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Teaching the Nature of Science in the Nature: A Summer Science Camp

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ABSTRACT: Teaching the nature of science has been one of the main goals of science education in recent years. In order to teach the nature of science in a way that would be appealing to children, a summer science camp was organized in this study. The science camp was held in an area, which was located near a beautiful lake by a mountain. 34 students who were in grades 6 to 8 participated in the camp. The first three days of the camp program were aimed at developing background for inquiry and collaboration skills. Later, the students conducted guided-inquiry on a research question that they asked about nature in small groups for two-days. Each group prepared a poster and presented it to their families on the last day of the camp. A few explicit Nature of Science (NOS) activities were carried out throughout the camp program. Views of Nature of Science questionnaire version D (VNOS D) (Lederman & Khishfe, 2002) was applied as pre- and post-test in order to determine the effectiveness of the camp in introducing NOS. The results showed that the camp program helped the students develop informed views of empirical and tentative nature of NOS. On the other hand, the camp program was less effective in developing informed views of imaginative and creative nature of science and least effective in introducing theory ladeness of scientific knowledge, scientific models and difference between observation and inference.
Keywords: Science camp, Nature of science, guided-inquiry, elementary science education

Introduction

Developing scientific literacy is one of the main goals of science education in many countries. Turkish Ministry of Education undertook two elementary science education curriculum development processes in 2000 and 2004. Both curricula stated the development of scientific literacy as main goal of elementary science education (TME, 2004, 2008). But, scientific literacy is a complex issue and has several aspects. Knowing the Nature of Science (NOS) is one of the main characteristics that a scientifically literate person should have (Bybee, 1997).

The change in the methods of teaching NOS is well documented in Lederman (2007). Different courses and programs were applied to develop aspects of NOS, but NOS was implicit in those earlier studies. The results of those studies showed that implicit instruction was not effective at all in developing NOS aspects unless the technique included either historical aspects of scientific knowledge or direct explicit attention to NOS (Lederman, 2007, p.852). Previously, it was assumed that children understood the nature of science for as long as they did science (Abd-El Khalick & Lederman, 2000). It was also assumed that the more science children did, the more they understood NOS. But, some studies reported that even children experiencing inquiry programs did not develop adequate level of understanding NOS (Khishfe & Abd-El Khalick, 2002; Meichtry, 1993). Implicit instruction of NOS in inquiry activities was claimed to be one of the reasons for that outcome (Abd-El Khalick & Lederman, 2000). Thus, in their recent studies Khisfe & Abd-El Khalick (2002) recommended the explicit instruction of NOS aspects. They also recommended explicit reflection of NOS aspects in inquiry activities by comparing students' inquiry processes with the work of scientists and joint reflection by students and teachers on NOS aspects whenever it was appropriate (Scharmann, Smith, James, & Jensen, 2005). This method was referred to as the explicit and reflective inquiry approach to introduce NOS (Khisfe & Abd-El Khalick, 2002) and found to be more effective than implicit inquiry-oriented instruction.

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History of science was also used to improve students' NOS conceptions (Arons, 1988). To that end, a curriculum named History of Science Cases for High Schools (HOSC) was developed. It consisted of historical cases that conveyed important ideas about science and scientists. Its application on a great number of students in biology, physics, chemistry, and geography courses for five months resulted in significant gains on students' conception of science and scientists. Connecting historical cases in biology to NOS was also suggested for use for students at both high school and college levels (Arons, 1988; Bentley & Garrison, 1991; Wandersee, 1985). The same approach was also used for high school teachers as a professional development program (Dawkins & Glatthorn, 1998). As an alternative to this approach, some studies reimplemented experiments from history of science with students to improve their NOS conceptions (Kipnis, 1998).

Science camps may be an interesting technique to introduce NOS to children. However, studies that employed summer science camps to introduce NOS are scarce in the literature; we were able to locate only one research study in which gifted middle school students experienced explicit inquiry in a science camp in Taiwan (Liu & Lederman, 2002). Although the researchers in that study applied the explicit inquiry method in the science camp, they did not find any change in students' understanding of NOS from pre- to post-test as the students had already done well on the pre-test. Ceiling effect and short period of instruction were two possible reasons suggested by the researchers for the absence of change from pre- to post-test. We believe that science camps deserve more research attention to assess their effectiveness in introducing NOS.

The present study aimed at searching the effectiveness of a science camp program on improving children's NOS views. Our science camp was held with regular school children and the method of instruction was a combination of implicit inquiry and a few explicit NOS activities. Indeed, the main theme of our camp program and that of Liu & Lederman (2002) was similar. Whereas they mainly did scientific inquiry-based activities, two field trips, and four explicit NOS activities, our program was based mainly on guided-inquiry in nature, and three explicit NOS activities. Two NOS activities, namely, Tricky Tracks and Fossil Fragment (Mc Comas, 1998), were the same in both studies. Assessment of students' NOS views were also similar; Liu & Lederman used a questionnaire which consisted of different items from VNOS series, by adding two new items about cultural issues. Because of this high similarity in our methodologies and assessment tools, our results would be very comparable to Liu & Lederman (2002). The difference, however, is in the participants. The participants were gifted students in the Liu & Lederman study. The participants in our study were regular school children coming from families who had low socio-economic status.

Although, it is difficult to find research studies on science camps, they are very common, especially, in the U.S. However, these camps are commercial, not research-based. Their main purpose is to provide entertainment for children through scientific activities such as hands-on science activities, field trips, and technological inventions. Even a simple search on the Internet would give a clear idea as to the popularity of these commercial summer camps. In a few studies, science camps were applied for various purposes such as getting students' attention to physical sciences and science education (Bischoff, Castendyk, Gallagher, Schaumloffel, & Labroo, 2008), 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).

Science enrichment programs in informal settings have been developed to enhance students' achievement in science, as well as their attitudes toward science and their understanding of NOS (Bell, Blair, Crawford, & Lederman, 2003). 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. Informal science education has become a special section both in journals such as

Science Education and in the conferences of professional organizations such as the National Association of Research in Science Teaching (NARST). In order to determine NARST's position with regard to informal science education, an ad hoc committee in NARST was also established (Dierking, Falk, Rennie, Anderson, & Ellenbogen, 2003). The committee pointed out six aspects of meaningful informal learning. According to the committee, in meaningful informal learning students are self-motivated, voluntary, and that learning occurs in authentic contexts, is cumulative and interrelated to children's lives, is considered as both a process and a product, and is assessed by creative methods. National Science Foundation provides more precise definition of informal science education as follows:

> 'Informal science education' is voluntary, self-directed, and life-long. It is learning that provides an experiential base and motivation for further activity and learning. (cited in Sladek, 1998, pp. 8)

Informal science learning is usually conducted in science museums (Anderson, Lucas & Ginns, 2003), science centers (Wellington, 1990), living museums (Zion & Stav, 2005), national parks and state forests (Ballantyne & Packer, 2002; Roberts & Sayyed, 2007), and school summer science programs (Markowitz, 2004). In these informal settings, children experience different scientific activities and get an idea of what science is. However, they do not specifically think and talk about the nature of science. In other words, these informal settings are not specifically aimed at introducing students to the nature of science such as tentativeness of scientific knowledge, theory ladeness of science, etc.

Science camps would be wonderful settings to introduce the nature of science since they provide informal learning opportunities for students to work on nature as scientists usually do. Science questions nature and provides answers through observations and experiments. Researchers of this study believe that one good way of teaching the process of scientific inquiry and the nature of science would be teaching science as it is, that is, by asking questions about nature and conducting inquiries in nature to answer them. In our summer science camp, nature walk was done around the camping area, and children were asked to observe in detail whenever they wondered something. In the second half of the camp program, they were required to ask a question about the objects and events that they observed around the camping area. They established their research questions in their small groups and conducted two-day long observations and experiments to answer them. Since doing science does not necessarily introduce NOS (Lederman, 2007), three explicit NOS activities were implemented on different days of the camp program. This combination of guided-inquiry and explicit NOS instruction was thought to be an interesting way of introducing NOS, and its effectiveness was assessed by applying VNOS D as pre- and post-test.

The significance of this study is to provide results that would be used in developing effective summer science camp programs to introduce science. Because, science camps are becoming popular by the support of Science and Society Department of the Scientific and Technological Research Foundation of Turkey (STRFT) and research would inform science camp founders and organizers. The present study aimed at searching the effectiveness of a science camp program supported by STRFT and aimed at introducing science and its specific aspects to children.

Method

Summer science camp was conducted between August 3-12, 2007 at a camp site located on a mountain. There was a lake, a stream, and forest around the camp. The camp was an appropriate place to work on nature.

Participants

Thirty-eight children participated in the camp. Four children left the camp because of health and adaptation problems. Thus, 34 children completed the camp. They were selected from four schools according to their interests toward nature and science courses and their socio-economic status. Children with low socio-economic status were especially selected because of the policy of the Science and Society Department of the Scientific and Technological Research Foundation of Turkey, which aims to popularize science in informal ways and to sustain scientific literacy in the society. There were 8 children in 6^{th} grade, 15 in 7^{th} grade, and 11 in 8^{th} grade. They are 10 to 13 years old. Thirteen of them were female and 21 of them were male.

Camp Environment and Educational Atmosphere

The camp was located on a mountain and surrounded by a lake, a stream, and a forest. Thus, the natural environment of the camp was rich enough to support the children to do research in nature. The children stayed in small bungalows each of which accommodated two children. A large area next to the bungalows was used to conduct camp sessions. There were also open football and basketball courts for leisure activities.

All camp sessions were held in open air. The children worked in small groups around tables during most of the sessions. In some sessions like drama, they freely moved around the camp area. The science camp was student-centered: the children were active in all activities; only a few short presentations were given by the educators. Most of the activities were hands-on. Although the camp was on the mountain, technological equipment (laptop computers, projection device, microscope, stereo-microscope, binoculars, and a telescope) and laboratory materials were transported to the camp by the project team members.

The project team consisted of four science advisors and three research assistants. The sessions were monitored by one of the science advisors; the three assistants supported the sessions by interacting with the groups working on a particular task. This enabled the activities to become more student-centered. Otherwise, it would have been difficult to do student-centered activities with 34 children. In order to provide medical assistance to the children, a nurse was available at the camp at all times.

Summer Science Camp Program

The camp program started on a Friday evening and different activities were conducted to enable students to learn each other's names and characteristics.

The first session of Saturday was the science session. In this session, the students were asked to draw a scientist. Their drawings were compared and similarities were quantified by calculating the frequency of some aspects such as long hair, lab coat, and laboratory devices, etc. After that, a black box activity, water machine, was done and the children modeled how it worked and shared it with their friends. In the afternoon, fun math session in which students examined the symmetry in their faces was conducted. Drama activities were held in the evening to enable students to relax and internalize their learning throughout the day.

On Sunday, a computer session was held in the morning. The children learned basic statistics (mean, drawing graphs) on a spreadsheet program. In addition, they learned how to prepare effective posters. In the afternoon, all students and the staff walked in the forest, observed nature in detail, and examined the objects they were interested in using magnifying glasses. A walking path from the forest to the lake and then to the river was chosen for this activity. The aim of this session was to draw the students' attention to the environment so that they could choose an object or an event to search more in the later part of the camp program. The staff guided the students' observations using questions and gestures. The students were also asked to collect material they might use in the following activity which was “math and art” in nature. The students examined cones and learned the golden spiral on them. Then, they examined flowers to see if they had Fibonacci numbers on them. At the end of this session, each child made a photograph frame using the natural materials they had collected. A picture of the camp was put in those frames, and the frames were given to children as a gift on the last day of the camp.

On Monday, basics of a scientific research study were introduced to the children. Pendulum was introduced to the children and its oscillation per minute was counted altogether. Afterwards, the factors that might affect the number of oscillations per minute were determined by the children. Each factor they pointed out was written on a board. The children determined the factors they were going to examine using the available instruments. They realized that they could study the effect of the length of the string, weight, and height of the starting point. After that the students worked in small groups and conducted three experiments in which they changed one variable at a time and controlled the other two variables. At the end of the activity, the groups shared their results and briefed each other on what they did and what they learned.

The rocket activity was next. In this activity a balloon was inflated and attached to a pipette, and a rope was passed through the pipette, and the other end of the rope was tied to a tree. The operation of the rocket was demonstrated to the children. Next, the children were asked to study in groups to find the best way to send their rockets to the space shuttle, which was a point at the end of the rod. The groups were observed to see if they tried each variable separately by controlling other variables. After each group found best conditions to send their rockets to the space shuttle, they presented it to other groups. In the afternoon, the students made a mask of their faces and decorated them with materials they had collected during the nature walk. In the evening, team-building activities were done to help the children form their groups and get used to working together.

On Tuesday, the groups discussed the subjects they wanted to inquire about and formulate their research questions. At this stage, the children were supervised by science educators who had specialized in the fields of chemistry, biology, physics, and mathematics education. The supervisors examined the research questions of all groups and decided which groups to supervise, using their expertise. In the end, each science supervisor supervised three groups. In the afternoon, the groups designed their investigations, and, under their science supervisors' guidance, they determined what they would need in their investigation. Each group wrote a simple research proposal which stated their research question, their method of investigation and required materials. There were twelve groups, and their research questions were about the moon, constellations, spiders, spider webs, insects, grasshoppers, stream water, lake water, Fibonacci numbers on the flowers, pine trees, birds, and snails.

On Wednesday, the students went to the capital city, Ankara, to visit the Science and Technology museum and a science center. They returned to the camp at night. In the meantime, half of the project team went to the university laboratories to collect the required materials for the groups' investigations and brought them to the campsite.

On Thursday and Friday, the main sessions were allocated to the groups' investigations. The groups conducted their investigations in nature with the materials given by the project team. They collected, recorded, and interpreted data and drew conclusions to answer their research questions. There were other sessions about fishing in the lake, environmental problems, the eco-system of the lake, and observing animals hunt at night. There was also a special science session to introduce the nature of science with Tricky Tracks and Fossil Fragment activities (Mc Comas, 1998). At midnight on both days, the students observed the Jupiter with a telescope, and the constellations and peredials by naked eye. The camp area was far away from the city lights and a wonderful place for sky observation.

On Saturday, the groups wrote a simple report which contained information about the purpose and method of their investigation, data, interpretation, and conclusion. Then, they prepared a poster to present their investigations. The science supervisors visited their groups and guided them throughout their investigation and reporting. Between such reporting sessions, there was a creative art session and the students painted a T-shirt on their own. In the evening, all groups' posters were ready. It was time to have fun as the camp program was coming to its end. A photograph show taken at different times of the camp was shown and the children had fun with the staff.

On Sunday, the posters were posted at different places in the center of the camp area. Children's families started to come to the camp around 11 a.m. The project coordinator made a speech and invited families to visit all posters, by asking children questions about their investigations and their posters. Then the children were given their certificates.

The Instrument

In order to assess the effectiveness of the camp program on developing informed views of the nature of science on children, VNOS D (Views of Nature of Science questionnaire version D) (Lederman & Khishfe, 2002) was applied as pre- and posttest. VNOS D consists of seven open-ended questions about some aspects of NOS such as the empirical nature of science, tentativeness of scientific knowledge, imagination and creativity in science, scientific model, theory ladeness, and difference between observation and inference. Some aspects were assessed by more than one question. VNOS D was chosen because it was the most suitable questionnaire, which consisted of items understandable for children and thus was recommended for use with elementary students by Lederman (2007). Pre-test was applied on the first day and post-test was applied on the last day of the camp. Lederman, Abd-El-Khalick, Bell and Schwartz (2002) suggested supporting VNOS D with interviews, but the project team could not interview the children at the camp because of time constraints. Instead randomly selected six children were interviewed after the camp. Interviewing six children was considered enough to get detailed data about children's NOS profiles as Lederman et al. (2002) recommended %15-20 of the participants to be interviewed. Interviews were conducted individually, recorded, and then transcribed. Interview data were used to understand children language and thinking in VNOS D items to better interpret children's responses to VNOS D questionnaire. Since interviews could not be done just after the application of questionnaires, interviews were not included in data analysis.

Analysis of the Data

Qualitative data from the VNOS D questionnaire was analyzed by content analysis technique (Fraenkel, Wallen; 1996; p. 405). Frequency of codes was used in the interpretation of the data. First, three researchers coded a questionnaire together to develop a coding scheme to increase the reliability of the analysis. After that, three researchers selected ten questionnaires randomly and coded them individually. They compared their coding and calculated the percentage of the same codes. The percentage was 92% which is high, and it indicated that consistency among three coders was established. The researchers reached a consensus on different codes as coders to increase consistency in their coding. After that, three researchers shared the remaining pre- and post-test questionnaires and analyzed individually. Although they coded the data individually, they did the remaining analysis (classification of codes) together and reached consensus on every issue as well. The codes were then classified according to the aspects of the nature of science at both pre and posttest. Frequencies of the codes at pre and posttest were compared to each other to figure out the effect of the camp program.

Results and Interpretation

The purpose of this research study was to investigate the influence of the summer science camp program on the children's understanding of the nature of science. The main theme of the camp program was guided-inquiry. A few sessions consisted of explicit NOS activities. VNOS D was applied as pre- and post-test, and the data was analyzed with respect to the following aspects of NOS:

- Empirical NOS
- Tentative NOS
- Creative and imaginative NOS
- Theory ladeness of science
- Scientific models
- Difference between observation and inference

The results of the study will be presented as separate sections according to these aspects of NOS.

Empirical Nature of Science

The first and second questions in the questionnaire aimed at revealing the children's ideas about science and its distinguishing features from other areas. Data regarding the empirical aspect of NOS was obtained through the children's answers to these questions.

In their definition of science at the pre-test, the children did not directly use the term empirical, but used terms which indicated the empirical NOS such as (frequencies in parentheses) inquiry (13), experiment (5), observation (3), and examine (2). Half of the children (53%) were already aware of the empirical nature of science at the beginning of the camp although their responses were not very detailed.

At the post-test, four children specifically used the term "empirical" in their definition of science. Terms indicating the empirical NOS such as inquiry (19), experiment (9), observation (8), and examine (1) were more frequently used by children at the post-test. At the post-test, 71% of children emphasized the empirical nature of science in their definition of science. When pre- and post-test results of the first question were compared, it was seen that the children became more familiar with the empirical nature of science after the camp.

Another difference between the pre and posttest is that some of the children stated the purpose of the science in their definition of science only at the posttest. They stated the purpose of the science using phrases such as 'finding out unknown (4)', 'solving the problems (3)', and 'answering questions (1)'.

Science and technology have similar processes, but they differ in their purpose. Technology has a commercial perspective and it always targets the needs of humans because manufacturers have to sell their products to humans. Science, on the other hand, is not necessarily guided by such commercial motives. As this difference is not well known by the society, science and technology are often confused. Some of the children in our camp were not an exemption. Ten children at pre-test and nine children at the post-test confused science with technology as it was evident in the following quotes:

> To me, science is technology. (GK, Pre, Q1)
> (Science) is a development of technology. (HO, Post, Q1)

Tentative Nature of Science

Third question in the questionnaire was about the tentativeness of scientific knowledge and asked whether scientific knowledge in the science textbooks might change or not. Twenty-five children at the pre-test and 30 children at the post-test responded to this question. At the pre-test, 17 (68%)

children expressed that scientific knowledge might change. But, when the answers were examined in detail, it was understood that eight (32%) children defined tentativeness as adding new knowledge to the available knowledge domain, which implies improvement and extension of scientific knowledge as seen in the quote below:

> I think it can change. In the future, more comprehensive research can be conducted and thus we can be more informed. (EO, Pre, Q3)

Only five (20%) children defined tentativeness as a radical change of the scientific knowledge.

> Current scientific knowledge can change in future. It was accepted in the past that the world was flat. Then it was proven that the world was like a ball. (CA, Pre, Q3)

Confusing science with technology again emerged in the answers to this question, and four (16%) children gave the development of automobiles and telephones as examples of change in scientific knowledge.

At the post-test, the number of children who recognized the tentativeness of scientific knowledge increased to 23 (77%). Of those children, the number of children who recognized change in scientific knowledge as an incremental addition to current scientific knowledge was four (13%) whereas the number of children who recognized change in scientific knowledge as a radical change in current scientific knowledge was 12 (40%). Interestingly, the number of children who mentioned technological changes as examples of the changes in scientific knowledge was seven (23%).

From pre-test to post-test, the number of children who recognized scientific change as incremental decreased from 8 (32%) to 4 (13%) whereas the number of children who recognized radical changes in scientific knowledge increased from 5 (20%) to 12 (40%). These results are positive because the society is more familiar with incremental addition in scientific knowledge as it is easier to understand than radical changes in the scientific knowledge. Interestingly, the number of children who mentioned technological changes as examples of the changes in scientific knowledge increased from four (16%) to seven (23%).

The percentage of children who did not accept the tentativeness of scientific knowledge was decreased from 32% (eight children) at the pre-test and to 23% (seven children) at the post-test. To justify their thinking these children used examples from mathematics and scientific laws, as it was evident in the following quotes:

> Did not change. Because, zero remains unchanged. Zero is zero (ED, Post, Q3)
> Did not change. Because, the properties of a square change only when square changes. But, square never changes.(DE, Post, Q3)
> To me, such (scientific knowledge in the textbooks) knowledge does not change. For example, Newton's law of gravity. (GK, Post, Q3)

Another question which aimed at deriving children's ideas about the tentativeness of scientific knowledge was the 4th question which asked how scientists were sure of the shape of dinosaurs. Twenty-seven children at the pre-test and 33 children at the post-test responded to this question. 14 (52%) children at the pre-test and 22 (67%) children at the post-test stated that scientists could not be sure of the shape of dinosaurs.

The last question which aimed at obtaining children's ideas about the tentativeness of scientific knowledge was the 5th question. The question was about meteorology and asked how certain meteorologists were about their computer models of weather patterns. Twenty-six children at the pre-test and 31 children at the post-test responded to this question. The number of children who stated that meteorologists could not be sure of weather patterns was 21 (81%) at the pre-test and 20 (65%) at the post-test.

When the results of these three questions (textbook, dinosaurs, and meteorology) are compared, it can be said that children's ideas about the tentativeness of scientific knowledge was strongly influenced by the context of those questions. For example, at the pre-test the number of children who recognized the tentativeness of scientific knowledge changed depending on the context of the question asked: the numbers were 17 (68%) children for Q3 (science textbooks), 14 children (52%) for Q4 (dinosaurs), and 21 (81%) for Q5 (meteorology). Best results were obtained in the meteorology question as weather itself is very changeable and the majority of the children easily developed idea of tentativeness in this context. At the post-test the number of tentative responses converged as 23 (77%) children for Q3, 22 (67%) children for Q4, and 20 (65%) for Q5 at the post-test. It is interesting that percentage of children who accepts tentativeness of scientific knowledge in textbook and dinosaurs questions increased from pre- to post-test whereas that of meteorology question was decreased.

Another interesting analysis was conducted at this point. The answers to these three questions regarding tentativeness of science was analyzed altogether and responses were categorized into three categories such as 'accepts tentativeness in all domains', 'accepts tentativeness in some domains but not others', and 'does not accept tentativeness in any domain'. Twenty-five children at the pre-test and 28 children at the post-test responded to all of three questions and thus included in this analysis.

The results of this analysis showed that at the pre-test only four (16%) children accepted the tentativeness of scientific knowledge at all domains, 14 (56%) children accepted tentativeness in some domains and rejected in others, and 7 (28%) children did not accept tentativeness in any domain. On the other hand, at the post-test, the number of children who accepted tentativeness in all domains was 14 (50%), the number of children who accepted tentativeness only in some domains was 9 (32%), and the number of children who did not accept tentativeness in any domain was 5 (18%). These results indicated the positive effect of the camp program in introducing the tentativeness of scientific knowledge, since the percentage of the children who accepted tentativeness of scientific knowledge increased from pre- to post-test.

Creativity and Imagination

Scientists use their creativity and imagination at every stage of their research. The 7th question of VNOS D is mainly intended for this purpose. It aims to elicit the extent of the awareness of children on this aspect of science. This is a two-part question, which starts as a Yes/No question at the beginning and later asks participants to explain reason/s for their choice. If a participant responds by choosing No, s/he is asked to state the reason for her/his response. If the response is Yes, the participant is asked to explain where creativity and imagination is used in a research study. Since it was easy to check one of two options, all children (34) responded to this question.

In the results, it was seen that 26 (76%) children at the pre-test positively responded to the question, but most of them did not provide any detail as to where it was used in research. The children who detailed their responses stated that creativity and imagination was used in planning (5), experimenting (3), data analysis (2), data interpretation (1), and the entire research process (3).

At the post-test, the number of children who recognized this aspect increased to 29 (85%), and those children stated that creativity was used in planning (6), experimenting (1), data analysis (3), data interpretation (5), explaining results (2), pre-planning (2), observation (1), and the entire research process (2).

The results indicated that most of the children were already aware of the use of creativity and imagination in science in a general sense; three more children noticed this aspect during the camp period, and at the post-test almost all of them became aware of this aspect of science. But, the children's awareness of the use of creativity and imagination in the scientific process was not very informed, because most of them did not check any part of research listed in the question. They are open to the idea, but they are not really sure about where creativity and imagination is used. Among stated responses, planning was the highest at both pre- and post-test. A few additional parts of research emerged at the post-test such as data interpretation, explaining results, pre-planning, and observation. These additional varieties indicated that few children noticed the use of creativity in different parts of research. Generally, they were far from recognizing the fact that creativity and imagination was used in every part of an investigation, as only three children at the pre-test, two children at the post-test stated that creativity and imagination was used at every part of an investigation.

When the data about creativity and imagination was analyzed in detail, it was seen that four of the seven children, who did not accept the use of creativity and imagination in science, did not change their opinions at the post-test. But, three of those seven children demonstrated a radical change in this aspect. These three children were among the highly motivated children during the camp activities. Their responses at the pre-test showed that as they trusted and valued science very much, they did not think that scientists could possibly use their creativity and imagination at their work. Their responses at the pretest are below:

> No. Because imagination cannot be a part of a subject like science. (EG, Pre, Q7)
>
> No. Because this (scientific) knowledge should always be based on facts. If they (scientists) don't do this, they cannot be scientists. (GK, Pre, Q7)
>
> No. Because using creativity and imagination might sometimes cause mistakes. For this reason, in order to reach right and clear results, research and experiments should be more explanatory and do not contain imagination. (BB, Pre, Q7)

These three children's responses warned the researchers to be more careful in the interpretation of the children's ideas. These quotes could have easily been interpreted as the evidence for the absolute view of science and accepted as naive ideas about NOS. However, the reason behind these seemingly naive ideas is the children's trust and high positive attitudes toward science and scientists, which is good for science educators. As seen in this study, sometimes the reason behind these seemingly naive ideas may be positive feelings towards science. Since the science camp program should have affected these children's ideas about the use of imagination and creativity in science without destructing their trust, they responded as follows at the posttest:

> Yes. I think people use their imagination in interpretation. (EG, Post, Q7)
>
> Yes. I think they (scientists) use their imagination and creativity in interpretation of research. (GK, Post, Q7)
>
> Yes. On the first day of the camp we tried to predict what was inside the black box. We did not have enough data. Because of that we tried to determine what was inside of it by combining the data with our predictions. In addition, in Tricky Tracks activity, footprints were our data and we tried to predict whose footprints those were and what might have happened there. We reached different theories. (BB, Post, Q7)

Theory Laden NOS

Theory is the fuel of scientific development. Scientific knowledge is therefore theory-laden. In addition, scientists' theoretical and disciplinary commitments, beliefs, prior knowledge, experience, and expectations do influence their work (Lederman et al., 2002). The 4th question aimed at obtaining children's views on this issue. It stated that scientists agreed that dinosaurs became extinct 65 million years ago, but that they differed in their explanation for the reason of the extinction. The question then asks why scientists had different explanations although they had the same information. All of the children (34) responded to the question.

At the pre-test, most of the children gave irrelevant answers to this question. Their answers led the researchers to think that the children may not have understood the question. Only two (6%) children provided answers, which indicated theory ladenness of scientific knowledge. One of these student's reply is as follows:

> Every person looks at subjects from different viewpoints. Scientists might look at a research result from different viewpoints and thus they make different interpretations. (SS, Pre, Q4)

At the post-test, the results were similar as well. Only four (12%) children indicated this aspect of science in their answers.

> They (scientists) have different ideas because they interpret the data differently. For example, in Tricky Track activity, we proposed different possibilities about what might have happened there by looking at the same footprints. (BB, Post, Q4)

These results showed that most of the children did not recognize this aspect of science. One reason for this may be that children at elementary grades may find it difficult to recognize the subjective nature of scientific knowledge.

Scientific Model

One of the questions in VNOS D directly asks what a scientific model is and asks participants to give an example of a scientific model they know of. At the pre-test, 11 (32%) children did not provide any answer at all to this question. Eighteen (53%) children provided unqualified answers which did not give any impression about their understanding of the scientific model. These children rather danced around the words *scientific* and *model*. Two of these responses are as follows:

> It is something related to science. (MG, Pre, Q6)
> It shapes creative ideas of scientists. (HO, Pre, Q6)

Only five children (15%) indicated that they had an idea of scientific model although their answers were not insightful. Two of these students' responses are given below:

> (Scientific model) is a model which makes a scientific development more understandable to people. (BB, Pre, Q6)
> (Scientific model) is a symbolic representation of a scientific result. (DM, Pre, Q6)

At the post-test, 5 children (14%) did not answer the question. 19 children (56%) provided unqualified answers in which they again danced around the words. Such answers were not meaningful enough to enable researchers to understand the children' ideas on the concept of scientific model. A few of these responses are:

> (Scientific model) is a model created by science. (AY, Post, Q6)
> It is related to science. (DB, Post, Q6)
> (It is) a model which is based on science. (BB, Post, Q6)

Ten children (29%) provided more qualified answers such as the following:

> It is a symbolic computer representation of or a hand-made small scale model of a scientific object or figure. (DM, Post, Q6)
> (Scientific model) is a sample which is used for better explanation of science. (BB, Post, Q6)

As can be seen from the pre- and post-test results, the children were not familiar with scientific models and the idea of modeling at the beginning. There was small increase from pre- to post-test in the children's understanding of a scientific model.

Distinction between Observation and Inference

Distinction between observation and inference is an important aspect of science, since observation is not enough to construct knowledge. Rather, it is just the beginning of doing science and produces data. Scientific knowledge is produced from data through scientists' interpretations and inferences. In this research study, data for this aspect of science was obtained via the fourth question in VNOS D questionnaire. The question asks how scientists know that the dinosaurs really existed and how certain they are about the shape of the dinosaurs.

At the pretest, almost all children (31, 91%) stated that they knew that the dinosaurs existed because scientists found dinosaur fossils, bones, and foot-prints. The children did not indicate that scientists did additional work or thinking on the fossils. Their answers indicated that scientists understood everything when they found the fossils.

> They know from fossils dating from that time. (OK, Pre, Q4)
> From foot-prints, fossils, and bones (FS, Pre, Q4)

Only three (9%) children indicated that scientists found fossils, produced ideas on them and discussed their views with others. Although their answers did not indicate that they had a full conception of inference, they were accepted because they included a sense of understanding inference. The answers revealed that the children knew that finding fossils was not enough, and scientists did additional thinking on them.

The situation was very similar at the post-test. Again 30 children (88%) provided answers, which indicated that scientists made observations, and only four children indicated that scientists made additional research after they found the fossils. One of such responses is the following:

> Because fossils and remainders which belong to the dinosaur era are found. So scientist gain knowledge through research, observation, and using these fossils and remainders. (EO, Post, Q4)

The responses to this question showed that the children noticed that scientists made observations, but they were not aware of scientists' thinking processes and thus inference in science. Supporting evidence also came from the children's definitions of science in the first question. In their definitions of science, the children mostly used words related to doing science such as inquiry, experiment, observation, and examine at both the pre-test and post-test. They rarely used words related to thinking in science such as thinking, reasoning, interpreting, explaining, learning, knowledge production and scientific viewpoint at both the pre-test and post-test. This indicates that children were more familiar with the methodological process of science and unfamiliar with the intellectual aspect of science. The science camp program could not produce a positive effect on the children regarding differentiating observation and inference.

Discussion

The results of the study showed that the children were aware of the empirical nature of science and the camp program influenced their recognition of science in a positive way. The percentage of the children who indicated that science was empirical increased from 53% to 71% from pre- to post-test. Guided-inquiry experience might have been the main reason for this positive influence since the children conducted an investigation with minimum guidance from their supervisors. This research study obtained similar results with the Khishfe & Abd-El-Khalick (2002) study as explicit and reflective instruction improved students' view of empirical aspect of NOS by increasing the percentage of students who held informed views from 6% to 48% from pre- to post-test. But, implicit instruction in the Khishfe & Abd-El-Khalick study had a negative effect on this aspect of NOS. The empirical aspect of NOS was the least researched aspect in the studies in the literature whereas the tentative, creative/imaginative nature of science and the difference between observation and inference aspect were investigated more.

The tentative nature of science was the most complex part of the data. When the tentativeness of scientific knowledge was questioned directly in Q3 at the pre-test (science textbooks), half of the children had already accepted that scientific knowledge could change. Among these children, the idea of incremental change in scientific knowledge was more common. At the post-test, the number of children who accepted the tentativeness of scientific knowledge increased somewhat as more children recognized the idea of radical change in scientific knowledge.

Tentativeness of scientific knowledge was implied indirectly in the questions that asked how scientists might be sure of dinosaurs and weather patterns. In these two questions, the contexts of the questions were different. The results of the meteorology question was better than the results of the dinosaurs question at the pre-test, but the percentage of children who accepted tentativeness of scientific knowledge in meteorology question decreased from 81% to 65% whereas that of dinosaurs question increased from 52% to 67%. The reason for the difference between the two questions at the pre-test may be the context of the question. Since the meteorology question was about weather patterns and the weather in the city where the children lived was very changeable, it is highly likely that the children could easily understand the idea that meteorologists could not be certain about weather patterns. This idea was evident in most of the children's replies such as *'weather is changeable'*, *'God knows'*, and *'weather forecasts sometimes do not work'*, which show that the children perceived weather as changeable, and thus they might find it easy to consider everything about the weather changeable. In addition, the children might also had been recognized the question as daily weather forecasts rather than computer models of weather patterns on which weather forecasts were established. On the other hand, when it came to dinosaurs, a decrease in recognizing the tentativeness of science was observed as the children mostly thought about scientific research. Their trust in scientists who conducted research on dinosaurs might have affected their idea regarding the tentativeness of scientific knowledge. However, at the post-test they might had been recognized the question better, as the percentage of acceptance of tentativeness in two questions were almost equal.

Interestingly, Lederman & O'Malley (1990) in their study of students' perceptions of tentativeness in science provided similar results. They asked four open-ended questions in a questionnaire and obtained different results for each question, regarding the tentativeness of science. For example, when it was directly questioned if theories might change, more students expressed a tentative view whereas when the difference between a law and a theory was asked, more students expressed the absolute view. Lederman & O'Malley stated that this might be interpreted as the students' being in transition and thus do not fully comprehend the tentative nature of science. The effect of the contexts of questions on deriving children's ideas is also discussed by Khisfe & Abd-El Khalick (2002) who stated that in their study the dinosaurs question elicited more informed views from children on the empirical, tentative, inferential, and imaginative and creative nature of science than the atom question because the context of the dinosaur question and content were more relevant and interesting to children than atomic structure.

In this study, the data from the three questions were then collectively analyzed and profiles, which categorized answers into three categories as "accepted tentativeness in all domains", "accepted tentativeness in some domains and rejected in others", and "did not accept in any domain," were developed. The results showed that the number of children who accepted tentativeness in all domains increased from pre- to post-test whereas the number of children who accepted this aspect only in some domains decreased. The number of children who did not accept tentativeness in any domain was already small at the pre-test and decreased further at the post-test. Thus, it can be more surely stated that our camp program was effective in introducing the tentative aspect of NOS regardless of the domain.

The scope of this study was also the scope of four previous studies: Children's views on the tentative nature of science was investigated in Khishfe (2008); Akerson & Volrich (2006); Akerson & Abd-El-Khalick (2005); and Khishfe & Abd-El-Khalick (2002). Khishfe & Abd-El-Khalick (2002) reported improvement in students' views on tentativeness in explicit/reflective instruction. In the implicit group, however, a slight decrease was observed. Khishfe (2008) also reported improvement in this aspect- only a few students continued to have naive ideas about tentativeness at the end of the study. Akerson & Volrich (2006) reported improvement, but not very informed ideas, instead the students accepted that science could change because scientists change their mind rather than the change based on new evidence or reinterpretation. In all of these studies, different explicit methodologies resulted in positive change in the students' views of tentative NOS. Similarly, in our study, the number of children accepted that scientific knowledge might change increased slightly from pre- to post-test, but real improvement was in the number of children proposed that scientific knowledge could totally change rather than additional change. Akerson & Abd-El-Khalick's (2005) study was not an experimental study, but a study of determination of students' views of NOS. In this study, only a few students proposed more informed views about change of scientific knowledge based on new evidence, most of the children related change in scientific knowledge to the development of better technology. As it can be seen, many of these research results about tentativeness of science were not very positive. On the other hand, more positive results reported by Moss, Abrams, Robb (2001). They conducted a longitudinal qualitative study with five pre-college students and reported that four of five students had full conception of tentativeness of science according to their model of coding scheme at the beginning of the year and did not change considerably throughout the year in which they experienced project-based and hands-on science instruction.

Regarding the creative and imaginative nature of science, our results differed from other studies in the literature. Half of the students in Khishfe's (2008) study had inadequate views of creative and imaginative aspect of NOS at the beginning of the study, but it decreased to 28% at the end of the study. Khishfe & Abd-El-Khalick's (2002) study with 6th graders searched effectiveness of explicit and reflective versus implicit inquiry oriented instruction resulted in that explicit instruction was more effective than implicit instruction on introducing creative and imaginative NOS. In both groups, most of the students had naïve views about creative and imaginative NOS at the pre-test, but the number of naïve ideas decreased in the explicit group at the post-test, whereas this number increased slightly in the implicit group. 63% of the students in the explicit groups still held the naïve view creative and imaginative NOS at the post-test. Most of the students in Akerson & Abd-El-Khalick's (2005) study stated inadequate definitions of scientific imagination and creativity and they did not believe that scientists used imagination and creativity in their work. Similarly, in Akerson & Volrich (2006), more than half of the students held inadequate view of imaginative and creative NOS at the beginning of the study, but after 13 weeks of science instruction in which NOS aspects were embedded, almost all of the students agreed on the use of imagination and creativity in science. These studies showed that the children had difficulty in accepting the use of imagination and creativity in science.

Interestingly, in our study, most of the students were already accepted at pre-test that scientists use their imagination and creativity at their work. With a small increase from pre- to post-test, almost all of the students accepted the role of imagination and creativity in science at the end of the study. But, these should not be interpreted as students have more informed views about the role of imagination and creativity in science. Because, in the same question, most of them did not detail which part of an investigation scientists used their imagination and creativity. Because of this, it was thought that the students intuitively accept that use of imagination and creativity, but they did not provide an informed reason for that. This point should deserve attention and would be searched more deeply. Similar positive results regarding imaginative and creative nature of science were only reported by Moss, Abrams, & Robb (2001). In their study, four of five pre-college students held full conception of this nature of science and one student did not express any idea about this aspect.

Theory ladenness of scientific knowledge was less researched aspect of science with children. One study with pre-college students (Moss, Abrams, Robb, 2001) asked two questions about science in social-cultural context and personal factors affect science. These questions also indicate theory ladenness of science. Their results showed that three of five students held full conception of theory ladenness of science and two students held partial conception of theory ladenness of science in both questions. The results of this study were less positive. Most of the children misunderstood the question and provided unrelated answers. Theory ladenness of scientific knowledge was the least recognized aspect of science in this study. But, theory-ladenness of scientific knowledge is less known aspect of science. Even adults might not recognize this aspect because positivist paradigm claims that scientific knowledge is objective (Leblebicioğlu, Metin, Yardımcı, 2011). The people who had positivist paradigm may have difficulty in recognizing and accepting the subjective nature of scientific knowledge, which is an idea of post-positivist paradigm.

Scientific models and modeling was again less known aspect of NOS in this study. Only five children at pre- and four children at the post-test represented not well informed but acceptable definitions of scientific models. Children came to our science camp without knowing scientific models and the camp program was also ineffective in helping them to learn scientific models and scientific modeling. Although a black-box activity, Water Machine, was done at the fist session of the camp program and the children modeled what was inside the box, they might not have been recognize the meaning of a scientific model effectively. Since it was the only activity in the camp program related to scientific model, it would not be enough in developing understanding of scientific model.

The reason for low familiarity with scientific models and modeling at the pre-test could be better explained by science education at elementary schools in Turkey. Actually, scientific models and process of scientific modeling is not taught in elementary schools in the way it was meant in the NOS. Although science teachers use scientific models such as model of cell, human body, DNA, flower, and solar system in their teaching of related subjects, they did not explain that they are scientific models and they are representations of scientific findings about that concept. They only use it as a maquette to support their teaching. Sometimes, teachers teach conceptual models such as atomic model, but even at that subject, teachers do not explain the idea of a scientific model and scientific modeling. They only teach as the representation of atomic structure. Science teachers also teach particulate nature of matter at different states, molecules, chemical bonding and chemical reactions, etc., but they do not even pronounce the word of scientific model in teaching these concepts. They teach them as scientific knowledge rather than a process in science. Although all the scientific formulas that were taught in science classes are scientific models themselves and they model the relationship between variables included in them, they are again taught as scientific facts in the science classes rather than examples of scientific modeling. Because of these reasons, children do not hear and learn scientific model and scientific modeling in their elementary school. Thus, one activity in the camp program would not have helped them recognizing its meaning.

On the other hand, many other western countries teach scientific models and scientific modeling as key features of science education. For example, the main teaching method of physics and chemistry at elementary level is modeling in Finland (Lampiselka, Savinainen, & Viiri, 2007). They did not only introduce models and idea of modeling to students, but they also explicitly applied modeling as a starting point in the physics and chemistry textbooks (cited in Saari & Sormunen, 2007, p. 227). In this way, they targeted the spread of idea of modeling to science teachers, since they mainly based on textbooks (Saari & Sormunen, 2007). They also believe that modeling is an important step for understanding the nature of scientific processes and knowledge, thus it combines epistemological and content aspects of science.

Science starts with observations, but most of the scientific process is consisted of inferences from data. Knowing the difference between the two is essential to understand NOS. Results of our study proved that most of the children were aware of the role of observation, since they stated that scientists know that the dinosaurs lived from their fossils. On the other hand, they might have thought that everything about a dinosaur could be understood when the fossils were found, because they did not explain any further process that scientists do. Only a few children indicated further thinking process after finding fossils. Although Tricky Tracks activity was done in one of the sessions in the camp program, nature of theories and change in theories were made explicit rather than the difference between observation and inference. Children conducted guided-inquiry at nature for two days, but aspects of science that they experienced were not discussed explicitly during the inquiry process. For example, children made observations as a group, provided data, interpreted these data, and made inferences from the data, but science advisors just helped children in performing these processes and they did not name them explicitly or did not explain what they were doing with scientific terminology. The reason for steady results from pre- to post-test might be this lack of explicit introduction of making inferences from their observations.

The reason for high percentage of students knowing only observation in science but not knowing inference at the pre-test in the science camp might be a result of doing cook-book type experiments in the schools. Children sometimes conduct experiments and make observations in these experiments. But these experiments are mostly verification type experiments by which they verify the scientific knowledge that they already know or small discovery activities in which the children discover a bit of scientific fact. They do not perform long term open- or guided inquiry activities in which they deal with an event that they do not know much about and construct their own knowledge from their data by making inferences. Thus, they do not experience the real process of science from data to scientific knowledge; they just do experiments and discover scientific facts. In addition, observation is widely used by science teachers' talk during the experiments or in the science textbooks. On the other hand, word of inference (çıkarım) is not used at all both by teachers and in science textbooks. Although inference is done by scientists or by students while doing science, this process was not consciously named and used in scientific communication. However, the word inference is started to be used by some science educators in recent years.

Conclusion

The science camp program which is a combination of guided-inquiry in nature and a few explicit NOS activities was found to be most effective in developing empirical aspect of science. It was also accepted to be effective in introducing tentativeness of science, especially in recognizing scientific knowledge does not only develop through addition of new knowledge but also sometimes undergoes a more radical change. The results of imaginative and creative nature of science aspect were superficially good, since children were usually accepted that scientists use imagination and creativity in their work by saying yes, but they did not provide informed views which part(s) of an investigation they were used. On the other hand, the camp program was least effective in introducing theory ladenness of scientific knowledge, scientific modeling and difference between observation and inference. Thus, camp program should be developed with respect to these aspects.

Introducing science for only ten days might not have been enough for children to learn what science is and how it is done. Schools do regular and longer science teaching. But, science teaching in schools generally based on teaching scientific facts and laws by lecturing or discovering them through experiments rather than conducting inquiry and reflecting on the aspects of NOS. Although latest National Elementary Science and Technology Education Curriculum (TME, 2004; 2008) aims at developing scientific literacy and emphasizes scientific process skills remarkably, it is not implemented effectively in the schools. Although the curriculum emphasizes scientific process skills to a great detail, introducing NOS aspects could not yet mentioned at all. In other words, both in the national curriculum and at school science teaching, methodological aspects of science are sometimes implemented, but epistemology of science is not reflected. Thus, children learn lots of scientific knowledge in their compulsory education, but do not recognize what science really is, what the elements of scientific knowledge are, and how scientists construct scientific knowledge.

When the period of science camp was compared to years of science teaching at the schools, it would be more effective if epistemology of science is taught with appropriate activities in the schools and reflections regarding the nature of science would be a major element of a science course. Other researchers also offered longer time and longer exposures to NOS instruction in different studies (Khisfe & Abd-El Khalick, 2002; Khisfe, 2008). The reason for having less informed views at the pre-test on most of NOS aspects would be explained by factors discussed above about science teaching in the elementary schools.

Another concern in the study was the VNOS D questionnaire. Five out of seven questions in VNOS D are generic questions asking related NOS aspects directly whereas in remaining two questions, NOS aspects were embedded into different contents such as dinosaurs and meteorology. Our experience with two content-embedded questions were that content of the questions affected children views of tentativeness of science. Khisfe & Abd-El Khalick (2002) also reported similar problem in their research. Thus, content of VNOS D questions should be appropriate to the children under study. For this reason, more appropriate content for Turkish children would be examined in future studies. For example, earthquake is a familiar concept for Turkish children and they hear scientific discussion about earthquakes more than dinosaurs and meteorology. Dinosaurs are only taught while teaching fossils and geological eras. Dinosaurs are not taught in Turkey as much as they are in western culture. Turkish children only hears weather forecast on TV, but they did not hear about scientific process behind it like modeling the data about weather events on computers. It is recommended that VNOS D questionnaire would be adapted to Turkish culture in order to provide more valid data about children's ideas about the aspects of NOS.

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Doğada Bilimin Doğasını Öğretmeye Bir Örnek: Yaz Bilim Kampı

Özet

Amaç ve Önem: Bilimin doğasını öğretmek son yıllarda fen öğretiminin ana amaçlarından biridir. Bilimin doğasını öğretmek için değişik yöntemler geliştirilmiş ve uygulanmıştır. Öğretilecek bilimin doğası özelliğinin netleştirildiği doğrudan mesajlarla sonuçlanan (explicit) bilimin doğası etkinlikleri son yıllarda yaygın olarak kullanılmaktadır. Buna ek olarak, çocukların yaptıkları araştırmanın bilim insanlarının yaptıkları araştırmalara benzetilerek bilim hakkında doğrudan mesajlar ileten araştırma (explicit inquiry) uygulamaları da uygulanmaktadır. Bilimi çocuklara öğretmeyi amaçlayan bir yaz bilim kampında bilimin sürecini ve değişik özelliklerini tanıtmak için doğrudan net mesajlara ulaşılarak (explicit) uygulanan yönlendirilmiş-araştırma (guided-inquiry) ve yine aynı yaklaşımla (explicit) uygulanan bilimin doğası etkinliklerinden oluşan bir program uygulanmıştır. Çalışmanın amacı çocuklara bilimi doğada tanıtmak için bilim hakkında doğrudan mesajlar ileten yönlendirilmiş-araştırma ve bilimin doğası etkinliklerinden oluşan bir yaz bilim kampı geliştirmek ve uygulayarak bilimin deneysel ve değişebilir olma özelliklerini anlamalarına etkisini belirlemektir.

Yöntem: Yaz bilim kampı değişik İlköğretim okullarının 6-8. sınıflarından doğaya ilgili olmaları nedeniyle seçilen 34 çocuk ile uygulanmıştır. Çocuklar İlköğretim 6 ve 8. sınıftadır. Kampın ilk üç gününde çocukların bilimsel bir araştırmanın temellerini öğrenmelerini ve gruplarını oluşturmalarını sağlayacak etkinlikler yapılmıştır. Daha sonra, küçük gruplar oluşturarak doğa hakkında sordukları bir soru üzerine iki gün süren araştırma yapmışlardır. Bundan sonraki günde araştırmalarını anlatan bir poster hazırlamışlar ve kampın son günü kampa gelen ailelerine sunmuşlardır. Kamp programında doğrudan mesajlarla iletilen yönlendirilmiş-araştırmaya ek olarak yine doğrudan mesajlarla biten bilimin doğası etkinlikleri yapılmıştır. VNOS D anketi yaz bilim kampı programının bilimin doğasını öğretmedeki etkisini belirlemek amacıyla ön ve son-test olarak uygulanmıştır. Elde edilen nitel veriler içerik analizi uygulanarak analiz edilmiştir. Kodların frekansları belirlenerek ön-test ve sontest kodlamaları karşılaştırılarak yorumlanmıştır.

Bulgular: Araştırmanın sonuçları yaz bilim kampı programının çocukların bilimin deneysel ve veriye dayalı olma özelliğini anlamalarını geliştirdiğini göstermiştir. Çocuklar kampın sonunda bilimin yöntemini öğrendiklerini belirten ifadeleri daha sıklıkla kullanmışlardır. Bilimsel bilgilerin değişikliklere tepki verme ve bunlara bağlı olarak değişme özelliğini anlamalarının geliştiği gözlenmiştir. Kampın başında çocukların bilimsel bilgilerin değişime açık olma özelliği hakkındaki düşünceleri sorunun içeriğine göre değişmiştir. Hava desenleri konusundaki bilgilerin değişebilirliğini daha fazla çocuk kabul ederken, dinozorların şekillerinin belirlenmesi konusundaki bilgilerin değişebilirliğini daha az çocuk kabul etmiştir. Hava olaylarını çalışan bilim insanlarının oluşturdukları bilgilerden dinozoları şekillerini bulmaya çalışan bilim insanlarından daha az emin olacaklarını belirtmişlerdir. Kampın sonunda bu içerik etkisi zayıflamış ve iki alanda oluşturulan bilimsel bilgilerin değişime açık olduğu sonucuna ulaşan çocuk sayısı artmıştır. Kamp programının bilimde hayal gücü ve yaratıcılığın etkisini öğretmede daha az etkili olduğu bulunmuştur. Bilimsel bilginin teoriye dayalı olması, bilimsel modeler ve gözlem ve çıkarım arasındaki fark gibi bilimin doğası özelliklerinin çocukların kampın başında çok az farkında oldukları özellikler olduğu ve anlamakta da en çok zorlandıkları özellikler olduğu gözlenmiştir.

Tartışma, Sonuç ve Öneriler: Kampa çocukların bilimin deneysel ve değişebilir doğası ile ilgili fikirlerindeki olumlu gelişmeye dayanarak kamp programın bilimin bu iki özelliğini tanıtmada etkili olduğu sonucuna varılmıştır. Bilimin doğasının diğer özelliklerini daha iyi tanıtılabilmesi için kamp programının geliştirilmesi gerektiği sonucuna varılmıştır.

Bilimin doğasını tanıtmanın bir çok değişik yolu bulunmasına ek olarak bilim kampları da çocukları bilimi informal ortamlarda tanıtmak içim iyi bir alternatif olabilir. Bu nedenle, benzeri bilim kamplarının yapılması önerilir.