SCIENCE EDUCATION
& CIVIC ENGAGEMENT
AN INTERNATIONAL JOURNAL

VOLUME TWELVE
ISSUE ONE
Winter 2020

SCIENCE EDUCATION & CIVIC ENGAGEMENT
AN INTERNATIONAL JOURNAL

Volume 12 Issue 1 · Winter 2020

ISSN: 2167-1230

National Center for Science and Civic Engagement
Department of Technology and Society
1432 Old Computer Science
Stony Brook University
Stony Brook, NY 11794-4400
www.ncsce.net

Partial support for this Journal was provided by the National Science Foundation's Course, Curriculum and Laboratory Improvement Program under grant DUE 0618431. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily represent the view of the National Science Foundation or the National Center for Science and Civic Engagement.

VOLUME TWELVE
ISSUE ONE
Winter 2020

About the Journal

Science Education and Civic Engagement: An International Journal is an online, peer-reviewed journal. It publishes articles that examine how to use important civic issues as a context to engage students, stimulate their interest, and promote their success in mathematics and science. By exploring civic questions, we seek to empower students to become active participants in their learning, as well as engaged members of their communities. The journal publishes the following types of articles:

- ***Book & Media Reports***
- ***Point of View***
- ***Project Reports***
- ***Research***
- ***Review***
- ***Science Education & Public Policy***
- ***Teaching & Learning***

The Journal is published twice per year in an online format. The official publisher of the journal is Stony Brook University home of the National Center for Science and Civic Engagement. Editorial offices for the Journal are located in Lancaster, PA.

WWW.SECEIJ.NET

Contents

From the Editors

For the Winter 2020 issue of this journal, we are pleased to feature two project reports and a research article that explore the impact of service learning on students, faculty, and civic engagement.

In a study of teacher leadership, **David Devraj Kumar** and **Sharon Moffitt,** both from Florida Atlantic University, examined how a service learning opportunity influenced the development of leadership qualities in a cohort of students who were training to be K-12 STEM teachers. Analyzing the self-reflections of the service-learning participants revealed an increase in their depth of scientific content knowledge, together with greater self-confidence in their capacity to communicate scientific ideas. This pilot study provides the foundation for future research into the connections between leadership skills, classroom capabilities, and student learning.

In another example of service learning, **Paula Kay Lazrus** and a team of colleagues from St. John's University describe the creation of a Faculty Learning Community that encompassed first-year courses in Chemistry, Mathematics, and Scientific Inquiry. Students in these courses participated in a service project to build solar phone chargers for a school in Puerto Rico in the aftermath of Hurricane Maria. Positive outcomes from the project include enhanced collaboration among the faculty and a sense of institutional belonging among the students since their service project is aligned with the St. John's University mission statement.

What is the impact of a service learning curriculum on environmental awareness? This question is investigated in a research article by **Daniel A. Mendoza** and a team of colleagues from the University of Alabama in Birmingham, George Washington University, and Creighton University. The study focused on a population of non-science majors, providing them with a service learning module and informational lectures by climate scientists. Student surveys revealed an increased understanding of climate change and plastic pollution as urgent environmental concerns. The authors note that developing the civic engagement of non-science majors, who are the majority of college graduates, is particularly important for generating informed citizens.

We wish to thank all the manuscript authors for sharing their scholarly work with the readers of this journal.

Matt Fisher
Trace Jordan
Co-Editors-in-Chief

PROJECT REPORT

STEM Teacher Leadership Development Through Community Engagement

DAVID DEVRAJ KUMAR
Florida Atlantic University

SHARON MOFFITT
Florida Atlantic University

Abstract

Academic service-learning through community engagement in a museum provides an opportunity for teacher leadership development in science, technology, engineering, and mathematics (STEM) education. Twenty student volunteers from teacher education in a public university took part in service-learning teacher leadership activities in STEM education through a local museum. A preliminary analysis of student responses to self-reflection questions indicated emerging themes predominantly in the areas of self-confidence development and depth of understanding of the topic, followed by audience STEM learning and sense of self-responsibility. Plans for future direction are explored with implications for teacher leadership in STEM education.

Keywords: STEM education, preservice teacher leadership, community engagement, museum, informal science education, service-learning, efficacy, student volunteer

Introduction

This paper describes academic service-learning by student volunteers in teacher education through community engagement in science, technology, engineering, and mathematics (STEM) education in a museum, with a focus on developing teacher leadership. Calls for a workforce that is STEM skilled are being heard from leaders in business, government, and education. For example, the Committee on STEM Education of the National Science and Technology Council (2018) stated that "the nation is stronger when all Americans benefit from an education that provides a strong STEM foundation for fully engaging in and contributing to their communities, and for succeeding in STEM-related careers, if they choose.... Even for those who may never be employed in a STEM-related job, a basic understanding and comfort with STEM and STEM-enabled technology has become a prerequisite for full participation in modern

society" (p. 5). According to President Donald Trump, his administration "will do everything possible to provide our children, especially kids in underserved areas, with access to high-quality education in science, technology, engineering, and mathematics" (Office of Science and Technology Policy, 2018, n.p.). How to transform such reform calls into action in K–12 classrooms is an important question. This article draws attention to the connection between teacher leadership in STEM areas and the university experiences and opportunities of aspiring teachers. Specifically, does academic service learning in STEM through community engagement in a local museum develop teacher leadership skills?

Teacher Leadership

For the purpose of this study, teacher leadership in preservice STEM education is defined as follows: It is a process of developing leadership qualities (e.g., knowledge, dispositions, skills) in preservice teachers by engaging in volunteer activities that extend beyond classrooms into the community, tapping into local STEM resources (Ado, 2016; Bond, 2011; Teacher Leadership Exploratory Consortium, 2011; Center for Strengthening the Teaching Profession, 2018; Wenner & Campbell, 2018).

Bond (2011) in a review of teacher leadership recommended that preservice teachers be given opportunities to serve and learn through volunteer activities in their local communities. Ado (2016) suggested "improving outreach and collaboration with families and community" (p. 15) for teacher leadership development. On the other hand, in a study of teacher leadership, Ado (2016) noticed that unless prompted, preservice teachers failed to address "improving outreach and collaboration with families and communities" (p. 15) as part of teacher leadership development. It is a reflection of our present system of education and preparation of teachers, which does not value outreach and community engagement. The Teacher Leadership Exploratory Consortium (2011) and the Center for Strengthening the Teaching Profession (2018) have recommended that preservice and in-service teachers engage in outreach activities in their local communities as a part of the process for developing teacher leadership.

Classroom teacher efficacy is key to student learning in K–12 education (Hattie & Timperely, 2007) and teacher leadership impacts student learning (Stronge & Hindman, 2003; Kumar & Scuderi, 2000). Without teacher leaders in our schools who are well prepared and confident enough to lead the STEM education reform, calls for STEM reform may not come to fruition. Teacher leadership also has the potential to retain teachers through support as they enter the teaching profession and as experienced teachers. In his study, Buchanan (2010) found that "lack of support emerged as the single strongest predictor of a decision to leave the profession" (p. 205). According to Danielson (2006), "precisely because of its informal and voluntary nature, teacher leadership represents the highest level of professionalism. Teacher leaders are not being paid to do their work; they go the extra mile out of a commitment to the students they serve" (p. 1). Students in this STEM program volunteer and already represent a group of individuals who are willing to go the extra mile.

Carlone and Johnson (2007) identified three constructs that support the development of teacher leaders:

- **Competence** – knowledge and understanding supportive of leadership pursuits
- **Performance** – social performances of relevant teacher leadership practices
- **Recognition** – recognition by oneself and others as a teacher leader

In this context, an opportunity for undergraduate teacher education students to volunteer in a museum supports teacher leadership development in STEM education through community engagement. Students develop their STEM skills along with their leadership skills through deepening their content knowledge, participating in teacher leadership practices as presenters in the museum, and receiving recognition by others as leaders in the STEM topic they choose. Students have the additional opportunity to identify creative ways to tap into community resources, to enrich learning experiences for their students, to connect classroom lessons with STEM outside the classroom, and to serve as change agents.

Community Engagement

It was after the publication of the article titled "Opportunities for Teachers As Policymakers" (Kumar & Scuderi, 2000) that volunteer opportunities for teacher leadership development in informal STEM education through community engagement were created for Florida Atlantic University (FAU) undergraduate students in the course "Principles and Methods: K-9 School Science." In the era of applying business models to the administration of schools and colleges, teachers are told what to do rather than given the opportunity to be professionals capable of making independent professional decisions in educational settings. This is reflected in the National Survey of Science and Mathematics Education (NSSME+) in the United States (Banilower et al., 2018). According to this NSSME+ survey, less than half of science teachers engaged in leadership activities, and elementary science teachers (8%) were less likely to lead a professional learning community in science than their high school peers. In this context, instilling in teachers, especially those in training, the confidence of leadership is essential if true education reform is the goal of the myriad of reform calls in STEM education (Kumar, 2019).

Discovery centers, planetariums, afterschool centers, and museums are excellent resources for community-based STEM education in the context of the real world. According to NSSME+ (Banilower et al., 2018), about 28% of elementary classes and 49% of high school classes have based their science instruction on lessons and units collected from sources such as museum partners, conferences, or journals, etc., rather than on traditional textbooks. Commercial textbooks published by the Museum of Science, Boston, are used in 4% of elementary classes. The survey also shows that only about 3% of elementary school students in self-contained classes have received science instruction from "someone outside the school," such as a staff person from a local museum, though 68% of elementary schools and 78% of high schools encourage students to attend summer camps organized by science centers or museums.

In order to tap into informal educational institutions in communities across the land, appropriate education for teachers in preparation is necessary. Incorporating informal educational community resources in teaching helps to improve teachers' content and pedagogical knowledge, besides improving the STEM knowledge and understanding of the students they teach (Kumar & Hansen, 2018; Brown, 2017; Jung & Tonso, 2006). Completing this task successfully adds to the "successful experience" of the student and "sets the stage for continued success" and raises self-efficacy (Bandura, 1986, noted in Versland, 2016, p. 300). Perceived self-efficacy refers to beliefs in one's capabilities to organize and execute the course of action required to produce given attainments. This is in line with construct three of Carlone and Johnson (2007): successful teacher leaders have belief in their own capacity as a teacher leader with strong STEM content knowledge. . . . Mastery of the content taught by teachers and confidence in the pedagogical skills they implement in teaching are critical to sustain teacher leadership qualities. A teacher leader in STEM will not shy away from taking advantage of any reasonable resource within reach to facilitate meaningful learning experiences for his/her students.

Leadership Through Community Engagement

Community engagement activities are an integral part of teaching and learning in STEM disciplines in the College of Education at FAU. Activities have included student volunteers engaging in STEM outreach to local K–12 classrooms and participating in service-learning community activities through informal science education institutions such as science museums, observatories, and planetariums as part of the undergraduate science education course. For example, an opportunity for teacher leadership development for student volunteers through community engagement is available through a local science museum. This is a unique opportunity for improving the pedagogical and science content knowledge of university students in the elementary/middle school science methods course. Preservice teachers need adequate knowledge of and access to reliable community resources in STEM disciplines, which they can tap into in order to develop teaching strategies to connect classroom STEM topics to the world around (Jung & Tonso, 2006). Presenting classroom STEM in the context of applications of STEM in the real world is a pedagogically effective way to augment and enrich students' learning experiences, and it can be achieved by connecting to local institutions such as museums, planetariums, and industries, and by

implementing carefully prepared instructional resources (e.g., multimedia anchors) (Kumar, 2010).

Students who are interested in the community engagement volunteering opportunity express their interest to the course instructor and the designated museum staff. In working with the museum staff the student volunteer sets up an initial appointment to visit the museum and receives a free entry pass and a guided tour of the exhibits at the museum. The tour guide discusses with the student volunteer the STEM-related themes and principles of the exhibits. Depending on their interest and comfort level, each student volunteer selects one exhibit for the community engagement activity. The student volunteer then informs the course instructor and the museum staff of the exhibit chosen and proceeds to develop a detailed lesson plan incorporating pedagogically appropriate hands-on activities in alignment with the Next Generation Sunshine State Standards. Topics related to museum exhibits chosen by student volunteers have included airplane wings (e.g., Bernoulli's Principle), weather, clouds, the water cycle, coral and coral bleaching, sharks, mangroves, the Everglades, etc. Twenty students have volunteered for this project since its inception.

The student volunteer has flexibility in the development of the lesson plan. Once the lesson plan is developed, the course instructor and the museum staff provide feedback. Every effort to improve the quality of the STEM content and pedagogical knowledge is made during this feedback process, with particular attention to misconceptions, correctness of content, cognitive levels of questions, connections to STEM in the real world, and the integration of suitable engaging hands-on activities. After finalizing the lesson plan, the student volunteer works with the museum staff to decide on a mutually convenient time and date to present the lesson in a group setting. Depending on the season, day and time, the group may be K–12 student visitors, tourists, parents, and/or senior citizens. Sometimes selected museum staff members are the audience that provides an opportunity for the student leader to answer questions that help build a deeper knowledge of the subject.

Once the lesson plan is implemented, the student volunteer receives feedback provided by the museum staff. The museum staff shares the feedback with the course instructor along with a summary of key aspects of the lesson presentation. In addition, each participating student volunteer is required to reflect upon their community engagement experience in terms of the following five prompts: (1) Describe any effect of the project on your level of understanding of the Science Concept/Principle you addressed. (2) Describe any effect on your level of confidence in explaining the Science Concept/Principle you addressed. (3) Describe any effect on your ability to relate science to real-world examples. (4) Describe any effect on your ability to teach science. (5) Describe any effect on your decision to utilize community resources such as museums in your future K–12 teaching.

Benefits to the Student Volunteer

At the end of the community engagement activity, the participating student volunteer receives credit in the form of bonus points toward course grade and FAU Academic Service Learning (ASL) credit. Since Fall 2017, students who participate in this community engagement project receive Academic Service Learning credit for approximately 10 hours spent on the project, with the corresponding ASL notation posted to their transcripts. Prior to the implementation of the FAU ASL credits system, participating students received volunteer hours in the FAU-designated Noble Hour. It should be noted that this community engagement by student volunteers supports the "Community Engagement and Economic Development" platform in the "Strategic Plan for the Race to Excellence 2015-2025" of FAU. Since Spring 2019, besides students in "Principles and Methods: K–9 School Science," students in "Science: Elementary and Middle School" and "Science Content: K–6 Teachers" courses are also eligible to participate in this community engagement teacher leadership development project and receive FAU ASL credit. A higher level of confidence, a level of understanding of content and pedagogy, and an ability to incorporate community resources in teaching are all essential to building teacher leadership qualities. As student volunteers build leadership skills through community engagement activities, they help the museum visitors see the exhibits through the eyes of the STEM lessons they present, providing the visitors a different dimension of enrichment and exposure to the exhibits not available elsewhere.

Method

For this preliminary study, data were collected from a reflective survey response completed by students who participated in the museum experience. The reflective survey was developed by Kumar (2017) to allow students to self-reflect on their experiences and provide insights for the research around the impact of the experience on the student's confidence and mastery of the subject. Since the development of the survey 12 students have participated in the project and received the survey, and seven students responded.

Analysis and Results

Each researcher reviewed survey responses individually to identify emerging themes. Researchers then reviewed and analyzed responses together. All responses from the students were coded collectively. Four major themes emerged.

- Self-Confidence Development
- Depth of Understanding of the Topic
- Audience STEM Learning
- Sense of Self-Responsibility

Table 1 summarizes the total responses by themes. In some themes the total number of responses exceeds the number of respondents. An analysis of each theme with specific quotes from respondents follows.

TABLE 1. Summary of Responses by Themes

THEMES	TOTAL RESPONSES
Self-Confidence Development	15
Depth of Understanding of the Topic	14
Audience STEM Learning	7
Sense of Self-Responsibility	4

Self Confidence Development

How did the self-confidence of the individual change during this activity? This theme emerged as the strongest one. Seven of the seven respondents shared 15 responses that support the development of self-confidence.

> *"This experience allows me to be more confident when teaching."*

> *"Presentation and demonstration allowed me to build confidence in explaining [the lesson]."*

Audience STEM Learning

How well did the audience learn the science concept taught by the student? Three of the seven respondents shared seven responses that positively represented this theme.

> *"Because of the level of confidence, I had in my project, this caused audience to gain more knowledge about..."*

Depth of Understanding of the Topic

How did this experience impact the depth of understanding of the selected topic? Six of the seven respondents shared 14 responses that positively represented this theme.

> *"Everything I learned [about my topic] will stick with me forever."*

> *"I have learned a lot about the different components of [the topic]."*

Sense of Self-Responsibility

Did this activity include a sense of responsibility on the part of the student? Two of the seven respondents shared four responses that positively supported this theme.

> *"It is important to me that students understand the effects humans have on the Everglades."*

Discussion and Implications

Teacher leadership development through community engagement is a volunteer project for undergraduate students at FAU. Based on the preliminary data analysis, there are several benefits to students. First, the community engagement activity helps to build a sense of efficacy and self-confidence, which is noted as a valuable part of teacher leadership (Bandura, 1997; Versland, 2016). Furthermore, as noted by Hunzicker (2017), "internal factors such as motivation and confidence are likely to influence the progression from teacher to teacher leader more so than external factors" (p.1). Second, it provides a platform for experiential learning by leveraging community

resources such as planetariums and museums to develop engaging STEM lessons that students identified as a deepening of their subject knowledge as aspiring leaders. Helping teachers develop content knowledge skills in their pre-teaching experiences is important, as these early career teachers may be more likely to advocate for instructional and curricular changes (Raue & Gray, 2015). Students who participate in experiential programs such as this have the opportunity to enter the beginning years of teaching with the ability to lead other teachers as the masters of the curriculum; they have built a sense of self-efficacy through repeated successes, which allows them to perform as confident teacher leaders (Huggins, Lesseig, & Rhodes, 2017; Bandura, 1997; Hunzicker, 2017). Third, it offers considerable pedagogical advantages, providing a unique opportunity to build confidence in teaching STEM lessons to audiences ranging from school children to senior citizens visiting the museum. These benefits are supported by the findings of Hunzicker (2012). Three factors were identified as those that develop teacher leadership: "exposure to research-based practices, increased teacher self-efficacy, and serving beyond the classroom" (p. 267).

Since 2013, 20 students have volunteered in teacher leadership development through community engagement in a museum. However, student self-reflections were not implemented until 2017. Since 2017, 7 out of twelve students have volunteered to submit self-reflections. A longitudinal study of those student volunteers who are now teaching in K–12 classrooms is needed to determine the effect of the community engagement experience on student learning and to understand the nature of teacher leadership development. Augmentation of the 5-item self-reflection questionnaire with additional specific teacher leadership questions is also underway. Based on the outcomes of future research and evaluations, creative ways to improve community engagement opportunities for teachers should be explored in order to contribute toward building teacher leaders who are champions of reforming STEM education in our classrooms.

It should be noted that this is a volunteer activity and that for various reasons, not many students signed up. Most of the students who attend classes on the FAU Broward campus are commuters or are employed full-time or part-time and have family obligations. A few times students who signed up and made the initial museum visit later changed their minds because of conflict of schedule with employment and/or family situations. Some students who struggled with the course have avoided the volunteer activity, while others in similar situations have taken advantage of the opportunity to improve their content and pedagogical knowledge in addition to improving their final grade.

Considering the benefits for student volunteers, opportunities for teacher leadership development through community engagement in partnership with local informal STEM education resources should be further developed. In most cities of the United States, informal science education resources such as museums, discovery centers, and planetariums that are suitable for establishing teacher leadership development opportunities through community engagement in STEM are available for teachers in training. Even in rural areas, building partnerships with farms, forestry businesses, aquaculture, and healthcare for STEM education are possible (Buffington, 2017). Universities and colleges with teacher preparation programs have a responsibility to explore and initiate collaborations with local informal education institutions. By establishing community engagement opportunities aimed at teacher leadership development, they can contribute to efforts to reform school science, technology, engineering, and mathematics education.

Authors

David Devraj Kumar is Professor of Science Education and Director of the STEM Education Laboratory in the College of Education at Florida Atlantic University. His research and scholarly activities focus on digital media enhanced STEM teaching and learning contexts, problem-based learning, science literacy, STEM leadership, education policy, and evaluation. He is a former Visiting Fellow in Governance Studies at the Brookings Institution. He is a recipient of the Sir Ron Nyholm Education Prize from the Royal Society of Chemistry, an elected Fellow of the American Association for the Advancement of Science, and a SENCER Leadership Fellow of the National Center for Science and Civic Engagement.

Sharon R. Moffitt is a clinical instructor in educational leadership and research methodology in the College of Education at Florida Atlantic University. Her research and work focus on teacher, school, and district leadership coaching. She is the coordinator of a partnership between a large school district and Florida Atlantic University, which is focused on developing aspiring administrators through a rigorous Master's Degree Program. She has 35 years of school and district leadership experience in the public school system.

References

Ado, K. (2016). From pre-service to teacher leader. The early development of teacher leaders. *Issues in Teacher Education, 25*(1), 3–21.

Bandura, A. (1986). *Social foundation of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice Hall.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York, NY: Freeman.

Banilower, E. R., Smith, P. S., Malzahn, K. A., Plumley, C. L., Gordon, E. M., & Hayes, M. L. (2018). *Report of the 2018 NSSME+*. Chapel Hill, NC: Horizon Research, Inc.

Bond, N. (2011). Preparing preservice teachers to become teacher leaders. *The Educational Forum, 75*(4), 280–297.

Brown, K. (2017). Pre-service teachers' acquisition of content knowledge, pedagogical skills, and professional dispositions through service learning. *Science Education & Civic Engagement, 9*(2), 13–26.

Buchanan, J. (2010). May I be excused? Why teachers leave the profession. *Asia Pacific Journal of Education, 30*(2), 199–211.

Buffington, P. (2017). *Closing STEM education opportunity gaps for rural students*. Waltham, MA: Education Development Center, Inc.

Carlone, H. B., & Johnson, A. (2007). Understanding the science experiences of successful women of color: Science identity as an analytic lens. *Journal of Research in Science Teaching, 44*(8), 1187–1218.

Center for Strengthening the Teaching Profession. (2018). *Teacher leadership skills framework*. Olympia, WA: CSTP.

Committee on STEM Education of the National Science and Technology Council. (2018). *Charting a course for success: America's strategy for STEM education*. Washington, DC: Executive Office of the President, Office of Science and Technology Policy.

Danielson, C. (2006). *Teacher leadership that strengthens professional practice*. Alexandria,VA: Association for School Curriculum and Development.

Hattie, J., & Timperely, H. (2007). The power of feedback. *Review of Educational Research, 77*(1), 81–112.

Huggins, K. S., Lesseig, K., & Rhodes, H. (2017). Rethinking teacher leader development: A study of early career mathematics teachers. *International Journal of Teacher Leadership, 8*(2), 28–48.

Hunzicker, J. (2012). Professional development and job-embedded collaboration: How teachers learn to exercise leadership. *Professional Development in Education, 38*(2), 267–289.

Hunzicker, J. (2017). From teacher to teacher leader: A conceptual model. *International Journal of Teacher Leadership, 8*(2), 1–27.

Jung, M. L., & Tonso, K. L. (2006). Elementary preservice teachers learning to teach science in science museums and nature centers: A novel program's impact on science knowledge, science pedagogy, and confidence in teaching. *Journal of Elementary Science Education, 18*(1), 15–31.

Kumar, D. D. (2010). Approaches to interactive video anchors in problem-based science learning. *Journal of Science Education and Technology, 19*(1), 13–19.

Kumar, D. D. (2017). *Capacity building in STEM education*. STEM Education Laboratory Informational Meeting, Florida Atlantic University, Davie, FL.

Kumar, D. D. (2019). *Road to American STEM education reform: Review of selected NSSME results*. A paper presented at the Critical Questions in Education Symposium organized by The Academy for Educational Studies, Chicago, IL.

Kumar, D. D., & Hansen, M. (2018). *Climate confusion: Content and strategies, not controversy, are the biggest challenges for science teachers*. (Brown Center Chalk Board, October 30, 2018). Washington, DC: The Brookings Institution.

Kumar, D. D., & Scuderi, P. (2000). Opportunities for teachers as policymakers. *Kappa Delta Pi Record, 36*(2), 61–64.

Office of Science and Technology Policy. (2018). *President Donald Trump is working to ensure all Americans have access to STEM education*. Washington, DC: Executive Office of the President. Retrieved from https://www.whitehouse.gov/briefings-statements/president-donald-j-trump-is-working-to-ensure-all-americans-have-access-to-stem-education/.

Raue, K., & Gray, L. (2015). *Career paths of beginning public school teachers*. Washington, DC: Institute of Educational Sciences, National Center for Educational Statistics. Retrieved from https://nces.ed.gov/pubs2015/2015196.pdf.

Stronge, J. H., & Hindman, J. L. (2003). Hiring the best teachers. *Educational Leadership, 60*(8), 48–52.

Teacher Leadership Exploratory Consortium. (2011). *Teacher leader model standards*. N.p.: Teacher Leadership Exploratory Consortium.

Versland, T. M. (2016). Exploring self-efficacy in education leadership programs: What makes the difference? *Journal of Research on Leadership Education, 11*(3), 298–320.

Wenner, J., & Campbell, T. (2018). Thick and thin: Variations in teacher leader identity. *International Journal of Teacher Leadership, 9*(2), 5–21.

PROJECT REPORT

Combining Cross-Disciplinary STEM Collaborations and Academic Service Learning to Help a Community in Need

PAULA KAY LAZRUS
St. John's University

ALISON G. HYSLOP
St. John's University

CHARLES FORTMANN
St. John's University

FLORIN CATRINA
St. John's University

RICHARD ROSSO
St. John's University

Abstract

This project report presents a multidisciplinary Faculty Learning Community model to foster civic engagement in STEM classes. It focused on first-year Chemistry, Math, and Scientific Inquiry courses and incorporated Academic Service Learning in a project to build solar cell phone chargers for a school in Puerto Rico recovering from the effects of Hurricane Maria in 2017. The project provided hands-on experiences for the students, with the tangible outcome of building the solar chargers for people in need. Student engagement was measured through surveys and reflective assignments; the students responded positively to their work and their sense of fulfilling the St. John's University mission. The members of the Faculty Learning Community have engaged in ongoing collaborative relationships.

KeyWords: Student Peer Mentoring, Knowledge Transfer, Academic Service Learning

Introduction

Faculty members from four different departments, Chemistry, Physics, Math, and Core Studies, were brought together as a Faculty Learning Community (FLC) under a St. John's University grant to improve undergraduate STEM education at St. John's (Cox, 2004; Baker, 1999). Expectations for the cohort were to attend the 2017 Association of American Colleges and Universities (AAC&U) Transforming STEM Higher Education conference, to disseminate their learning experiences to the wider St. John's faculty, and to develop their own STEM project (Association of American Colleges & Universities, 2017). Inspired by an introductory talk at the AAC&U meeting, the cohort developed a multidisciplinary Academic Service Learning (ASL) project in which St. John's students constructed solar cell phone chargers for students at a Puerto Rican school impacted by Hurricane Maria (Escuela Segunda Unidad Botijas #1 in Orocovis). ASL is a known high-impact practice that provides the potential for applied learning and civic engagement (Strage, 2000; Kuh, O'Donnell, & Reed, 2013). In our project, students in first-year Chemistry, Mathematics, and Scientific Inquiry (a required class for non-science majors) used their scientific knowledge and skills to help others by building 100 solar phone chargers for students who were without power in a mountainous region in Puerto Rico. The participants in this ASL project met outside of their scheduled class times to collaborate on assembling the chargers, participate in discussions with our Puerto Rican partners, and create videos on the construction process and the use of the chargers. Additional videos were produced by the St. John's students in which they reflected on their involvement in the project.

Our FLC illustrates the power of this structure to encourage interdisciplinary cooperation and to build stronger ties among faculty members, which benefits the faculty, students, and the community beyond the university (O'Neil, Yamagata, Yamagata, & Togioka, 2012). This project, with its focus on civic engagement, integrated STEM learning and real life applications and excited the students about the tangible and practical impacts of STEM (Turrini, Dörler, Richter, Heigl, & Bonn, 2018; Strage, 2000). Furthermore, current research on learning acknowledges the many factors beyond classroom pedagogy and specific content—including individual, social, cultural, and institutional influences—that affect learning, for both faculty and students (Pandya, Dibner, & Committee on Designing Citizen Science to Support Science Learning, 2018).

Faculty Learning Communities

Faculty Learning Communities typically involve voluntary groups of teachers, students, and administrators with a clear sense of membership, common goals, and extensive face-to-face interaction (Baker, 1999). Our FLC differed in some ways from that model in that it was a closed group, and the members were invited to join by the Dean and a faculty leader who acted as a group facilitator. The goals of the FLC were to develop a project and to share knowledge with STEM colleagues within a one-year time frame. Following best practices, the participants represented faculty from diverse disciplines (Sonnenwald, 2007; Hunt, Layton, & Prince, 2015; Ferrini-Mundy, 2013). Even though the members were largely unacquainted with one another at the outset, the FLC provided an opportunity for increased engagement across the disciplines.

The FLC was sent to the AAC&U conference to learn about new pedagogies and tools that they could bring back to the wider university STEM community. Most of the members of this FLC had not been exposed previously to some of these newer pedagogies. During the opening welcome, the Conference director challenged the attendees to consider projects that would help the people of Puerto Rico impacted by Hurricane Maria. Having decided to address this challenge by developing a project that built on our strengths in ASL, the group designed a project that would provide students with an applied-science-related activity that would also benefit people in Puerto Rico.

As a result of attending the conference, the FLC became a more coherent unit that provided a foundation from which to learn about each person's discipline and personality. Exposure to our various disciplines, approaches to research, and our professional trajectories led to creative collaborations and problem-solving (Olson, Labov, & National Research Council (U.S.), 2014). This in turn led to a greater understanding of the strengths

of each member and ultimately to a successful working relationship that is ongoing.

Project Overview

In response to the charge to create projects to help the victims of the hurricane, the FLC decided to focus on a STEM-centered ASL project that would aid this population. Realizing that many of the communities of Puerto Rico remained without electricity, the idea for a solar powered project emerged. Our ASL office identified Nuestro Ideal (Nuestroideal.org, n.d.), a local, non-governmental organization, as an effective collaborator. Nuestro Ideal selected a school without electricity in Puerto Rico. With funds provided by St. John's University, the FLC acquired materials and organized classroom opportunities to bring together the different classes taught by the members of the FLC. Upper-level students from the Society of Physics provided assistance by preparing materials as well as acting as coaches during the assembly process. Two out-of-class sessions were scheduled for the project, one to learn the skills needed to build the chargers, and one to assemble them. An online repository was established for students to post video reflections on their work and to tie their experience to what they were learning in their individual classes.

The goals for the project were to:

- Provide a STEM-based project with a civic engagement focus for a community in need in Puerto Rico.
- Create a STEM experiential learning environment for STEM and non-STEM students.
- Ensure that the hands-on applied project was accessible for students with different experiences and academic backgrounds.
- Foster collaborations among these students in a multi-disciplinary project.
- Create an opportunity for the upper-class students to share their expertise and enthusiasm for science.

Project Process

Upon receipt of the solar cell phone charger components, the Society of Physics students helped design and test the prototypes, pre-assembled the wiring harnesses with blocking diode housings, and fastened the connector housings to the solar cell frames (Fortmann, Lazrus, Rosso, Catrina, & Hyslop, 2019). At the initial ASL session, the students learned to solder and make reliable electrical connections, skills necessary for making the final products. They also learned about the school in Puerto Rico and the students who would receive the chargers. At the second session, the wires from the solar panels were soldered and attached to the USB connectors. All soldered connections were covered with silicon to prevent rust or disconnections. The entire assembly process was livestreamed via WebEx to the teachers and students in PR. The student groups were also asked to create two videos, one in which they described what they were doing and how to use the chargers and the other a reflective piece on their experiences. Two instructional videos were made by students for our partners, one in English, the other in Spanish, explaining the process of using the final product. A local TV station, upon hearing about the project, sent a news team to interview students about the impact of their experience (Fox 5 News, 2018). The solar cells were then packed and shipped to the school. We received pictures, videos, and thank you notes from the faculty and students in Puerto Rico.

Outcomes

We worked with Nuestro Ideal to provide a civic engagement focus with the community in Puerto Rico. With their help it was possible to set up a weblink during the assembly process, which fostered a greater sense of connection between our students and the recipients. Our students were able to see the environment in which the chargers would be used and gain a sense of purpose for their activity.

The project needed to be suitable for students with different academic backgrounds, experiences, and motivations. It became clear to the faculty that the students would need assistance in learning to solder and in understanding how solar cells work. We addressed this by having the Society of Physics students work with the groups learning to assemble the solar chargers. This also gave the upper-class students an opportunity to share their

expertise and excitement for science. Students come to their classes with different motivations; when an opportunity for real-world applications of scientific skills is provided, the incentive to learn increases as students perceive the usefulness of their work (Committee on How People Learn II, 2018; see also student comments below).

In order to foster collaborations among the students in the different classes, they worked in groups of three to five on each charger and video. Just as the FLC worked across disciplines, an effort was made to form groups across the different classes. St. John's University is one of the most diverse institutions in the country, and many of our students related to the recipients and the needs of the project, sharing their knowledge with their peers.

Evaluation

A survey was sent to all St. John's students involved in the project. The results showed positive responses in evaluating scientific information and in their connection to the University and its mission. The results were strongest for the math and chemistry cohorts, with more than 60% of the students responding positively. In particular, the written responses from the math students indicated a new understanding of practical applications for STEM and a realization of the impacts of STEM on people's lives. This was also the case in Strage's work with ASL and lecture classes (Strage, 2000). A popular response noted that the experience "opened me up to the global aspects of STEM." One possible improvement would have been the provision of more scaffolding for the ASL project within each individual class. This would have allowed the students to feel a greater ownership of the activity. In addition to the reflection and instruction videos, the use of process summaries might also have helped students integrate the new skills they were learning and reflect on their applications in the real world to a greater degree (Smith, n.d.; Keranen & Kolvoord, 2014). These types of activities expand the classroom learning experience, and, furthermore, expose students to the different types of knowledge that their peers bring to the project (Committee on How People Learn II, 2018; Olson et al., 2014).

The FLC experience has had a lasting impact on the participating faculty members, developing new cross-disciplinary relationships and leading to a desire to explore additional outreach projects together. The results of this initial project led to poster presentations at the 2018 AAC&U Transforming STEM Higher Education conference and at the 2019 New York City SENCER meeting. The project also had an impact on the Society of Physics students, and importantly, a large number of Society of Physics students in the 2018 graduating class intended to continue their education in engineering graduate school. Several student participants in this ASL project went on to engage in undergraduate research as second-year students.

Conclusions

The collaborations within the FLC, between the faculty members and administration, and between St. John's and Nuestro Ideal created an opportunity for civic engagement within the STEM disciplines. In the short term, the group has applied for a small internal St. John's grant to continue collaborating with Nuestro Ideal to identify new projects, including providing larger solar cell systems for water pumps in isolated farmhouses and transferring upkeep knowledge to the recipients. It also led to an additional ASL project in the fall of 2019 wherein students provided a handbook of seed bank best practices based on research to Nuestra Ideal for dissemination to a local farm project. Beyond that, the success of this project and the FLC led this group to apply for an NSF Ethical and Responsible Research grant. In this future project the group intends to assess methods of exposing students through mentoring, ASL, and personal interactions to ethical behavior in STEM fields, especially with regard to research choices and dissemination.

Authors

Florin Catrina, an associate professor of mathematics, has been at St. John's University since 2006. He is active in the Mathematical Association of America and is a mentor for Project NExT, a professional development program for new or recent PhDs in the mathematical sciences. His research focuses on non-linear analysis of partial differential equations.

Charles Fortmann is currently an associate professor in the Department of Physics. Before joining the faculty at St. John's, he was the vice president for research at Idalia Solar Technologies. He serves as the faculty advisor for the Society of Physics and Sigma Pi Sigma physics honor society.

Alison G. Hyslop, an associate professor of chemistry, has been at St. John's University since 2000. She has served as the faculty coordinator for STEM Faculty Learning Communities at St. John's for three years, is active in the Women in Science program, and was the chair of the Department of Chemistry from 2012 to 2018 and the coordinator for Scientific Inquiry from 2006 to 2012.

Paula Kay Lazrus is an associate professor in the Institute for Core Studies and Department of Sociology and Anthropology at St. John's University, and has been at St. John's since 2003. She is active in the Reacting to the Past community and has served on its Board of Directors since 2016. As an archeologist, she has participated in the Bova Marina Archaeological Project and is active in the Archaeological Institute of America and the Society for American Archaeology.

Richard Rosso, an associate professor of chemistry, has been at St. John's University since 1999. He was the chair of the Department of Chemistry from 2006 to 2012, and has served the American Chemical Society both locally and at the national level.

References

Association of American Colleges & Universities. (2017). *2017 Transforming STEM higher education: Discovery, innovation, and the value of evidence*. Retrieved from https://www.aacu.org/conferences/stem/17/

Baker, P. (1999). Creating learning communities: The unfinished agenda. In Bernice A. Pescosolido and Ronald Aminzade (Eds.). *The social worlds of higher education: Handbook for teaching in a new century* (pp. 95-109). Thousand Oaks, CA: Pine Forge Press.

Committee on How People Learn II: The Science and Practice of Learning, Board on Behavioral, Cognitive, and Sensory Sciences, Board on Science Education, Division of Behavioral and Social Sciences and Education, and National Academies of Sciences, Engineering, and Medicine. (2018). *How people learn II: Learners, contexts, and cultures*. Washington, DC: National Academies Press. https://doi.org/10.17226/24783

Cox, M. D. (2004). Introduction to faculty learning communities. *New Directions for Teaching and Learning, 2004*(97), 5–23. https://doi.org/10.1002/tl.129

Ferrini-Mundy, J. (2013). Driven by diversity. *Science, 340*(6130), 278. https://doi.org/10.1126/science.1235521

Fortmann, C., Lazrus, P., Rosso, R. Catrina, F. & Hyslop, A. (personal communication 2019)

Fox 5 News. (2018). Solar cell phone chargers from St. John's University to Puerto Rico. Fox 5 News. April 16, 2018. Retrieved from http://mms.tveyes.com/MediaCenterPlayer.aspx?u=aHR0cDovL21lZGlhY2VudGVyLnR2ZXllcy5jb20vZG93bmxvYWRnYXRld2F5LmFzcHg/VXNlcklEPTE3NDAxMCZNREIEPTk2NzQ3NTkmTURTZWVkPTM4OTgmVHlwZT1NZWRpYQ%3D%3D

Hunt, V., Layton, D., & Prince, S. (2015). *Why diversity matters*. McKinsey & Company. Retrieved from https://www.mckinsey.com/business-functions/organization/our-insights/why-diversity-matters

Keranen, K., & Kolvoord, R. (2014). *Making spatial decisions using GIS and remote Sensing: A workbook*. Redlands, CA: ESRI Press.

Kuh, G. D., O'Donnell, K., & Reed, S. D. (2013). *Ensuring quality & taking high-impact practices to scale*. Washington, DC: Association of American Colleges and Universities.

Nuestroideal.org. (n.d.). Retrieved from http://www.nuestroideal.org/

Olson, S., Labov, J. B., & National Research Council (U.S.). (Eds.). (2014). *STEM Learning is everywhere: Summary of a convocation on building learning systems*. Washington, DC: National Academies Press.

O'Neil, T., Yamagata, L., Yamagata, J., & Togioka, S. (2012). Teaching STEM means teacher learning." *Phi Delta Kappa International, 94*(1), 36–38, 40.

Pandya, R., Dibner, K. A., & Committee on Designing Citizen Science to Support Science Learning (Eds.). (2018). *Learning through citizen science: Enhancing opportunities by design*. Washington, DC: National Academies Press. https://doi.org/10.17226/25183

Smith, E. (n.d.). *LibGuides: MYP Personal Project 2018/19: Process Journal*. Retrieved from //gemschicago.libguides.com/c.php?g=829169&p=5920504

Sonnenwald, D. H. (2007). Scientific Collaboration. *Annual Review of Information Science and Technology, 41*(1), 643–681. https://doi.org/10.1002/aris.2007.1440410121

Strage, A. (2000). Service-learning as a tool for enhancing student outcomes in a college-level lecture course. *Michigan Journal of Community Service Learning, 2000*, 5–13.

Turrini, T., Dörler, D., Richter, A., Heigl, F., & Bonn, A. (2018). The threefold potential of environmental citizen science - generating knowledge, creating learning opportunities and enabling civic participation. *Biological Conservation, 22*, (September), 176–186. https://doi.org/10.1016/j.biocon.2018.03.024

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."

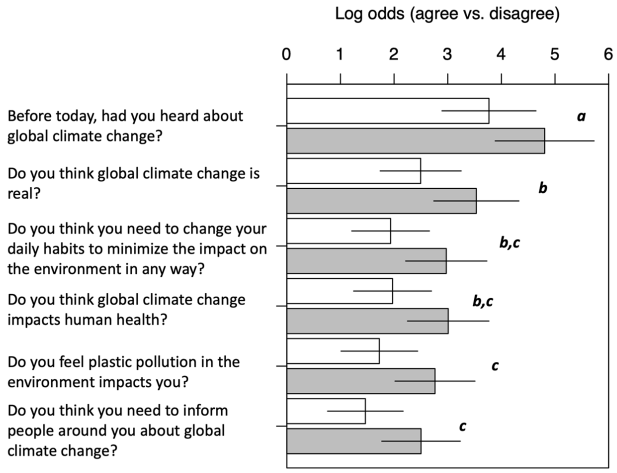
Results

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.

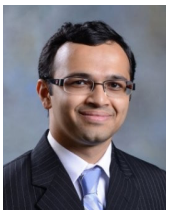
Funding

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*