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Considering the Role and Nature of the Scientist: The Case of Darwin and Evolution

SERAP ÖZ AYDIN

ABSTRACT

For many students, preconceived notions about Darwin are among the most significant obstacles in learning about the theory of evolution by natural selection. I present an activity designed to eliminate this obstacle and encourage empathizing with Darwin, utilizing the history-of-science approach. Through the activity, students' negative thoughts about Darwin disappeared, Darwin's position as a scientist came to the fore, students' interest in evolution increased, and they started to discuss the theory within a scientific framework.

Key Words: Evolution; Darwin; history of science.

○ Introduction

In Turkey, as in many other countries, a great majority perceive Darwin and the theory of evolution negatively (Miller et al., 2006; Kim & Nehm, 2011). As a result of anti-evolution campaigns (Rixinger, 2002), students enter the universities with minimal or no scientific study of evolution. One student in my class commented, "I never took a course on evolution but my elementary school teacher sometimes said in passing that Darwin was stupid and silly, so I haven't liked Darwin since then and I don't believe in evolution." As observed by Dagher and Boujaoude (2005), similar sentiments exist in the United States.

Negative attitudes may adversely affect an open reception to, and understanding of, evolution. However, there is growing evidence that engaging students in stories and the human dimensions of scientists can improve attitudes and facilitate learning science concepts as well as the nature of science (Herreid, 2007; Hadzigeorgiou et al., 2012; Hong & Lin-Siegler, 2012; Erten et al., 2013). In particular, stories may potentially soften a perceived conflict between science and religion (Bickmore et al., 2009). Here, I describe an activity designed to address the attitudinal obstacle about learning evolution by using the history of science to encourage empathizing with Darwin. I report the

effect of this activity on the attitudes toward Darwin and the theory of evolution among a group of 30 college students.

○ The Activity

The activity adopts a familiar format of leading students through Darwin's journey on the *Beagle* (WGBH, 2001; American Museum of Natural History, 2005; Girard et al., 2009; Natural History Museum, 2012). But it differs from many descriptive accounts by posing questions directly to students, inviting them to think and make decisions in Darwin's own context, a style that has proved effective in other cases (Hagen et al., 1996; Herreid, 2007, pp. 169–170; Allchin, 2012). Some questions ask for scientific interpretations. But others involve attitudes and emotions, encouraging the students to imagine Darwin's personal challenges and empathize with his struggles.

Darwin's life is divided into 18 segments. These items include characteristics of Darwin as an individual and as a scientist, as well as information about the nature of science, scientific thinking, and the theory of evolution (Gould, 2005; Darwin, 2009). Each is presented in sequence, either on a projected screen or on an individual student worksheet. Students are given 3 minutes to complete written responses before proceeding to the next segment. It takes about 55 minutes to complete the activity. However, the duration can be decreased by either combining or skipping some items. The activity can be administered to high school students with some modifications. When using this activity with

high school students, instructors could combine items 3, 4, and 5 into one item and skip items 13, 14, 17, and 18.

Word association tests (WAT) can be performed before and immediately after the implementation of a worksheet to assess students' understanding of, and attitudes toward, Darwin and the theory of evolution. The WAT requires students to write down the

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Table 1. Activity evaluation.

1. Did this activity interest you?	100% Yes
2. In what way did you find it interesting?	90% Empathy
3. Which of your thoughts and emotions changed after the activity?	(Content analysis; see Table 2)
4. What did this activity teach?	(What was learned?; see Table 3)

words he or she associates with Darwin within a certain period (usually 30 seconds; Ashcraft, 1994). Next, the students are requested to respond in writing to the questions in the Activity Evaluation Sheet, which includes four questions regarding their feelings and ideas about the activity (see Table 1). Total time for the pre-WAT, the worksheet, the post-WAT, and the Activity Evaluation is 70 minutes. After completing the activity, in subsequent class sessions, the documentary *National Geographic: Darwin's Lost Voyage* could be shown to the students to further enhance their understanding and attitudes.

The 18 items presented to the students in this activity are as follows.

Let's suppose that...

Instructions: Please read, consider and respond to the following items in order without going back to earlier ones or ahead to those you have not yet seen. Thank you.

1. Let us suppose that you were born as the child of a prosperous doctor in England in 1809. Your most prominent childhood characteristic is that you are an incurable collector (insects, etc.). Storing away objects, then pretending to find them again, telling everyone when you see a strange bird, and making up stories about natural history are important parts of your personality. You study medicine for a while like your father wanted, but then you go to Cambridge University to pursue the ministry. As a young man, you believed the Bible word for word. Just like other people of your time, you believe in the unchangeability of species. Under the circumstances, what compels you to anger many of your peers by trying to develop and explain a theory?
2. You're 22 years old and you take the route below to go around the world on a 3-year sea voyage. The main reason for this trip is to complete your map of the South American coast. But you won't have an official title or duty on board the ship. You will meet the expenses of this trip yourself, and the journey will be costly. On journeys like this, many travelers have died from tropical diseases or in disasters at sea. Not only that, but your ship is a small one nicknamed "Coffin." Even your family is against your going on the journey. Besides that, your cabin on the ship is very small and you have to sleep in a hammock. Would you take a journey like this? Explain why.
3. It is 1835. You have decided to take a journey like this, either because you really want to or because you're forced to. What would you want to do on this journey?

4. The journey takes 4 years and 9 months. It costs more than 50,000 pounds (~\$84,000) in today's currency. More than 3200 km of the 75,000-km journey is spent on horseback. During the trip, you take 1751 pages of notes on biology and geology. You've seen so many places and living creatures! You fill up 770 pages of your diary, and you collect and label 3907 bones, animal hides, and live samples. You've immersed 1529 animal samples in alcohol. What will you do with all that you've collected?
5. Of the 74 people on the journey, 6 lost their lives along the way. At many stops, your life was endangered by an epidemic of cholera. You must tolerate the difficulties of escaping the danger of death and the seasickness that tears you apart. Why don't you abandon the journey? Why do you still continue?
6. During the trip, you found some giant fossils of mammals that don't exist today. What explanation for this might you offer?
7. While you were on the journey, a big earthquake that hit Chile caused a permanent swelling of the sea floor. The native folk told you that they dove very deep to find oysters. But in your own research, you have reached this kind of shellfish even at depths of 400 m. What does this mean?
8. After visiting the Galápagos Islands (an island chain clustered around either side of the Equator in the Pacific Ocean), why didn't you see each species living in special areas prepared uniquely for them, like everyone believed, or species that existed all around the world but did not exist on the Galápagos Islands, or even species that lived here but did not live anywhere else, especially in places where there was a density of people? In the same way, if other living beings were created to serve man, how could we explain the existence of species that lived for millions of years in places where man has never set foot?
9. The Galápagos Islands are home to a total of 14 different finches that are all close relatives. The most striking difference between the species is the structure of their beaks. What do different beaks and body structures mean?
10. When you return from the trip, you are greatly influenced by the work of geologists Hutton and Lyell. Their observations have shown that geological change comes about not abruptly but through very slow and continuous activity. What can be said about the age of the world on the basis of this information?
11. In 1838, you read an article by Malthus on the human population. The article says that hunger will take over the world with the increase in population and, related to this, there will be wars and massacres for food and shelter. In addition, it points to what natural scientists already know, that all species produce more offspring than can actually live in the world. What thoughts has this idea prompted in you?
12. The first symptoms of a disease, perhaps Chagas disease, begin in 1840, promising to affect your health for the rest of your life. Nausea, insomnia, and fatigue have you in bed for weeks. You can't work for more than one or two hours; you have to rest every so often. You contracted the sickness when a *Benchucha* bug bit you during your journey. In spite of this, you still say, "I will only die when I have to stop my

Table 2. Content analysis based on empathy.

Emotional Empathy	
Forming a personal bond	Participant 14: Darwin was the same age as us when he made those observations and performed the experiments but our perspectives on the world and on nature are different. I was disappointed to realize my shortcomings.
Identifying	Participant 25: I was thinking that reading and learning about Darwin's life was not anything that I needed to do. When I learned about the sacrifices Darwin made to attain scientific knowledge and saw that he was a researcher and an inquirer, my perspective changed. It made me want to search for knowledge in the right way.
Imagining	Participant 9: When I imagined the events, the worth of what occurred grew in my eyes.
Humanizing	Participant 29: We saw that Darwin was being unfairly treated.
Cognitive Empathy	
Understanding different points of view	Participant 1: We tore down our prejudices about Darwin and tried to look at him from a scientific point of view.
Understanding the actions	Participant 27: Darwin's waiting 20 years is proof of how hard it is to travel this road.
Understanding that knowledge can change	Participant 26: Learning about evolution softened my thoughts about evolution.
Critical thinking	Participant 17: It made me think scientifically...

observations and experiments." What part of your personality does this show?

13. You have never distorted the evidence you obtained from your observations, collections, and documents during your journey in order to make them suitable to your beliefs, traditions, family interests, or religion, or to political authorities. Ultimately, in 1844, you shared a 231-page draft with a scientist friend of yours. "A light lit up in my mind all of a sudden and, completely contrary to my original idea, I became convinced, as if confessing to a crime, that species are not unchangeable. I think (and here is the audacity) that I have discovered that species very simply adjust magnificently to adapt to various purposes." Why did you wait as long as 20 years (a short time actually!) to announce your very significant ideas to the world?
14. The treatise you wrote on barnacles took you exactly 8 years to complete (1846–1854). Can you imagine thinking about only one subject for 8 years, from morning till night? A 4-volume work of 1000 pages. You've said, "Nobody would dare to read this book." How could you have benefited from this work? At the same time, which part of your personality does this show?
15. In 1858, you received a letter from a fellow scientist name Alfred Wallace. Here was another person talking about your still unpublished theory of natural selection in this letter. Now what are you going to do?
16. Why has this theory become more identified with you? How do you think scientific circles and other communities reacted to this theory?
17. You're 72 years old; what do you think your peers are doing at this point in life? At this age, you're wondering about whether the worms in your plants at home have awareness. You don't use expensive tools or equipment in your experiments. (This experiment constitutes the beginning of the science of evolutionary psychology.) This is your last book. Could you please tell us how you performed these experiments?

Table 3. What was learned?

Recognizes the characteristics of a scientist	60%
Knows who Darwin is	33%
Students find out that each step of the evidence gathered in the theory of evolution is not solely the product of Darwin's mind while sitting at his desk, but the result of very serious scientific work.	27%
Understands the difficulties involved in the formulation of the theory of evolution	37%
Understands that no one and nothing should be viewed with preconceived notions	30%
Recognizes the characteristics of science	30%
Ensures that events are viewed from different viewpoints	20%
Learns scientific thinking	20%

○ Results & Discussion

A convenience sample of 30 senior preservice science teachers participated in the activity. The activity took place within a two-credit undergraduate Evolution course. The preservice teachers reported that they completed the activity enthusiastically without getting bored (Table 1).

"Empathy" is defined as identifying with and imagining another person's thoughts and feelings, evaluating these with the same standards as that person. Empathy has both emotional and cognitive dimensions (Harris & Foreman-Peck, 2004). The participants were able to empathize because the person setting out on the journey was 22 years old, the same age they were, so the activity was easy and meaningful for them. Table 2 presents empathy-related example statements of the participants.

The results presented in Table 3 suggest that the implementation of the activity fulfilled its goal. While there were 17 words

associated with Darwin and the characteristics of scientists before the activity, the number climbed to 58 after the activity. The increase in the number of words suggests that the activity helped participants acquire more knowledge about the key concepts.

The overall findings indicate that through the activity, the students learned about Darwin and his struggles, became aware of the characteristics of scientists, and found that Darwin's theory of evolution was produced stepwise through evidence (not merely from sitting and thinking at a desk). Thus, the concept of evolution as a scientific theory came to the forefront. When the students shed their misconceptions in this way, an important obstacle that stood in the way of their learning about the theory of evolution was eliminated. A similar activity involving the personal challenges and science of Alfred Russel Wallace could be implemented as a follow-up activity (Friedman, 2010). Such an activity would raise students' awareness that Darwin's concepts were not exclusive to him and that, with the appropriate experience and evidence, others could reach the same conclusion.

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