RESEARCH PROJECT

Service-Learning Curriculum Increases Climate Change Awareness

DANIEL A. MENDOZA *
The George Washington University

SARAH J. ADKINS *
University of Alabama at Birmingham

JAY M. BHATT
Creighton University

J. JEFFREY MORRIS
University of Alabama at Birmingham

SAMIKSHA A. RAUT
University of Alabama at Birmingham

Abstract

National efforts to reform undergraduate education have highlighted the need to relate abstract concepts in biology to real-world examples, especially for non-majors who may undervalue scientific processes. We therefore decided to introduce a module titled "Climate Change, Sustainable Practices and Plastic Pollution," utilizing such high-impact practices as service-learning. This module involved connecting the course objectives with three hours of community service. Our mixed-methods approach across two different course iterations (n=117) indicated that at the end of the course, non-majors were significantly more likely to agree with all the statements on an open-ended pre- and post-survey about civic engagement and sustainable practices, as adapted from Dauer and Forbes (2016). Focus group and free response data confirmed that students valued service-learning and connected the experience to both learning objectives and their everyday lives. We therefore recommend service-learning as an active engagement tool to teach concepts related to global climate change and environmental pollution.

*These two authors contribute equally to this work

Introduction

A large body of literature suggests that science educators need to adopt active-learning and inquiry-based curricula to enhance student learning and retention (Brame, 2016; American Association for the Advancement of Science [AAAS], 2009; Freeman et al., 2014). While a majority of these reforms are targeted towards science, technology, engineering, and mathematics (STEM) majors, very few studies have explored the impact of innovative curricula and high-impact practices for students majoring beyond the sciences, often referred to as "non-majors." In fact, non-majors are less likely to have confidence in their ability to perform or understand science, despite the need for an informed scientific citizenry of tomorrow's voters, workers, consumers, and policy-makers (Dauer & Forbes, 2016; Cotner, Thompson, & Wright, 2017). Non-major classes, which cater to diverse majors and student populations, often seek to connect biology to students' day-to-day lives and can do so through student-centered pedagogical approaches (Knight & Smith, 2010). Therefore, it is incumbent upon institutions of higher education to design these student-centric curricula for non-majors that help them recognize the relevance of science to their lives.

Service-learning is one such pedagogical innovation that allows the student to implement knowledge from the classroom (Keupper-Tetzel, 2017) to serve the community and thus represents an example of a model active-learning experience (Lynch, 2016). Broadly defined, service-learning is a set of immersive activities related to concepts in the course material that allows students to relate abstract concepts to concrete examples and gives students transferable and applicable skills related to the material (Dauer & Forbes, 2016; Matthews, Dorfman, & Wu, 2015). Notably, service-learning has improved retention rates not only in biology but also across disciplines (Nigro & Farnsworth, 2009), making service-learning of particular interest in reforming education for non-majors and other diverse student populations. Importantly, in order for the experiences to be of quality, the instructor, with course objectives in mind, must interface with community partners with specific needs. Research has shown that when community partners were highly involved in the process (e.g., by reinforcing learning objectives) students demonstrated greater content learning gains (Little, 2012).

In the scientific community and in the classroom, much attention is being paid to environmental science, especially in relation to plastic pollution and anthropogenic climate change (Hawkins & Stark, 2016; Schuldt, Konrath, & Schwarz, 2011; Lineman, Do, Kim, & Joo, 2015). Service-learning has a place in this discussion for its ability to show students the relevance of environmental science in their lives and to increase their critical thinking skills (Dauer & Forbes, 2016; Celio, Durlak, & Dymnicki, 2011; Herlihy et al., 2016; Wu, Lu, Zhou, Chen, & Xu, 2016; Harvey, 2018; Yokota et al., 2017; Haward, 2018; Galgani, Pham, & Reisser, 2017). In fact, students may not consider plastic pollution a concern unless they have participated in clean-up efforts, for example through service-learning (Yokota et al. 2017; Haward 2018; Galgani et al., 2017). There also exists a population that does not accept that climate change is occurring even when presented with supporting data. While many efforts seem content to simply inculcate a dogmatic belief in climate change, a superior pedagogical approach is to teach students how to interpret data and draw their own conclusions (Lineman et al., 2015; Schuldt et al., 2011; Dauer & Forbes, 2016). With good reason, many service-learning opportunities for non-majors couple objectives related to the scientific process and data analysis to environmental stewardship (Packer, 2009). Sustainability and environmental science are showing up more and more on course syllabi, and service-learning is a promising strategy to add hands-on stewardship activities to environmental course material.

For these reasons, service-learning was introduced to a non-major biology course at the University of Alabama at Birmingham (UAB), which is an urban, public, research-intensive institution in central Alabama. This study, in line with *Vision and Change: A Call to Action* (AAAS, 2009), was intentionally done with non-major students whose participation in this class may be the last STEM course of their college curriculum. We tested the hypothesis that a service-learning course module, which included a three-hour service-learning component and data-driven lectures, would affect non-major student attitudes about climate change and topics related to environmental stewardship, including sustainability and plastic pollution.

Methods

Course and Recruitment

This study was approved by the UAB Institutional Review Board IRB-300000955. Ninety-four students were enrolled in BY 101: Topics in Contemporary Biology in the fall semester of 2017 and 89 students in the fall semester of 2018. BY 101 is an elective course for non-majors at UAB that gives a general overview of biology. The course learning objectives, designated on the syllabus (see Supplemental Materials), are as follows:

1. Understand the basic process of science
2. Identify the valid sources of scientific literature
3. Environmental consciousness and civic responsibility
4. Analyze and apply scientific information to make everyday decisions
5. Gain a basic understanding of the cell and its functions as it relates to health and wellness
6. Understand the process of evolution and evidence behind it

The lecture component of the service-learning module included three guest lectures from climate scientists at UAB, including: Dr. James McClintock, Antarctic climate scientist and author of *Lost Antarctica: Adventures in a Disappearing Land* (St. Martin's Griffin, 2014); Dr. Jeffrey Morris, who studies the impact of ocean acidification on marine microbial interactions; and Dr. Dustin Kemp, who is a coral reef ecologist. A special lecture titled "Plastic Pollution and Climate Change" was delivered by author Samiksha Raut. All students were required to complete pre- and post-surveys as well as three hours of service-learning. Since this was a high-enrollment class, we decided to limit service-learning to only three hours. Because of the large number of students in this class, service-learning assignments were generally scheduled during the class meeting times to avoid schedule conflicts. By the end of both semesters, only three students (1.6%) had dropped out, while six (3.3%) did not complete any of the required service-learning components. Out of the 174 remaining students, 118 (67.8%) students consented to their data being used in this study and 117 (67.2%) completed both pre- and post-surveys. Their demographic composition is shown in Supplemental Table 1.

FIGURE 1. Students Participate in Service-Learning Projects

Left: Two students partner with UAB Sustainability to do campus litter pickup. ©Sarah Adkins.

Right: Students partner with UAB Recycling to sort recyclable materials. ©Jon Paolone.

Speed-Matching Event and Service-Learning

Early on in the semester, community partners approved and recommended by UAB's Office of Service-Learning and Undergraduate Research were scheduled to visit the class in a unique "Speed-Matching Event." All the community partners introduced their organization and their general mission to meet the needs of the community while embracing sustainable practices to combat climate change. This was done with an intent to enable the students to understand the community partner's goals and how they related to the learning objectives discussed in the classroom. Students committed to a minimum of three hours with their service-learning partner, which, along with the required surveys, constituted 15% of the student's final grade. To be cognizant of the students' schedules as well as any transportation issues, all opportunities provided were on campus (UAB Sustainability, Figure 1), within a 10-minute walk of campus (Railroad Park), or had transportation provided (UAB Recycling, Figure 1). Some of the opportunities provided with UAB Sustainability and Railroad Park were scheduled during class time, so that students did not have to take extra time out of their week. This also helped to make these activities inclusive for students with obligations outside of class time. Students who had the physical inability to be outside for extended periods of time had the opportunity to build pamphlets for the Red Mountain State Park. These approaches enabled us to make these assignments inclusive for all our students. After the speed-matching event, a Google form was sent to the students to sign up for a day and time for their service-learning. Students received reminders about their assignments and also about their community partner's expectations, such as timeliness and dress code. Each of the student groups was overseen by

upperclass undergraduate students who had volunteered their time to function as "site leaders." Their task was to make sure that the students were diligent in completing the assignment. The list of partners and total number of student participants is shown in Table 1. During the service-learning, community partners had students sign in and out to account for attendance.

TABLE 1. Service-Learning Partners and Number of Participants from 117 Students in Both 2017 and 2018 BY101 Cohorts

Service-Learning Partner	Student Responsibilities	Number of Consenting Student Participants
Moss Rock Preserve Festival	Assist in recycle-centric arts and crafts festival	16 (13%)
Railroad Park	Litter pickup in the park; Waste removal from the pond; Floral maintenance	21 (18%)
Trips for Kids Birmingham	Bicycle maintenance	8 (7%)
UAB Recycling	Litter pickup at athletic events	6 (5%)
UAB Sustainability	Campus litter pickup; UAB-owned community gardens	66 (56%)

Assessments

Prior to the implementation of the service-learning module, students were given a six-item paper survey adapted from Dauer and Forbes (2016) where students could agree, disagree, or state uncertainty with beliefs about the six statements and follow up by explaining their reasoning for their responses. This was done to ascertain the familiarity of the students with climate change, sustainable practices, and plastic pollution. (For survey forms, see Supplemental Materials.) Three additional items asked the students to reflect on their content knowledge and expectations for service-learning but were not included in this analysis, as they were beyond its scope. We are not aware of any validated existing surveys that cover the breadth of our research question. We therefore decided to adapt our survey from Dauer and Forbes (2016). Most importantly, their items were in the form of open-ended questionnaires focused on science literacy and decision-making. Completion of both assessments combined was worth 5% of the student's overall grade. Responses from the consenting students were transcribed into a Google spreadsheet. Names were de-identified with assigned numbers to be later matched with post-survey assessments. After the completion of this module, post-surveys with the same items as the pre-surveys were administered to the students to determine any changes in student attitudes.

In addition to the students, we also surveyed two teaching professors and four community partner personnel with the same post-survey and collected their responses. These six expert respondents agreed to all statements and confirmed that the questions reflected the appropriate learning objectives, with the exception of one expert who did not fully agree to the statement about making additional changes to daily habits (data not shown). Paper-based pre- and post-surveys were transcribed for analysis and any unambiguous student misspellings or typing errors were corrected via spell check. Qualitative data from pre- and post-surveys were analyzed via two independent coders (S. A. and J. M.), who identified themes through emergent selective coding (Strauss & Corbin, 1998; Onwuegbuzie, Dickinson, Leech, & Zoran, 2009) and then shared their findings. A consensus was reached (100% agreement) by both coders on a theme that applied to each statement. Representative quotes were selected unanimously.

Focus Group Interviews

Following the final course examination, students had the opportunity to participate in a focus group interview to share their commentary and leave their feedback about the service-learning experience. Students were compensated with light hors d'oeuvres as well as $10.00 scholarships for their time. Ten

students from the 2017 class agreed to participate in a focus group discussion (which is 11.7% of that class). Questions that guided the discussion were as follows:

1. What does it mean for a person to live sustainably?
2. How do you think the service-learning experience will help you put your BY 101 course content into actual practice?
3. Before today, had you heard about global climate change?
4. Describe in your own words what you think global climate change is all about?
5. Do you think global climate change is real?
6. Do you think global climate change impacts human health?
7. Do you feel plastic pollution in the environment impacts you?
8. Do you think you need to change your daily habits in any way to minimize the impact on the environment?
9. Do you think you need to inform people around you about global climate change, suggest/recommend to them about any lifestyle changes they need to make to attempt to minimize the impact on the environment?

Recordings were later transcribed and analyzed for qualitative analysis. Two coders (J. B. and D. M.) worked independently to identify themes within the transcribed focus group interviews using constant comparison analysis. Emergent themes were identified through open coding followed by iterative cycles of axial and selective coding (Strauss & Corbin 1998; Onwuegbuzie et al., 2009). Afterwards, the two coders discussed the findings and reached a consensus (100% agreement). Quotes which best represented overarching themes were then selected.

Statistical Analysis

Survey data were fitted to binomial mixed effects models using the *glmer* package in R. Students could respond "agree," "disagree," or "don't know" to each question. Student responses coded "don't know" were grouped with "disagree" during quantitative analysis, with the rationale that both "disagree" and "don't know" represent non-expert attitudes. Thus, each question represented a binary choice, and our models asked whether the probability of a student's expressing expert attitudes was affected by the course (i.e., differences in a given student's response on pre- and post-surveys) or by a variety of demographic characteristics (course year, year in college, gender, underrepresented minority status, parent's education level, highest level biology taken in high school, number of college biology courses taken previously, and whether or not the student was a nursing major or enrolled in an honors program). Student ID was included as a random effect in the model, allowing us to correct for possible different starting levels of agreement among the different students. Our strategy for model analysis was to initially fit a model using all of the possible predictors as non-interacting fixed effects, and then to fit refined models that removed any predictors that were not significantly affecting student response. In these refined models, we then added interaction terms between all remaining predictors and pre/post to determine whether demographics predicted student receptiveness to course content; if these interaction terms were not significant, they were removed from the final analysis. Predicted levels of agreement for each question were computed from the final, refined model using the *lsmeans* package in R, and these were used to conduct pairwise comparisons between the questions. Predicted values from the model are expressed (e.g., in Figure 2) as log odds ratios, interpretable as the natural logarithm of $p/1\text{-}p$, where p is the probability of agreement and $1\text{-}p$ the probability of disagreement or "don't know."

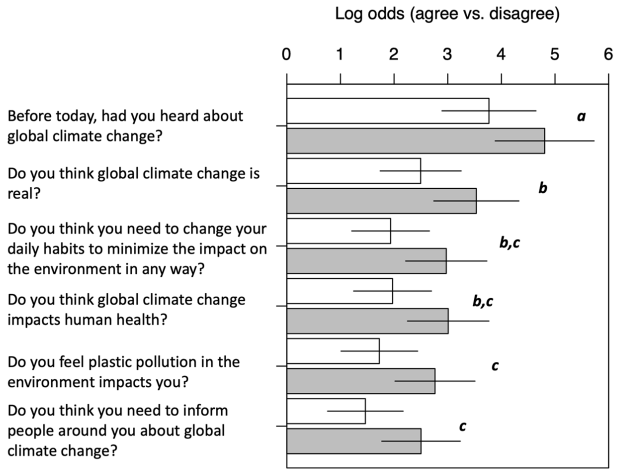
Results

Quantitative

One hundred seventeen students completed the pre- and post-surveys across the 2017 and 2018 cohorts. Students were significantly more likely to agree with each of the six statements regarding global climate change and plastic pollution after completing the service-learning module (see Figure 2; effect of pre- vs. post- on the log odds ratio, $+1.04 \pm 0.17$, $p = 1.2 \times 10^{-9}$). Also, female students were significantly more likely than male students to agree with the questions (log odds ratio $+0.82 \pm 0.35$, $p = 0.02$), and honors students were more likely than others to agree (log odds ratio $+1.59 \pm 0.61$, $p = 0.01$). There was no statistically significant impact of parental education level, minority status, or other demographic categories on the likelihood of agreeing with the statements, nor was there evidence that any of the demographic categories predicted how much a student's attitude would change over the course of the semester.

The likelihood of agreement varied dramatically among the questions as well. Students were significantly more likely to express familiarity with the concept of global climate change (Figure 2, Question 1) than to agree to any of the other statements. Students were also significantly more likely to accept the reality of global climate change (Figure 2, Question 2) than to express a feeling of responsibility for educating others about climate change or a concern about the impact of plastic pollution on themselves (Figure 2, Questions 5 and 6). There was no statistical evidence that agreement with any of the questions increased more than the others between the pre- and post-surveys; instead, they all increased by a similar amount.

FIGURE 2. Change in Student Attitudes About Climate Change



Students were asked six questions about their attitudes toward climate change; the natural logarithm of the odds of agreeing with each question vs. disagreeing are represented here by the bars, with error bars representing standard errors of the log odds estimate. For example, a value of 2 indicates that the odds of agreeing vs. disagreeing are e2, representing ~88% probability of agreement. A value of 0 would indicate equal odds of agreeing vs. disagreeing. Odds were calculated by averaging across all significant demographic predictors. Students were significantly more likely to agree with each question after taking the service-learning class (gray bars) than before taking it (white bars) (logistic mixed effects model, $p < 0.0001$). Lowercase letters represent significance groupings for pairwise least squares means comparisons among questions; note that there was no significant interaction between pre/post and question, i.e., the difference between pre-survey and post-survey is the same for all questions.

Qualitative

For a part of our qualitative analysis, we analyzed the same pre- and post-survey data set with particular attention not just to overall class trends, but also to the accompanying student justifications that were collected from the free-response portion of the questions. Twenty-one student responses changed from one or more of their pre-survey disagreements to agreement statements. A majority of the students who changed their minds to agreement expressed a realization of their responsibility as stakeholders in global climate change and plastic pollution (12 of the 21 student responses in this category); the rest of the students reported an increase in awareness about these issues (nine of 21 student responses in this category) (Table 3). On the other hand, 11 students remained either opposed or uncertain regarding one or more statements (Supplemental Table 4), with the most common being the need to inform others about climate change (Figure 2, Question 6). These 28 student responses reported apathy (three of 28), that it wasn't their place to change minds (four of 17), that they were already doing what they could (five of 28), or that the issues presented were not actually problems or were not real (13 of 28) (Table 3). Stances that remained unchanged included a student going from, "The world is changing on its own. We have a miniscule impact on it. Show me hard evidence that we have truly caused climate change," to "Because I don't know what sources to trust." Two other students reported on their post-surveys: "There is no real evidence...." and "...The science says it is real, but I question the integrity of the studies...." We note that the students who reported a lack of strong enough evidence were all from 2018, and interestingly, this cohort also included references to two political figures (Donald Trump and Al Gore), whereas the 2017 cohort did not (Supplemental Tables 2–4).

Fourteen students (12% of the overall 117) disagreed with post-survey statements who did not disagree with the pre-survey statements (Supplemental Table 3). Interestingly, these students' views were similar to those of students who maintained disagreement, with the addition of some students who reported a change in awareness after the course (Table 3). Similar to the students who disagreed in both pre- and post-surveys, several 2018 students expressed concerns possibly related to emotionally-charged political rhetoric. For instance, one student commented "Global climate change has become a loaded term in today's society associated with a kind of man-made apocalypse" and another was uncomfortable "spreading that our world is getting worse and worse" despite being willing "to spread about recycling and no littering." The

2017 cohort expressed no comparable sentiments. Across the spectrum of agreement and disagreement, however, students recapitulated themes addressed in the course as well as notions related to data or evidence that were presented in the data-driven lectures (Table 3, Supplemental Table 2).

Note: responses reflect total number of question responses rather than number of students. Question numbers (e.g. Q1) refer to the order of statements in Figure 2.

TABLE 2 Shifts in Pre- to Post-Survey Dispositions from Students in Both the 2017 and 2018 Cohorts.

Themes	Representative Student Quotes
Disagree to agree (21 responses)	
Changed awareness (9 of 21) Direct reference to course (1 of 9)	"Evidence shows that the way we currently live, is putting the world in danger. If we do not change things will give to be harder for human life on earth." Q3 "We depend on the environment and negative things occurring in it affect us." Q5
Realization of responsibility (12 of 21) Direct reference to course (1 of 12) Evidence-based (1 of 12) Political mention (1 of 12)	"Yes, there have been times when I would just throw my little trash on the ground or spit my gum out on the ground and I think that I am "giving back" to the world because the ants will eat it. After my service-learning, I see that is wrong and it hurts our environment." Q3 "People may not know how much they are destroying our planet with simple everyday habits. Educating them could/will help our planet and ourselves." Q6
Agree (or don't know) to disagree (17 responses)	
Not a current problem (7 of 17) Evidence-based (1 of 7) Direct reference to course (1 of 7) Political mention (2 of 7)	"I think it could potentially in the future, but right now I am unaware of any evidence supporting this theory." Q4
Doing as much as I can (2 of 17)	"I already recycle and conserve water as well as walk instead of drive as much as possible." Q3
Apathy (1 of 17)	"It happens on a much larger scale" Q5
Not my place (4 of 17)	"People live their lives the way they want to. It's not my job or place to tell them how to live and why." Q6
Changed awareness (3 of 17) Evidence-based (1 of 3) Direct reference to course (1 of 3)	"I do not think it impacts humans as much which is why only a select amount of people care about stopping plastic use for our wildlife/sea life, who it does affect." Q5
Disagree to disagree (28 responses)	
Not a current problem (13 of 28) Evidence-based (3 of 13) Political mention (4 of 13) Direct reference to course (1 of 13)	"It does not impact me directly I do not feel its influence yet. I am sure that one day I will though." Q5 "Again, this really is a skeptical thing for me anyway, so I'm not going to go around saying "the sky is falling" to anyone anytime soon. Yeah, the science says it is real, but I question the integrity of the studies. All of the professors seemed biased about it from the get go. I think that they also get paid to find results in their experiments that only favor global warming." Q6
Doing as much as I can (5 of 28)	"No. I stopped using plastic, don't litter, don't waste food, and live a relatively healthy lifestyle. I think that I'm good, but if someone comes to me and gives me tips or recommendations on ways to improve, then I will do what I can to improve." Q3
Apathy (7 of 28) Evidence-based (1 of 7) Direct reference to course (1 of 7)	"One person won't make a change and it's not convenient." Q3 "It does not impact me physically nor does it cause me any harm. Plastic pollution is sad but does nothing to me physically." Q5 "No, at this point they don't know because of lack of exposure/unawareness, instead they simply don't care." Q6
Not my place (3 of 28)	"I do not personally need to make people aware of climate change as it is a mainstream topic of debate and anyone who denies it isn't going to be swayed by me badgering them." Q6

We then analyzed the focus group interview (n=1 interview with 10 students). Three themes emerged from our analysis of this focus group data, including student comments on course structure, a connection between the service-learning experience and the lecture component, and a connection of the material to the student's everyday life. The themes and subthemes that emerged from the analysis are reflected in Table 4, along with representative quotations.

Interview responses from questions in Table 4 were coded into three themes (in dark blue boxes), each having its own subtheme (in light blue boxes) supported by student quotes from 10 different students from the 2017 cohort.

TABLE 3 Student Focus Group Data

University/class structure	
The service-learning component was diverse and already accounted for student's schedules.	"I did service-learning last semester with another class [but] this class was really good because she gave us time and blocked out certain class periods where we just didn't have to show up and instead do SL." "...providing a lot of options too that you didn't have to travel too far to get to."
Service-learning could be integrated into other courses these students may take or into other STEM courses.	"A business class would be really interested because you can evaluate green practices and how those work." "I think a foreign language class [would benefit from service-learning] ... if it was implemented, [you could] work with people in Spanish speaking communities."
Connection to course material/education	
Students made connections between service-learning and lecture material.	"She talked to us about plastics and pollution, especially in our oceans, and we picked up plastic for three hours and that was a cool thing to see that doing that helps it not get in rivers and oceans... [My service-learning experience] tied directly into what we learned in class."
Students adopted new behaviors and encouraged their friends and family about sustainable practices.	"This past Thanksgiving, we used plastic cups and paper cups, different things... I was the one that was supposed to buy them so I just didn't buy them. I was like, let's just use regular dishes and I'll wash them." "I started having a recycling bin in my own home...it actually reduces the amount of trash bags you use because you can end up saving."
Connection to everyday life	
Students were more cognizant of pollution around campus and the city.	"[Picking up litter], you kind of got to see how disgusting people really are." "I never thought we had a problem with littering until I had to go out and pick up the litter and I was like, 'we have a problem'. We found two whole pizzas up in the parking garage."
Students recognized climate change, pollution, and sustainability affects their everyday life.	"The details and how [pollution] affects your everyday life is what I learned the most about." "[The most important thing I learned was] sustainability improves our everyday lives."
Students acknowledged the future impact of climate change and steps they could take to lessen their impact.	"...but in the future, it's going to be major...it's going to change everything." "There are a lot of small actions that everyone can do, and that activated across the entire state or nation or world can really make a difference."

Discussion

Service-learning is recommended to engage non-major students (Packer, 2009) and there exists a need for students to better understand scientific data (Lineman et al., 2015; Schuldt et al., 2011; Dauer & Forbes, 2016). In this study, we targeted two non-major biology courses with data-driven class discussions led by climate change scientists, followed by service-learning projects involving environmental pollution and sustainable practices.

Students were significantly more likely to agree with six statements about climate change in our survey after taking our revised course (Figure 2). Importantly, there was no effect on the results due to previous biology experience or to racial or socioeconomic demographics, suggesting that this curriculum can be used across student groups. The large majority of students were familiar with climate change and accepted its reality, but were much less likely to agree with statements suggesting that individuals had a responsibility to change their own behavior or encourage others to do so. Our curriculum did not explicitly encourage students to promote these practices for others, but as some of our students noted, this could be embedded into other curricula that target other behavior or disciplines (Table 4), such as public speaking or business courses.

The open-ended format of our survey allowed students to justify their responses, giving us insight into the thought processes leading to changes in agreement between pre and post surveys. For those students who changed their minds from disagreement to agreement, the data-driven lectures and service-learning were directly referenced in several student justifications and seemed to have had an effect on their perspectives about climate change as they (Table 3, Supplemental Table 2). For students who did not agree with the statements by the end of the semester (Supplemental Tables 3 and 4), the majority indicated that global climate change is not a current problem, either because it is not real, not of significant magnitude to matter, or not under human control. Of these, several students cited a lack of scientific evidence, which suggests that students need more opportunities to judge the source of data in order to draw their own conclusions (Lineman et al., 2015; Schuldt et al., 2011; Dauer & Forbes, 2016), whereas other students referenced political reasons. Interestingly, we find these political sentiments only expressed by students in the 2018 cohort, possibly reflecting heated U.S. political discourse around climate change and the increasing polarization of U.S. politics following the controversial 2016 presidential election. It is possible that efforts to directly address the validity of differing political perspectives in the context of course material may improve the ability of these students to productively engage with the material, as have successful efforts to teach evolution to religious students (Barnes, Brownell, & Perez, 2017).

Three broad themes emerged from the focus group data: (a) students enjoyed the course structure, (b) students connected the service-learning experience to the classroom content, and (c) students connected their experiences to their day-to-day lives (Table 4). We know that service projects should be relevant and applicable to the learning objectives in the classroom so that students do not feel they are doing charity as busywork (Lynch, 2016; Chong, 2014), and when those connections are made, student mental networks of information are strengthened (Daniel & Mishra 2017; Lumpkin, Achen, & Dodd, 2015). When executed effectively service-learning has the capacity to foster student engagement at multiple levels: cognitive, behavioral, emotional, and social (Simonet, 2008; Celio et al., 2011). These components contribute to the learning process as well as to the student's own personal development and sense of involvement (Nigro & Farnsworth, 2009). Our responses confirmed the student's connections between the course learning objectives and their service-learning experience (Table 4).

In summary, we have shown promising effects for non-major students' understanding of environmental stewardship in a three-hour service-learning module coupled with data-driven lectures. Notably, the demonstrated student gains in both specific learning objectives and civic engagement are on par with longer service-learning modules (Begley, 2013; Larios-Sanz, Simmons, Bagnall, & Rosell, 2011; Cain, 2013); students commented positively on the time commitment, making a graded three-hour requirement a feasible option for instructors considering service-learning. Students also applauded how a few of the service-learning opportunities were during the actual class hours as opposed to being scheduled outside class time. Moreover, although many community supervisors aligned students with learning objectives of the course,

the engagement levels with students varied depending on the service-learning partner. When executed at UAB, this service-learning experience required the use of upper-level student supervisors to ensure students were participating for the entire time duration. We encourage interested professors to recruit teaching assistants and other student help for similar roles.

One limitation of this study is that students did not also answer formative, self-reflection questions about their overall experience, which is an important feature of the service-learning experience (Chong, 2014; Phelps, 2012; Soska, Sullivan-Cosetti, & Pasupuleti, 2010). Furthermore, this study did not tease out the degree to which the guest lectures, the professor lectures, or service-learning played a role in student gains, but rather approached these gains holistically, and we cannot be sure to what degree service-learning, as opposed to the broader curriculum, influenced the observed changes in student attitudes. We therefore recommend that future studies should attempt to analyze these components separately and should explicitly investigate how a student's political beliefs could possibly influence their experiences in community-centered courses. Despite these limitations, we find that our service-learning curriculum was effective for our students. We therefore encourage other educators not only to consider service-learning as an educational pedagogy, but also to use such activities in the context of stimulating a dialogue on polarizing topics like global climate change (Hawkins & Stark, 2016; Yoho & Vanmali, 2016), as a means of engaging non-major biology students.

Acknowledgements

We thank Gabrielle Richards for data entry and Dr. Jeffrey Olimpo as a reference for qualitative data analysis. This work would not be possible without the UAB Office of Undergraduate Research and Service-Learning, and especially Ms. Amy Badham. A special thank you to all of our community partners and site leaders including Dr. Julie Price with the office of Sustainability at UAB. We would also like to acknowledge our guest speakers Drs. Dustin Kemp and James McClintock. A huge thank you also to all our site leaders from the introductory biology classes.

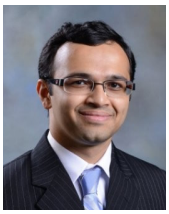
Funding

This material is based upon work supported by the National Science Foundation Research Coordination Networks in Undergraduate Biology Education [Grant No. 1826988] to J. J. M. and S. R. and the National Science Foundation Graduate Research Fellowship Program [Grant No. 1450078] to S. J. A. Student scholarships as an incentive to participate in the focus group interviews were supported by a mini-grant from the Office of Undergraduate Research and Service-Learning at UAB.

Authors

Daniel A. Mendoza is a Gates Millennium Scholar as well as a McNair Scholar. He graduated with a BS degree from the University of Alabama at Birmingham in 2019 and is currently a master's student at The George Washington University, studying special education for culturally and linguistically diverse learners.

Sarah Jeanne Adkins is a PhD Candidate and National Science Foundation Graduate Research Fellow studying biology education and microbiology at the University of Alabama at Birmingham, with interests in reforming science using art and interdisciplinarity and in course-based undergraduate research experiences. Sarah serves as the Chair for STEM Education for the Alabama Academy of Science and co-founded the Research On STEM Education (ROSE) Network.



Jay M. Bhatt is a research assistant professor at Creighton University in the Department of Pharmacology and Neuroscience. His biology education research focuses on engaging and mentoring undergraduate students in scientific life sciences research. His biomedical research focuses on understanding the molecular mechanisms that lead to human diseases.

J. Jeffrey Morris is an assistant professor at the University of Alabama at Birmingham and director of the ROSE Network, a NSF Research Coordination Network focused on the dissemination of evidence-based teaching practices to community colleges in order to improve the retention rates of transfer students into STEM programs at R1 universities. He also studies the ecology and evolution of marine bacteria, with a specific focus on the social lives of phytoplankton/bacterial consortia.

Samiksha A. Raut is an associate professor at the University of Alabama at Birmingham and an associate director of the ROSE Network, a NSF-RCN funded initiative for the dissemination of evidence-based teaching practices to community colleges. Her current research interests are focused on analyzing the impact of professional development on undergraduate teaching assistants and assessing the efficacy of different interventions in majors and non-majors biology courses. She has extensive experience in designing service-learning courses and is the recipient of the Provost Award for Faculty Excellence in Service-Learning at UAB. **Address all correspondence to : S. Raut (sraut@uab.edu)**

References

"UAB Student Data." (2017). Office of Institutional Effectiveness and Analysis. http://www.uab.edu/institutionaleffectiveness/images/factbook/sections/26_FactsFigures2018_StudentData.pdf

"Vision and change in biology undergraduate education, a call for action." (2009). In: Carol Brewer DS (ed.). American Association for the Advancement of Science. Washington, DC.

Barnes, M.E., Brownell, S.E., and Perez, K.E. (2017). "A call to use cultural competence when teaching evolution to religious college students: introducing religious cultural competence in evolution education (ReCCEE)." CBE Life Sciences Education, 16(4), es4.

Begley, G. S. (2013). "Making connections: service-learning in introductory cell and molecular biology." Journal of Microbiology & Biology Education: JMBE, 14(2), 213.

Brame, C. J. (2016). "Active learning." Vanderbilt University Center for Teaching.

Cain, D. M. (2013). "Impact of a service-learning project on student success in Allied Health Microbiology course." Journal of Microbiology & Biology Education: JMBE, 14(1), 129.

Celio, C. I., Durlak, J., & Dymnicki, A. (2011). "A meta-analysis of the impact of service-learning on students." Journal of Experiential Education, 34(2): 164-181.

Chong, C. S. (2014). "Service-learning research: Definitional challenges and complexities." Asia-Pacific Journal of Cooperative Education, 15(4): 347-358.

Cotner, S., Thompson, S., & Wright, R. (2017). "Do Biology Majors Really Differ from Non–STEM Majors?." CBE—Life Sciences Education, 16(3), ar48.

Daniel, K. L., & Mishra, C. (2017). "Student Outcomes From Participating in an International STEM Service-Learning Course." SAGE Open, 7(1), 2158244017697155.

Dauer, J. M., & Forbes, C. T. (2016). "Making decisions about complex socioscientific issues: a multidisciplinary science course." Science Education & Civic Engagement: An International Journal, 8(2), 5-12.

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). "Active learning increases student performance in science, engineering, and mathematics." Proc Natl Acad Sci USA, 111(23): 8410-8415.

Galgani, F., Pham, C. K., & Reisser, J. (2017). "Plastic Pollution. Frontiers in Marine Science," 4, 307.

Harvey, C. (2018). "Climate change is becoming a top threat to biodiversity." Scientific American.

Haward, M. (2018). "Plastic pollution of the world's seas and oceans as a contemporary challenge in ocean governance." Nature Communications, 9(1), 667.

Hawkins, A. J., & Stark, L. A. (2016). "Bringing Climate Change into the Life Science Classroom: Essentials, Impacts on Life, and Addressing Misconceptions." CBE—Life Sciences Education, 15(2), fe3.

Herlihy, N., Bar-Hen, A., Verner, G., Fischer, H., Sauerborn, R., Depoux, A., Flahault, A., & Schutte, S. (2016). "Climate change and human health: What are the research trends? A scoping review protocol." BMJ Open, 6(12), e012022.

Keupper-Tetzel, C. (2017). "Service learning: An engaging teaching concept." The Learning Scientists.

Knight, J. K., & Smith, M. K. (2010). "Different but equal? How nonmajors and majors approach and learn genetics." CBE—Life Sciences Education, 9(1), 34-44.

Larios-Sanz, M., Simmons, A. D., Bagnall, R. A., & Rosell, R. C. (2011). "Implementation of a service-learning module in medical microbiology and cell biology classes at an undergraduate liberal arts university." Journal of Microbiology & Biology Education: JMBE, 12(1), 29.

Lineman, M., Do, Y., Kim, J. Y., & Joo, G.-J. (2015). "Talking about Climate Change and Global Warming." Plos One, 10(9): e0138996.

Little, A. M. (2012). "Service learning in non-majors biology: Learning outcomes and lessons from the field."

Lumpkin, A., Achen, R. M., & Dodd, R. K. (2015). "Students perceptions of active learning." College Student Journal.

Lynch, J. (2016). "What does research say about active learning?" Pearson.

Matthews, P. H., Dorfman, J. H., & Wu, X. (2015). "The impacts of undergraduate service-learning on post-graduation employment opportunities." International Journal of Research on Service-Learning and Community Engagement, 3(1).

McLaughlin, J., Patel, M., Johnson, D. K., & de la Rosa, C. L. (2018). "The Impact of a Short-Term Study Abroad Program that Offers a Course-Based Undergraduate Research Experience and Conservation Activities." Frontiers: The Interdisciplinary Journal of Study Abroad, 30(3).

Nam, Y., & Ito, E. (2011). "A climate change course for undergraduate students." Journal of Geoscience Education, 59(4), 229-241.

Nigro, G., & Farnsworth, N. (2009). "The effects of service-learning on retention." Northern New England Campus Compact.

Onwuegbuzie, A. J., Dickinson, W. B., Leech, N. L., & Zoran, A. G. (2009). "A qualitative framework for collecting and analyzing data in focus group research." International journal of qualitative methods, 8(3), 1-21.

Packer, A. (2009). "Service Learning in a Non-majors Biology Course Promotes Changes in Students' Attitudes and Values About the Environment." International Journal for the Scholarship of Teaching and Learning, 3(1), n1.

Phelps, A. L. (2012). "Stepping from service-learning to SERVICE-LEARNING pedagogy." Journal of Statistics Education, 20(3).

Schuldt, J. P., Konrath, S. H., & Schwarz, N. (2011). ""Global warming" or "climate change"?: Whether the planet is warming depends on question wording." Public Opinion Quarterly, 75(1): 115-124.

Simonet, D. (2008). "Service-learning and academic success: The links to retention research." Minnesota Campus Compact, 1, 1-13.

Soska, T. M., Sullivan-Cosetti, M., & Pasupuleti, S. (2010). "Service Learning: Community Engagement and Partnership for Integrating Teaching, Research, and Service." Journal of Community Practice, 18(2-3): 139-147.

Strauss, A., & Corbin, J. (1998). "Basics of qualitative research: Techniques and procedures for developing grounded theory." Thousand Oaks, CA: Sage publications.

Wu, X., Lu, Y., Zhou, S., Chen, L., & Xu, B. (2016). "Impact of climate change on human infectious diseases: Empirical evidence and human adaptation." Environ Int, 86: 14-23.

Yoho, R. A., & Vanmali, B. H. (2016). "Controversy in biology classrooms—citizen science approaches to evolution and applications to climate change discussions." Journal of microbiology & biology education, 17(1), 110.

Yokota, K., Waterfield, H., Hastings, C., Davidson, E., Kwietniewski, E., & Wells, B. (2017). "Finding the missing piece of the aquatic plastic pollution puzzle: Interaction between primary producers and microplastics." Limnology and Oceanography Letters, 2(4): 91-104.

Supplemental Information

Pre-/Post-Reflection BY 101-1C (Fall 2017/Fall 2018)

(Responses to italicized questions were not included in the analysis.)

Please provide as much information as you can about your opinions and why you think that way. There are no right or wrong answers. We are just interested in knowing your views.

Your Name: _____

Your selected Community Partner: _____

1. *What does it mean for a person to live sustainably? Explain.*
2. *How do you think the service-learning experience will help (or has helped) you put BY101 course content into actual practice? Expla*in.
3. Before today, had you heard about global climate change? Agree / Disagree / Don't know

   Explain the reasoning for your above-mentioned response.
4. *Describe in your own words what you think global climate change is all about.*
5. Do you think global climate change is real? Agree / Disagree / Don't know

   Please explain your reasoning for your response.
6. Do you think global climate change impacts human health? Agree / Disagree / Don't know

   Please explain your reasoning for your response.
7. Do you feel plastic pollution in the environment impacts you? Agree / Disagree / Don't know

   Please explain your reasoning for your response.
8. Do you think you need to change your daily habits in any way to minimize the impact on the environment?

   Agree / Disagree / Don't know

   Please explain your reasoning for your response.
9. Do you think you need to inform people around you about global climate change, suggest/recommend to them about any lifestyle changes they need to make to attempt to minimize the impact on the environment? Agree / Disagree / Don't know

   Please explain your reasoning for your response.

Supplemental Table 1

Demographic Information on 117 Consenting Students

Gender	64.4% Female 35.6% Male
Race/Ethnicity	56.8% Caucasian 33.9% African American 1.7% Asian 0.8% American Indian 3.4% Other 3.4% Unreported
Classification	16.1% Freshmen 48.3% Sophomore 24.6% Junior 5.9% Senior 5.1% 5th year Senior
Highest biology course taken in high school	47.5% Regular 22.9% Advanced Placement 22.0% Honors 3.4% Other 3.4% None 0.8% Unreported
Number of biology courses taken in college	65.3% One 28.0% Two 2.5% Three 3.4% Four or more 0.8% Unreported

Supplemental Table 2

Explanations from Students Who Disagreed at the Beginning of the Semester but Agreed with Statements at the End of the Semester

Cohort Year	Pre-Survey Disagree Explanation	Post-Survey Agree Explanation
2017	"I feel like I am very good to the environment." Q3	"After looking at my "footprint" I realized that many things I do are harming the earth - from the amount of time I spend showering to how many hours I spend driving a non-eco-friendly car" Q3
2017	"I feel that I am surrounded by people who are also very good to the environment." Q6	"I live in a house with my 3 siblings and 2 parents who do not believe in climate change, and their "footprint" is larger than mine. Although changing 5 people won't make a huge impact, you have to start somewhere." Q6
2017	"While it doesn't impact me, it affects the environment which I am part of." Q5	"Plastic pollution literally surrounds me on a daily basis." Q5
2017	"I will let people around me do their own thing, so I won't make them change their lifestyle, but I may still let them know about climate change." Q6	"Yes. It is crazy how just using plastic or littering can make such a huge impact on the environment. These are small things that, if people stopped doing, would seriously help contain the negative impacts of pollution, littering, etc. Everyone needs to know about the negatives that come as a result of pollution and using plastic, and I could tell them." Q6
2017	"Whether or not people believe in climate change, its going to take something terrible to happen to make people change their ways." Q6	"People may not know how much they are destroying our planet with simple everyday habits. Educating them could/will help our planet and ourselves." Q6
2017	"I recycle and throw away my trash. I'm sure there is more I could do right now I'm doing as well as I know." Q3	"I could reuse water bottles more and recycle bottles, paper, plastic bags, and other things." Q3
2017	"I'm pretty sure I do my best at recycling and keeping the environment clean." Q3	"Evidence shows that the way we currently live, is putting the world in danger. If we do not change things will give to be harder for human life on earth." Q3
2017	"I already avoid using air conditioning and leaving lights on if not necessary. Also do not drive a car in the city and try to recycle the garbage if possible." Q3	"I need to be more cautious not to put garbage in the wrong sequence. Don't leave light on etc." Q3
2017	"I don't really feel that it impacts me besides the fact that it is ugly, but I am against it because it can hurt animals." Q5	"I think plastic pollution impacts everyone in some way. Some people are impacted more than others depending on the amount of pollution, but everyone is affected at some point." Q5
2017	"I am already pretty environmentally conscious and try to do my part in keeping it clean." Q3	"I recycle and use reusable products such as stainless steel bottles, but there is always a way in which you can change your habits improve the environment." Q3
2018	"Because everyone with the means to live better simply have chosen not to, my words won't change them." Q6	"If not now, when." Q6
2018	"I have heard mentioning of it but did not get detailed information about it." Q1	"At first before class, I really did not have a good understanding of what it was but now due to this class or course I do." Q1
2018	"I really don't know, but yes and no because some people would actually come and have a community day. Then there's some people that don't care about their community and how disgusting it looks." Q6	"Yes, we should try to at least make a change and come together to help other people and their communities stay clean." Q6

2018	"People do not and will not listen to an issue affecting everyone until it's on their doorstep. Only direct involvement spurs action.' Q6	"If I have to change so do you guys. Seriously though, we can only joke about climate change for so long before its not funny. Please do even your smallest part to help. We messed up bad when we let Trump win, don't let pollution win too." Q6
2018	"I do not litter or harm the environment in any kind of way." Q3	"Yes, there have been times when I would just rhow my little trash on the ground or spit my gum out on the ground and I think that I am "giving back" to the world because the ants will eat it. After my service-learning, I see that is wrong and it hurts our environment." Q3
2018	"I do not believe trash, pollution, etc. is changing our climate, but I do believe it hurts our earth." Q1	"We have surrounded this class with learning about climate change." Q1
2018	"It impacts much of the wildlife around me, nut not me specifically, not even by association." Q5	"We consume too much plastic, it's sad." Q5
2018	"I haven't noticed a change." Q5	"Plastic is not good for your health or for the environment." Q5
2018	"I personally won't experience the effects, my grandchildren are a different story. That's a selfish perspective but it's true." Q5	"We depend on the environment and negative things occuring in it affect us." Q5
2018	"I could recycle more , but other than that I see myself as an environmentally friendly person." Q3	"I could recycle more and stop using plastic bottles." Q3
2018	"The climate plays a big role in agriculture which affects a human's daily diet. Diet is directly correlated with health." Q4	"It changes the type of resources we have to live in our environment." Q4

Question numbers (e.g., Q1) refer to the order of statements in Figure 2.

Supplemental Table 3

Explanations from Students Who Changed from Agreement (A) or "Don't Know" (DK) at the Beginning of the Semester to Disagreement at the End of the Semester

Cohort Year	Pre-Survey Explanation	Post-Survey Disagree Explanation
2017	A: "Things like exhaust from vehicles affects human health & less oxygen content in the air also affects human health." Q4	"I think it could potentially in the future, but right now I am unaware of any evidence supporting this theory." Q4
2017	A: "We have had a change in the weather with different hurricanes, tropical storms, and earthquakes." Q1	"I really haven't been aware of the climate changes." Q1
2017	A: "A small change in bad habits can eventually lead to a better outcome." Q3	"I already recycle and conserve water as well as walk instead of drive as much as possible." Q3
2017	DK: "This is more of a question of how much a single person's actions can change the world." Q3	"I do not currently affect the environment in an outstandingly negative manner." Q3
2017	A: "When they melt down plastic, it releases toxic fumes" Q5	"It happens on a much larger scale" Q5
2017	DK: "Some things people need to learn for themselves" Q6	"Everyone chooses those things personally" Q6
2017	DK: "People make their own choices." Q6	"People live their lives the way they want to. It's not my job or place to tell them how to live and why." Q6
2018	DK: "I am sure it does to a certain extent, but I would not say it does directly." Q5	"As of now, it doesn't, but it will in the future if I am still alive." Q5
2018	DK: "I try to live sustainably but I am sure there is room for improvement." Q3	"I believe I live reasonably sustainably" Q3
2018	DK: "I can see why people will blame global warming on us but the world goes through phases like the Ice Age, land __rdge, and other stuff like that." Q2	"We had an Ice Age the Earth goes through phases." Q2
2018	A: "It probably does in some way." Q4	"No it's not a big enough difference now." Q4
2018	A: "Our climate is always going through its natural course. It was debunked as global warming, so the term got changed to climate change." Q1	"I do not believe in climate change. I believe it was propaganda starting with Al Gore as global warming. That was debunked and then the liberal media started using the term climate change. I don't believe in what the liberals promote." Q1
2018	DK: "I do not think it impacts humans as much which is why only a select amount of people care about stopping plastic use for our wildlife/sea life, who it does affect." Q5	"I think polluting the earth with plastic content is harming our earth and animals more than anyone is aware of. Especially sea life." Q5
2018	A: "I heard about global climate change in my previous science classes" Q1	"I didn't know anything about global climate change until I took this class." Q1
2018	DK: "As stated before, I am not sure what I do affects the environment but I would once I fully understand." Q6	"Most people know the impact on the climate so I would not continue to tell them. At the end of the day it's their choice to make." Q6
2018	DK: "This topic hasn't study a long enough trend to be an issue. But climates definitely change so what climate change looks like today is not knowable." Q2	"Global climate change has become a loaded term in today's society associated with a kind of man-made apocalypse. This doesn't exist. But it is getting kind of warm." Q2
2018	A: "The more people that help, the better and faster our earth becomes." Q6	"I don't think spreading that our world is getting worse and worse but to spread about recycling and no littering." Q6

Question numbers (e.g., Q1) refer to the order of statements in Figure 2.

Supplemental Table 4

Explanations from Students Who Disagreed with Survey Statements in both the Pre- and Post- Surveys

Cohort Year	Pre-Survey Explanation	Post-Survey Explanation
2017	"Not me personally I don't feel the effects but I know there are effects." Q5	"It does not impact me directly I do not feel its influence yet. I am sure that one day I will though." Q5
2017	"In my daily life, I do minimal damage to the environment, and I feel no need to change my routine in order to save it." Q3	"No. I stopped using plastic, don't litter, don't waste food, and live a relatively healthy lifestyle. I think that I'm good, but if someone comes to me and gives me tips or recommendations on ways to improve, then I will do what I can to improve." Q3
2017	"The plastic is just in a landfill and won't affect me in my time." Q5	"I don't see it and I haven't had a problem with it so who knows." Q5
2017	"I don't use much plastic or anything so I think I'm good." Q3	"I don't waste a lot. My footprint isn't that big so I don't think I need to change my methods" Q3
2017	"I don't personally buy-in to the whole global warming stuff so no, I don't think I need to inform people." Q6	"Again, this really is a skeptical thing for me anyway, so I'm not going to go around saying "the sky is falling" to anyone anytime soon. Yeah, the science says it is real, but I question the integrity of the studies. All of the professors seemed biased about it from the get go. I think that they also get paid to find results in their experiments that only favor global warming." Q6
2017	"I don't really know because I have not done my research on it enough." Q2	"I don't really believe so. I think it is natural." Q2
2017	"Anyone willing to do so most likely already knows about it, as it's one of the main things people have been arguing over the past decade." Q6	"I do not personally need to make people aware of climate change as it is a mainstream topic of debate and anyone who denies it isn't going to be swayed by me badgering them." Q6
2018	"It is not my place to shove a lifestyle down someone's throat." Q6	"I'm not a dick who spouts out unsolicited opinion. It isn't my responsibility to control the actions of others." Q6
2018	"I do what I can to protect the earth and do my best to help it stay clean, there are things I do that are harmful, but I don't have the ability to cut those things." Q3	"I live in a pretty eco friendly way." Q3
2018	"I feel that others do enough, and get annoyed when people stick their noses in my life. I won't do the same." Q6	"Plenty of other people do that." Q6
2018	"Although I use plastic bottles, I'm not careless to place the bottles anywhere except the recycling bin."	"Unlike some people, I don't litter." Q3
2018	"It's more convenient and affordable to use plastics and other pollutants." Q3	"One person won't make a change and its not convenient." Q3
2018	"People aren't going to go out of their way to save a few others." Q6	"No one cares enough." Q6
2018	"It's not my place to nor do I have enough facts to." Q6	"I don't have enough knowledge to inform people nor am I passionate enough." Q6
2018	"It is something Al Gore invested in so it cannot be a good thing. I believe it is a man made hoax." Q2	"There is no real evidence. The climate is taking its natural course. We will probably have another ice age." Q2
2018	"Bad habits like smoking and being around smoke is bad for your health. Pollution is man made and that can be bad for your health. It has nothing to do with the climate." Q4	"I believe people are going to have health issues for many reasons. Not exercising, not eating health, smoking, drug and alcohol use." Q4
2018	"I may need to change daily habits but they have nothing to do with the climate." Q3	"I don't litter. I throw trash out. I don't care to take the time to recycle." Q3

2018	"I don't believe in climate change." Q6	"It is not an important issue for me." Q6
2018	"Life changes and we learn to adapt, species dying from "climate change" is natural. Dinosaurs don't still exist but were once here." Q2	"Air pollution and things of that nature are real but the raising of temperature is dumb" Q2
2018	"In rural areas no, but high polluted cities it definitely does." Q4	"I believe emission intake can impact human health and air pollution, but a slight rise in temperature does not." Q4
2018	"Personally, not here in Alabama but it does impact animals and humans globally." Q5	"Personally, no, in other countries, yes. For example, in Brazil people cannot swim in the ocean because of the plastic within it." Q5
2018	"I never litter. I recycle and try to limit my waste and plastic usage." Q3	"I properly throw my trash away as well as recycle. But I drive a car like anyone else, what am I supposed to do, bike to school?" Q3
2018	"I don't believe in climate change." Q6	"Freedom allows you to do what you want. If you wanna drive a Gas Guzzler then go for it." Q6
2018	"I don't think any pollution is hurting the atmosphere to change the climate, but I believe pollution hurts our world in other ways." Q2	"I don't believe in global warming because I don't see enough of a difference to make this 100% true. For example, the coral dying from rising temp. That same coral reef is growing back and no one knows why." Q2
2018	"I think plastic water bottles, but they are very practical to my life- I know this is selfish." Q3	"Our daily life events don't impact "climate change" in comparison to volcanoes." Q3
2018	"The world is changing on its own. We have a miniscule impact on it. Show me hard evidence that we have truly causes climate change." Q6	"Because I don't know what sources to trust." Q6
2018	"At this point they don't know or don't want to. Its 2018 research backs it and it's on individuals to govern themselves accordingly." Q6	"No, at this point they don't know because of lack of exposure/unawareness, instead they simply don't care." Q6
2018	"I don't think so because plastic does not affect me whatsoever." Q5	"It does not impact me physically nor does it cause me any harm. Plastic pollution is sad but does nothing to me physically." Q5

Question numbers (e.g., Q1) refer to the order of statements in Figure 2.

INTRODUCTORY BIOLOGY (Non-Science Majors) – BY 101 2E

Topics in Contemporary Biology

Fall 2018

Instructor: Dr. Sami Raut

Office: Campbell Hall - 104

Office Phone Number: (205) 934-9680

Email: sraut@uab.edu

Office Hours: By appointment on most days of the week

Lecture: Tuesday & Thursday (Section 2E) 2 pm – 3:15 pm (HB 105)

Textbook (Recommended): Biology: Science for Life with Physiology, 5th Edition, Belk & Borden Maier (Note: This book has can been customized and is now available as an e-book for $23.92)
https://collections.pearsoned.com/#purchaseebook/1323549234
Another free reference book from Openstax:
https://cnx.org/contents/s8Hh0oOc@12.1:Pj8cW7X1@5/Introduction

Course Description:

To begin with, this course will introduce you to the fundamental principles in Biology and the process of science in general. Besides, this course also aims at developing the critical thinking skills required to make well-informed, fact-based logical decisions and opinions related to personal, social and ecological issues. There is a special learning module on environmental issues and it is tied with service – learning. Service- learning is a form of teaching and learning strategy that integrates meaningful community service with instruction and reflection to enrich the learning experience, teach civic responsibility, and strengthen communities.

Course Learning Objectives:

Understand the basic process of science
Identify the valid sources of scientific literature
*Environmental consciousness and civic responsibility
Analyze and apply scientific information to make everyday decisions
Gain a basic understanding of cell and its functions as it relates to health and wellness
Understand the process of evolution and evidence behind it
*Includes a service-learning component

Class Policies:

Attendance:-

Lecture attendance is highly encouraged so that you can gain a better understanding of the material and do not fall behind. Note: The class will exactly start at the assigned time and therefore, please see that you come to class on time. Additionally, quizzes/ assignments, case studies, etc will be given at intervals. It is therefore, to your advantage to come to class and gain valuable participation points. There will not be any make-up quizzes or assignments, etc. If you do miss a class, then it is your responsibility to obtain lecture materials, handouts, assignments and class announcements from your fellow classmates. This also applies to additional material included in the lecture other than the textbook. There is a lot

of additional material in this course that will get incorporated from variety of different sources. We will have many guest lectures at intervals.

Class Ambience–

Please note that the class ambience is **"highly social"**! We incorporate many **active learning** techniques, which means you will be asked to collaborate with your immediate neighbor and exchange a few words or maybe complete an assignment. So, please see that you are seated next to someone. Many studies in the recent times have shown that students tend to learn better, when there is incorporation of active learning techniques in the classroom. This class attempts to create a positive and an inclusive learning environment for all so that no one feels inhibited to express themselves. Therefore, please be courteous to your classmates; do not indulge in unnecessary side/random conversations and all kinds of digital distractions.

Lecture Exams -

Attendance for all the exams is mandatory and is highly encouraged. All evaluated exams and quizzes/assignments have to be returned back to the instructor and are the sole property of the instructor. If you fail to do so, it will result in a "ZERO" for that particular exam or quiz/assignment. Bonus Quizzes/assignments will be announced or unannounced.

Make-up Exams-

Attendance for the scheduled exams is mandatory. Make-up exams are ONLY given in cases of medical in capacitance or extreme hardship. You must notify me before the exam if you will not be able to take the exam. Documentation clearly stating the date of the scheduled exam will be required. Failure to notify me within 24 hours of the scheduled exam will be an automatic 0. Please note: Make-up exams are essay exams. The make-up will be at the convenience of the instructor. Allow 3 hours for the make-up exam. Official university business that is in conflict with the exam will be considered excused if the student notifies me at the earliest date and provides a letter from the event's sponsor.

Exam Format-

In general, the exam format will be multiple-choice and true/false.

DSS Accessibility Statement

UAB is committed to providing an accessible learning experience for all students. If you are a student with a disability that qualifies under Americans with Disabilities Act (ADA) and Section 504 of the Rehabilitation Act, and you require accommodations, please contact Disability Support Services for information on accommodations, registration and procedures. Requests for reasonable accommodations involve an interactive process and consist of a collaborative effort among the student, DSS, faculty and staff. If you are registered with Disability Support

Services, please contact DSS to discuss accommodations that may be necessary in this course**. Students registered with Disability Support Services must provide a DSS accommodation request letter to their instructor via email before receiving any academic adjustments.** If you have a disability but have not contacted Disability Support Services, please call 934-420 or visit http://www.uab.edu/dss or Hill Student Center Suite 409.

Title IX Statement

The University of Alabama at Birmingham is committed to providing an environment that is free from sexual misconduct, which includes gender-based assault, harassment, exploitation, dating and domestic violence, stalking, as well as discrimination based on sex, sexual orientation, gender identity, and gender expression. If you have experienced any of the aforementioned conduct, we encourage you to report the incident. UAB provides several avenues for reporting. For more information about Title IX, policy, reporting, protections, resources and supports, please visit http://www.uab.edu/titleix for UAB's Title IX Policy, UAB's Equal Opportunity, Anti-Harassment Policy and Duty to Report and Non-Retaliation Policy.

Withdrawing-

You may withdraw from a course and receive a grade of "**W**" up to and including **October 19th.** Please follow the University procedures to withdraw.

Cheating-

Please read and make sure you understand the UAB Academic Honor Code. Academic dishonesty will be reported to the appropriate university officials. Punishment is explained in the student handbook. **Cheating is taken very seriously and will result in greater administrative action.**

Grading-

Exams: 70%
Class Participation: 10 %
Service Learning: 20 %

Service Learning: Out of the 20% allotted to service learning, 15% will be assigned to the complementation of **three service-hours** with the community partners and the remainder of 5% will be devoted to the pre (2.5%) and post-reflection (2.5%). There will be a sign up required to participate in service hours with the specified community partners. You cannot show up at the community partner's site without a sign-up.

Three exams each worth 50 points (Please bring #2 pencils and an eraser for each exam. Answers marked on the scantron will only be taken into account and scantrons will not be re-run. So, please mark and erase your answers if there were a need on the scantron very clearly.)

Exams begin promptly at the scheduled time. You must be on time for exams. **Note: If you are more than 10 minutes late then you won't be allowed to take the exam.**

Grades will be assigned as follows:

A: 90-100%
B: 80-89.99 %
C: 70-79.99 %
D: 60-69.99 %
F: under 59.99%

NOTE: There is NO EXTRA-CREDIT!!

A Teaching Assistant (TA) is available for this class. TA will conduct a review session prior to every exam.

Canvas-

All class power points will be uploaded on Canvas after the lecture. Note: The class power points simply supplement the lecture and hence, coming to class and taking notes will be helpful.

Electronic Gadgets-

Usage of cellular devices inside the classroom including **texting is strictly prohibited!** Texting in the class will result in a 10-point deduction from your overall grade each time you text. Laptops and ipads are ONLY allowed for taking notes. However, if you are doing anything else on these devices other than taking notes, this will result in banning you from future use of the laptop/ipad. Taking screen-shots of the blackboard with electronic devices is strictly prohibited as well.

Review Session Location & Hours: TBA

II. Tutoring Service at UAB-

To get a tutor please email: uasc@uab.edu or call 205-975-4884.
This service is free of charge to all enrolled UAB students and is offered by the University Academic Success Center.

Topics in Contemporary Biology BY 101-2E (Fall 2018)

Tentative Lecture Schedule

Note: This schedule is subject to change at the instructor's discretion.

Week of	Lecture Topic and Chapter(s)
Aug 27th	**Ch. 1** Can Science Cure the Common Cold An introduction to the Scientific Method
Sept 3rd	**Ch. 2** Science Fiction, Bad Science and Pseudoscience Water, Biochemistry and Cells ***Speed-Matching Event with Community Partners** *
Sept 10th	**Ch. 3** Is it possible to supplement your way to better performance and health? **Ch. 6** Cancer DNA synthesis, Mitosis and Meiosis
*Sept 17th	*Global Climate Change & Sustainable Practices
*Sept 24th	*Global Climate Change & Sustainable Practices
Oct 1st	**Exam # 1** **Ch. 7** Are you only as smart as your genes? Mendelian and Quantitative Genetics
Oct 8th	**Ch. 8** DNA detective Complex patterns of inheritance and DNA profiling
Oct 15th	**Ch.9** Genetically modified organism Gene Expression, Mutation, Stem cells and Cloning
Oct 22nd	**Ch. 11** Where did we come from? The evidence for Evolution
Oct 29th	**Ch. 20** Vaccination: Protection and Prevention or Peril?
Nov 5th	**Exam # 2** **Ch. 17** Organ Donation Tissues & Organs
Nov 12th	Endocrine System Endocrine Disruptors
Nov 19th	THANKS-GIVING BREAK!
Nov 26th	Infectious Diseases: bacteria & viruses Cardiovascular System : Heart diseases
Dec 3rd	Digestive System : Obesity & Diabetes
Dec 10th	Final Exam (Tuesday December 11th from 1:30 pm & onward) only on material covered after exam # 3

**Service-Learning*