"Evo in the News:" Understanding Evolution and Students' Attitudes Toward the Relevance of Evolutionary Biology

Lynn M. Infanti and Jason R. Wiles*

Department of Science Teaching, Syracuse University, 101 Heroy, Syracuse, NY 13244

*Corresponding Author: jrwiles@syr.edu

Abstract: This investigation evaluated the effects of exposure to the "Evo in the News" section of the *Understanding Evolution* website on students' attitudes toward biological evolution in undergraduates in a mixed-majors introductory biology course at Syracuse University. Students' attitudes toward evolution and changes therein were measured using the Evolutionary Attitudes and Literacy Survey. We employed a quasi-experimental design with pre-test/post-test comparison wherein an experimental group was assigned pre-laboratory work using "Evo in the News" articles while a control group was assigned similar pre-lab work without exposure to "Evo in the News." At the conclusion of the semester, the experimental group showed significant improvement in their perceptions of the relevance of evolution to understanding real-world scientific problems and to their daily lives while the control group did not. Incorporating "Evo in the News" activities into an introductory biology course is a cost-effective and non-labor-intensive way to expose students to ongoing, practical science research based on evolutionary theory. This study supported the hypothesis that exposure to real-world applications of evolutionary theory such as those featured in "Evo in the News" is correlated with increases in students' attitudes toward evolutionary science, particularly with regard to their perceptions of its relevance.

INTRODUCTION

Biology is a broad and complex field of study, encompassing areas as diverse as biochemistry and ecology and everything in between. There are, however, unifying principles that tie together the study of all of these seemingly independent subtopics. Among the most central of these unifying principles is biological evolution (Alles, 2001; Dobzhansky, 1972; Gould, 2001; Linhart, 1997; Wiles, 2010).

The teaching of evolution though, particularly in the United States, has been beset with difficulties that have led to poor understanding of evolution among the general public (Alters, 2005; Alters & Alters, 2001; Cobern, 1994; Demastes et al., 1995; Lawson & Worsnop, 1992; Scott, 2004; Sinclair & Pendarvis, 1998; Wiles & Ashgar, 2007; Wiles, 2010). Numerous polls of the general public have demonstrated that, compared to citizens of other industrialized nations, Americans exhibit a striking lack of understanding and acceptance of evolution and related aspects of science (Miller et al., 2006; Wiles, 2010). In addition, it appears that a substantial portion of the American public tends to eschew evidence-based scientific theories on the history and diversity of life on Earth and, instead, favors non-scientific explanations that are rooted in religious creationism, including its recent incarnation known as "intelligent design" (Alters & Alters, 2001; Nelson, 2008; Wiles, 2010).

Considering the social divide over evolution and its implications for teaching, Wilson (2005) asserted that regarding evolution there are "two walls of resistance, one denying the theory altogether and the other denying its relevance to human affairs" (p.364). Wilson's (2005) EVoS program was designed to overcome both of these walls; however, the program requires replacing the introductory biology courses that have become firmly entrenched at most universities with a full course centered on evolution and its applications. Herein we explore a potential means of surmounting at least the second of these walls within the context of an existing biology course with minimal curricular change. Students may find difficult concepts such as evolution more engaging and potentially easier to understand when they are able to see the relevance of the content (Hillis, 2007). The use of popular media to present real-world issues and their connection to scientific concepts has been shown to increase students' understandings in scientific areas (Bondos & Phillips, 2008). However, implementation of these tools is often hindered when teachers are underprepared to use them, the tools are too complicated for the students to use, or the tools are too expensive to implement.

One of the pedagogical tools developed to address these concerns is the University of California Museum of Paleontology's *Understanding Evolution* website (www.evolution.berkeley.edu). This award-winning, online resource incorporates extensive guidelines and suggestions for teachers regarding its classroom use. It is user-friendly for students and teachers and includes a host of activities organized according to grade-level appropriateness across K-16 settings. And, importantly, it is freely accessible.

Although this site was initially developed with K-12 students and teachers in mind, it has since been expanded for use in post-secondary education (Musante, 2011). Initial research has been done on

the impact of the tools found in the *Understanding Evolution* website and the site as a whole (Nadelson & Sinatra, 2009; Scotchmoor & Thanukos, 2007). However, until recently the focus has been on the uses for and perceptions of K-12 students and their teachers. One of the sections of the website is titled "Evo in the News." This section uses popular media articles and videos to showcase current scientific inquiry into real-world problems, and it draws explicit connections between highly applicable research and its evolutionary underpinnings which can be related to classroom content. It is aimed at helping students understand the relevance of evolutionary science in the context of practical situations.

The purpose of this study was to compare changes in student attitudes about biological evolution and understandings of evolutionary concepts among students participating in the use of "Evo in the News" as a supplement to their coursework in a general biology class.

METHODS

Data were collected and analyzed according to a protocol that had been approved by the appropriate Institutional Review Board. Participants were students (n=117) enrolled in an introductory biology lecture and lab course at Syracuse University. Students at Syracuse University do not declare their academic majors until the end of their first year. As such, the Biology Department views all first-year students as potential biology majors, and there is no non-majors general biology course. The course in which the participants were enrolled serves as a foundational course for biology majors, but it is also taken by non-majors in order to fulfill a degree requirement for a science course with a lab. Course content was consistent with the range of topics typically addressed in a majors or mixed-majors biology survey course using the widely-adopted Campbell Biology text. Students represented all levels of undergraduate study from freshmen to seniors.

We employed a pre-test/post-test design for this quasi-experimental study and compared changes in student attitudes about biological evolution among students who were exposed to "Evo in the News" as a supplement to their coursework (experimental group) and those who were not exposed to "Evo in the News" (control group) in a general biology class. The research questions guiding this study were:

1. What are the initial attitudes about and knowledge of biological evolution for our sample of students?

2. Is there a significant difference in changes in student attitudes regarding evolution between the group of students participating in the biology course as traditionally presented (control group) as opposed to those students participating in the "Evo in the News" activities (experimental group)?

There is no reason to believe that the control group differed from the experimental group in any way other than the experimental variable. Each teaching assistant (TA) in Introductory Biology is assigned to teach two sections of laboratory. Students enroll in these sections according to how they fit with their academic schedules, and we have seen no tendencies for students of any demographic to preferentially enroll in any section in particular. Each TA taught one "control" section and one "experimental" section so that potential differences between TAs would not be an issue between control and experimental groups. Furthermore, we randomized which section (the first one taught by a TA in a week versus the second one) would be control or experimental. Apart from the differential assignment of pre-lab activities described herein, other aspects of the lab experience were identical between control and experimental groups.

Both groups were given similar pre-lab assignments (online articles of equivalent length, same number of pre-lab questions, relating to same content) prior to each lab experience throughout the semester. For four of the lab experiences during the semester, the experimental group was assigned pre-lab experiences based on a section of "Evo in the News" chosen to match the content being studied in the particular lab experience with which it was paired. Four labs represented about a third of the sessions, and it was a manageable number of sessions for the researcher to coordinate during the study. They were evenly space throughout the semester. Assignments for the control groups were similar in structure, but materials were not drawn from "Evo in the News," and did not make explicit connections to evolution. (See sample exercises in Appendices A and B.)

Instrumentation

In order to assess students' understandings of evolution as well as their attitudes toward evolutionary theory, the data collection instrument used in this research was the original (long-form) Evolutionary Attitudes and Literacy Survey (EALS, Hawley et al. 2010). This instrument was developed to address concerns about other instruments' validity and reliability as well as to comprehensively survey both attitudes and understandings with the same instrument. The long-form EALS consists of 104 statements divided into 16 constructs or areas of study. (Note: A short-form has since been constructed. See Short & Hawley [2012].) Students responded to the statements on a 7-point Likert scale in which 1 represented strongly disagree, 4 represented neither agree nor disagree, and 7 represented strongly agree. Voluntary participants were asked to respond to all statements in the EALS electronically via our online course management

system (Blackboard) both at the beginning of the semester and at the conclusion of the semester.

Students in the treatment group were also asked to answer several open-ended questions at the conclusion of their responses to the EALS. These were developed to provide feedback on the uses of and the students' perceptions of the "Evo in the News" tool as it pertained to their experiences in this lecture and laboratory course.

RESULTS AND DISCUSSION

With regard to the attitudes constructs of the EALS for the initial survey, of particular interest is the relevance construct. For the statement "Evolution is relevant to our everyday lives," 36% of the participants answered at or below the midpoint on the Likert scale. This indicates that these individuals had neutral to negative feelings regarding the relevance of the evolutionary theory to problem solving in the real world. The other statements in this category all deal with whether evolutionary theory is relevant to biology, the humanities, understanding plants, understanding animals, etc. The percentage of the respondents that had negative feelings regarding evolutionary theory's relevance ranged from a low of 17.1% for evolution's relevance to biology to a high of 46.2% for evolution's relevance to the humanities. Hence, there was certainly room for improvement among a substantial portion of the participant population prior to the intervention.

Interesting results emerged when looking at the differences in student attitudes toward biological evolution from the beginning of the course to the end. Specifically, within the attitudes constructs, we calculated overall gains between pre- and post-measurements in the "relevance" construct for each student and conducted an independent samples t-test between the experimental and control groups. Students in the experimental group who were assigned pre-lab activities involving "Evo in the News" articles from the *Understanding Evolution* website showed significant gains in their views regarding the relevance of evolutionary science over students who were not assigned to complete these activities as measured by the EALS survey (See Figure 1. t=2.177, p =.041).

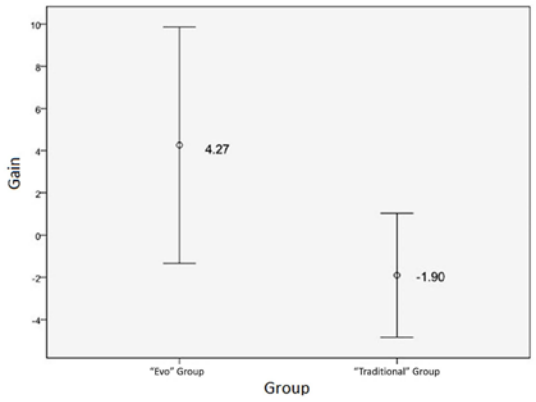

Fig. 1. Mean gains in relevance scores on the EALS for the experimental group (evo) versus the control group (traditional). Gains were calculated as the difference in the sums of the relevance scores from pre-survey to post-survey.

Responses to open-ended questions for students in experimental group

The students in the experimental group were also given the opportunity to complete several open-ended questions regarding their experiences with the "Evo in the News" pre-labs and their attitudes regarding evolution. The response rate was extremely low, with only 15 students volunteering to fill out the questionnaire, but their comments do reveal an interesting array of reactions to the activities.

One of the questions asked whether students thought that evolutionary science was more relevant to their everyday lives after completing the "Evo in the News" assignments than they did before the assignments. They were asked to respond yes or no and explain. Of the 15 respondents, two did not respond to this question, six responded with a yes and seven with a no.

Almost half of the students who responded with "no," however, explained that they didn't feel differently because they already found evolution to be quite relevant prior to the course. One of the students replied, "no, I like reading the idea about evolution; comparing it to my beliefs, but reading one article is not going to change the way that I think completely." This student was not convinced about the relevance of evolutionary theory, but s/he did think that the assignments had some value. Two students did seem to have decidedly negative feelings about evolutionary science itself. One student responded, "No, we are being force fed evolution, denying our right to believe what we believe," and another with "No because I just don't see why it should affect my life."

Of the students who responded "yes," several explained that they "enjoyed" the articles and being exposed to other applications of evolution besides those introduced in class. Responses included, "they made me realize how interwoven the issue of evolution is with so many other aspects of daily life," and "because evolutionary science is found in many various current day issues." Another student replied saying, "I've gained a greater understanding of the evolution of behavior, something that I never really considered as an entity that could be acted upon by natural selection."

The other open-ended question asked students whether they thought after being exposed to "Evo in the News" that evolution could help solve real-world problems more than they might have thought before. Two did not answer, six said "yes," and seven "no." Three of the students who answered "no" explained that they already had strong positive feelings

regarding the uses of evolutionary theory. One of the more resistant students answered, "no, I just do not believe in evolution. Maybe it does occur but it is within species, there is no way that the complexity of our organisms and the amazing diversity and efficiency of other organisms happened by chance."

Several of the students who answered "yes" explained that they had never before been exposed to the uses of evolution and found it to be much farther reaching than they had known before. Typical responses included, "I think evolutionary science provides a basis to consider who we are and where we came from and how we can best use our abilities to solve problems in the real world," and "yes, because some ideas from evolutionary science can be applied to real-world problems."

CONCLUSION

Students' understandings of and attitudes toward the relevance of evolution to scientific research and discovery, as well as to their daily lives, are of great importance. Being able to connect evolutionary concepts to scientific problems is a fundamental skill for any student of biology. This is, no doubt, one of the reasons Wilson (2005) has emphasized the relevance of evolution so strongly in his very successful EvoS program and identified denial of the relevance of evolution to human affairs as one of the two walls of resistance to evolution among students and the general public.

Wilson's efforts with the EvoS program are both ambitious and commendable, and they have been shown to be effective in generating improvements in students' attitudes regarding the relevance of evolution. However, implementing the EvoS program in most college and university settings may require more institutional commitment and curricular overhaul than is likely to be practical in many post-secondary settings. The results of this study, which indicate that students can adopt better understandings and attitudes toward the relevance of evolution with a much less labor-intensive intervention are, therefore, quite encouraging. While our results may not be as striking as those reported by Wilson (2005), our study suggests that our incorporation of activities involving "Evo in the News" articles into existing curricula helped students who initially considered evolutionary science to be of little importance to change their minds substantially regarding their assessment of the relevance of evolution.

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Appendix A – Example of Pre-Lab "Evo in the News" Assignment

- Use the link below to access the article entitled, "Got lactase".
  http://evolution.berkeley.edu/evolibrary/news/070401_lactose
- Read the article including the sidebar.
- Answer the following questions based on the article. Your answers should be handed in at the beginning of lab and you should be prepared to discuss this assignment on that day.

Questions :

1. What is lactose intolerance?
2. What is the difference between those individuals who are lactose tolerant and those who are lactose intolerant? Why are they one or the other?
3. In what types of environments or cultures is lactose tolerance advantageous?
4. Why is milk drinking more common in modern Europe?
5. When/why did lactose tolerance become an advantageous trait among many populations in Africa?
6. In evolutionary terms, why is it surprising that many Hadza are lactose tolerant?
7. What is "selective sweep"?
8. What is convergent evolution, and how is lactose tolerance an example of this concept?

Appendix B – Example of Pre-Lab Control Group Assignment

- Use the link below to access the article entitled, "Digestive enzymes and food absorption".
- http://www.livestrong.com/article/291983-digestive-enzymes-food-absorption/
- Read the article.
- Use the link below to access the article entitled, "Difference between glucose and lactose".
- http://www.livestrong.com/article/271341-difference-between-glucose-lactose/
- Read the article.
- Answer the following questions based on the article. Your answers should be handed in at the beginning of lab and you should be prepared to discuss this assignment on that day.

Questions :

1. Carbohydrates, fats, and proteins are broken down in the human digestive system into constituent molecules that can be absorbed. Identify the smaller constituent molecules derived from carbohydrates, fats, and proteins that can be absorbed into the circulatory system.
2. Identify the major groups of digestive enzymes used in the human digestive system.
3. Where does absorption of these molecules take place in the human?
4. Why do whole grains make you feel full longer than simple sugars?
5. What are the major similarities between glucose and lactose?
6. How does the human digestive system treat glucose and lactose differently?
7. How does glucose enter the cells of the body from the bloodstream?
8. What happens in the human digestive system if an individual is lactose intolerant?