Scientific Literacy and its Correlates: Knowledge of Evolution, Genetics, and the Physical Sciences among UWEC Freshmen

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Background

Evolution by natural selection (Darwin, 1859) is the foundation of the biological sciences and is well supported by data from laboratory experiments as well as from the natural world as represented in morphology, embryology, paleontology, and biogeography (Quammen, 2004). In scientific circles, evolutionary theory ranks alongside theories in other areas such as medical sciences, economics, and genetics. We designed this study to determine whether these patterns replicate among UWEC students and whether they demonstrate growth over their time here given literacy in biological and evolutionary theory.

In this poster, we describe the results of Phase I of a planned longitudinal study of UWEC students' scientific literacy. During the 2009-2010 academic year, we collected responses from 264 freshmen enrolled in a 100-level general education course. Students completed measures of scientific reasoning and basic scientific knowledge (physics, chemistry, evolution, and genetics), as well as measures of religiosity and young earth creationist beliefs. We display students' distributions of scores and correlations among the constructs.

Method

Overview

A total of 199 female, 63 male) from a 100-level GE course completed a variety of measures involving scientific knowledge and reasoning, attitudes toward science, and religious beliefs. Upon completion of the questionnaire, participants provided contact information to enable us to find them again in three years for a follow-up data collection.

Attitude Scales

Four separate measures were designed to evaluate attitudes toward science and religious beliefs. These items assessed participants' moral objections to evolution (2 items, α = .64; e.g., "People who accept evolution as fact are immoral", "Students who accept evolution as fact are anti-God"); distrust of science (6 items, α = .72, e.g., "Science and technology have created a world that is full of risks for people"); young earth creationist beliefs (4 items, α = .89; e.g., "Adam and Eve from Genesis are the universal ancestors of the entire human race"); and, social support for intelligent design fallacies (6 items, α = .76; e.g., "There is scientific evidence that humans were created by a supreme being or intelligent designer"). All attitude items were completed using a 5-point response scale that ranged from disagree strongly to agree strongly.

Knowledge Scales

In addition to the attitude scales, participants also completed a number of true/false items designed to assess science literacy. Questions were of relatively equivalent difficulty and spanned topics including genetics (15 items, α = .67), biology (7 items, α = .18), evolutionary theory (14 items, α = .23), the inorganic sciences (7 items, α = .27), and general scientific reasoning abilities (6 items, α = .39). Sample items from each set of knowledge items include: genetics, "The genetic information encoded in DNA molecules provide instructions for assembling fats and lipids"; biology, "The laymen who breathe away from plants"); evolutionary theory, "Dinosaur genetic variability may have been more resistant to extinction"); inorganic sciences, "The continents on which we live have been moving among their locations for millions of years and will continue to move in the future"); scientific reasoning, "Good theories give rise to testable predictions.

Results

As displayed at left and right, UWEC freshmen performed quite well overall (M = 81%) on general science literacy items. These items involved recognizing that the Earth goes around the Sun (and that it happens once a year), recognizing appropriate experimental design, and recognizing independent events. Their knowledge of evolutionary theory (e.g., T/F: "Evolution means progression toward perfection") was less impressive, coming in at 64%.

Table 1. Descriptive statistics and correlations among scientific knowledge bases, attitudes toward science, and religious attitudes.

<table>
<thead>
<tr>
<th>Scale</th>
<th>M</th>
<th>SD</th>
<th>CR</th>
<th>R</th>
<th>Science</th>
<th>Evolution</th>
<th>Genetics</th>
<th>Philosophy</th>
<th>Religion</th>
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<td>.70</td>
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<td>.70</td>
<td>.40</td>
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<td>.27</td>
<td>.23</td>
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<tr>
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<td>.70</td>
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</tbody>
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Discussion

Researchers have singled out poor grasp of biological concepts, especially genetics, as an important contributor to society's lack of confidence in evolution by selection (Miller et al., 2006). In the current analysis, we replicated previously documented positive links between knowledge of genetics and understanding of evolution, and negative links between knowledge of genetics and moral objections to evolution. We also documented a strong negative link between young earth creationist beliefs and understanding of evolution and a moderate negative association between moral objections to evolution and understanding of evolution. In three years, we will survey these students again as they approach graduation. We hope that our longitudinal design will help disentangle this web of associations among scientific knowledge, attitudes toward science, and religious beliefs. Are strong religious beliefs predictive of continued distrust of science and lower levels of knowledge and evolutionary knowledge? Will exposure to science coursework be accompanied by a decline in religiosity or moral objections to evolution? In our sample, students reported moderate levels of distrust of science and technology (mean of 4, with a theoretical midpoint of 5, on a 0 to 10 scale). This is somewhat disconcerting. The knowledge base in science and technology is expanding rapidly; presumably, some critical level of scientific reasoning skill and knowledge of these fields will be increasingly relevant for daily living as well as major life decisions. For example, humans will need to make informed medical decisions, ensure appropriate use of genetic information (Hags, 2006), and evaluate the benefits and costs of technical gadgets and genetically engineered products. Arguably, society will look to college graduates to be leaders in important decisions surrounding societal applications of genetic and evolutionary knowledge (Vite Bowling, Heather, & Wang et al., 2008). These years from now, we will be able to report whether college students at UWEC, in various disciplines and career paths, demonstrate growth in scientific reasoning and in these scientific knowledge bases.

References


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