

## More interactive historical vignettes

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### Abstract

One of the main components of science education, science literacy, entails understanding the concept of the nature of science (NOS). One way of teaching the NOS is to make use of the history of science. Interactive historical vignettes (IHV) that are based on the history of science, through which students can find many opportunities for discussion and that use the life stories of scientists, can be used as an effective technique in teaching the NOS. The purpose of the current study is to see how effective enhanced concept cartoons and visuals are in teaching the NOS and in contributing to students' scientific thinking and argumentation. IHV enhanced with concept cartoons to develop understanding of the NOS were used by 23 fifth graders for five weeks. Developments in students' conception of the NOS were analysed by examining video recordings and IHV documents. The findings show that the students' conception of the NOS developed as a result of the application. Improvement was observed in the conception of NOS in 19 students out of 23. Of these 19 students, 13 participated more in discussions related to IHV and, over time, started to use statements more in compliance with the NOS. This is believed to be because the enrichment of IHV with concept cartoons and visuals enabled the students to think more scientifically and thus improved the discussion atmosphere in the class. As a result, it is believed to be effective in focusing students on the elements of the NOS that exist in IHV and in developing their understanding of the NOS.

Keywords: nature of science, interactive historical vignettes, concept cartoons, middle school.

## 1. Introduction

One of the main components of science education, science literacy, entails understanding the nature of science (NOS) (Abd-El-Khalick, Bell & Lederman, 1998; Lederman, 1992; MEB, 2013; NGSS, 2013). However, research shows that there are several shortcomings in students' conception of the NOS (Roach & Wandersee, 1995; Taşar, 2006). Therefore, special emphasis must be placed on certain applications in courses aiming to develop students' understanding of the NOS (Lederman, Abd-El-Khalick, Bell & Schwartz, 2002). One way of teaching the NOS is to make use of the history of science (Khishfe & Abd-El-Khalick, 2002). Interactive historical vignettes (IHV) that are based on the history of science, through which students can find many opportunities for discussion and that are prepared using the life stories of scientists, can be used as an effective technique in the instruction of the NOS (Clary & Wandersee, 2006; Easley, 2006; Roach, 1993; Wandersee & Roach, 1998; Yücel, 2009). Concept cartoons are drawings through which students' possible conceptual fallacies and patterns of thinking are discussed through the use of human and animal figures, etc. (Keogh & Naylor, 1999). In creating settings for students, IHV provide students with opportunities to think (Roach & Wandersee, 1993). Assuming that concept cartoons serve this purpose, the incorporation of concept cartoons into IHV when discussion and thinking are promoted seems to be quite reasonable.

The purpose of the current study is to plan how to make IHV more effective in teaching the NOS with the aid of at least one concept cartoon embedded in each story. The purpose of the current study is to see how effective enhanced concept cartoons and visuals are in teaching the NOS and in contributing to students' scientific thinking and argumentation.

## 2. Method

The current study was conducted by employing action research considered to be within the qualitative research paradigm. Teachers and educational researchers use action research to evaluate their instruction and make changes to their students' learning (Samaras & Freese, 2009). In this way, teacher researchers can monitor learning-teaching environments engaged in a dynamic process full of conscious changes, planning, data collection and analysis (Phillips & Carr, 2010).

### 2.1. Study group

The current study was conducted with the participation of 23 fifth graders. All of the participants live in a village and commute from the village to the school everyday. The group consists of students gathered in a class by chance. Thus, the same opportunity to enhance their conception of the NOS was offered to students whose cognitive and social developments are different from each other.

### 2.2. Data collection tool and data analysis

The data of the current study were collected in a detailed manner by video recording the students while they discussed their responses to IHV documents. Moreover, before and after the application, interviews were conducted with the students about the NOS. A "narrative" technique was used to make the best sense and analysis of the collected data. The principal objective of the "narrative" method, and why it was considered suitable for the current study, is because it elicits interpretations specific to a certain incidence by means of free narratives (Mayring, 2011). Aware of the problem of disintegration and distancing from meaning, researchers present the "narrative" technique as a new way of reintegration and making sense of the data in its natural form as a story (Punch, 2005).

### 2.3. Research process

The research process began with the writing of IHV and the drawing of concept cartoons, taking into account the age of the students. Given the importance of IHV in the introduction of Turkish scientists, the researchers agreed that it was suitable to investigate five scientists known for their work. The researchers agreed to use the model of the NOS developed by Roach (1993), who is regarded as the pioneer of IHV. Roach adapted the model of the NOS by reviewing the former literature. The researchers wrote IHV included this model of the NOS by seeking expert opinions. The elements of the NOS included in IHV and the scientists addressed in the current study are as follows:

Table 1. The elements of the NOS included in IHV and the scientists addressed.

| <i>Elements of the NOS</i>   | <i>Ahmet Çelebi with<br/>Thousands of Sciences</i> | <i>Kuşçu Ali's Love<br/>for the Moon</i> | <i>Ömer Hayyam Observing<br/>the Heavens</i> | <i>Great Man Kocasinan</i> | <i>Ak dede Akşemseddin</i> |
|--|--|--|--|----------------------------|----------------------------|
| Scientific knowledge is tentative.   |  |  | √  | √                          | √                          |
| Science is a process utilising many scientific methods.  |  | √  | √  |                            | √                          |
| Science is a search for knowledge; technology is the application of science to alter the environment or human condition. | √  | √  | √  | √                          | √                          |
| Science is a human endeavour involving curiosity, creativity and imagination.  | √  | √  |  | √                          | √                          |
| Science is grounded in nature.   | √  | √  | √  |                            | √                          |
| Science searches for the simplest explanation of events, often using mathematics in this search for parsimony.           |  |  | √  | √                          |                            |

Five IHV enhanced concept cartoons were administered to the study group for five weeks in order to develop students' understanding of the NOS. Before and after the application interviews were conducted with the students about the NOS and the progress in the students' conception of the NOS was monitored.

### 3. Findings

Throughout the application period, some sample excerpts demonstrating the development in the students' conception of the NOS are presented as part of the findings:

#### 3.1. Findings related to "Scientific knowledge is tentative"

Some excerpts related to the students' opinions before the application about scientific knowledge being tentative are given below:

*“Scientists do everything correctly, teacher.” (S1)*

*“There is no margin of error in the data collected by scientists as they use machines in their studies.” (S2)*

Some excerpts related to the students’ opinions after the application about scientific knowledge being tentative are presented below:

*“There is a place for suspicion in science because every man can make a mistake, new information may be discovered.” (S1)*

*“As technology is developing, some shortcomings can be found in previously discovered data; thus, some information may change.” (S2)*

While prior to the application, all of the students did not believe that scientific knowledge would change, following the IHV applications, fifteen students started to believe that there could be a place for suspicion in science and some scientific knowledge might change over time.

### *3.2. Findings related to “Science is a process utilising many scientific methods”*

Some excerpts related to the students’ opinions before the application about science as a process utilising many scientific methods are presented below:

*“We ask our teachers, we search on the computer.” (S5)*

*“We check it with Google; we consult our teacher or resources in the library.” (S12)*

Some excerpts related to the students’ opinions after the application about science as a process utilising many scientific methods are presented below:

*“Science can utilise models and mathematics. He said that he could conduct his research by making observations, thinking mathematically, using technology and carrying out experiments.” (S5)*

*“We try to reach a conclusion via observations and experiments. I would try to find the solution to the illness by continuously conducting experiments and asking what they did during the day.” (S12)*

While prior to the application four students made limited explanations regarding scientific methods, following the IHV applications, fifteen students were observed to have gained some information about scientific methods.

### *3.3. Findings related to “Science is a search for knowledge; technology is the application of science to alter the environment or human condition”*

Some excerpts related to the students’ opinions before the application about science being a search for knowledge and technology being the application of science to alter the environment or human condition are presented below:

*"Invention of the boat is directly related to science. Science can do everything." (S6)*

*"Technology and science are the same thing. Teacher, I think science would exist even if nature did not exist because then it would have to search the unknown." (S1)*

Some excerpts related to the students' opinions after the application about science being a search for knowledge and technology being the application of science to alter the environment or human condition are presented below:

*"There is everything in nature. If there were no nature, we would not need science. I have learned what science means; science means discovering nature." (S6)*

*"Teacher, science searches things wondered in nature. Science searches, technology does." (S1)*

Prior to the application, while only two students attempted to create connections between science and technology, following the IHV applications, eighteen students expressed their thoughts about science and technology using their own words as a result of having understood the meaning of science and technology.

#### *3.4. Findings related to "Science is a human endeavour involving curiosity, creativity and imagination"*

Some excerpts related to the students' opinions before the application about science being a human endeavour involving curiosity, creativity and imagination are presented below:

*"Science can be done through machines. People learn from them." (S15)*

*"If people use their imagination, they cannot do science." (S4)*

Some excerpts related to the students' opinions after the application about science being a human endeavour involving curiosity, creativity and imagination are presented below:

*"Anyone curious, never giving up and self-confident can be a scientist." (S15)*

*"A scientist uses his/her imagination and is creative." (S4)*

While prior to the application the students did not think that science is a human endeavor, that scientists do not need to use their imagination and that science does not require curiosity and creativity, following the IHV applications, fourteen students were observed as being able to explain in their own words that science is achieved through human effort, which includes curiosity, imagination and creative thinking.

### 3.5. Findings related to “Science is grounded in nature”

Some excerpts related to the students’ opinions before the application about science being grounded in nature are presented below:

*“Teacher, I think that science would already exist even if there were no nature because then it would search the unknown.” (S6)*

*“Science discovers new things; it is not related to nature.” (S19)*

Some excerpts related to the students’ opinions after the application about science being grounded in nature are presented below:

*“We learn about trees and animals through science. If there were no nature, we would not need science.” (S6)*

*“Those who observe and watch nature become scientists. Shade exists in the world. That is, it searches for something existing in nature; therefore, Ahmet Çelebi can be a scientist.” (S19)*

While before the application none of the students stated that science is grounded in nature, following the IHV applications, thirteen students associated science with nature.

### 3.6. Findings related to “Science searches for the simplest explanation of events, often using mathematics in this search for parsimony”

Some excerpts related to the students’ opinions before the application about science searching for the simplest explanation of events, often using mathematics in this search for parsimony are presented below:

*“Science means conducting experiments.” (S7)*

*“Science is the same thing as technology. Mathematics is different...” (S10)*

Some excerpts related to the students’ opinions after the application about science searching for the simplest explanation of events, often using mathematics in this search for parsimony are presented below:

*“Sometimes, mathematics helps scientists; they make calculations and find something.” (S7)*

*“We make mathematical calculations to find the distance of the sun from the world.” (S10)*

While prior to the application the students did not know that science uses mathematics to explain events, following the IHV applications, eight students were observed to have noted how science uses mathematics to explain events.

#### 4. Results and discussion

After the application began with a student being asked, “Do scientists have shoes?” it was observed that the students considerably developed their conception of nature through the use of IHV. The findings show that the students’ conception of the NOS developed as a result of the application. Improvement was observed in the conception of the NOS in 19 students out of 23. Of these 19 students, 13 participated more in discussions related to IHV and, over time, started to use statements more in compliance with the NOS. This is believed to be because the enrichment of IHV with concept cartoons and visuals enabled the students to think more scientifically and thus improved the discussion atmosphere in the class. As a result, it is believed to be effective in focusing students on the elements of the NOS that exist in IHV and in developing students’ conception of the NOS.

The enhancement of IHV with concept cartoons and visuals and the encouragement of students to focus on the elements of the NOS by creating motivating classroom discussion settings are believed to have contributed to this development.

As the prepared IHV were very appealing to the students, they found many of their details, ranging from stories to cartoons, attractive and interesting. Attentiveness was the first step of the learning process and, in this regard, IHV were successful. “The most important point to be focused on for learning to occur is to draw students’ attention to objectives and to enable them to maintain their attention for a long time” (Öztürk & Kısaç, 2003). In line with this principle of information processing theory, great care was taken in the use of affective and physical stimuli throughout the application process of IHV.

It should be stressed that visuals are conducive to the development of critical thinking skills by increasing the motivation and thinking opportunities for students (Costa da Silva & Infante-Malachias, 2009). Concept cartoons not only help students have fun but also prompt them to question what they know (Keogh & Naylor, 1999). After the application, the students were found to have positive opinions about IHV and they expressed their positive opinions using their own words. One student said that, “I liked the drawings and dialogues in the cartoons in which Hayal and Umut are depicted”; another student noted that, “The story we read this time is extraordinarily good” while another student said that, “I felt happy because of Akşemseddin”. The students’ curiosity in IHV resulted in their focusing on the NOS. Wherever there is a child, there is curiosity and wherever there is curiosity, there is science (Howitt & Blake, 2010). When children try to understand the world around them and when they are affected by this world, they start developing ideas about what the world is and how it operates (NRC, 2012).

As it is conducive to the development of the conception of the NOS, it is suggested that IHV should be enhanced with visuals and concept cartoons for teaching the NOS.

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