose on the box. Using the materials, we added water and measured. We measured how much water we got from the box. By measuring, we obtained our data. It could be better if we got more data. But we completed our research by interpreting the available data. (Zeynep)*

Although her mind was not clear about science at the beginning of the interview, this child described science on the black-box activity that had been done at the science camp by indicating that s/he had a good grasp of the process of science. S/he indicated that science works on subjects although it could not be seen. She also indicated that measurement is a way of creating data, more data is better and inquiry is completed by interpreting the available data. This definition of science was more comprehensive and scientific processes were connected to each other. S/he only incorrectly stated that interpretation and imagination were used when data is limited. S/he explained scientific process better while s/he was explaining science on the black-box activity rather than general terms. Another exemplary quote is the following:

*I: You defined science as producing something from data, experiments by using our interpretations and imagination. Do you want to add something?*
*C: Science is collecting data and examines the data in detail to find out the reality.*
*I: Did you do science at this camp?*
*C: Yes, we observed swallows and we collected data. We did not know their features to a great detail. But, we learned about them using data which based on the amount of our observations. (Asli)*

Aslı was pointing out making observations and collecting data in the process of science. She also indicated the importance of the amount of observations and the data in the resulted knowledge (stated as learning about something). The children in this category (detailed description of both product and process of science) stated the product of science as getting knowledge (3), finding results (3), and being a group of knowledge (1).

The science camp also extended the children's understanding of the inquiry. Some of the children defined inquiry as searching knowledge at the beginning of the science camp. Fortunately, they realized experimental inquiry after the science camp as it was evident in the following quote.

*I was thinking about searching knowledge in books or from the Internet rather than doing inquiry at first hand. When my science teacher assigns inquiry homework, I will do inquiry at the nature. I was searching trees from the Internet, but it won't be like that anymore. Because, we can get more knowledge if we look at it at the first hand. (Buket)*

When the children's opinions related to purpose of science were examined, it was seen that same number of children indicated that science is done in order to find unknowns (7). But, fewer children indicated that the purpose of science is doing inventions (3) and none of them stated taking patent as a purpose of science. This indicated the decrease in the number of children who confused science with technology. Only one child defined science as technology. Another child mentioned relationship between science and technology. This child indicated that science uses technology to do more detailed research.

*Everything is done by technology any longer. Once upon a time, people could not observe moon closely. But now we have technological devices*

*and we observe everything elaborately. Science needs some technological devices to do experiment. For example, scientists will search dinosaurs. Dinosaurs' bones are examined by technological devices and thus, scientists find the color of dinosaurs' skin, the shape of dinosaurs and like these. (Berk)*

More children thought that science is fundamental for other areas at the end of the science camp. They did not use only specific areas such as space, and underground resource to indicate the scope of science.

*Before the science camp, I thought that science was only the science course we take in school. But, I learned at this science camp that science is not only related to the science course, but also all areas. Scientists came to our camp. One of them was psychologist and there were also biologist and chemist. We only talk about science in science course in the schools. I did not know that there is science in other areas. There is science is in health and education. In other words there is science in all areas. (Yonca)*

Some children mentioned emotional aspects of science only at the end of the science camp. They thought that science requires patience, respect, and effort.

*Science is different from other areas since it requires more effort than music, math or language. It also requires patience. (Cagla)*

Because of the experiences during the science camp, the children realized the emotional aspects of science. They conducted their research and thus they experienced the research process. They sometimes had difficulties and worked hard. Such experiences would have developed some emotions about science.

As it was evident in the quotes, the children seemed to learn and understand science including its process at the end of the science camp. It was an improvement that they expressed both process and product of science with exhaustive statements when defining science. They also talked about new scientific processes such as collecting data, predicting, and measurement. More children realized that science is very comprehensive. They also realized emotional aspects of science after the science camp. Although there were less quantitative increases in the children's definitions of science, there were positive qualitative developments. After the

science camp, they described science by using more detailed and explanatory statements.

# Discussion

The purpose of the present study was to search the effectiveness of a science camp program which aimed at introducing science by using inquiry and explicit NOS activities on children's understanding of science. Comparison of data at the beginning and end of the science camp indicates improvements in the children's conception of science. They came to the science camp with a superficial understanding of the process of science, thinking science as technology or invention of technology and an area which works for benefits of the society. On the other hand, they became more aware of the process of science.

As a restricted conception of science, four children knew science only as scientific knowledge at the beginning of the science camp whereas only one child left with this conception of science at the end of the science camp. It was a positive result, because remaining three children recognized the process of science behind the scientific knowledge.

There were five children who defined only the process of science both at the beginning and end of the science camp. On the other hand, fifteen children indicated both the process and product of science at the beginning of the science camp and it increased to eighteen at the end of the science camp. In addition to this quantitative increase, the real improvement was qualitative. All of these children defined science superficially by sequencing scientific processes at the beginning of the science camp. Ten of them became able to define science in more detail by connecting scientific processes to each other and by stating their functions in science. The most obvious difference between superficial and detailed definitions of science was the interconnectedness of scientific processes. In superficial definitions, scientific processes are just sequenced without indicating their relationship or functions whereas the same processes were used by implying their functions in the scientific process in detailed definitions. This difference would also indicate the progress in children's conception of science. When they first introduced scientific processes they basically related them to science, but they did not understand their functions in the scientific process. As they progressed, they better recognized their functions and conceptualize scientific process and connect them to each other and form a concise conception of the scientific process.

Other qualitative differences were also evident in the children's definitions of science such as the addition of new scientific processes in both superficial and detailed definitions. Although none of the children used collecting data in defining science at the beginning of the science camp, most of them stated this process at the end of the science camp. They learned data and realized its importance in science during the science camp. In most of the activities, they collected data at the nature. Sometimes data were generated from simulation games. In one activity, earthquake data were given as a list. In all of these activities, they interpreted data and constructed scientific knowledge. So, they experienced these processes many times during the science camp and understood the importance of data in the scientific research. Thus, most of the children started to realize that science is empirical. Similarly, other processes such as measurement, prediction, and interpretation emerged only at the end of the science camp indicating that they learned them throughout the science camp.

If the results of this study were compared with that of related studies, there was an interesting difference. The common conception of science was considering science as a school subject. This conception of science was very common in Stein and McRobie's (1997) study conducted in Australia. Sixty percent of seventh grade children participated to their study defined science as what is done or learnt at school. Similarly, in BouJaoude and Abd-El Khalick (1995) study, 85% of the students in a public school and 65% of students in two private schools, and 40% of students in another public school defined science as school subject. In addition, most of the research conducted in the U.S. similarly reported that students perceive science as a school subject (Charron, 1991; Reif and Larkin, 1991; Song and Black, 1991; Urevbu, 1991). On the contrary, this conception of science was very low (4) at the beginning of the science camp and disappeared at the end of the science camp. The reason for the difference between this study and other studies would be the name of the course in Turkey. There are two words corresponding to science in Turkish which are 'fen' and 'bilim'. 'Fen' corresponds to the positive sciences whereas 'bilim' corresponds to science in general. Integrated science is taught from first to eight grade in Turkey and 'fen' is used in the name of the course. But, in daily life and in the questionnaire used in this study general term for science (bilim) was used. Thus, fewer children related science to the course studied in the school at the beginning of the science camp. Since their conceptions of science shifted toward process of science at the science camp, there was no child left defining science as a school subject at the end of the science camp.

A similar study on a science camp conducted by Liu and Lederman (2002) found very little change in the students' understanding of NOS from pre- to post-test. Their science camp was conducted with a group of gifted seventh-grade students from Taiwan. They explained the reason for little change from pre- to post-test as the students being already well at the pre-test. The participants in the science camp presented in this study were regular 6th and 7th grade students and we found positive changes in children's views of science. The reason for this was that there was a room for change in the children's conceptions of science, since they started to the science camp with a popular understanding of science.

The ten-day long science camp provided the participants with a unique out-of-school experience. Although duration of the science camp was short, the science camp program mainly consisting of explicit NOS activities and guided inquiry, was effective in developing the children's conception of science. There is increasing evidence in the literature that explicit approaches are more effective than implicit approaches in improving student's views of NOS (Abd-El-Khalick&Lederman, 2000; Khishfe&Abd-El-Khalick, 2002, Khishfe, 2008). There are also research studies which aimed at introducing NOS aspects with inquiry-oriented instructional approach reporting positive change in children's views of NOS (Khishfe&Abd-El-Khalick, 2002; Khishfe & Lederman, 2006; Khishfe, 2008). This study showed that the combination of both explicit NOS and guided-inquiry was also effective in developing children's conception of science.

# Conclusion

The results of the study revealed that the children learned the process of science at the science camp. Their conceptions of science shifted from popular conception of science which includes finding unknowns, making inventions, making life easier, and benefits to the society to more scientific conception which includes a concise and detailed understanding of the scientific processes such as inquiry, experiment, data collection, observation, measurement, interpretation, and prediction. This shift in their conception of science demonstrates the effectiveness of the science camp program, because guided-inquiry in the science camp program would have facilitated their understanding of the process of science by conducting inquiry at the nature. In addition, they had opportunity to reflect their understanding of the scientific process during the explicit NOS activities.

In this study, science was introduced to the children in an informal learning environment by conducting guided-inquiry at the nature. This is an authentic way of introducing science, since science itself searches nature. Depending on the positive changes in the children's conception of science, we recommend such informal learning environments to introduce science to children in an alternative way.

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