

# The Use of History of Science as a Cultural Tool to Promote Students' Empathy with the Culture of Science\*

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## Abstract

It is difficult for students to understand historical settings, connect to today's world, interpret and appreciate scientists' efforts within current perspectives. Empathizing with historical characters and events can mediate understanding nature of physics for students. The purpose of this study was to investigate the effect of history of science on students' empathy with the historical characters and the events. With regards of socio-cultural theory, empathy was defined as a cultural tool, which mediates between students and the science society. The study was conducted in a private high school with participation of twenty-one 9th grade students in physics class for the unit of The Nature of Physics. A qualitative case-study method was employed. Data resources were video and audio recordings, field notes, students' tasks, interviews, and surveys. After transcribing and categorizing, the data were analyzed and patterns were organized. The findings supported eight aspects of empathy: Making Personal Connections, Imagination, Identification, Humanization, Understanding the Events, Understanding Different Perspectives, Understanding the Tentativeness of the Conclusions and Taking Perspectives. The results supported that students could interact with the culture of science with the use of the aspects of historical empathy. The use of the aspects of empathy attracted students' interest in physics lesson. The results are also promising for students' understanding nature of science.

## Key Words

History of Science, Empathy, Physics Education.

Educational psychologists agreed on that learning is based on cultural and social settings (Woolfolk, 2007). According to Vygotsky, construction of knowledge starts with the interaction between individuals in a socio-cultural medium (Vygotsky, 1978). This interaction does not only occur among individuals of a same culture or same medium, but

it also occurs among different cultures. For example, cross-cultural studies consider that students do not apprehend a concept, which does not exist in their cultures (Langford, 2005). When an interaction between students and different cultures is in question, teacher should familiarize the students with other cultures. In the light of socio-cultural theory, the culture brought in class by a science teacher is culture of science.

In this study, culture of science is composed of values of a community and their effects on the scientific endeavors; development of scientific knowledge, and the role of individuals/groups in this community who are working for science. With these aspects, culture of science can inform students about how science works and what scientists do. Therefore, understanding culture of science can facilitate understanding nature of science, develop positive attitudes toward science and change the

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students' image of scientists. However, it is difficult for students to understand and evaluate an unfamiliar culture in past, within their contemporary perspectives. So, how can students interact with an unfamiliar culture? Studies in history education suggest that students can get familiar with a culture with the use of empathy. Since the history education aims at presenting and familiarizing different cultures, which are unfamiliar, empathy is defined as one of the important factors to provide connection between students and another culture (Levstik, 2001; Skolnick, Dulberg, & Maestre, 2004).

History of science is a way to provide students a medium to interact with the culture of science. In the literature, there are studies that have used scientists' life stories (Seker, 2004; Wieder, 2006), their works (Solomon, Duveen, & Scot, 1992) or original historical papers (Osewold, 2005; Viard, 2005), in order to investigate students' understanding of the nature of science or attitudes toward science (Craft & Miler, 2007; Irwin, 2000; Klopfer & Cooley, 1969; Lin & Chen, 2002; Olson, Clough, Bruksvoort, & Vanderlinden, 2005; Rudge, Geer, & Howe, 2007; Seker & Welsh, 2006; Solomon et al., 1992). These can be considered as examples that familiarize students with culture of science. In science education, with the help of empathy, students can try to view scientists and their works in given historical settings and understand the culture of science. Although empathy is an important tool for a cultural connection, no specific study has been observed that connects classroom culture and culture of science with the use of empathy. For these reasons, in this study, the role of empathy in classroom on interaction with the culture of science was investigated.

## Theory

The word 'empathy' comes from a Greek word which was created by combining the *em* prefix that means 'in, into' and *pathia* that means 'suffering/feeling'. Due to this combination, empathy can be defined as *feeling into*. Researchers do not define empathy only in affective aspect but also in its cognitive aspects. Whereas affective empathy is defined as sharing others' feelings, cognitive empathy is defined as understanding others' perspectives. History education, on the other hand, focuses on historical empathy, which concerns historical events and characters. Yeager and Foster (2001), state that empathy is an effective tool for understanding history. Considering the literature on historical empathy and complex nature of historical empathy, following aspects are developed to define empathy.

## Affective Aspects of Empathy

Affective aspects of empathy can be discussed under four main headings. These aspects are Making Personal Connections, Imagination, Identification and Humanization.

*Making Personal Connections* can be defined as the first step of the process of historical empathy (Skolnick et al., 2004). People make connections with things that attract their interest or they care. Therefore, students can imagine themselves in such situations. They can think what they could do as if they have experienced the same thing. If they have a similar past experience with the historical people, they can also compare or contrast their experiences with the historical people's actions (Barton & Levstik, 2004).

*Imagination* in historical empathy can be described with statements like 'if I were him/her' (Dilek & Yapıcı, 2005). People put themselves in others' shoes in order to understand them, interpret their feelings and thoughts and meanwhile they imagine as if they experienced the same thing (Coskun-Keskin, 2007).

*Identification* is defined as an expected outcome of imagination. Students may identify themselves with the character that they imagine as if they are. Identification is not to imitate someone else. It involves development of concept of 'others' (Dilek ve Yapıcı, 2003), taking someone as a role model by adopting some qualities of him/her in order to form their ideas (Coskun-Keskin, 2007).

*Humanization* can be defined as an act of giving human qualities. Students may view historical characters are different, even they were completely perfect. Humanization in historical empathy involves understanding the people in past and developing humanistic attitudes towards them (Geneser, 2005; Stoddard, 2005).

## Cognitive Aspects of Empathy

Cognitive aspects of empathy can be discussed under four main headings. These aspects are; Understanding the Events, Understanding Different Perspectives, Understanding the Tentativeness of the Conclusions, Critical Thinking (Or Perspective Taking).

*Understanding the events/facts* is one of the aims in historical empathy. It involves understanding why historical characters acted as they did and appreciating their actions in the settings they had lived (Foster, 2001). Appreciation of the action refers to understanding the settings of the history and interpreting the outcomes within this perspective.

*Understanding different perspectives* can be discussed in two ways. First way is to understand that individuals have different perspectives due to their educational, historical, social or cultural backgrounds. Second way is to understand perspectives in the eras due to their settings. In order to understand the facts about the history, and empathize with historical characters, students should have an understanding of distinction between today and past, and should switch between these perspectives (Downey, 1999 as cited in Jensen, 2008). Comparing and contrasting setting of eras are also important for developing historical empathy (Pate & Klages, 1999 as cited in Geneser, 2005).

*Understanding the tentativeness of the conclusions* can be described as developing an appreciation of variable conclusions on similar settings. Different individuals might act in different ways in a given similar settings because of their different perspectives. Historical empathy requires investigating, and understanding the perspectives of people in the past and appreciating the tentativeness of the conclusions (Foster 2001, p. 175).

*Critical Thinking (or perspective taking)* can be defined as the last step of the process of historical empathy (Skolnick et al., p. 17). In historical empathy, main task is to view the world in historical characters' eyes. Besides, they should judge in their perspective (Tosh, 1999 as cited in Harris & Foreman-Peck, 2004). Judging the events in a historical perspective requires critical thinking and perspective taking. In this aspect of empathy students can feel themselves as the part of the community and they can attend to solve problems of the community (Skolnick et al., 2004, pp.17-18).

### Method

A qualitative case-study method was employed in this study. The study was conducted in a private high school in Istanbul with participation of twenty-one 9<sup>th</sup> grade students in a physics class for the unit of The Nature of Physics. Instructional materials for the unit were developed based on 9<sup>th</sup> grade physics curriculum (Milli Eğitim Bakanlığı [MEB], 2007). In these materials, history of science was integrated into curriculum with stories, examples, and activities. While a science teacher used the materials, the researcher was a non-participant observer.

In order to collect data lessons were videotaped, field notes were taken. The other data sources were students' tasks, audio recordings of interviews and open-ended surveys. Throughout the study, seven

lesson hours (280 minutes) video recordings and 108 minutes audio recordings, written papers from students' assignments and classroom activities, and surveys were collected. All data were transcribed with respect to students' statements without any correction. Transcriptions were analyzed; the analyses were categorized by the aspects of empathy. The study demonstrates its trustworthiness through its data's dependability, credibility, confirmability, and transferability. In order to provide credibility, the data sources, data collection methods were triangulated. Volunteer participation was aimed for more credible and sincere responses. To provide, transferability of the study, methodology, process, and the results were described in details. For the dependability, and confirmability of the study, statements of the students were discussed with the help of the concepts from the literature. To achieve reliability and validity, researcher moved back and forth in research iteratively by checking data and interpretations constantly until analysis fits conceptual framework (Morse, Barrett, Mayan, Olson, & Spiers, 2002).

### Results

In the study each lesson was considered as a case. Throughout the study, the data from activities, assignments, observations, interviews, and surveys were analyzed. Aspects of empathy were observed more frequently in students' expressions that were gathered from assignments, classroom activities, and interviews than video recordings and surveys. Findings supported eight aspects of empathy: Making Personal Connections, Imagination, Identification, Humanization, Understanding the Events, Understanding Different Perspectives, Understanding the Tentativeness of the Conclusions and Taking Perspectives. Considering the strong patterns on aspects of empathy, results for six lessons are presented below.

#### Lesson 1

In the first lesson, affective aspects of empathy; Making Personal Connections, Identification and Imagination were observed. Students' expressions supported that they had started to build a bridge between their own culture and the culture of science. For instance, Ahmet's answer to the question 'What would you prefer to do if you were a scientist?' is an example of question for the Identification aspect of empathy. Ahmet's expression supported that he would like to adopt some characteristics

of Newton by saying 'If I were a scientist, I would connect mathematics and geometry with nature, as Newton did.'

In another activity in the first lesson, a story about Mary Curie was told and her feelings about her discovery of Uranium were asked. Most of the students respond questions considering and assessing the case of Marie Curie.

*Emel:* Marie Curie must have felt very happy and enthusiastic because she had worked hard and succeed. She should have felt so special.

*Ekin:* She must have been happy because she had contributed to science and she should be proud of herself.

*Ahmet:* She must have been happy because she contributed one more new thing to universe.

Students define Marie Curie's feelings with stressing her happiness as a result of her hard works. These expressions supported that; they can understand the feelings of Curie and appreciate her studies in her setting. By this way, it is supported that students can understand the events of Curie and be familiar with the culture of science.

## Lesson 2

Making Personal Connection aspect of empathy was frequently observed in the analysis of the data about an activity in the second lesson that focuses on Aristotle and Galileo controversy. Most of the students stated that they liked the activity and they felt as if they were scientists. Discussion about the scientists and their ideas by using personal knowledge and experiences, and making experiments with simple materials, might have helped students to get interested in the activity. This activity also helped students to contact with scientist(s), feel like a scientist and understand the culture of science. Therefore, students' expressions supported that students gradually became a part of the debate between two scientists by taking a side.

At the first step of the activity, students stated their ideas about the phenomenon with using their own ideas and tried to make personal connections.

*Banu:* I think Aristotle is right. Because; for example, if we drop a bottle with water and an empty bottle from same height, the full one will reach ground faster. I mean, the heavier one will reach ground first.

*Ilker:* I think Galileo is right, because the friction of a bigger stone is bigger because of its surface and adding its weight, this fact becomes balanced and big stone and the smaller stone reach ground at the same time.

Throughout the activity, students firstly observed falling objects. Then, they measure the time of the falling objects. Some students encountered with a different result, which they did not expect and they supported. By experiencing the ideas, these students recognized that knowledge that had been believed in past can be falsifiable and conclusions are tentative.

*Emel:* Before the experiment, I thought that heavy one goes faster, of course.

*Researcher:* Why did you think like that?

*Emel:* You know ... it is heavier ... I mean it goes faster because its force is too much

*R:* After the experiment?

*Emel:* After doing the experiment I saw that both two are going at the same time.

.....

*Researcher:* How do you interpret scientists have different ideas on the same phenomenon?

*Ilker:* Everyone has different fields. You see, some separates, like medicine, philosophy or logic. They may interpret due to their fields.

In this conversation, Ilker's expressions supported that he recognized that different ideas could be possible, because people had different interests, so their conclusions might be different in their perspectives.

In this activity, students presented their ideas about the phenomenon from the HOS. They decided which idea is more reasonable due to their previous ideas and experiences. Then, they experienced scientists' ideas, and finally they experienced and realized that knowledge can be changed through the time. By this way, students' expressions supported that they have interacted with the culture of science and have started to understand this culture by behaving as a part of his/her culture.

## Lesson 3

In lesson 3, questions were asked in order to help students imagine a historical case about development of measurement through the history. Students were expected to interact with this era. Analyses of data supported that students tried to think more complex

when they use the Imagination aspect of empathy. They moved towards making personal connections, understanding events and different perspectives, defining the problems and seeking for solutions.

*Teacher (T):* Someone hunted an animal. I say 'I want two hand span piece of this animal' and you say 'OK. Everyone can take two hand span piece of it'. But my hand span and yours...

*Student (S):* They may choose one.

*T:* They choose one? Then they choose a *measurer*, they choose a hand span man. You say, he comes and measures for all...

.....

*S:* Humans are not same, for example if everyone measures with hands, they are not same.

*S:* That's why they did the measurement instruments.

In this example above, students tried to imagine, understand, and find solutions to the problems. Instead of offering a modern instrument, they offered a '*measurer*'. This perspective supported that students can be a part of a community (culture) and they attend to find a solution for the existing problems of this community (Critical Thinking). Also student's expression 'That's why they did the measurement instruments' supported that she understood the facts and problems in that setting (Understanding the Events/Facts), and this supported that student could interact with this culture.

### Lesson 5

For lesson 5, a story about George Simon Ohm was given as an assignment. In this story, a little passage about Ohm and a problem in his electric current experiment was given and the question 'What would you do if you were Ohm?' was asked. Imagination, Understanding Events and Critical Thinking aspects of the empathy was observed in the analysis of the data.

*İpek:* I would have thought that the problem was depended on battery. I would have fixed this and do the experiment again.

*Aycan:* I would use various wires of same material in different lengths, and I would use batteries that are more enduring.

*Gülse:* If I were Ohm, I would have thought that those results were because of cumbersome batteries and I would use more useful batteries. If the problem was not batteries, I

would have tried to be careful and use correct materials in my experiment.

All students firstly used their imagination, because they all tried to put themselves in Ohm's shoes. Then they tried to define the problem in terms of the batteries (Understanding the Events). Finally, they tried to suggest a solution to the problem with thinking critically. Consequently, they started to a one-way communication with the scientist.

### Lesson 6

For lesson 6, students were given an assignment to read stories about Newton and Galileo. Some questions to explore students' ideas were asked at the end of the stories. One of the questions in this assignment was 'In your opinion, why did Galileo choose to be against to the accepted ideas by trying them with experiments?'

*Aycan:* Because, till that time no one had made experiment. Everyone had stuck to a specific logic and no one had tried to learn the truth.

Aycan defined the time of Galileo and mentioned people who believed Aristotle. This statement supported that student could define the settings of the time and understand why Galileo made experiments.

*Eylül:* Because, I think, he can't stand on Aristotle's success, and complain as why I couldn't discover this and say Aristotle was wrong.

In this example, Eylül used her imagination, because she thought that Galileo envied Aristotle. Neither she nor we had an idea about Galileo's feelings inside about Aristotle so Eylül's answer is an example of Imagination aspect of empathy. In another question, it was asked that if they would have lived in Galileo's time, whether they would pursue Aristotle's doctrines or believe in experiments.

*Gülse:* If we presume that we had lived in such a period, I would pursue Aristotle's ideas. Because, it is the one that all other people believe in and trust, so I would not believe an individual has such a power to change everything.

Gülse's statement is an example for Making Personal Connections. Gülse, in her answer, states that she would pursue Aristotle. As a cause for that answer, she puts her beliefs forward.

Considering these examples, we can interfere that students thought and told about the events of the scientists and they tried to interact with the culture

of science by using Imagination, Making Personal Connections and Understanding Events aspects of the empathy.

### Lesson 7

In the last lesson, Galileo's pendulum experiment was conducted. Only, Making Personal Connections aspect of the empathy was observed in the analysis of the data that was gathered from students' expressions. Students expressed that they liked the activity.

*R:* Is there anything attracted your interest during your lessons about history of science or scientists.

*Umut:* You see, there, Galileo's life and such like. Interesting

*R:* What was interesting for you?

*Umut:* Well, for example, there in the church, once he was there ... he thought pendulum and such like.

Umut stated that the activity attracted his interest. Interest is a way to make a connection between two sides. Therefore, student's statement in this conversation is an example for Making Personal Connection aspect of empathy. Students' similar expressions supported that they tried to communicate with the culture of science environments.

### Conclusion

In this study, empathy was defined as a cultural tool that mediates interaction among cultures within the sociocultural approach, and role of empathy on the interaction between teaching environment and culture of science was investigated. As a result of this study, it was observed that students interact with the culture of science by using dimensions of empathy as cultural tools, and made a progress in understanding nature of physics which is consisted with the objectives stated in New Physics Teaching Program (MEB, 2007).

It was seen that students expressed their own ideas and made interpretations on the historical cases by using their own conceptions when the cases were tailored to instructional activities in physics lesson. Some evidences were observed on the influence of using historical cases used in this study on the interestingness of physics lessons and student participation to the lesson. In the study, the discussion sessions on controversial subjects from history of science also helped some students understand sci-

ence and the progress of science. It was observed that students do not hesitate to make interpretations on the controversial subject even if they do not have detailed knowledge about it when a discussion topic trigger imagination as it is in caveman example used to present the need of measurement instruments. When controversial ideas of the scientists were presented to some students and it was asked them to choose a scientist to support, it was seen that they expressed their own ideas first and then compared their own ideas with scientists'. They also justified their ideas to support the scientist whom they think right on the controversial subject.

The results of this study also provide evidence on students' feelings of identification themselves as a part of culture of science when an original experiment derived from the history of science was repeated in science teaching. By using simple pendulum and measuring time with pulse beats, students faced with similar problems to the scientist and they tried to find solutions to these problems by interpreting error sources. Since students experienced the same experience with the scientist, it can be stated that using original experiments in lessons can make a connection between culture of science and students, and help students to empathize culture of science.

The results of this study suggest that students respect scientist and their scientific studies, understand the relationship of societies with scientific endeavors, and how science works in culture of science when historical cases were used as a cultural tool in science teaching. Accordingly, it can be implied that historical cases used in this study can be recommended as curricular materials as the results of this study were consistent with the objectives of the New Physics Curriculum. The historical cases related to the culture of science can play an important role on understanding the objectives of the curriculum for teachers in the transition to the new curriculum.

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