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Developing Primary School Students' Views on the Nature of Science by Storytelling

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Abstract

The study aimed to explore the development of third graders' nature of science views by using children's literature. The participants of the study were 18 third graders (12 F, 6 M) aged 8-9 years old. The method of the study was a basic interpretive qualitative study and data were collected by means of open-ended questionnaires, (Views of Nature of scientific views, VNOS-D) reflective journals, and semi-structured interviews. The implementation of the study was taken for seven weeks and students enrolled in explicit-reflective nature of science activities coupled with children's literature highlighting stories including nature of science. The results of the study showed that primary students held misconceptions regarding of nature of science mostly on the aspects of the difference between observation and inference, the tentative nature of scientific knowledge, the subjective nature of scientific knowledge, and scientific models. Results of the study revealed that students improved their nature of science views substantially. The majority of the nature of science aspects have been improved to informed views, only the views on scientific models improved to adequate views after the intervention. Our research findings have claimed that storytelling could be a strong pedagogical tool in developing children's nature of science views.

Keywords: Nature of science teaching, primary students' nature of science views, children's literature

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Introduction

In the century we live in, science and technology are undergoing rapid development and change. This change that is taking place reveals the necessity for human communities and countries to prioritize educational programs in the field of science. According to Lederman (2004), one of the main goals of teaching activities in the scientific field is to help people understand science and scientific developments. In order for individuals to reach the right decisions by making use of scientific results, they must first learn how knowledge is created and then reach the basic elements that make up this knowledge. Therefore, people's ability to understand and properly apply technological innovations and science-related information depends on being a scientifically literate individual (Roberts & Bybee, 2014). For this reason, it is considered very important for people to be science-literate individuals, to learn new inventions with scientific concepts, and to be at a level that will raise the standards of social life (Liu, 2009). Scientifically literate people are those who can comprehend the nature of science, adapt the laws, definitions, and principles related to science to their daily lives, see the connections between human beings and developing technology, and want to research science. As well as it can be defined as the ones who have a desire to study nature and the planet we live on, believe that scientific knowledge can change with new information, and appreciate the good and bad aspects of science on the individual's life (Anagün, 2008). Viewing science as a human activity, and appreciating the values inherited in the development of scientific knowledge has been a vital part of scientific literacy (Tatar, Karakuyu, & Tüysüz, 2011). That is known as a concept of the nature of science is also included in the science curriculum implemented in Turkey for years (MoNE, 2018).

Although there is no single, clear, and unambiguous definition of the nature of science, the agreed definition is recognizing science as way of knowing, and appreciating the beliefs and values inherent in development of scientific knowledge(Lederman, 1992). Although there is no clear definition of the nature of science, researchers have similar views on the characteristics that constitute the nature of science. The nature of science shows how scientists construct events and phenomena by developing different perspectives, the relationship between observation and inference and the difference between them, the changing and evolving nature of scientific results, the impact of society on scientists and scientific studies, and especially the importance of creativity at every stage of scientific work (Hanuscin & Lee, 2009; Khishfe & Lederman, 2007). The tenets of the nature of scientific knowledge which were the concern of the current study were the empirical nature of scientific knowledge, the difference between observation and inference, the tentative nature of scientific knowledge, the subjective nature of science, the scientific models and imagination and creativity in the development of scientific knowledge.

In the Turkish context, the studies related to the nature of science (NOS) with younger students have been conducted very limited. The literature showed that the research has been mostly focused on the students at the second level of primary education and secondary education levels, as well as some few studies at the preschool level (Alan, 2014; Çelik, 2016; Çetin, 2019; Deve, 2015; Kapucu, 2013; Yılmaz, 2016). Considering the fact that it was an early age for children to develop a positive attitude towards science as well as an adequate understanding of scientific knowledge as well as the misconceptions regarding science, it is important to look for better ways to improve better image of science in their young minds. Therefore, it will be promising specifically for primary teachers as well as science who have less experience with teaching science as a way of knowing within a context of actual teaching practice in the path of raising young students as scientifically literate individuals. Additionally, specifically in teaching contexts in which science classes begin in the third grade (around the age of 8), it is important to emphasize the nature of science while introducing scientific concepts to facilitate ease of understanding of these concepts and developing a more positive attitude towards science by young learners.

Teaching nature of science mainly embodies two approaches: implicit and explicit approach (Abd-El-Khalick & Lederman, 2000a, 2000b; Doğan, Çakıroğlu, Bilican, & Çavuş, 2012; Khishfe & Abd-El-Khalick, 2002; Köseoğlu, Tümay, & Budak, 2008). Studies showed that the use of an explicit reflective nature of science instruction has been more effective in improving both in/pre-service teachers, and students from various age groups. (Quigley, Pongsanon, & Akerson, 2010). The main focus idea embodying the explicit reflective nature of science teaching has been, intentional and direct-explicit teaching of NOS concepts and recognizing it as a cognitive outcome (Khishfe & Abd-El Khalick, 2002).

In the current study, it was aimed to reveal the effect of direct reflective NOS activities integrated with stories on primary school students' NOS views. For this purpose, it was aimed to improve the views of the third-grade primary school students with explicit reflective NOS activities integrated with stories. In line with this goal, the study aims to investigate the contribution of explicit reflective NOS activities coupled with stories to the NOS views of primary school students. In this direction, this study seeks answers to the following questions:

-What are the students' NOS views before participating in open reflective NOS activities integrated with stories?

-What are the students' NOS views after participating in open reflective NOS activities integrated with stories?

Method

This section includes information on the research model, population and sample, data collection process, data collection tools, data collection and analysis.

Research Model

This study is interpretive qualitative research. According to Merriam (2015), interpretive qualitative research adopts an in-depth examination of individuals' experiences and experiences related to the situations compared and is frequently used in the field of education. In this study, a basic qualitative research design was used to examine the development of third-grade primary school students' NOS views using stories. The third-grade primary school students' views on the nature of science, students' experiences in the classroom, and their thoughts about the products they produced as a result of their experiences were examined in depth.

Participants

This study was conducted with 18 third-grade students (12 F, 6 M) studying in a primary school in the Middle central part of Turkey. A convenient sampling method was used to select the participants (Patton, 1990). The researcher used this method because the participants were his students, he had easy access to students and their parents, he had the opportunity to examine the participants in depth because he knew them closely, and the fact that they were his students created the opportunity to work flexibly. In such cases, the aim is not to generalize the results to the population. For this reason, care was taken to understand the sample holistically and in-depth. All of the students participated in the implementation process one-on-one. The ages of the students were between 8-9 years old. Since the participants were third-grade students, they were taking science courses for the first time. They had taken courses related to science such as "natural phenomena, plants and animals, natural disasters, directions and movements of the earth" at a basic level in the life science course in previous years. The study was conducted voluntarily by obtaining the necessary permissions from the participants and their parents. The real names of the students were not used in the current study, the participants were named with numbers such as S1, S2….S16, etc.

Data Collection Tools

In this study, the Views of Nature of Science questionnaire form D (VNOS-D) semi-structured interviews, reflective writings (diaries), and stories written by students were used as data collection tools.

Views of the Nature of Science Questionnaire Form D (VNOS-D): The Views of the Nature of Science Version D (VNOS-D) developed by Lederman and Khishfe (2002) was used in this study. VNOS-D consisted of seven separate survey questions designed to determine the views of elementary school students on the following aspects of the nature of science: the difference between observation and inference, the subjectivity of science and scientific knowledge, the formation of scientific knowledge in the light of data, the characteristics and definitions of scientific models, the evolving and changing nature of scientific knowledge, and the place of creativity and imagination in science. This questionnaire was suitable for the study because it allowed students to express their opinions without being bound by stereotypes and choices determined by the practitioner, it was appropriate for students' readiness and age groups, and it allowed six different NOS dimensions to be measured in one questionnaire (Akerson & Abd-El-Khalick, 2005).

Semi-structured Interviews: Semi-structured interviews were conducted by using the questions in the VNOS-D forms to ask the students to give their written answers in a broader and more detailed way and to eliminate misinterpretation of the data. Semi-structured interviews were recorded with a voice recorder and these interview recordings were then transcribed to obtain the data.

Documents

In this study, the NOS stories written by the students after all the activities were evaluated as documents. In addition, transcribing the audio recordings of the interviews conducted with eight students before and after the application and comparing them with the VNOS-D scale data kept during the interview will prevent or minimize data loss. Prior to the stories prepared by the researcher, expert opinion was obtained from the consultant, and feedback was provided and created in this way. In addition to these documents, reflective writings (student diaries) are among the tools used in data collection.

Implementation and Data Collection Process

This study was carried out using free activity lessons within the scope of science lessons for third-grade primary school students. The activities and the implementation process were carried out over seven weeks in the spring semester of the 2018-2019 academic year, using different NOS activities each week. In addition to these NOS activities, stories written by the researcher and in which NOS dimensions were integrated were used, supported by expert opinion. In the study, the implementation and data collection process was carried out in the order of data collection before the implementation, data collection during the implementation, and data collection after the implementation. The activities and studies carried out during the implementation process, which lasted a total of seven weeks, were implemented as shown in Figure 1 below.

Figure 1. Implementation and Data Collection Process

Data Analysis

The interviews with the students were recorded with a voice recorder and the resulting data were analyzed using the content analysis method. Content analysis requires in-depth analysis of the collected data and allows the emergence of themes and dimensions that were not previously evident. In this way, content analysis is tried to interpret the opinions and find the results hidden in these data (Yıldırım & Şimşek, 2016). During data analysis, the answers given to each interview question were analyzed and categorized according to the concepts extracted from the data. Then, in the opinion determination process carried out by applying the VNOS-D form to the students, the opinions given by the participants were analyzed and categorized according to the content analysis method. This categorization was adapted by the practitioner from the research conducted by Akerson and Donnelly (2010). The opinions of the students on the VNOS-D form were categorized and analyzed as inadequate, adequate, and informed for the NOS subscales. Another data analysis applied was semi-structured interviews with five students before the application and eight students after the application using VNOS-D questions. In this way, higher validity and reliability were ensured in the analysis of the written form. In addition, a diary book was created for all participant students before the implementation. The students were asked to evaluate the activities related to the weekly practices, the activities in the process, and the stories written by the practitioner and read along with the activities in these diaries with dates and titles. They were also asked to write the parts that interested them and that they liked and to summarize the process. The VNOS-D forms, reflective writings, interviews, and observations conducted in the classroom were analyzed with a holistic approach, and the information revealed was realized by making connections between all these tools and supporting the data in the creation of categories. In the analysis of all data, the systematic method created by Huberman and Miles (as cited in Creswell, 2016) was used to find the significant points of all data sources and to establish connections between the points found and the dimensions. In this context, reflective literatures were examined in connection with the categorization created. At the end of the whole application, students were asked to write a scientific story in which the dimensions of NOS were also mentioned. In the analysis of these stories, like the others, all data were associated with each other. The NOS views used by the students in their stories were also used by associating them with categories. The resulting data were analyzed in a holistic structure by associating the views expressed by the participants in the VNOS-D form.

Validity and Reliability of the Study

When the literature is examined, there are different approaches, but three elements applied for validity come to the fore. These elements are reliability, authenticity, and credibility (Creswell, 2016). In this study, the researcher was present in the field where the study was conducted and had the opportunity to observe the whole process since the researcher had her students. In order to triangulate, she linked the pre and post-implementation forms with semi-structured interviews and student diaries. All personal characteristics of the researcher were explained in detail. The findings of the study were described in detail to ensure transferability. The interpretation of the collected data was checked by two different people who were not involved in the research. These people are experts who have sufficient knowledge about the nature of science. In short, research validity was ensured by applying all of the above-mentioned items.

If the results of a research overlap with the first results in the repetition of the research, the reliability of this research is ensured. However, since it is difficult to ensure the repetition of the data collected, especially in qualitative research, the relationship between the data collected and the results is very important when reliability is considered (Merriam, 2015). While observation, interview, and other information were obtained from the data collection methods used in this study, especially during the activities, audio and video recordings were made by prioritizing the volunteerism of students and parents. The written and digital records obtained were examined many times to ensure that important points were not overlooked. The counselor also made the necessary examinations and gave feedback. In this way, necessary coding was done. The categorization used in the analysis of the VNOS-D forms before and after the implementation was used by many researchers in the literature and general concepts were reached. All data sources used in the study were associated with the data obtained from the forms filled out by the students before and after the application. At the same time, all coding was examined and categorized by the counselor, the researcher, and another expert.

Findings

This study aims to investigate the effect of direct reflective NOS activities integrated with stories prepared by the researcher and in which NOS sub-dimensions are integrated into the content on the NOS views of primary school students. In this direction, with the data obtained from the students, the answer to the question "How did the NOS views of third-grade primary school students change by using explicit reflective NOS activities integrated with stories?" was sought. VNOS-D form directed to the students, student opinions before the implementation, student opinions after the implementation. The data obtained from semi-structured interviews and student diaries (reflective writing) were analyzed, then these data were transferred with the help of quotations and tables, and then the findings were formed with the help of the analysis of the data. The findings of the students' views on the NOS dimensions before the implementation, categorized as inadequate, adequate, and informed, are given in Table 1.

Table 1.
Third-grade primary school students' views on the nature of science before the implementation

Nature of science dimension	Inadequate	Adequate	Informed
The empirical nature of scientific knowledge	8	10	0
The difference between observation and inference	16	2	0
Scientific models	9	8	1
The tentative nature of scientific knowledge	13	2	3
Subjective nature of scientific knowledge	13	4	1
Imagination and creativity in science	6	10	2

Previous to the implementation of the study, VNOS-D form and semi-structured interviews applied to third-grade primary school students, it was observed that students had more adequate views than inadequate views in the dimensions of the empirical nature of scientific knowledge, scientific models, imagination, and creativity in science, and more inadequate views in other dimensions. On the other hand, it is seen that the opinions at the Informed level were not at all in the dimensions of the difference between observation and inference and the experimental nature of scientific knowledge, and very few changes were detected in the other tenets.

When the post-implementation VNOS-D (Children's Views on the Nature of Science Questionnaire Part D) form and semi-structured interviews applied to third-grade primary school students were analyzed, there was one inadequate opinion from the students in the dimensions of the scientific model, the difference between observation and inference, and the experiment-based nature of scientific knowledge. There were no inadequate opinions in other dimensions. Regarding the adequate views, 10 students responded in the adequate category in the dimension of scientific models, five students in the dimension of the difference between observation and inference, four students in the dimension of the empirical nature of scientific knowledge, and only one student in the dimension of the changeable nature of scientific knowledge. There were no opinions in the sufficient category in the subjective nature of scientific knowledge and imagination and creativity in science dimensions.

When the opinions of the students in the Informed category are analyzed, the most striking result is that all of the students in the dimensions of imagination and creativity in science and the subjective nature of scientific knowledge reported opinions in the Informed category. It is seen that 17 students in the dimension of the changeable nature of scientific knowledge, 13 students in the dimension of the experimental nature of scientific knowledge, 12 students in the dimension of the difference between observation and inference, and seven students in the dimension of scientific models expressed opinions at the Informed level. When Table 2 is examined, it is seen that in almost all of the dimensions of the nature of science, the number of students expressing opinions in the Informed category is the highest. Only in the scientific model dimension, the number of adequate opinions is higher than the number of students in the Informed category. The findings of the students' views on the NOS dimensions after the application, categorized as insufficient, sufficient, and Informed, are given in Table 2.

Table 2.
Third-grade primary school students' views on the nature of science after the implementation

Nature of science dimension	Inadequate	Adequate	Informed
The empirical nature of scientific knowledge	1	4	13
The difference between observation and inference	1	5	12
Scientific models	1	10	7
The tentative nature of scientific knowledge	0	1	17
Subjective nature of scientific knowledge	0	0	18
Imagination and creativity in science	0	0	18

When Table 2 is examined, it is seen that in the post-application VNOS-D form and semi-structured interviews applied to third-grade primary school students, the students' Informed opinions were higher than the other opinions in the dimensions of the experimental nature of scientific knowledge, imagination, and creativity in science, the difference between observation and inference, the subjective nature of scientific knowledge and the changeable nature of scientific knowledge, and the adequate opinions were higher in the scientific models’ dimension. Views in the inadequate category were very few in all dimensions and none in the dimensions of the changeable nature of scientific knowledge, the subjective nature of scientific knowledge, and imagination and creativity in science.

As can be seen in Table 2, in the NOS forms used to collect data before the intervention, there were more inadequate opinions on the dimensions of the difference between observation and inference, scientific models, the changeable nature of scientific knowledge, and the subjective nature of scientific knowledge, whereas, in the NOS forms used after the intervention, there were more students' opinions at the adequate level in the dimension of scientific models and the Informed level in all other dimensions. The findings showing the change in student opinions about the NOS dimensions during the implementation are given in Figure 2.

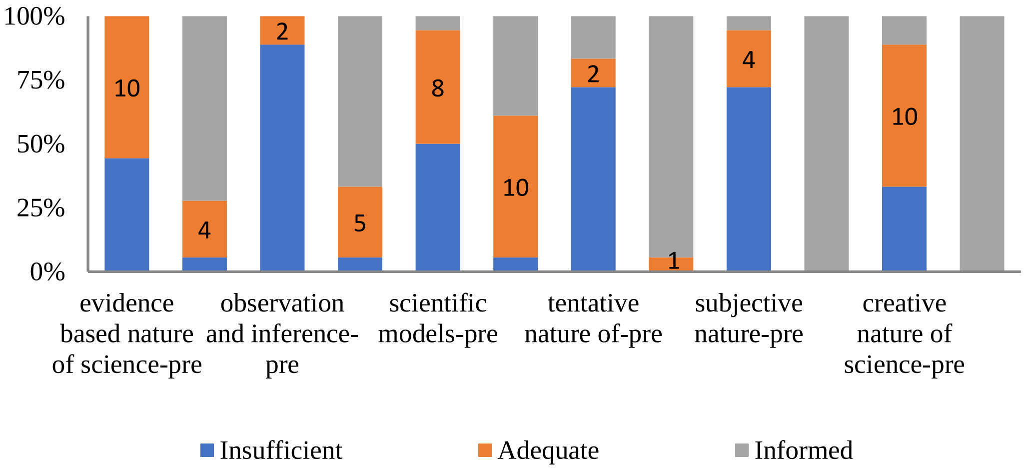

Figure 2. Change In Students' Views on the Nature Of Science.

In Figure 2, the change in the NOS dimensions and some student views examined during the implementation period are presented in order to compare student views before and after the implementation. When the pre-implementation findings of the experiment-based nature of scientific knowledge are analyzed, it is seen that eight students expressed inadequate, 10 students expressed adequate, and no opinion was expressed in the Informed category. After the implementation one student expressed inadequate, four students expressed adequate, and 13 students expressed Informed opinions. When the change in students' views on the experimental nature of scientific knowledge was analyzed, no negative change was observed. One student remained in the inadequate category and one student remained in the adequate category, and no change occurred. The remaining 16 students showed positive development and moved to higher categories. The change in (S15)'s view on the experimental nature of scientific knowledge was as follows. He showed inadequate views of the empirical nature of science before the implementation; "I think science makes beautiful experiments. People get better... I think science finds something. They cannot know the other subject." (S15). His views evolve to informed views after the implementation; "Science is observation, evidence, research. Science is done in groups. There is research and experimentation. They collect information and reach an invention" (S15).

When the pre-implementation findings of the dimension of the difference between observation and inference are examined, it is seen that 16 students expressed inadequate, 2 students expressed adequate, and no opinion was expressed in the Informed category. After the application, one student expressed an inadequate opinion, five students expressed an adequate opinion, and 12 students expressed an informed opinion. When the change in students' views on the difference between observation and inference was analyzed, no negative change was observed. One student remained in the inadequate category and no change occurred. The remaining 17 students improved positively and moved to higher categories. The change in (S1)'s opinion on the difference between observation and inference was as follows:

> Scientists do research. Dinosaurs know very well by research. They see it in their dreams or they go back in time. I think it is very true. Because scientists find things by researching. Scientists are very smart. (T1, Pre-implementation).

> They researched and found dinosaur fossils. By studying the fossils they find, they can know what time they belong to. It's not very precise. Because they all think differently, they can misplace the fossils. Because scientists have different ideas. They study the fossils and make different conclusions. The dinosaur in their minds is different.(T1, post implementation).

When the pre-implementation findings of the scientific models' dimension are analyzed, it is seen that nine students expressed inadequate, eight students expressed adequate, and one student expressed Informed opinions. After the application, one student expressed inadequate, 10 students expressed adequate, and seven students expressed Informed opinions. When the change in the students' views on the scientific models' dimension was analyzed, one student dropped from the sufficient category to the insufficient category and a negative change was realized. One student remained in the sufficient category and no change occurred. The remaining 12 students improved positively and moved to higher categories.

> A scientific model is the reality of something we make. For example, a model house is its reality. In other words, a scientific model is the reality of something. (S13. Pre-implementation)

> It's making a model of something and then making a model. It is not exactly the same. It happens with the information gathered by the scientist and his/her dreams. (S13, post implementation)

When the pre-implementation findings of the changeable nature of scientific knowledge are analyzed, it is seen that 13 students expressed inadequate, two students expressed adequate and three students expressed Informed opinions. After the application, there were no students who expressed inadequate views, one student expressed adequate views and 17 students expressed Informed views. When the change in students' views on the changeable nature of scientific knowledge was analyzed, no negative change was observed. All of the students showed positive development and moved to higher categories. The change in (S11)'s view on the changeable nature of scientific knowledge was realized as follows:

> No, it doesn't change. For example, schools can become more electronic. For example, lessons can be taught with tablets. But nothing changes in science. (S11. Pre-implementation)

> Yes, it changes. They used to call the world a box, now it's round. Because a lot of new information has been collected. A very long time has passed. Everything has improved.(S11. After Implementation)

When the findings of the subjective structure of scientific knowledge before the application are examined, it is seen that 13 students expressed inadequate, four students expressed adequate, and one student expressed an opinion in the Informed category. After the application, all of the students expressed an opinion in the Informed category. When the change in students' views on the subjective structure of scientific knowledge was analyzed, no negative change was observed. Since all of the students moved to the Informed category, they showed positive development and moved to higher categories. The change in (S13)'s view of the subjective nature of scientific knowledge was as follows:

> Because scientists have not experimented. If they did experiments, everybody's would be the same. They are very precise. Because experts always predict the weather conditions very accurately. (S13. Before Implementation)

> Because the environment they live in is different; because the theories they believe in are different... They are a bit precise. They cannot collect the information completely. Even if they collect it, they cannot predict it completely. (S13. After the Application)

When the pre-implementation findings of the dimension of imagination and creativity in science are examined, it is seen that six students expressed inadequate opinions, 10 students expressed adequate opinions, and one student expressed an opinion in the Informed category. After the application, all of the students expressed opinions in the Informed category. When the change in students' views on the dimension of imagination and creativity in science was analyzed, no negative change was observed. Since all of the students moved to the Informed category, they showed positive development and moved to higher categories. The change in (S18)'s opinion on the dimension of imagination and creativity in science was as follows:

> No. They don't use it... They don't imagine...(S18. Pre-implementation)

> Yes. They use it...I think they use it in all of them. Planning, experimenting, observing, analyzing data. (S18. After Implementation)

In addition to all these findings and student opinions, when the scientific story samples written by the students at the end of the implementation were analyzed, it was observed that the students mentioned the dimensions of the nature of science in their stories. Especially the subjective nature of scientific knowledge and the difference between observation and inference were found in almost all students' stories. This finding shows that students internalized these dimensions of NOS after the implementation. In addition, other NOS dimensions were also used in the stories.

Another finding in these stories written by the students is that the scientific model dimension was used by very few students. The students frequently used the dimensions of scientists working in cooperation, imagination, and creativity in science, the experimental nature of scientific knowledge, and the changeable nature of scientific knowledge in their stories. The dimensions of the nature of science used by S16 in her story are as follows:

> A few days later, the dinosaur was gone. Kara said it was a sheep. Keloğlan said it was a chicken. Balkız said it was a bear. Then Balkız found another fossil piece and added it. Everyone's interpretation changed.(S16)

Discussion, Conclusion, and Suggestions

This study aims to investigate the effect of direct reflective NOS activities integrated with stories prepared by the researcher and in which NOS sub-dimensions are integrated into the content on the NOS views of primary school students. In this direction, the study was conducted to examine the development of third-grade primary school students' NOS views by using the direct reflective NOS method integrated with stories. For this purpose, the opinions of the students about the NOS were obtained through the VNOS-D form and interviews before and after the 7-week NOS activity process. The changes in students' views during the activity process were analyzed. The NOS-D version (VNOS-D), reflective writings, scientific stories written by students, and semi-structured interviews were used as data collection tools.

When the VNOS-D forms were applied to the third-grade primary school students before and after the activities were compared, the changes of the students on the dimensions of the nature of science such as the difference between observation and inference, the changeable nature of scientific knowledge, scientific models, the experimental nature of scientific knowledge, imagination and creativity in science, and the subjective nature of science were examined and it was concluded that the students' opinions changed positively on all dimensions. Especially in the pre-implementation student views, students reported inadequate views on the subjective nature of science, scientific models, the difference between observation and inference, and the changeable nature of scientific knowledge, and it was seen that they did not have many concepts of the nature of science. In many studies conducted with students on NOS in Turkiye and abroad, (Akerson et.al., 2024, Doğan & Abd-El Khalick, 2008; Khishfe & Abd-El Khalick, 2002; Khishfe, 2008). At the end of the study, the majority of the students showed substation improvements in their NOS views. In parallel with the study of Murphy, Smith, and Broderick (2021), engagement with NOS issues with both teachers and students had a positive influence on students' thinking of science and the improvement of better NOS views as a result.

The effect of the stories in which NOS dimensions were integrated, which is an important point of the research, is objectively seen in the reflective writings. While the students wrote in their reflective writings what they learned during the course and what interested them, it was observed that they liked the stories very much and mentioned the NOS elements in the stories. In light of this information, it is concluded that direct reflective NOS activities integrated with stories positively affect students' NOS views. The findings of the study conducted by Avşar-Erümit and Aversion (2022) also support the findings of the current study and state that appropriately designed children's science books can be used as classroom tools to support NOS teaching.

In the analysis of the VNOS-D form applied before the application to develop the NOS views of primary school students within the scope of the study, it was determined that the majority of the students were distant from the NOS concepts and had never heard of some concepts. In other studies in which NOS views of primary school students were investigated, it was observed that students were mistaken about NOS concepts, and suggestions were made on this situation (Erdoğan, 2004; Lederman, & O'Malley, 1990).

All these dimensions, the results of which are explained after the implementation, reveal that the NOS activities integrated with the direct reflective teaching method and stories were very successful in developing students' NOS views. In many previous studies, it was found that NOS activities provided positive developments. The most important result that draws attention here is that student views have improved more in all dimensions, especially imagination and creativity in science, the subjective nature of science, and the changeable nature of scientific knowledge, compared to the results of other studies (Çalışkan, 2005; Pekmezci, 2014; Yılmaz, 2013; Yiğit, 2007).

There may be many reasons for this high-value improvement in students' views, which is found in other studies. The factors that are thought to be important among these reasons are the stories in which NOS dimensions are integrated and the implementation of direct reflective teaching. Stories make difficult-to-understand experiences understandable. As such, students are motivated towards the lesson and meaningful learning takes place (Turgut & Kışla, 2015). Since students in this age group are very interested in reading and comprehension activities, stories make the subject more fun and understandable for them. Stories are created to enable students to have fun, learn while having fun, meet their mental and spiritual development needs, be curious about the subject they read, and perceive social life as it is (Biçici, 2006). During the implementations, first, the stories were read and then the activities were carried out. Thus, the stories first introduced the concepts to the students. It is thought that the students who recognized the concepts better understood the NOS concepts through direct reflective activities. Akerson, Avşar Erümit & Evcan Kaynak (2019) provided information supporting this information in their study and stated that teachers with pedagogical content knowledge can bring the activities to a level that students can understand and can translate NOS knowledge into a form that young students can understand and comprehend. In addition to all these features, the use of stories in the research can be thought to help students become more enthusiastic, put themselves in the place of story heroes, create a fun lesson process, and make the lessons more understandable and more permanent, thus helping to achieve positive results. When the cartoon heroes that children like are integrated with stories and combined with science subjects in the lesson, students will become curious and enthusiastic about science and will be interested in science lessons (Coşkun, 2012).

When the results of the research were evaluated, positive changes were realized in students' NOS views. It is thought that the most important variable that contributed to these developments was the direct reflective transfer of NOS elements through stories. Students at the primary school level especially like stories and story heroes and experience the story in their imagination. Especially 3rd-grade students, who are in the concrete operations period, have great difficulty in learning and understanding NOS dimensions that have abstract concepts. Since many science-related topics and definitions in the science curriculum are complex and abstract for students, they have difficulty in making sense of these definitions and therefore tend to memorize them. For this reason, the concepts explained to students should be made concrete and they should find materials that will develop their imagination, emphasize their curiosity, and enable them to become active in the process. Stories are among these materials (Demircioğlu et al., 2006; Gölcük, 2017). One of the starting points in this research is how to teach these abstract concepts to students in this age group. At this point, stories helped the researcher to concretize these abstract concepts. Stories have an important place in ensuring that students both listen carefully and retain the concepts. This idea is supported by many studies conducted with primary school students with the help of stories and with positive results (Cruz & Breda, 2024; Çalışkan, 2005; Pekmezci, 2014; Yılmaz, 2013; Yiğit, 2007).

Recommendations

Within the scope of the research, it has been investigated how it affects the NOS development of third grade primary school students through direct reflective activities using stories and the results have been found to be quite positive. It was found that the use of stories with the direct reflective method had positive contributions to students' learning. Therefore, such studies can be conducted with students at other grade levels. The reason for this is that students should be introduced to NOS concepts at a younger age.

Within the scope of this research, it was concluded that stories are effective. For this reason, it is thought that the research we have conducted will benefit both researchers and teachers within the scope of activities with stories. In this study, stories were created by the researcher and their effects on NOS views were examined together with the direct reflective method. These stories can also be written by students. In this way, both reading comprehension and writing skills can be improved and student materials can be created. In addition, these activities can eliminate the congestion in the lessons and allow the NOS teaching to continue within the scope of Turkish lessons. It is recommended to research what kind of methods and materials should be used according to the age groups and age levels of students within the scope of NOS teaching. In addition, the NOS objectives in science textbooks should be given more space and should even be included in all education and training activities in the form of inclusion at all grade levels. In this way, permanence in NOS views can be ensured. It was stated that there is a need for materials for teachers and students in NOS activities (Yenice & Özden, 2015). In this context, it is thought that the stories to be created can significantly meet the need for materials.

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Ethics statement: In this study, we declare that the rules stated in the "Higher Education Institutions Scientific Research and Publication Ethics Directive" are complied with and that we do not take any of the actions based on "Actions Against Scientific Research and Publication Ethics". At the same time, we declare that there is no conflict of interest between the authors, in which all authors contribute to the study, and that all the responsibility belongs to the article authors in case of any ethical violations.

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