Exploring the Impact of Gamified Role-Playing on Climate Change Knowledge and Nature Relatedness: Evidence from an Online Undergraduate Course on Environmental Health

Miryha Gould Runnerstrom
Kameryn Denaro
Janet DiVincenzo

Working Paper #24-24

May 2024
Article

Exploring the Impact of Gamified Role-Playing on Climate Change Knowledge and Nature Relatedness: Evidence from an Online Undergraduate Course on Environmental Health

Miryha Gould Runnerstrom 1*, Kameryn Denaro 2 and Janet DiVincenzo 2

1 School of Nursing and Health Studies, University of Washington Bothell (USA)
2 Division of Teaching Excellence and Innovation, University of California, Irvine (USA)
* Correspondence: miryha@uw.edu

Abstract: In an online environmental health course, undergraduate students worked in groups of five and were immersed in a team-based climate change case study set in the Amazon Rainforest. Each student was assigned a character role—a logger, a farmer, a conservation biologist, an environmental activist, and a policymaker. We aimed to understand whether student character assignments influenced their climate change knowledge, environmental concern, and connection to nature. Regression models were generated to test for differences in the outcome variables between characters at pre- and post-test. We observed higher gains in nature relatedness scores for students assigned the logger role. After controlling for previous climate change knowledge, first-generation college students had lower climate change knowledge at the end of the course compared to non-first-generation students, but low-income students had higher climate change knowledge at the end of the course compared to non-low-income students. Environmental concern had no change over the term; scores were high during the pre- and post-survey for all students. There may be potential to develop a connection to nature by assigning students to play specific characters. Also, despite ongoing work to support first-generation college students, there remain opportunities to develop academic support programs for these students.

Keywords: undergraduate climate change education; environmental health curriculum; gamification; role-playing; team-based learning; case-based learning; problem-based learning; online course

1. Introduction

Young people will face the consequences of climate change throughout their lives to a greater degree than previous generations [1]. Given the high stakes of inaction on climate change, it has never been more urgent to ensure that university students learn about climate change from broad, interdisciplinary perspectives that include connections to the social determinants of health and social issues more broadly [2,3]. Further, there is an immediate need to transform the way we teach undergraduate students about climate change so they are prepared to engage with the challenges of meeting international climate goals and preventing the most catastrophic global climate repercussions of these changes [3]. To address student engagement with climate change beyond the classroom, designing course outcomes must move beyond student learning objectives to heighten students’ environmental concern and connection to nature. This is of critical importance as educators work to cultivate student interest in tackling global climate change beyond their time at the university.

1.1 Background

The human need for a connection to nature is described as biophilia or “the innate tendency to focus on life and lifelike processes.” [4] (p. 1). The biophilia hypothesis states...
that “human dependence on nature…extends far beyond the simple issues of material and physical sustenance to encompass…the human craving for aesthetic, intellectual, cognitive, and even spiritual meaning and satisfaction” [5] (p. 21). Research over the past five decades has focused on the interrelationship between humans and nature and how the strength of this connection can shape environmental concern and pro-environmental or sustainability behaviors [e.g., 6,7,8]. For instance, individuals who participate in outdoor recreational experiences have a heightened level of environmental concern compared to individuals who don’t recreate in nature [8]. Those who participate in appreciative nature experiences (e.g., hiking or bird-watching) have greater levels of environmental concern compared to those who participate in more consumptive or mechanized nature experiences (e.g., fishing, snowmobiling) [7,9]. Two recent meta-analyses conclude that there is a positive relationship between connection to nature and pro-environmental behavior [10] and that time spent in nature is positively associated with a connection to nature, which in turn is associated with an increase in pro-environmental attitudes and behaviors [11]. Importantly, recent work by Knight and Hao finds that a greater enjoyment of nature corresponds with a higher level of concern about climate change [12]. Individuals with higher levels of nature relatedness, or connection to nature, also have higher levels of climate change issue engagement [13].

National data show that 72% of American adults believe that climate change is happening and 43% state that they have been personally harmed by the impacts of climate change [14]. A heightened concern about climate change is evident among young people, as demonstrated in one instance by high school students participating in Fridays For Future walkout strikes [15]. In fact, more than half of American teenagers state they are afraid of climate change and roughly a quarter have taken action to express their views on climate change through school walkouts, protests, or writing to an elected official [16,17].

Although young people demonstrate concern around the impacts of climate change and may actively participate in civic actions to elevate awareness about climate change, their climate science literacy is relatively low [18]. Focus groups of college students have revealed that they often believe climate change or its effects are linked to other environmental issues including damage to the ozone layer or marine pollution, for example [18]. As science educators, we have an opportunity to combat such misunderstandings in our courses. Recent work on teaching sustainability and climate change in service learning courses shows that students become empowered to take action against climate change as they increase their knowledge of environmental stewardship as it relates to climate change [19].

Formal and informal environmental science education has the potential to kindle nature connectedness as well as pro-environmental behaviors and perspectives in students. For instance, field trips and other similar educational nature experiences can increase participants’ connection to nature and willingness to engage in pro-environmental behaviors [20]. Immersive virtual reality is another way to explore environments being shaped by climate change; these virtual experiences can increase knowledge about climate change, spark interest in learning about the drivers of climate change, and increase pro-environmental behavior [21].

The challenge for educators, then, is to design and create educational experiences that open the door for students to gain greater insight into climate change repercussions. We posit that role-playing in education provides such meaningful opportunities for students to practice their reasoning and argumentation skills, build empathy, and experience a new perspective. Role-plays that address climate change scenarios can mimic the debate and consensus-building processes found in the real world, although the sophistication of the argumentation may vary [22]. Students participating in a role-playing activity reported increased knowledge about climate change as well as increased pro-environmental behaviors [23]. Since Paschall and Wüstenhagen struggled with student engagement and
lack of student energy in their online sessions [23], we incorporate scaffolding, goal-setting, and support to overcome these issues.

One way to scaffold and support student learning in virtual environments is through the use of teams, team assignments, and regular virtual team meetings. Collaborative learning experiences and teamwork provide myriad opportunities for learner growth and are especially important for first-generation college students [24-27]. This also holds true for synchronous team meetings in online courses where small group activities can help to build community [28]. Synchronous, video-based discussions in an online course may allow students to develop higher levels of cognitive presence, defined as “the extent to which learners are able to construct and confirm meaning through sustained reflection and discourse in a critical community of inquiry,” [29](p. 11) [30,31].

1.2 Course context

For this project, we examined student environmental concern, nature connection, and climate change knowledge in an online lower-division undergraduate public health course, Environmental Quality and Health (EQH). EQH has a substantial focus on climate change and covers a range of topics in environmental health, including epidemiology, toxicology, policy and regulation, zoonotic and vector-borne diseases, and water quality and availability. In addition, modules specifically addressing climate change are included on a range of topics, such as air quality, climate change literacy, community engagement in climate change adaptation and mitigation efforts, the social determinants of health, and environmental quality and psychological health. EQH is one of many courses available to any undergraduate on our campus to satisfy the three-course Science and Technology general education requirement. In addition, EQH is one of four courses that students majoring in Public Health can take to satisfy the major’s lower-division requirements.  

We acknowledge that many online courses tend to lack robust interaction among students. Our goal for the design of EQH was to create an engaging and engrossing experience that promoted sustained interaction among all students, the instructor, and the teaching assistants. To achieve this, students in EQH are able to engage in the course materials both asynchronously (e.g., recorded mini-lectures, readings, supplemental videos, interactive online lessons) and synchronously (e.g., discussion sections). The EQH discussion sections take place virtually via video conferencing technology built into the Canvas LMS [32,33] once per week for seven weeks of the 10-week quarter. During these discussion sections led by teaching assistants, students collaborate (while role playing in character) with their group to complete the week’s assignments. More information about the team aspect of the course, including student learning objectives, team meeting agendas, weekly assignments, and the structure and facilitation of the group work can be found in Supplement 1, Supplement 2, and Supplement 3.

1.3 Case study

The genesis for our pedagogical approach for EQH was a case study located on the website of the National Center for Case Study Teaching in Science [34]. Entitled, “The Deforestation of the Amazon: A Case Study in Understanding Ecosystems and Their Value,” the case instantly hooks the reader. In the first paragraph, we encounter an imaginary and heated dialog among a farmer, a logger, and an environmentalist arguing about deforestation in the Amazon from different points of view. We used this model depicting different stakeholders in conflict as a jumping-off point for a key aspect of the course design. To the three personas in the aforementioned case study, we added a conservation biologist and a policymaker (see Table 1). We then proceeded to design the lessons to generate debate during student interactions in their small teams. Our goal was for students to engage in the complex issue of deforestation through the lenses of perspectives that may have been different from their own. Our secondary goal was for students to leave the course with an appreciation for the complex interplay between climate science, multiple levels of environmental policy making, and community stakeholders.

1.4 Research questions
To understand whether student character assignments influenced their climate change knowledge, concern for the environment, and connection to nature, we formulated these research questions:

1. To what extent do different character assignments heighten students’ nature relatedness?
2. What influence does the course, and respective character assignments, have on students’ knowledge about climate change and environmental concern?

2. Materials and Methods

2.1 Study context

This research was conducted at a large, public, minority-serving research university on the west coast of the United States. The university is designated as both a Hispanic-Serving Institution (HSI) and an Asian American and Native American Pacific Islander-Serving Institution (AANAPISI). During the academic year, courses run quarterly for 10 weeks plus a finals week.

2.2 Participant recruitment and incentives

We sent two surveys (pre- and post-test) to all students using the announcement function of the course learning management system. Survey participants were awarded 2.5 points (<1% of total points for the quarter) for completing the first survey and 2.5 points for completing the second survey. We distributed the first survey at the beginning of the quarter and prior to the start of the team discussion sections, and distributed the second survey at the end of the quarter after the team discussion section meetings ended but prior to the release of final grades. Reminder notifications were sent to students before the survey deadlines.

2.3 Exclusion criteria

Any student enrolled in EQH was eligible to participate in this study and participation was voluntary. Some participants took the surveys more than once, but we only analyzed the first attempt. Institutional Review Board approval was granted before recruitment (IRB HS# 2018-4211).

2.4 Measures

The first and second survey had an identical set of questions designed to evaluate students’ connection to nature, their level of environmental concern, and their level of climate change knowledge at the beginning and end of the quarter. Survey data were collected electronically using Qualtrics [35]. The pre- and post-test survey used in this study is available in Supplement 4.

2.4.1 Nature relatedness

We used the six-item short-form version of the Nature Relatedness Scale (NR-6) [36] to assess students’ subjective connection with nature and the natural environment. Participants responded using a five-point Likert scale ranging from 1, disagree strongly to 5, agree strongly. The order of the six items was randomized by the survey software. NR-6 scores were calculated by averaging participant responses to the six items.

2.4.2 Climate change knowledge

Ten items assessing participants’ overall climate knowledge were adapted from questions included in a national study of Americans’ knowledge of climate change [37]. Participant responses to the items were scored as 1 (correct) or 0 (incorrect) for each item or subitem, as appropriate. Likert-type true/false responses (i.e., “definitely true,” “probably true,” “probably false,” “definitely false,” or “don’t know”) were converted to simple true/false dichotomous variables for ease of analysis. Questions were removed from analysis if fewer than 25% of participants answered them correctly as suggested by Leiserowitz and colleagues [37]. Scores were calculated as a percentage for each participant based on their total number of correct answers.
2.4.3 Environmental concern

We evaluated students’ attitudes of environmental concern toward themselves, others, and the biosphere using a 12-item scale [38]. Participants rated their environmental concern using a seven-point Likert scale ranging from 1, not at all important to 7, extremely important. Overall environmental concern was calculated by averaging the responses to the items. The sequence of the items was randomized by the survey software.

2.5 Character assignments

Students enrolled in EQH are assigned to one of five different character roles and asked to embody these characters throughout the quarter and especially when they are meeting with their team in the discussion sections and collaborating on related assignments. The characters include a policymaker, a conservation biologist, an environmental activist, a logger, and a farmer (Table 1). The randomization process that character assignments were based on is detailed below.

Table 1. Character names and descriptions

<table>
<thead>
<tr>
<th>Character Name</th>
<th>Brief Biography</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maria</td>
<td>Maria is a policy development specialist for the World Health Organization. She is based in Geneva, Switzerland, but regularly travels through Latin America for work.</td>
</tr>
<tr>
<td>Rachel</td>
<td>Rachel currently works for an environmental non-profit in Belém, Brazil. She previously worked for Greenpeace, the World Wildlife Fund, and the Rainforest Action Network.</td>
</tr>
<tr>
<td>Marco</td>
<td>Marco is a farmer who lives outside of Belém, Brazil. To support his partner and their children, he grows soybeans on a small plot of land that is cleared of trees.</td>
</tr>
<tr>
<td>Antonio</td>
<td>Antonio is a logger and he lives near Belém, Brazil. To support his partner and their children, he works for a logging company.</td>
</tr>
<tr>
<td>Carolina</td>
<td>Carolina is a conservation biologist who lives in Rio de Janeiro, Brazil. She is visiting Belém, Brazil as part of her research on the health of the rainforest.</td>
</tr>
</tbody>
</table>

2.5.1 Demographic data

Unique identifiers were collected from all participants who took the surveys. Demographic data, including gender identity, first-generation college student status, low-income status, race/ethnicity, transfer status, and major at admission, were obtained from institutional data records and linked to the corresponding survey responses.

Students enrolled in EQH self-selected one of five discussion sections based on their day and time preference. An outside researcher (insert name after blind review) then created a systematic randomized design by ordering the students based on demographic variables: 1) exposure to climate change-focused coursework through their major (yes if student was majoring in public health, physical sciences, or biological sciences, otherwise no); 2) female gender identity (yes/no); 3) persons excluded because of their ethnicity or race (PEERs) (yes/no) [39]; and 4) first-generation college student (yes/no). Next, the outside researcher sorted students into teams using an A-B-B-A order, where A = 1, 2, 3, … n and B = n, n-1, n-2, … 1. Then, the outside researcher randomly assigned students to a character number (1-5) within teams. Independently, the instructor (insert name after blind review) assigned character roles to each character number. We have provided the descriptive statistics to show the randomization overall (Table 2) and by team (Table S1), as well as supplementary data with the randomization and character assignments (Table S2). Very few students (n=4) changed teams during the quarter and none changed ...
Most changes occurred in the first week of the quarter (before the first team meeting) and one student changed teams in the middle of the quarter.

Table 2. Participant Demographic Information

<table>
<thead>
<tr>
<th>Participants</th>
<th>EQH (%)</th>
<th>Character % Mean (SD)</th>
<th>Team % Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students who are:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>68</td>
<td>68 (7)</td>
<td>70 (19)</td>
</tr>
<tr>
<td>Black, Latinx, Pacific Islander, Indigenous to the US and its Territories</td>
<td>47</td>
<td>47 (8)</td>
<td>47 (28)</td>
</tr>
<tr>
<td>First Generation</td>
<td>46</td>
<td>46 (5)</td>
<td>47 (29)</td>
</tr>
<tr>
<td>Low Income</td>
<td>35</td>
<td>34 (9)</td>
<td>33 (26)</td>
</tr>
<tr>
<td>Transfer Students</td>
<td>17</td>
<td>16 (7)</td>
<td>18 (19)</td>
</tr>
<tr>
<td>Discipline:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public Health</td>
<td>41</td>
<td>41 (8)</td>
<td>40 (26)</td>
</tr>
<tr>
<td>Physical Sciences, Information and Computer Sciences, Engineering, Biological Sciences</td>
<td>16</td>
<td>16 (7)</td>
<td>16 (20)</td>
</tr>
<tr>
<td>Social Sciences, Social Ecology, Education, Business, Humanities, Art</td>
<td>43</td>
<td>43 (7)</td>
<td>45 (25)</td>
</tr>
</tbody>
</table>

Note: Only one student was majoring in Humanities and one in Art. Percentages, means, and standard deviations rounded to the nearest whole number.

2.6 Data analysis

For our analysis, we used R [40] to calculate descriptive statistics and generate regression models to test for differences in the outcome variables between characters. Data visualizations include box plots [41] providing the minimum, 25th percentile, median, 75th percentile and the maximum (see Figure S1 for further discussion). To test for the difference in paired differences for nature relatedness, environmental concern, and climate knowledge for the five characters, we conducted an analysis of variance (ANOVA) using an overall F-test [42,43] and conducted the pairwise comparisons between each of the characters.

To present evidence of the impact of character assignment, student demographics, and pre-test scores on post-test scores, ordinary least squares (OLS) regression was used. We modeled the post-test scores to address our specific research questions about nature relatedness and climate knowledge. More specifically, we wanted to know whether there would be an increase in the post-test scores based on character assignment as well as student demographic characteristics (gender, PEER status, first-generation status, low-income status, transfer student status, and major). The assumption of the OLS model is that there is a linear relationship between the predictor variables and the post-test scores. Assuming we have a sample of \( n \) independent observations, \( (x_i, y_i) \), we obtain estimates for \( \beta' = (\beta_0, \ldots, \beta_k) \). Let \( Y \) be the post-test scores and let \( x^i = (x_{1i}, \ldots, x_{ki}) \) be the \( k \) predictors in the model and \( \epsilon_i \) be the random error for the \( i \)th student, which is given by:

\[
y_i = \beta_0 + \beta_1 x_{1i} + \ldots + \beta_k x_{ki} + \epsilon_i.
\]

The model with the lowest Akaike Information Criteria (AIC) indicates a balance of model fit with generalizability [44,45]. The AIC is given by:

\[
AIC = -2 \ln(L) + 2k,
\]
where $L$ is the likelihood and $k$ is the number of parameters of the model. The AIC is based on the log-likelihood (a measure of how likely the observed data is, given a model) and is penalized as the parameter complexity increases. The reason for the penalty is that adding parameters into a model can lead to overfitting of the data. Therefore, AIC strikes a balance between the best model fit and the model complexity.

In order to understand the relationship between nature relatedness, climate change knowledge, and environmental concern with character assignment and student demographics, we follow the procedure as outlined for each response variable (nature relatedness and climate change knowledge). Environmental concern was included in our regression model of climate change knowledge because climate change knowledge, especially knowledge of the causes of climate change, may be an important driver of environmental concern [46]. First, we built a model where we include pre-test scores, character assignment, and student demographics as the covariates and post-test scores as the response. Next, we performed best subsets linear regression using the bestglm package in R [47] where we minimized the AIC to choose the best fitting model. In step 1, we fit a model for all possible subsets of covariates (pre-test scores, character assignment, and student demographics) and then we calculate the corresponding AIC for each model. In step 2, we carried out best subsets linear regression to choose the best-fitting model and interpret our results.

3. Results

The results of our analysis of paired differences in pre-test and post-test scores for nature relatedness, climate change knowledge, and environmental concern are presented below along with the findings from our regression modeling.

3.1 Nature Relatedness

Analyses of paired differences in pre-test and post-test scores for the NR-6 reveal that being assigned to environmental activist (Rachel), farmer (Marco), logger (Antonio), and conservation biologist (Carolina) had a positive impact on nature relatedness scores (Table 3). Before taking into account any other variables, there was not a significant difference in nature relatedness scores for the different characters (Figure 1).

<table>
<thead>
<tr>
<th>Character</th>
<th>Pretest</th>
<th>Posttest</th>
<th>Paired Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
<td>$M$</td>
</tr>
<tr>
<td>Policymaker</td>
<td>3.70</td>
<td>0.89</td>
<td>3.79</td>
</tr>
<tr>
<td>Environmental Activist</td>
<td>3.67</td>
<td>0.80</td>
<td>3.90</td>
</tr>
<tr>
<td>Farmer</td>
<td>3.40</td>
<td>0.73</td>
<td>3.81</td>
</tr>
<tr>
<td>Logger</td>
<td>3.74</td>
<td>0.77</td>
<td>4.13</td>
</tr>
<tr>
<td>Conservation Biologist</td>
<td>3.68</td>
<td>1.03</td>
<td>4.05</td>
</tr>
</tbody>
</table>

Table 3. Results of Nature Relatedness Scores at Pretest and Posttest with Paired Differences
Figure 1. Paired Differences in Nature Relatedness Scores by Character Assignment. Paired differences in nature relatedness scores (post-test nature relatedness - pre-test nature relatedness). The p-value for the overall F-test for the difference in means of the nature relatedness paired differences across the five character assignments are presented at the top of the plot. The (unadjusted) p-values for the pairwise comparisons of the paired differences in nature relatedness scores are presented on top of each horizontal bar. See supporting information for assistance in reading box plots if needed. Character assignments are: policymaker (Maria), environmental activist (Rachel), farmer (Marco), logger (Antonio), and conservation biologist (Carolina).

The regression results for nature relatedness scores are presented in Table 4. After adjusting for the nature relatedness pre-test scores, many of the characters (conservation biologist, farmer, and environmental activist) are similar to the policymaker (Maria). However, we find that the logger’s character has significantly higher nature relatedness post-test scores compared to the policymaker (p=0.047). It is of note that the conservation biologist character is trending toward significance (p=0.079). Regardless of their character, students with higher nature relatedness pre-test scores have higher nature relatedness post-test scores (p<0.001).

Table 4. Full and Best Subset Regression Models for Nature Relatedness Variable

<table>
<thead>
<tr>
<th>Model</th>
<th>Variables</th>
<th>Estimate</th>
<th>SE</th>
<th>95% CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full</td>
<td>Intercept</td>
<td>1.72</td>
<td>0.292</td>
<td>1.14 2.30</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Nature relatedness pretest</td>
<td>0.584</td>
<td>0.062</td>
<td>0.461 0.707</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>-0.125</td>
<td>0.117</td>
<td>-0.356 0.106</td>
<td>0.285</td>
</tr>
<tr>
<td></td>
<td>PEERS</td>
<td>0.086</td>
<td>0.108</td>
<td>-0.128 0.300</td>
<td>0.429</td>
</tr>
<tr>
<td></td>
<td>First-generation</td>
<td>0.109</td>
<td>0.114</td>
<td>-0.117 0.335</td>
<td>0.343</td>
</tr>
<tr>
<td></td>
<td>Low-income</td>
<td>-0.146</td>
<td>0.117</td>
<td>-0.378 0.085</td>
<td>0.214</td>
</tr>
<tr>
<td></td>
<td>Transfer</td>
<td>-0.108</td>
<td>0.147</td>
<td>-0.398 0.182</td>
<td>0.463</td>
</tr>
<tr>
<td></td>
<td>Major – STEM (RG)</td>
<td>--</td>
<td>--</td>
<td>-- --</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>Major – other STEM</td>
<td>-0.086</td>
<td>0.162</td>
<td>-0.407 0.236</td>
<td>0.599</td>
</tr>
</tbody>
</table>
Our analyses of paired differences in climate knowledge pre-test and post-test scores showed that being assigned to characters farmer and logger had a positive impact on climate change knowledge scores (Table 5). Prior to taking into account any other variables, there was not a significant difference in climate knowledge for the different characters (Figure 2).

### Table 5. Results of Climate Change Knowledge Scores at Pretest and Posttest with Paired Differences

<table>
<thead>
<tr>
<th>Character</th>
<th>Pretest</th>
<th>Posttest</th>
<th>Paired Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
</tr>
<tr>
<td>Policymaker</td>
<td>69.12</td>
<td>12.71</td>
<td>73.76</td>
</tr>
<tr>
<td>Environmental Activist</td>
<td>70.81</td>
<td>10.59</td>
<td>71.04</td>
</tr>
<tr>
<td>Farmer</td>
<td>67.53</td>
<td>14.99</td>
<td>74.77</td>
</tr>
<tr>
<td>Logger</td>
<td>71.27</td>
<td>11.00</td>
<td>78.73</td>
</tr>
<tr>
<td>Conservation Biologist</td>
<td>69.54</td>
<td>14.66</td>
<td>70.87</td>
</tr>
</tbody>
</table>
Figure 2. Paired Differences in Climate Change Knowledge Scores by Character Assignment. Paired differences in climate change knowledge scores (post-test climate change knowledge - pre-test climate change knowledge). The p-value for the overall F-test for the difference in means of the climate change knowledge paired differences across the five character assignments are presented at the top of the plot. The (unadjusted) p-values for the pairwise comparisons of the paired differences in climate change knowledge scores are presented on top of each horizontal bar. See supporting information for assistance in reading box plots if needed. Character assignments are: policymaker (Maria), environmental activist (Rachel), farmer (Marco), logger (Antonio), and conservation biologist (Carolina).

Table 6 summarizes the regression results for climate change knowledge scores. After adjusting for climate change knowledge pre-test scores, students who identify as first-generation college students have significantly lower climate change knowledge post-test scores (p=0.015) and students who identify as low-income have significantly higher climate change knowledge post-test scores (p=0.016). Environmental concern pre-test scores are trending toward significance in the model (p=0.065).

Table 6. Full and Best Subset Regression Models for Climate Knowledge

<table>
<thead>
<tr>
<th>Model</th>
<th>Variables</th>
<th>Estimate</th>
<th>SE</th>
<th>95% CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intercept</td>
<td>11.28</td>
<td>3.79</td>
<td>3.77</td>
<td>18.79</td>
</tr>
<tr>
<td></td>
<td>Climate knowledge pre-test</td>
<td>0.402</td>
<td>0.092</td>
<td>0.220</td>
<td>0.583</td>
</tr>
<tr>
<td></td>
<td>Environmental concern pre-test</td>
<td>0.741</td>
<td>0.485</td>
<td>-0.218</td>
<td>1.70</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>0.011</td>
<td>0.919</td>
<td>-1.81</td>
<td>1.83</td>
</tr>
<tr>
<td></td>
<td>PEERS</td>
<td>0.590</td>
<td>0.840</td>
<td>-1.07</td>
<td>2.25</td>
</tr>
<tr>
<td></td>
<td>First-generation</td>
<td>-2.27</td>
<td>0.879</td>
<td>-4.00</td>
<td>-0.526</td>
</tr>
<tr>
<td></td>
<td>Low-income</td>
<td>1.77</td>
<td>0.900</td>
<td>-0.009</td>
<td>3.552</td>
</tr>
<tr>
<td></td>
<td>Transfer</td>
<td>1.09</td>
<td>1.12</td>
<td>-1.12</td>
<td>3.30</td>
</tr>
<tr>
<td></td>
<td>Major – other STEM</td>
<td>-0.352</td>
<td>1.27</td>
<td>-2.87</td>
<td>2.16</td>
</tr>
<tr>
<td></td>
<td>Major – non-STEM</td>
<td>-0.797</td>
<td>0.874</td>
<td>-2.53</td>
<td>0.932</td>
</tr>
</tbody>
</table>
Character – Environmental Activist -0.814 1.31 -3.41 1.78 0.535
Character – Farmer 0.821 1.31 -1.77 3.42 0.532
Character – Logger 1.48 1.24 -0.981 3.94 0.236
Character – Conservation Biologist -0.636 1.26 -3.12 1.85 0.614

Best Subset
- Intercept 10.9 3.35 4.28 17.5 0.001
- Climate knowledge pretest 0.395 0.088 0.221 0.57 <0.001
- Environmental concern pretest 0.830 0.447 -0.053 1.71 0.065
- First-generation -2.017 0.822 -3.64 -0.390 0.015
- Low-income 2.10 0.862 0.397 3.81 0.016

Note: Full regression model was statistically significant, adjusted $R^2 = 0.162, F(13, 125) = 3.05, p < 0.001$. Best subset regression model was statistically significant, adjusted $R^2 = 0.173, F(4, 134) = 8.22, p < 0.001$.

### 3.3 Environmental Concern

Environmental concern pre-test scores were predictive of environmental concern post-test scores, but there were no other predictors in this model. It is of note that environmental concern was very high from the start of the course (Table 7).

#### Table 7. Results of Environmental Concern Scores at Pretest and Posttest with Paired Differences

<table>
<thead>
<tr>
<th>Character</th>
<th>Pretest</th>
<th>Posttest</th>
<th>Paired Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
</tr>
<tr>
<td>Policymaker</td>
<td>6.43</td>
<td>0.61</td>
<td>6.48</td>
</tr>
<tr>
<td>Environmental Activist</td>
<td>6.01</td>
<td>0.79</td>
<td>6.20</td>
</tr>
<tr>
<td>Farmer</td>
<td>6.00</td>
<td>0.71</td>
<td>6.03</td>
</tr>
<tr>
<td>Logger</td>
<td>6.15</td>
<td>0.72</td>
<td>6.41</td>
</tr>
<tr>
<td>Conservation Biologist</td>
<td>5.84</td>
<td>1.22</td>
<td>6.10</td>
</tr>
</tbody>
</table>

### 4. Discussion

We set out to understand the extent to which different character assignments in an online, lower-division environmental quality and health course heighten students’ nature relatedness.

Our analyses show that being assigned to the character farmer (Marco), logger (Antonio), conservation biologist (Carolina), or environmental activist (Rachel) had a positive influence on participants’ nature relatedness scores. However, after we adjusted for nature relatedness pre-test scores, the logger was the only character with significantly higher post-test scores compared to the reference group (policymaker, Maria). Students in the course learn that Antonio works as a logger for a big company, and he believes logging in the Amazon rainforest is driven by consumer demand in the United States. Antonio shares that he feels big city environmentalists don’t understand his way of life in Brazil. After learning about the ecosystem benefits that the Amazon rainforest provides for the entire planet, a student assigned the role of Antonio may have a strong, negative reaction to their character’s occupation as a logger. In particular, students assigned to Antonio may develop an affinity for the Amazon rainforest and wish to protect the forest from negative actions like logging. This may, at least in part, explain the significantly higher nature
relatedness post-test scores for students assigned to the character Antonio. Our findings are consistent with existing studies that find a positive association between science or sustainability education, connection to nature, and pro-environmental behaviors [e.g., 20,48].

In this study, we also wished to understand the influence the course and respective character assignments have, if any, on knowledge about climate change. We found that being assigned to the farmer or logger character had a positive influence on climate change knowledge scores, but after adjusting for pre-test scores, character assignment did not have an impact on climate change knowledge gains. It was not our intention for character assignment to impact climate change knowledge gains during the quarter, so this is a positive study outcome. However, after adjusting for pre-test scores, we find that first-generation college students had significantly lower climate change knowledge post-test scores while low-income students had significantly higher climate change knowledge post-test scores. Studies of first-generation students have shown that students who are the first in their families to attend college face a number of structural barriers in STEM majors [24,49,50], as well as academic success barriers [51,52] and obstacles that decrease retention and bachelors degree attainment [53-55]. Although online courses may offer time flexibility for first-generation learners, an online learning modality may not always provide the extent or variety of communal learning opportunities that first-generation students prefer [24,25]. Importantly, our campus offers a number of academic success programs [56,57] for students who identify as first-generation and low-income college students; however, there are no programs specifically focused on supporting students’ online learning.

We wished to explore the impact that course content and character assignment have on environmental concern, if any. Students in this course began the quarter with high levels of environmental concern, and at the end of the quarter, student environmental concern remained at a high level. Research on the relationship between specific academic majors (e.g., environmental studies, biology, and outdoor recreation) and environmental concern finds that students in some majors have greater levels of environmental concerns than those in other majors, though the direction of this relationship is unknown [58,59]. Given that student environmental concern in our study was high from the start, the use of a different environmental concern measure with a greater range of possible scores could help us to understand changes in environmental concern across the course.

4.1 Implications for research and practice

There are some important implications of this work for future teaching practice and research. Overall, there may be potential to stimulate a connection to nature by assigning students in a course to play a character whose occupation centers on some facet of environmental degradation, which may force students to grapple with the complex realities of sustainability and local job availability. This should be done in a manner that doesn’t vilify the character, but instead brings forward their humanity, as we aimed to do with the logger’s character. For us, the character assignments served to transport students out of their own lives and into a scenario with different stakeholders, while exploring the essential ecosystem services that the Amazon rainforest provides locally and globally. Faculty looking to gamify their classes with role-playing may wish to employ similar characters and case studies. We recommend analyses similar to those presented here to test for unintended benefits for some characters compared to other characters.

Finally, students’ environmental concern was universally high in both the pre- and post-test, signaling the potential to build on this reservoir by developing additional measures of environmental concern that provide a more nuanced understanding of student concerns about the environment. Today’s college students are coming of age in a world that is already experiencing the impacts of global climate change. As we are a minority-serving institution, our students are likely to belong to frontline communities experiencing the first and the worst impacts of climate change. We recommend further development of a measure of environmental concern that aims to evaluate the lived
experiences of college students to better understand their level of concern across different domains.

4.2 Limitations

Our research is not without its limitations. We evaluated only one offering of an online environmental quality and health course at a single university. In the future, we plan to explore comparative analyses across the same course and across different courses on similar topics, both with and without character assignments as part of the course design. It is possible that students self-selected into our course due to their interest in environmental quality and health, which may partially explain the high levels of environmental concern measured at pre-test and post-test. Although this class fulfills a science and technology general education requirement for all students on campus, most students were public health majors or other STEM majors. Public health and other STEM majors may have a higher level of environmental concern compared to non-STEM majors based on their prior coursework, exposure to information about global climate change, and their interests around the health of the environment in general.

5. Conclusions

Role playing activities combined with small group work are one way to bring real-world experiences into an online course. When students embody an archetypal character as part of a teamwork assignment this provides them with an opportunity to view the world through another perspective and set of lived experiences. We found evidence that students assigned to the logger working in the Amazon rainforest (Antonio), experienced greater increases in their nature relatedness scores across the course compared to the reference group (policymaker, Maria). This finding signals the potential for character-specific activities to enhance students’ connection to nature in an environmental quality and health course.

Supplementary Materials: The following supporting information can be downloaded at: www.mdpi.com/xxx/s1, Supplement 1: Team Activities in Environmental Quality and Health (EQH); Supplement 2: Discussion Section Agendas; Supplement 3: Team Assignment Worksheets; Supplement 4: Questions Included in Pre-test and Post-test Surveys; Table S1: Participant Demographic Information by Group; Table S2: Participant Demographic Information by Character; Figure S1: Box Plot Example.


Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Institutional Review Board Statement: The study was approved by the Institutional Review Board of University of X, Y, Z (IRB HS# 2018-4211).

Informed Consent Statement: A study information sheet outlining the potential risks and benefits of the study, as well as instructions for how to opt-out of the study, was provided to all students involved in this research.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to student privacy.

Acknowledgments: We would like to thank Heidi Beazley (Manager of Instructional Design for the School of S E at University of X, Y, Z) who developed the character biosketch documents. We would like to thank XYZ Summer Session for supporting the development of the course. Also thank you to the support staff of the course including teaching assistants (La Keisha Jeanmarie and Nik Warren), graduate reader (Steve Nguyen), and undergraduate course assistant (Nabiha Kamran). Finally, thank you to the students for participating in the study and providing suggestions for the ongoing improvement of the course.
Conflicts of Interest: The authors declare that there is no conflict of interest.

References


34. Camill, P. The deforestation of the Amazon: A case study in understanding ecosystems. 1999.


**Supplement 1. Team Activities in Environmental Quality and Health (EQH)**

Students enrolled in EQH were required to sign up for one of five discussion section times. Within each discussion section, students were divided into teams of approximately five people. The 50-minute weekly discussions sections were mandatory and were held seven times during the 10-week quarter between Weeks 2 and 9. Discussions were synchronous through video conferencing technology built into Canvas LMS [1,2]. Student teams worked in breakout rooms during the discussion and the instructional team, including the Instructor (insert name after blind review) and teaching assistants dropped in to these meetings multiple times each session to field questions and provide feedback and tips.

To support the student teams and provide structure for each of the weekly discussion section meetings, we provided students with a meeting agenda, including information about the team assignment for that week and substantive discussion prompts. These discussion prompts provided context around character discussions as well as hints about possible sticking points among the characters.

Each week, we gave students a worksheet with details of the weekly assignment, which they were encouraged to write-up together as a team during the discussion section time. The Instructional Designer (insert name after blind review) created three interactive media-rich online lessons in Articulate Storyline (Articulate Global, LLC., 2023) that feature dialogue among characters, discussion questions, non-graded quizzes, and additional information about deforestation in the Amazon rainforest and climate change. Student teams could go through these lessons during the discussion sections on given weeks (Weeks 2, 5, and 7) for additional detail about the case study and context to be used in the assignment.
## Student Learning Outcomes by Week

<table>
<thead>
<tr>
<th>Week</th>
<th>Theme</th>
<th>Student Learning Outcomes</th>
</tr>
</thead>
</table>
| Week 1 | Welcome and Class Introductions            | Navigate comfortably around this Canvas platform Calendar all the deadlines for course assignments  
|        |                                            | Remember when your discussion section meets and block out that time during Weeks 2-5 and 7-9  
|        |                                            | Know how to turn on and use your webcam. If you want to make sure that it works, there are many websites that will test your webcam. Just google it!                                                                                       |
| Week 2 | Introduction to Environmental Quality and Health; Environmental Epidemiology | Understand the basics of environmental quality and health, and how the human population and environmental epidemiology are related to environmental quality and health.  
|        | Assignments: Character Biosketch Assignment (Individual) Biosketch Team Discussion Forum (Individual) | Locate Brazil on a map.  
|        |                                            | Describe your role (your character) with respect to the issue of deforestation in the Amazon.  
|        |                                            | Describe the landscape of stakeholders (who stands to gain or lose from rainforest deforestation?).  
|        |                                            | Explain the "end point" of the class. Where does your team need to be in Week 10? It's a well-known life hack to "begin with the end in mind." Knowing this goal will keep your team on track and prevent you from getting lost along the way. |
| Week 3 | Environmental Toxicology; Environmental Policy and Regulation | Understand how environmental toxicology is important to the study of environmental quality and health.  
|        | Assignments: Hypothesis Assignment (Team)  | Understand the process of environmental policy and regulation.  
|        |                                            | Identify what makes a hypothesis good or bad.  
|        |                                            | Generate a testable hypothesis that pertains to deforestation in the Amazon rainforest in Brazil.  
<p>|        |                                            | Describe how your character views the issue of Amazon rainforest destruction. |</p>
<table>
<thead>
<tr>
<th>Week 4</th>
<th>Zoonotic and Vector-Borne Diseases</th>
<th>Understand how zoonotic and vector-borne diseases are important to the study of environmental quality and health.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignments:</td>
<td>Final Hypothesis Worksheet (Team)</td>
<td>Generate a stronger testable hypothesis that pertains to deforestation in the Amazon rainforest in Brazil.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Describe what distinguishes an opinion from a hypothesis.</td>
</tr>
<tr>
<td>Week 5</td>
<td>Water Quality and Availability</td>
<td>Understand common issues with water quality, and the importance of water quality to human and environmental health.</td>
</tr>
<tr>
<td>Assignments:</td>
<td>Ecosystem Services Assignment (Team)</td>
<td>Understand the concept of ecosystem services, and give examples of the ecosystem services provided by the Amazon rainforest.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Assess the validity of scientific evidence and sources of scientific evidence.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Describe your character’s perspective of readings about ecosystem services in the Amazon rainforest.</td>
</tr>
<tr>
<td>Week 6</td>
<td>Rainforest Protection and Source Credibility</td>
<td>Describe how people in Brazil view the Amazon rainforest.</td>
</tr>
<tr>
<td>Assignments:</td>
<td>Video Reaction Class Discussion Forum (Individual)</td>
<td>Understand the role FUNAI plays in protecting the Amazon rainforest in Brazil.</td>
</tr>
<tr>
<td></td>
<td>Source Credibility Class Discussion Forum (Individual)</td>
<td>Assess if a news story is credible.</td>
</tr>
<tr>
<td>Week 7</td>
<td>Air Quality; Global Climate Change</td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>----------------------------------</td>
<td></td>
</tr>
<tr>
<td>Assignments:</td>
<td>Rainforest Value Assignment (Team)</td>
<td></td>
</tr>
<tr>
<td>Understand common issues with air quality, and the importance of air quality to human and environmental health.</td>
<td>Understand why global climate change is a threat to human and environmental health, and provide examples of proposed solutions to curb global climate change.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Discuss why there is cause for optimism about the issue of global climate change.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Describe the value of the Amazon rainforest in Brazil from the perspective of different stakeholders.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Describe your character's perspective on the value of the rainforest and the hazards, risks, costs of continued rainforest destruction.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Week 8</th>
<th>Local Approaches to Global Climate Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignments:</td>
<td>Bending the Curve Assignment (Team)</td>
</tr>
<tr>
<td>Describe local efforts taking place at the University of California, in the state of California, and beyond to curb global climate change.</td>
<td>Understand the University of California's efforts to &quot;bend the curve.&quot;</td>
</tr>
<tr>
<td></td>
<td>Describe why the University of California would commit to being carbon neutral.</td>
</tr>
<tr>
<td></td>
<td>List the cities in Orange County that have signed on to the Paris Climate Agreement.</td>
</tr>
<tr>
<td></td>
<td>Evaluate the impact that state and local efforts to curb global climate change may have on reducing carbon emissions.</td>
</tr>
<tr>
<td>Week 9</td>
<td>Environmental Quality and Psychological Health</td>
</tr>
<tr>
<td>--------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Assignment: Decision-Making Assignment (Team)</td>
<td></td>
</tr>
<tr>
<td>Understand the links between psychological health and environmental quality. Discuss how knowledge of global news stories is related to news sources. Discuss why humans have trouble being alone in today's technological society. Describe the ethical issues involved with Amazon rainforest deforestation in Brazil, as well as the links between rainforest deforestation and global climate change. Assess the relevance of the Precautionary Principle of environmental policy making to the problem of global climate change. Discuss the role of experts vs. climate change deniers in the policy-making process. Provide a policy solution to the problem of rainforest deforestation in the Brazilian Amazon.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Week 10</th>
<th>Class Wrap-Up and Future Directions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignment: Reflection Assignment (Individual)</td>
<td></td>
</tr>
<tr>
<td>Describe what is meant by “planetary health,” and the main points of the planetary health manifesto. Discuss your contribution to the problem of deforestation in the Amazon rainforest in Brazil. Discuss your role in preventing future destruction of the Amazon rainforest in Brazil. Discuss your personal plan to help improve the environmental quality and health at different levels. Discuss how your team functioned as a group throughout the quarter. Discuss the processes of consensus building and staying in character.</td>
<td></td>
</tr>
</tbody>
</table>

References
Supplement 2. Discussion Section Agendas

Discussion Section Agenda 1

Before the meeting: Consult and review the resources listed in the “Discussion Section Materials” section of the weekly module.

During the meeting:

1. Introduce yourself to your team and share why you are interested in taking this course.
2. Introduce your character to your team and tell your team how you are similar and/or different from your character.
3. Test out your technology so that by the end of your meeting you are comfortable connecting via both audio and video, typing notes to your team, and sharing important documents.

Avoid these meeting traps!

● Don’t spend time dwelling on the “unknowns” of your character or the class. As the weeks progress, you will discover more. We will always point you in the right direction.

● In order to ensure that you are able to make it through the agenda during your discussion time, avoid chatting about items not on the agenda.

This week, your team’s goal is to get to know one another, your characters, and explore the Learning Management System (Canvas) Conferences technology, Big Blue Button.

1. One by one, discuss:
   ● What did you do over the holiday break?
   ● What interests you about this class?
   ● What character are you?
   ● What’s your character’s perspective on the issue of rainforest deforestation?

2. We recommend that you share contact information with your team (emails, phone numbers, etc.) so that you have a variety of ways of getting in touch throughout the quarter.

After the meeting:

1. Refine, complete, and submit the Biosketch Assignment.
2. Continue your conversation online in the Biosketch Team Discussion Forum in Canvas.
Discussion Section Agenda 2

Before the meeting: Consult and review the resources listed in the “Discussion Section Materials” section of the weekly module.

During the meeting:
1. Don’t forget to arrive at your team meeting as your role and stay in character throughout the discussion.
2. Assign a notetaker to take notes in the Hypothesis Worksheet (we suggest Maria or Marco).

Avoid these meeting traps!
- Don’t spend time dwelling on the “unknowns” of the case or the class. As the weeks progress, you will discover more. We will always point you in the right direction.
- In order to ensure that you are able to make it through the agenda during your discussion time, avoid chatting about items not on the agenda.

This week, your team’s goal is to sort out what a research hypothesis is, and to come up with a feasible and testable hypothesis about the problem of rainforest destruction in Brazil.

1. One by one, briefly remind your team:
   - What character are you?
   - What’s your character’s perspective on the issue of rainforest deforestation?
2. Discuss what makes a hypothesis good or bad.
   (Unsure? Review the Discussion Section Materials in the weekly module)
3. Generate possible hypotheses about the problem of rainforest destruction in Brazil.
   ○ For each hypothesis that your team creates, consider the following:
     - What is the role of humans in the process of rainforest destruction?
     - How does the political and economic background of your character influence their perspective on a given hypothesis?

After the meeting:
1. Refine, complete, and submit the Hypothesis Worksheet.
Discussion Section Agenda 3

Before the meeting: Consult and review the resources listed in the “Discussion Section Materials” section of the weekly module.

During the meeting:
1. Don’t forget to arrive at your team meeting as your role and stay in character throughout the discussion.
2. Assign a notetaker to take notes in the Final Hypothesis Worksheet (we suggest Carolina or Antonio).

Avoid these meeting traps!
- Don’t spend time dwelling on the “unknowns” of the case or the class. As the weeks progress, you will discover more. We will always point you in the right direction.
- In order to ensure that you are able to make it through the agenda during your discussion time, avoid chatting about items not on the agenda.

This week, your team’s goal is to use our feedback on your Hypothesis Worksheet to refine and finalize your research hypothesis, ensuring that your team comes up with a feasible and testable hypothesis about the problem of rainforest destruction in Brazil.

1. Review our feedback on your Hypothesis Worksheet
2. Discuss the variety of ways that your research hypothesis could be improved, keeping in mind that your hypothesis should be a declarative statement about the nature and direction of expected relationships between factors/variables.
   (Unsure? Review the Discussion Section Materials in the weekly modules)
3. Refine your hypothesis about the problem of rainforest destruction in Brazil.
   ○ Remember to consider the following:
     • What is the role of humans in the process of rainforest destruction?
     • How does the political and economic background of your character influence their perspective for a given hypothesis?

After the meeting:
1. Refine, complete, and submit the Final Hypothesis Worksheet.
Discussion Section Agenda 4

Before the meeting: Consult and review the resources listed in the “Discussion Section Materials” section of the weekly module.

During the meeting:
1. Don’t forget to arrive at your team meeting as your role and stay in character throughout the discussion.
2. Assign a notetaker to take notes in the Ecosystem Services Worksheet (we suggest Rachel or Maria).

Avoid these meeting traps!
• Don’t spend time dwelling on the “unknowns” of the case or the class. As the weeks progress, you will discover more. We will always point you in the right direction.
• In order to ensure that you are able to make it through the agenda during your discussion time, avoid chatting about items not on the agenda.

This week, your team’s goal is to review and react to three articles (Hint: Review the Discussion Section Materials in the weekly module) that discuss the ecosystem services provided by the Amazon rainforest, and come to a consensus on the credibility of the scientific evidence provided in each article.

1. Discuss what is meant by “ecosystem services” and why these services are important
2. Discuss the scientific evidence presented in each article (e.g., what type of evidence is presented and what/who is the sources of the evidence)
3. One by one, discuss:
   • Your character’s perspective of each article

After the meeting:
1. Refine, complete, and submit the Ecosystem Services Worksheet.
Discussion Section Agenda 5

Before the meeting: Consult and review the resources listed in the “Discussion Section Materials” section of the weekly module.

During the meeting:
1. Don’t forget to arrive at your team meeting as your role and stay in character throughout the discussion.
2. Assign a notetaker to take notes in the Rainforest Value Worksheet (we suggest Marco or Carolina).

Avoid these meeting traps!
- Don’t spend time dwelling on the “unknowns” of the case or the class. As the weeks progress, you will discover more. We will always point you in the right direction.
- In order to ensure that you are able to make it through the agenda during your discussion time, avoid chatting about items not on the agenda.

This week, your team’s goal is to determine the value of the Amazon rainforest, as well as what is at stake if deforestation in the Amazon rainforest is allowed to continue.

1. One by one, discuss:
   - Your character’s thoughts about the value of the Amazon rainforest
   - Your character’s perspectives on the hazards, risks, and costs associated with continued Amazon rainforest deforestation
   - Your character’s opinions about who stands to gain or lose if destruction of the Amazon rainforest continues

After the meeting:
1. Refine, complete, and submit the Rainforest Value Worksheet.
Discussion Section Agenda 6

Before the meeting: Do the readings, watch the lecture and supplemental videos, and consult and review the resources listed in the “Discussion Section Materials” section of the weekly module.

During the meeting:
1. This week you can take a break from your assigned role and speak from your own perspective throughout the meeting.
2. Assign a notetaker to take notes in the Bending the Curve Worksheet (we suggest Antonio or Rachel).

Avoid these meeting traps!
- Don’t spend time dwelling on the “unknowns” of the case or the class. As the weeks progress, you will discover more. We will always point you in the right direction.
- In order to ensure that you are able to make it through the agenda during your discussion time, avoid chatting about items not on the agenda.

This week, your team’s goal is to evaluate the University of California (UC) system’s carbon neutrality commitments, and the value of local efforts in the state of California and beyond to “bend the curve.”

1. One by one, discuss:
   - Your thoughts about the UC Bending the Curve Report and the UC Report on Sustainable Practices.
   - Your perspectives on the UC system’s commitment to be carbon neutral by 2025.
   - Your opinion of local efforts (e.g., state of California and other US states, US Climate Mayors, Global Covenant of Mayors, C40 cities) to “bend the curve.”

After the meeting:
1. Refine, complete, and submit the Bending the Curve Worksheet.
Discussion Section Agenda 7

Before the meeting: Consult and review the resources listed in the “Discussion Section Materials” section of the weekly module.

During the meeting:

1. Don’t forget to arrive at your team meeting as your role and stay in character throughout the discussion.
2. Assign a notetaker to take notes in the Decision-Making Worksheet (we suggest Maria or Marco).

Avoid these meeting traps!

- Don’t spend time dwelling on the “unknowns” of the case or the class. As the weeks progress, you will discover more. We will always point you in the right direction.
- In order to ensure that you are able to make it through the agenda during your discussion time, avoid chatting about items not on the agenda.

This week, your team’s goal is to consider the ethical implications of taking no action to curb deforestation in the Amazon rainforest, as well as to determine the strength of the scientific evidence supporting the link between destruction of the Amazon rainforest and global climate change, and the amount of uncertainty that is present in this evidence.

1. Discuss the ethics of Amazon rainforest deforestation
2. Discuss the evidence supporting the links between Amazon rainforest destruction and global climate change and the uncertainty of this evidence
3. Discuss who you think is qualified to provide evidence regarding the environmental quality and health impacts of Amazon rainforest deforestation (don’t forget to consider the role of climate change deniers)
4. Discuss one possible policy solution to the problem of Amazon rainforest destruction

After the meeting:

1. Refine, complete, and submit the Decision-Making Worksheet.
Supplement 3. Team Assignment Worksheets

Hypothesis Worksheet

Hypotheses are used to guide a research study, and are an important part of the scientific method. Specifically, the scientific method requires that hypotheses be testable, and typically hypotheses are phrased such that they offer an educated explanation for the phenomenon that is under investigation.

As a team, please answer the questions below.

1. List the possible hypotheses that your team discussed during your meeting. Next to each hypothesis indicate both the character and real-life name of the person that offered that hypothesis for consideration.

2. What hypothesis did your team think was the best? Why? (2 to 4 sentences or more)

3. Walk us through why and how your team decided on that hypothesis. Be sure to comment on any difficulties that your team faced and how you overcame these challenges. (6 or more sentences)

4. Is your best hypothesis testable? Yes or No? (Hint: your hypothesis must be testable!)

5. How do you know that your hypothesis is testable? In other words, what makes it testable? (1 to 3 sentences or more)

6. Does your best hypothesis offer an educated explanation for the phenomenon of destruction of the Amazon rainforest? Yes or No?

7. Does your best hypothesis include human impacts on the rainforest? Yes or No?

8. If your best hypothesis does not include human impacts on the forest, why not? If your hypothesis does include human impacts on the rainforest, describe why you included these impacts? (1 to 3 sentences or more)

9. Describe why each of you might prefer a different hypothesis than the other stakeholders on your team. Remember to stay in character and include both the character and real-life name of the person associated with each part of your response (2 to 3 sentences per teammate’s response)
Final Hypothesis Worksheet

Scientists spend a considerable amount of time considering and refining research hypotheses to ensure that their hypotheses are testable and phrased such that they offer an educated explanation for the phenomenon that is under investigation.

As a team, please answer the questions below.

1. What was your team’s best hypothesis from the Hypothesis Worksheet (question #2)? (1 sentence)

2. Walk us through how your team improved your previous hypothesis to come up with your final hypothesis for this week. Be sure to comment on any difficulties that your team faced and how you overcame these challenges. (6 or more sentences)

3. How did your team use the PICOT model to shape your final hypothesis? Please provide specifics for each of the five PICOT components (5 to 7 sentences or more) (Hint: See The Hypothesis in Science Writing resource under the weekly Discussion Materials for more information about the PICOT model)

4. What is your team’s final hypothesis? (1 sentence that is testable)

5. Is your team’s final hypothesis testable? How do you know it is testable? (2 to 3 sentences or more) (Hint: your hypothesis must be testable!)

6. Does your team’s final hypothesis offer an educated explanation for the phenomenon of destruction of the Amazon rainforest? Yes or No?

7. Does your team’s final hypothesis include human impacts on the rainforest? Yes or No?

8. How did your team reach a consensus about the final hypothesis given the differing opinions of each person’s assigned character? (2 to 4 sentences or more)

9. Provide one current example from the news of a team/group of people with differing opinions that must work together to identify a common solution. Please be specific in your response and include a link to the source(s) of your information. (4 to 5 sentences or more)
Ecosystem Services Worksheet

Once your team has met formally through your video conference to review the three assigned ecosystem services articles and you have reached a consensus, please work as a team to fill in the table questions below.

<table>
<thead>
<tr>
<th>Article</th>
<th>What was the main point of the article? (2 or 3 sentences or more for each article)</th>
<th>What is one weakness of the evidence provided in the article? (3 or 4 sentences or more for each article)</th>
<th>What makes the evidence and the source of evidence in the article a credible source of information? (1 or 2 sentences or more for each article)</th>
<th>How do each of your characters react to the information presented in the articles? (4 or 5 sentences or more for each article)</th>
<th>How easy was it to read and understand the article? Circle one. (1=extremely difficult, 5=extremely easy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Casado and Londoño (2019)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>Holzman (2012)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>Ehrlich and Wilson (1991)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>
Source Credibility Worksheet (aka the C.R.A.P. Test)

Anyone can write anything and publish it online these days. In order to be informed consumers of information, we must carefully evaluate media sources and identify if information is credible or not. Once you find a news article that relates to the topic of our class, complete this worksheet.

One way to evaluate sources of information is to use something called the “C.R.A.P. Test.” Using the C.R.A.P. Test, you can identify the following attributes of an article:

- Currency
- Relevance
- Authority
- Purpose

Evaluate your selected article using the C.R.A.P. criteria in the table below:

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Question</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>What is the URL for the article?</td>
<td></td>
</tr>
<tr>
<td>Currency</td>
<td>When was the article published? (Please provide the specific date.)</td>
<td></td>
</tr>
<tr>
<td>Relevance</td>
<td>Is the information in the article still relevant today?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Are there links to any other sites within the article? If so, how many?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>What type of article is it? An editorial? A personal blog? A wiki?</td>
<td></td>
</tr>
<tr>
<td>Authority</td>
<td>Who authored the article? Is there a byline? Is it a person or an institution?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>What are the website’s/publication’s credentials? How do you know this author is an expert?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Using Google, look up the author and/or institution. What</td>
<td></td>
</tr>
<tr>
<td>Category</td>
<td>Question</td>
<td></td>
</tr>
<tr>
<td>--------------------------</td>
<td>--------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Others Say About</td>
<td>Do others say about the author/institution?</td>
<td></td>
</tr>
<tr>
<td>Bias</td>
<td>What is the author’s and/or institution’s bias? (The Oxford Dictionary defines bias as “inclination or prejudice for or against one person or group, especially in a way considered to be unfair.”)</td>
<td></td>
</tr>
<tr>
<td>Purpose</td>
<td>Why was this article published? Is it intended to persuade or inform?</td>
<td></td>
</tr>
<tr>
<td>Audience</td>
<td>Who is the intended audience? The general public? College students? Other groups?</td>
<td></td>
</tr>
<tr>
<td>Advertisements</td>
<td>Are there advertisements attached to the site where the article is published? If so, how many? And how do the ads relate to the content?</td>
<td></td>
</tr>
<tr>
<td>Bottom Line</td>
<td>Is this source credible? Why or why not?</td>
<td></td>
</tr>
</tbody>
</table>

This worksheet was developed with content from:
https://scholarsphere.psu.edu/resources/76c558da-b7f9-4704-a7b1-54559d0bdd20
https://blogs.agu.org/geoedtrek/2016/02/24/crap-test/
Rainforest Value Worksheet

Once your team has met formally through your video conference to discuss this assignment and you have reached a consensus, please work as a team to answer the questions below.

1. Overall, how much is the Amazon rainforest worth? (2 to 4 sentences or more)

2. How much is the Amazon rainforest worth to Brazil? (2 to 4 sentences or more)

3. How much is the Amazon rainforest worth to the health of the planet? (2 to 4 sentences or more)

4. How did you come up with these values? (4 to 6 sentences or more)

5. What scholarly sources (e.g., books, articles, etc.) did you consult to help you with your value estimates? (please list a minimum of 3 sources)

6. What is really at stake if rainforest deforestation in the Amazon is allowed to continue? What environmental health hazards or risks are associated with Amazon rainforest deforestation? (6 to 9 sentences or more)

7. Who (individuals, communities, regions, countries) stands to gain or lose from Amazon rainforest deforestation? What are the social costs of Amazon rainforest deforestation (i.e., the costs to society)? (8 to 12 sentences or more)

8. In what ways are the stakeholders that you mention in your answer to Question 7 being impacted by deforestation in the Amazon rainforest? (4 to 6 sentences or more)

9. From each of your characters’ perspectives, what is worrying them the most about Amazon rainforest loss due to deforestation? (5 or more sentences)
Bending the Curve Worksheet

Once your team has met formally through your video conference to discuss this assignment and you have reached a consensus, please work as a team to answer the questions below.

1. What is the role of a public university, such as the University of X system, when it comes to “bending the curve”? (4 to 6 sentences or more)

2. Why would the University of X get involved with efforts to bend the curve? (4 to 6 sentences or more)

3. How many cities in the United States have joined the Global Covenant of Mayors for Climate & Energy (Hint: use this link to search for this information: https://www.globalcovenantofmayors.org/global-covenant-cities-data/) (1 sentence)

4. Has the city of Y signed on to the Global Covenant of Mayors for Climate & Energy? Why do you think this is the case? (2 to 3 sentences or more)

5. In the year 2050, what is the expected reduction in emissions below the business as usual (BAU) scenario in North America due to efforts by the Global Covenant of Mayors for Climate & Energy? (please give your answer in metric tons of carbon dioxide equivalent or MtCO₂e) (Hint: use this link to search for this information using the interactive graphs and figures): https://www.globalcovenantofmayors.org/impact2022/) (1 sentence)

6. In the year 2050, what is the Global Covenant target emissions level for North America (please give your answer in MtCO₂e)? (1 sentence)

7. How many MtCO₂e will be cumulatively avoided across all participating cities by 2050 because of the Global Covenant of Mayors for Climate & Energy? (1 sentence)

8. Which cities in Z County have adopted the Paris Climate Agreement? (Hint: use this link to search for this information: http://climatemayors.org) Why is the Paris Agreement important to these cities? (4 to 6 sentences or more)

9. How many cities in North Dakota and South Dakota have adopted the Paris Climate Agreement? Why do you think this is the case? (4 to 6 sentences or more)

10. What can communities do to support efforts to bend the curve? (3 to 4 sentences or more)

11. How can you help to bend the curve? (3 to 4 sentences or more)
12. Considering everything that you have learned this week about local efforts to curb global warming, do you think that local and state governments in the U.S. are more capable or less capable of bending the curve compared to the U.S. federal government? Why? (4 to 6 sentences or more)
Decision-Making Worksheet

Once your team has met formally through your video conference to discuss this assignment and you have reached a consensus, please work as a team to answer the questions below.

1. Who are the experts that you would involve in the policy-making process to prevent further deforestation in the Amazon (give at least two specific examples of experts and explain their credentials)? (4 to 6 sentences or more)

2. Given the scientific evidence on global climate change, do you think that policy makers should invoke the Precautionary Principle (Hint: see p. 69 in the textbook) when it comes to policymaking? (4 to 6 sentences or more)

3. What role do so-called “Internet experts,” or climate change deniers have when it comes to rainforest policymaking in Brazil? In the world? For a summary of recent research on climate change denial, check out this article - https://www.washingtonpost.com/news/energy-environment/wp/2016/02/22/science-confirms-it-denial-of-climate-change-is-all-about-the-politics/ (4 to 6 sentences or more)

4. Do the stakeholders on your team agree about the need to address Amazon rainforest deforestation by creating new policies? Please explain. (4 to 6 sentences or more)

5. Given what you know about the 2015 Paris Climate Summit agreement and given how your team has interacted in this class, do you think your team could have been as successful as the world leaders and nations were at reaching this historic climate agreement? Please explain. (4 to 6 sentences or more)

6. Do the stakeholders on your team support the recent actions taken by governors (e.g., California, New York, Washington, Hawaii) and mayors (e.g., Austin, Pittsburg, Los Angeles, San Francisco) in the US to uphold the Paris Climate Summit agreement after President Donald J. Trump stated that the US would pull out of the agreement? Please explain why or why not. (4 to 6 sentences or more)

7. Do the stakeholders on your team agree about the impacts that rainforest deforestation in the Amazon has on global climate change? Please explain. (4 to 6 sentences or more)

8. Describe one solution to the problem of deforestation in the Amazon rainforest. (4 to 6 sentences or more)

9. Why is it important that we solve the problem of deforestation in the Amazon rainforest? (4 to 6 sentences or more)
Supplement 4. Questions Included in Pre-test and Post-test Surveys

Nature Relatedness [1]

For each of the following, please rate the extent to which you agree with each statement, using the scale from 1 to 5 (Strongly Disagree to Strongly Agree) as shown below. Please respond as you really feel, rather than how you think “most people” feel.

- My ideal vacation spot would be a remote, wilderness area.
- I always think about how my actions affect the environment.
- My connection to nature and the environment is a part of my spirituality.
- I take notice of wildlife wherever I am.
- My relationship to nature is an important part of who I am.
- I feel very connected to all living things and the earth.

Environmental Concern [2]

People around the world are generally concerned about environmental problems because of the consequences that result from harming nature. However, people differ in the consequences that concern them the most. Please rate each of the following items from 1 to 7 (not at all important to extremely important) as shown below in response to the question:

I am concerned about environmental problems because of the consequences for ________.

Plants

Marine life

Birds

Animals
1. Recently, you may have noticed that global warming has been getting some attention in the news. Global warming refers to the idea that the world’s average temperature has been increasing over the past 150 years, may be increasing more in the future, and that the world’s climate may change as a result. What do you think? Do you think that global warming is happening?
   a. Yes
   b. No
   c. Don’t know

1a. (if answered yes to the previous question) How sure are you that global warming is happening?
   a. Extremely sure
   b. Very sure
   c. Somewhat sure
1b. (if they answer no to the previous question) How sure are you that global warming is not happening?
   a. Extremely sure
   b. Very sure
   c. Somewhat sure
   d. Not at all sure

2. Assuming global warming is happening, do you think it is:
   a. Caused mostly by human activities
   b. Caused by both human activities and natural changes
   c. Caused mostly by natural changes in the environment
   d. None of the above because global warming isn’t happening
   e. Other
   f. Don’t know

3. Which comes close to your own view?
   a. Most scientists think global warming is happening
   b. Most scientists think global warming is not happening
   c. There is a lot of disagreement among scientists about whether or not global warming is happening
   d. Don’t know enough to say

4. Have you ever heard of the “greenhouse effect”?
   a. Yes
   b. No

5. (if answered yes to the previous question) The “greenhouse effect” refers to:
6. Which of the following gasses in the atmosphere are good at trapping heat from the Earth’s surface? (select all that apply)
   - Methane
   - Water vapor
   - Hydrogen
   - Oxygen
   - Don’t know

7. Are each of the following statements definitely true, probably true, probably false, definitely false, or you do not know? [Definitely true (1) Probably true (2) Probably false (3) Definitely false (4) Don’t know (5)]
   ○ Weather often changes from year to year.
   ○ Climate means the average weather conditions in a region.
   ○ Climate often changes from year to year.
   ○ Ocean currents carry heat from the equator toward the north and south poles.
   ○ Weather means the average climate conditions in a region.
   ○ Climate and weather mean pretty much the same thing.
   ○ The atmosphere carries heat from the north and south poles toward the equator.

8. Which of the following are “fossil fuels”? (select all that apply)
   - Oil
9. To the best of your knowledge, roughly how much carbon dioxide is in the atmosphere today?
   a. 300 parts per million
   b. 350 parts per million
   c. 400 parts per million
   d. 450 parts per million
   e. Don’t know

10. Are each of the following statements definitely true, probably true, probably false, definitely false, or do you not know? [Definitely true (1), Probably true (2), Probably false (3), Definitely false (4), Don’t know (5)]
   ○ Global warming will cause some places to get wetter, while others will get drier.
   ○ The decade from 2000 to 2009 was warmer than any other decade since 1850.
   ○ Global warming will increase crop yields in some places, and decrease it in others.
   ○ Global warming will cause temperatures to increase by roughly the same amount in all countries.
   ○ The record snowstorms this winter in the western United States prove that global warming is not happening.
   ○ Global warming is happening, but will be more beneficial than harmful.
   ○ Global warming will cause most of the glaciers to melt away.
   ○ Global warming will cause global sea level rise.
11. How much do you think each of the following actions would reduce global warming if they were done worldwide? [A lot (1), Some (2), A little (3), Not at all (4), Don't know (5)]

○ Switching from fossil fuels to renewable energy (wind, solar, geothermal)

○ Planting trees

○ Reducing tropical deforestation

○ Reducing toxic waste (nuclear, chemical)

○ Switching from gasoline to electric cars

○ Driving less

○ Increasing public transportation

○ Switching from regular (incandescent) to compact fluorescent light bulbs

○ Insulating buildings

○ Switching from fossil fuels to nuclear power

○ Banning aerosol spray cans

○ Stop punching holes in the ozone layer with rockets

○ Placing a large tax on all fossil fuels

○ Having at most 2 children per family

○ Fertilizing the ocean to make algae grow faster

○ Stop eating beef

○ Using airplanes to scatter dust high in the atmosphere

References


<table>
<thead>
<tr>
<th>Group</th>
<th>Female (%)</th>
<th>PEERs (%)</th>
<th>First Generation (%)</th>
<th>Low Income (%)</th>
<th>Transfer Students (%)</th>
<th>Public Health (%)</th>
<th>Other STEM (%)</th>
<th>Non-STEM (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100</td>
<td>67</td>
<td>67</td>
<td>67</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>60</td>
<td>60</td>
<td>80</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>0</td>
<td>80</td>
</tr>
<tr>
<td>3</td>
<td>67</td>
<td>67</td>
<td>67</td>
<td>67</td>
<td>33</td>
<td>33</td>
<td>0</td>
<td>67</td>
</tr>
<tr>
<td>4</td>
<td>67</td>
<td>33</td>
<td>67</td>
<td>33</td>
<td>33</td>
<td>33</td>
<td>33</td>
<td>33</td>
</tr>
<tr>
<td>5</td>
<td>100</td>
<td>50</td>
<td>50</td>
<td>0</td>
<td>50</td>
<td>0</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>6</td>
<td>75</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>0</td>
<td>25</td>
<td>0</td>
<td>75</td>
</tr>
<tr>
<td>7</td>
<td>60</td>
<td>40</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>60</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>8</td>
<td>67</td>
<td>50</td>
<td>33</td>
<td>50</td>
<td>17</td>
<td>67</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>9</td>
<td>75</td>
<td>50</td>
<td>25</td>
<td>25</td>
<td>0</td>
<td>75</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>10</td>
<td>60</td>
<td>20</td>
<td>40</td>
<td>40</td>
<td>20</td>
<td>60</td>
<td>0</td>
<td>40</td>
</tr>
<tr>
<td>11</td>
<td>100</td>
<td>0</td>
<td>33</td>
<td>0</td>
<td>0</td>
<td>67</td>
<td>0</td>
<td>33</td>
</tr>
<tr>
<td>12</td>
<td>60</td>
<td>60</td>
<td>80</td>
<td>60</td>
<td>40</td>
<td>40</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>13</td>
<td>100</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>100</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>14</td>
<td>75</td>
<td>0</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>50</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>15</td>
<td>75</td>
<td>75</td>
<td>100</td>
<td>50</td>
<td>0</td>
<td>50</td>
<td>0</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>100</td>
<td>100</td>
<td>50</td>
<td>50</td>
<td>100</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>---</td>
<td>-----</td>
<td>------</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>60</td>
<td>80</td>
<td>20</td>
<td>40</td>
<td>0</td>
<td>40</td>
<td>40</td>
<td>20</td>
</tr>
<tr>
<td>18</td>
<td>60</td>
<td>20</td>
<td>80</td>
<td>20</td>
<td>40</td>
<td>60</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>19</td>
<td>75</td>
<td>25</td>
<td>75</td>
<td>50</td>
<td>0</td>
<td>50</td>
<td>0</td>
<td>50</td>
</tr>
<tr>
<td>20</td>
<td>50</td>
<td>25</td>
<td>25</td>
<td>0</td>
<td>0</td>
<td>50</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>21</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>50</td>
<td>0</td>
<td>50</td>
<td>0</td>
<td>50</td>
</tr>
<tr>
<td>22</td>
<td>75</td>
<td>0</td>
<td>25</td>
<td>50</td>
<td>25</td>
<td>50</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>23</td>
<td>100</td>
<td>67</td>
<td>33</td>
<td>0</td>
<td>33</td>
<td>33</td>
<td>0</td>
<td>67</td>
</tr>
<tr>
<td>24</td>
<td>50</td>
<td>75</td>
<td>75</td>
<td>75</td>
<td>25</td>
<td>0</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>25</td>
<td>100</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>50</td>
<td>0</td>
<td>50</td>
</tr>
<tr>
<td>26</td>
<td>67</td>
<td>67</td>
<td>33</td>
<td>0</td>
<td>33</td>
<td>33</td>
<td>33</td>
<td>33</td>
</tr>
<tr>
<td>27</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>50</td>
<td>0</td>
<td>0</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>28</td>
<td>67</td>
<td>33</td>
<td>33</td>
<td>33</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>29</td>
<td>67</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>33</td>
<td>0</td>
<td>67</td>
<td>33</td>
</tr>
<tr>
<td>30</td>
<td>67</td>
<td>67</td>
<td>33</td>
<td>0</td>
<td>33</td>
<td>33</td>
<td>0</td>
<td>67</td>
</tr>
<tr>
<td>31</td>
<td>33</td>
<td>33</td>
<td>67</td>
<td>67</td>
<td>33</td>
<td>33</td>
<td>33</td>
<td>33</td>
</tr>
<tr>
<td>32</td>
<td>25</td>
<td>50</td>
<td>25</td>
<td>0</td>
<td>0</td>
<td>25</td>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>33</td>
<td>60</td>
<td>60</td>
<td>40</td>
<td>60</td>
<td>20</td>
<td>60</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>34</td>
<td>75</td>
<td>75</td>
<td>25</td>
<td>75</td>
<td>0</td>
<td>50</td>
<td>0</td>
<td>50</td>
</tr>
<tr>
<td>35</td>
<td>80</td>
<td>60</td>
<td>40</td>
<td>60</td>
<td>0</td>
<td>40</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>36</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>25</td>
<td>0</td>
<td>50</td>
<td>0</td>
<td>50</td>
</tr>
<tr>
<td>37</td>
<td>67</td>
<td>67</td>
<td>33</td>
<td>0</td>
<td>67</td>
<td>0</td>
<td>67</td>
<td>33</td>
</tr>
<tr>
<td>38</td>
<td>50</td>
<td>50</td>
<td>0</td>
<td>25</td>
<td>0</td>
<td>25</td>
<td>0</td>
<td>75</td>
</tr>
</tbody>
</table>

Mean (SD)  | 70 (19) | 47 (28) | 47 (29) | 33(26) | 18(19) | 40(26) | 16(20) | 45(25) |

Note. Percentages, means, and standard deviations rounded to the nearest whole number.

‘PEERs = persons excluded because of their ethnicity or race; Black, Latinx, Pacific Islander, Indigenous to the US and its Territories
‘Other STEM = Physical Sciences, Information and Computer Sciences, Engineering, Biological Sciences

‘Non-STEM = Social Sciences, Social Ecology, Education, Business, Humanities, Art
Table S2. Participant Demographic Information by Character

<table>
<thead>
<tr>
<th>Character</th>
<th>Female (%)</th>
<th>PEERs* (%)</th>
<th>First Generation (%)</th>
<th>Low Income (%)</th>
<th>Transfer Students (%)</th>
<th>Public Health (%)</th>
<th>Other STEM+ (%)</th>
<th>Non-STEM# (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Policymaker</td>
<td>62</td>
<td>46</td>
<td>50</td>
<td>38</td>
<td>15</td>
<td>35</td>
<td>27</td>
<td>38</td>
</tr>
<tr>
<td>Environmental Activist</td>
<td>73</td>
<td>50</td>
<td>42</td>
<td>19</td>
<td>23</td>
<td>42</td>
<td>19</td>
<td>38</td>
</tr>
<tr>
<td>Farmer</td>
<td>77</td>
<td>54</td>
<td>50</td>
<td>42</td>
<td>4</td>
<td>54</td>
<td>8</td>
<td>38</td>
</tr>
<tr>
<td>Logger</td>
<td>67</td>
<td>33</td>
<td>40</td>
<td>33</td>
<td>20</td>
<td>43</td>
<td>13</td>
<td>43</td>
</tr>
<tr>
<td>Conservation Biologist</td>
<td>61</td>
<td>52</td>
<td>48</td>
<td>39</td>
<td>19</td>
<td>32</td>
<td>13</td>
<td>55</td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>68 (7)</td>
<td>47 (8)</td>
<td>46 (5)</td>
<td>34 (9)</td>
<td>16 (7)</td>
<td>41 (9)</td>
<td>16 (7)</td>
<td>42 (7)</td>
</tr>
</tbody>
</table>

Note. Percentages, means, and standard deviations rounded to the nearest whole number.

*PEERs = persons excluded because of their ethnicity or race; Black, Latinx, Pacific Islander, Indigenous to the US and its Territories

+Other STEM = Physical Sciences, Information and Computer Sciences, Engineering, Biological Sciences

#Non-STEM = Social Sciences, Social Ecology, Education, Business, Humanities, Art
Figure S1. Box Plot Example. Box plots contain the minimum value, 25th percentile, 50th percentile (median), 75th percentile, and the maximum. The box itself represents the middle 50% of the data. The interquartile range (IQR) is calculated by subtracting the value of the 25th percentile from the value of the 75th percentile. Outliers are denoted with an open circle when a value from the data is greater than 1.5 * IQR from the middle 50% of the data. In the case of outliers, the whiskers will reach the next closest data point to the center of the distribution.