SCIENCE EDUCATION
& CIVIC ENGAGEMENT
AN INTERNATIONAL JOURNAL

VOLUME FOURTEEN
ISSUE ONE
Winter 2022

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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***

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Contents

From the Editors

IN THE WINTER 2022 ISSUE OF THIS JOURNAL, we are delighted to feature a collection of five project articles, plus a special tribute to Dr. David Ferguson, whose generosity of spirit and commitment to student success touched many within the SENCER community and beyond. This tribute section is introduced by Dr. Eliza Reilly, Executive Director of the National Center for Science and Civic Engagement.

Steven Bachofer (St. Mary's College) and Marque Cass (Alameda Point Collaborative) describe a collaboration to develop a community outreach chemistry lab under the constraints of the COVID-19 pandemic. Using portable microscale gas chemistry equipment, students at St. Mary's College recorded an instructional video on how to perform the lab activity, which guided students at the Alameda Point Collaborative Youth Program as they performed the experiment during a shared Zoom meeting. This case study shows how cooperation and creative use of technology was able to create a shared scientific experience despite the challenges of the pandemic.

Jacqueline Curnick and **Brandi Janssen**, both at the University of Iowa College of Public Health, examine the transfer of scientific knowledge after a science café. These community gatherings provide an opportunity for scientific researchers to engage with the general public in an informal setting. The authors organized two science café series held in rural Iowa, with a focus on environmental health. A qualitative evaluation of the events included a questionnaire and follow-up phone interviews. This evaluation revealed that science café participants shared the information they learned via three main connections—family and friends, professional colleagues, and community groups. This article demonstrates the value of science cafés as a forum for informal scientific outreach to local communities.

David Green (Florida Gulf Coast University) provides a critique of an ecoresort exercise that is a team-based, active learning component of a course on environmental sustainability. After describing the structure and learning goals of the ecoresort activity, the author compares the project design to educational best practices, such as Fink's Taxonomy of Significant Learning and Merrill's Principles of Instructional Design. This careful analysis of a SENCER-based instructional module illustrates how the application of teaching and learning principles can be used to enhance educational effectiveness.

What are "funds of knowledge"? **Laura B. Liu** and **Taylor Russell** from Indiana University-Purdue University Columbus explore this concept in the context of farming practices. By interviewing participants who have farmed in the U.S. and international regions, the authors reveal interesting connections between farming and culture, such as automatic vs. manual labor These funds of knowledge about farming can be used to inform K–12 curricula and instruction to support multicultural and multilingual learners.

A team of faculty from New York City College of Technology (**Diana Samaroo, Liana Tsenova, Sandie Han,** and **Urmi Ghosh-Dastidar**) developed an interdisciplinary biodiversity project to examine the water quality in Prospect Park Lake in Brooklyn, NY. Students engaged in authentic civic research by integrating analytical techniques from microbiology, chemistry, and mathematics. After collecting and analyzing their data, students developed their communication skills by presenting their results at conference poster sessions.

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

SPECIAL SECTION

INTRODUCTION

Tributes for David Ferguson

THIS SECTION OF THE JOURNAL is a small but heartfelt collection of essays in honor of someone who gave a great deal of his time, thinking, and heart to our collective work in civically engaged science education. A key leader in SENCER from its beginnings in 2001, David Ferguson played an even more important role from 2015 until his death when, as Associate Provost and Chair of Technology and Society, he became the National Center for Science and Civic Engagement's institutional sponsor at Stony Brook University. As such, he was involved in all aspects of our work and was responsible for greatly expanding our programming into engineering and technology. These tributes are from just a small sampling of the literally hundreds of colleagues who were profoundly impacted by Dave's life and work, but they are exemplary of the high esteem and affection he inspired.

My own history with David Ferguson goes back to the late 90s. At the time, I was the Executive Director of the American Conference of Academic Deans and accompanied my colleague David Burns, later the founder and PI of SENCER, on a visit to Stony Brook University. Dave was then the director of the newly formed Center for Excellence in Learning & Teaching (CELT) and was already supporting problem-based and student-centered curricular programs that Science Education for New Civic Engagements would be advancing a few years later. As a community of faculty practice, SENCER is grounded in the ideals of both democracy and science, and not in a particular method, pedagogical approach, or disciplinary canon. It is those ideals, which Dave both espoused and lived, that bind our community and have held it together for over two decades.

Fidelity to those scientific and democratic ideals—of integrity, honesty, open-mindedness, and respect for evidence—underpinned Dave's commitment both to SENCER and to his Stony Brook family. Although Dave had garnered national recognition as a researcher, he chose to spend most of his career, and his considerable talent for attracting funding, on expanding access and diversity in STEM through countless initiatives and programs. Given his widely recognized success as an administrator, PI, and collaborator, it was obvious that Dave could have focused more on his own career

advancement. But personal gain, recognition, or greater authority over others was never a motivator for Dave, and his unwavering loyalty and commitment to Stony Brook University, an institution and a community he loved unreservedly, was one of his most distinguishing characteristics. For Dave, Stony Brook was his version of the "beloved community"—a term coined by the philosopher Josiah Royce and popularized by Dr. Martin Luther King—a community of common purpose, mutuality, and civility in the service of a better world.

In his autobiography, the Argentinian writer Jorge Luis Borges asserted, "My father was very intelligent and, like all intelligent men, very kind." No one embodied that wise observation better than Dave. Most of the essays here focus on that kindness, and the consideration and generosity that characterized all his relationships. For me it was his intelligence—emotional, organizational, intellectual—that was the foundation of his kindness. He was a mathematician by training, and his clear and logical approach to problems, projects, and organizational structures was evident, both in his extraordinary administrative accomplishments and in the respect he garnered from faculty and administrators from every division of his university.

That intelligence ensured that Dave's kindness was inextricable from strong convictions and a clear moral compass, one that did not turn a blind eye to self-serving, dishonest, and hypocritical individuals and actions. In her essay, Lauren Donovan, who worked with Dave for many years, notes that she never heard him raise his voice. Sadly, in some of our many conversations and planning sessions in what turned out to be the last years of his life, I DID hear Dave raise his voice, in both anger and genuine bewilderment at the callous, unilateral, and uncaring leadership that increasingly dominated both higher education and the country at large. But even Jesus himself felt anger, especially toward those who prized money and personal gain over faith and turned a temple into a marketplace. In remembering Dave, I will try to emulate his kindness, patience, openness, and untiring commitment to science education that promoted social good, while also holding on to his acute ethical discernment, clear sense of mission, and even his righteous anger at injustice and hypocrisy that has no place in the educational enterprise. We owe him nothing less.

Eliza Reilly
Executive Editor

Memorial Tribute for Dr. David Ferguson

Dr. Candice J. Foley
Professor Emeritus of Chemistry,
SUNY Suffolk

I'm grateful to be able to share fond memories of my friend, mentor, and colleague Dr. David Ferguson to celebrate his life and career. Dave was the ultimate "connector" of people and projects dedicated to equity and inclusion at all levels in STEM. He accomplished this with his characteristic gentleness, warmth, humility, and humor, but his resolve to achieve his goals was a true force to be reckoned with! No one could say, "No" to Dave. Early on Dave recognized the crucial importance of creating bridges and pathways for our talented STEM students at Suffolk County Community College (SCCC), to empower and inspire underrepresented STEM scholars to attain their educational goals. As a result of Dave's championing of many inter-institutional collaborations for more than two decades, we at SCCC have a robust model for serving underrepresented minority students (URMs) at all levels in STEM. Taken together, these programs provide entry points and mentoring opportunities at all junctures of a student's journey in STEM, from secondary school through community college, transfer to a four-year college, and on to pre-doctoral and post-doctoral training. Dave was influential in so many important international, national, and statewide SUNY arenas. He encouraged and provided mentorship and entrée to innumerable faculty members, helping them to catalyze their initiatives and careers, and he was always generous with his time. When we asked him frequently to be our keynote speaker at our annual STEM recognition ceremony, he also never said, "No." He always inspired our students to believe in themselves, and one of my fondest memories of his pearls of wisdom was his invoking of Christopher Robin's words to Winnie the Pooh,

"Promise me you'll always remember:

You're braver than you believe,

And stronger than you seem,

And smarter than you think."

Of all of Dave's many gifts and talents, his strongest legacy is his enduring faith in us all to continue the journey that was his life's work.

He Left Us a Rainbow

TRIBUTE TO DAVE FERGUSON

Deb Dwyer
Economist, Colleague, Friend

I don't even know where to begin. I first learned of Dave Ferguson when I was a junior faculty member at Stony Brook University in the Department of Economics. I taught the teaching practicum to our Ph.D. candidates with the aim of producing effective teachers of economics—this was back in the late 1990s. I wanted to do it right, and so I took advantage of the resources the university had to offer. I was pointed to the Center for Excellence in Learning and Teaching (CELT) directed by Dave Ferguson. From the beginning, in my mind his name was synonymous with leader, mentor, teacher. Dave's name continued to come up as a prominent academic leader, promoted to the provostial level at the university.

Years later, when I found myself in a position where I could no longer work with the dean of my college due to misaligned priorities, I was directed to Dave Ferguson by a friend, the dean of the graduate school. I was told that Dave, chair of the Department of Technology and Society, could use my experience and skills to build up his PhD program in Technology, Policy, and Innovation. As an economist who has successfully designed graduate programs, I would not only fit in substantively as a faculty member but would be an asset in the administration of the program. Dave agreed to meet with me because he recognized the value of an economist in a policy program.

I had heard a lot about him before we met—specifically that he was kind and extremely dedicated to prioritizing and maximizing the production of knowledge in higher education. We hit it off immediately over our shared values, mutual understanding of the mission of academia, and more specifically, a common vision for a successful PhD program. We wanted to produce students who would have real impact, and we wanted to be creative and inclusive. Citing my reputation as "dangerously smart," he ended the conversation as follows: *"You are convicted. I like that. I like that a lot. I am convicted too. What I ask of you is to respect the fact that I am the chair of this department. My door is always open, and I welcome your input, and even your criticism. I will process it. But ultimately, I am the chair. And I get to decide."* He had no idea how much those words meant to be. I finally found a leader who "got it." A leader who was confident enough to take criticism and to be kind, and even grateful for it. A leader who sought out folks who might have expertise that went beyond his own if it improved the probability of success. A leader who took a chance on me, despite advice from his peers who criticized me.

Many mistook Dave's gentle manner and kindness as weakness. Nothing could be farther from the truth. It was a sign of strength and security that he did not need to exert power and control. When he presented me to the then dean of engineering, Yacov Shamash, he was taking a risk. And Yacov, being a truly strong leader as well, ended the conversation with *"Treat her well."* I am still honored to be friends with Yacov and so blessed to have been brought into their world.

Dave knew I left my previous college and dean precisely because I acknowledged that he was in charge, and he got to set the priorities. My options were to run my department aligned with those priorities or to leave. My leaving was a signal to Dave that I did understand governance and what I had control over. We understood each other. He saw me.

Dave and I became like siblings. We trusted and valued each other's opinion more than any others. We spent hours on issues that mattered. We talked about the strengths and weaknesses of each and every graduate student in our program. We sought to break down barriers and encourage success. We made tough decisions together when it was best for the student to leave the

program. And we went to battle against injustice against our students. Dave did not fight for himself. Despite attacks against his credibility and weakening of his position at Stony Brook, he smiled and said he was okay. He had his research grants. He had his colleagues around the world. At any conference even indirectly related to engineering and/or technology and society, folks asked, "Do you know Dave Ferguson?" Everyone in the field loved, admired, and respected Dave. He did not seek approval, and he did not fight for it, but he would use any leverage he had to defend students, particularly vulnerable students. We co-advised. We took up the fight together. And we won on more than one occasion. Because we were right.

Dave didn't fight just for vulnerable students. I was not tenured which made me vulnerable as well. He knew I was the product of an imperfect system, particularly for women in economics, and this was yet another barrier. Dave fought hard for me when it really mattered. I am forever grateful to him for that. I often contemplated how hard he had to work to get to the status and prominence he did achieve. It is clear how much smarter he had to be to get a seat at the table, especially given the era he grew up in. He must have known what it means to be vulnerable himself.

One of the things that brought us together was a shared faith. We were able to take our conversations to a higher level. That is something I am not sure too many knew about Dave. We prayed together. Though we were not self-righteous, we sought to be righteous by deferring to a higher power. We wove that into our conversations and planning. We were not too proud to believe.

Trust is not easy in a political environment like the one you find in academia. I trusted Dave with my very life. He was selfless and true. The last email he sent me, which arrived the day he died, was assuring me that one of our students would be okay. We had just come out of one major battle, and found ourselves in yet another, which was the new normal under new leadership. One of the last things he was focused on was working behind the scenes to make sure that another student was treated justly and fairly. The student subsequently had a very successful defense and made us proud, even though, sadly, without Dave physically present. But he was there, very much a part of the success. And that is yet another success story, against the odds.

I still feel a close bond to my dear brother Dave. The day he died, a song started to play for me over and over—on my car radio and on Alexa, without my asking for it, Carole King's "You've Got a Friend." I still hear it when I think of him. He simultaneously shared a different song for the last advisee we hooded at Stony Brook University, Jonelle Bradshaw de Hernandez. Someone we both admire and love, and who made us so proud. Someone we were willing to expend enormous political capital on to ensure she had a successful defense despite unfair opposition from some members of the department.

The song she heard was Simon and Garfunkel's "Bridge Over Troubled Water." Others believe in coincidences. We do not. The day of Dave's memorial service at Stony Brook University was a grey misty day. I was walking over to the venue with a colleague, and I said "This is the kind of weather that calls for a rainbow. Dave is going to send us a rainbow." A few minutes after entering the building that colleague yelled out "Deb, your rainbow. It's your rainbow." There was one of the brightest double rainbows I have ever seen. All in the room rushed over to the glass walls to witness it. Then provost, Michael Bernstein, mentioned it more than once, citing it as a message from Dave, as he hosted the ceremony. Dave is not truly gone. He is in a better place, and he continues to inspire us. Still, we miss his physical presence. There are very few like him.

The Gatekeeper: Honoring the Legacy of Dr. David Ferguson

Dr. Jonelle Bradshaw de Hernandez

I met David Ferguson in 2014 at Stony Brook University, but I knew of Dave before I met him. Everyone spoke about his excellence, kindness, and dedication to the fields of technology, math, and science. Most of all, I continued to hear about his brilliance, but also his humility. At the time of our first meeting I was pursuing a doctorate at another university focusing on STEM and higher education effectiveness. I met wonderful faculty members at my previous institution, but I was not happy with the program so I began to look elsewhere. Stony Brook University was not on my list. I graduated from Cornell University and Columbia Teachers College with undergraduate and graduate degrees respectively, and I was hoping to stay at a private, Ivy League institution. That all changed when I heard about the Stony Brook University College of Engineering Program in Technology and Society, and especially when I met David Ferguson.

Dave and I met and immediately connected around the pursuit of science to meet the most challenging needs of society. We were both passionate about the opportunity to utilize higher education to create a talented workforce committed to shaping a better world. Science, data, and technology were at the crux of our conversations. I did not speak to Dave about my interest in enrolling in his department after we connected around academics. Frankly, I never met anyone like him. He understood my intellectual pursuits in science and problem-solving and never questioned my academic goals. He was the first academic in my experience who did not downplay my objective of pursuing the highest and most rigorous goal of scholarly work for the advancement of democracy and society through engineering science, technology, policy, and education. He never questioned my status as a mid-career black woman pursuing the most exclusive credential of higher education—the doctorate. Dave was a fantastic listener, a quick processor of information, and a deep thinker. He saw me.

I spoke with a number of faculty in the department before I spoke with Dave. I did not want a perception that if I applied and was accepted that it was through his support alone. As a black student I was aware that although he was highly admired, he was still a black man leading a prestigious department. I did not want him to be seen as providing preferential treatment. I recognized early on that even with strong grades from top institutions and recommendations from exceptional faculty members across the nation, my student status would be questioned if I were admitted. After three faculty members from the department encouraged me to apply I spoke with Dave. I will never forget that conversation. I think it lasted a couple of hours. Synergy. We talked about philosophy, government, policy, and basic science pursuits. We spoke about the ever-increasing role of technology literacy and its application in pursuit of a better society. I told him I wanted to apply, he said he would be delighted to read my application.

I applied and was admitted and thence followed the best years of my academic life. Dave was the chair and co-advisor along with the brilliant Dr. Debra Dwyer. I learned so much from Dave, Deb, and a cast of characters that I could only describe as, well, quirky. Months before my upcoming graduation everything changed. Dave was no longer the chair, and it seemed from the outside that he was being stripped of everything he had built at Stony Brook. I asked Dave several times if he was OK, but as many of you know, he said he was fine. Modest and stalwart, even in the face of challenge. As more initiatives and more authority were taken away from him, I watched as he made sure we, his academic students, were OK. I was fine, although the politics were tough, and I was being questioned. But we managed until the unthinkable happened. I was accused of plagiarism because of a few grammatical errors in a paper. The accusation did not include the theft of ideas or philosophical views. It was

designed to intimidate. It was an attack on me, and the goal was to publicly discredit and to create doubt when people saw my name. I remember the choices I was given, leave the program within months of graduation, or stay an additional three years with a full course load (despite being ABD) under different advisors, or face a public trial. I spoke with my committee, who were livid. Dave was just sad. He continually apologized and I saw in his eyes a sense of impending defeat. I looked Dave in the eye and said I am not going to hide; we do not intend to associate our names with weak scholarship. Through my tears I said let's go for the public trial. And it was in that moment that I realized that Dave was not just brilliant, kind, and humble, but that he was strong, and because he was kind he was underestimated. His demeanor turned from impending defeat to fiery strength.

This story is long and the people who initiated this charge don't deserve my time, but the outcome was total vindication and success. The process worked, and an anonymous committee cleared my name and allowed me to move forward. I will be forever grateful for the policy, processes, faculty, and leaders that provided students the ability to be heard and to defend. I will never forget the letter clearing me of the charge of plagiarism. It restored my faith in higher education.

But I realized it was Dave and Deb Dwyer—two academic powerhouses—who saw that this was more than an accusation. It was a process to eliminate future academic leaders of color in the science and tech space, people who were poised to make a difference. Dave spent his entire life at the gates of academic innovation and equity in science, technology, and higher education. Some people saw this as a threat. It did not matter the pedigree of the student he helped, the grades, the recommendations and the academic and professional accomplishments, he knew that they would see me as black and as not belonging. Dave made sure to hold the gates open for those who wanted to pursue our shared goals at the highest level. He recognized the talent, he saw the excellent work, and he wanted to move the field forward and ensure inclusivity.

I watched Dave hold the gate open for me as his last doctoral student. As he was being stripped of his titles and authority, he stumbled a bit, but he kept the gate open. Even as he was under the most extreme professional stress, he provided one final push and I made it through. I graduated with the support of people who believed in me and kept me going. At the end, Dave's integrity was intact, and the people who supported me not only stood for truth, they did it because they trusted and respected Dave.

Dave died and I was devasted. Dr. Teng was a good friend of his and he joined my committee and pushed me to my limits. Sadly, he also died soon after, so I was the last Ph.D. student they saw graduate. I'm eternally grateful for their generosity. They opened the gates for scholars like me, and their legacy lives on.

With this tribute I will say only that Dave's contribution to the field as the honest gatekeeper has been multiplied exponentially. His students, including me, are at the table moving billions of dollars (yes, billions) of resources in science, technology, and innovation for research and application pursuits. We work in higher education and in policy think tanks, and a few of us simply can't disclose where we are because of the classification of the work. All of my cohort were exhorted by Dave to make an impactful difference, and we are his disciples in plain sight, doing just that.

So, Dave—don't worry, your life is full of academic children where your work lives on forever. The gate is still there, but guess what: we will no longer merely open the gate; we are determined to kick it off its damn hinges.

Dr. Jonelle Bradshaw de Hernandez is a Research Assistant Professor at University of Texas, School of Information and is the Executive Director of Foundation Relations at UT Austin. She is a mom and loving wife and after living in the great state of New York is now enjoying her new life in the friendly city of Austin, Texas. She continues to work with leaders and scholars in the areas of science, technology and workforce development. She also speaks with scholars of color who left the scientific field after policies like plagiarism were weaponized to keep them out and helps them to pursue a life of purpose for society's benefit.

Tribute in Honor and Memory of David Ferguson

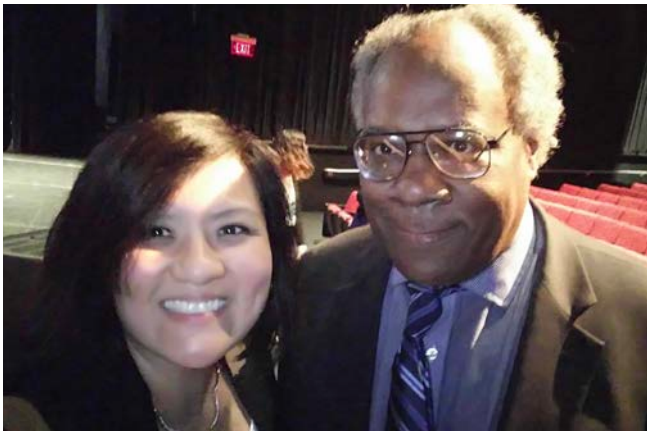
Nina Maung-Gaona

Dear Friends,

On Friday July 12, 2019, Stony Brook University lost a beloved, esteemed, and prominent international leader, Dr. David L. Ferguson, SUNY Distinguished Service Professor, longtime Chair of the Department of Technology and Society, and Director of STEM Smart. Dave was my boss for 11 years, co-advisor of my doctoral dissertation, my professional mentor for 19 years, and most of all, my hero.

Although I was his protégé, Dave always treated me like an equal partner. Following his example, I try every day to emulate his leadership style: passion and compassion. He would always tell me that the best leaders are the ones who inspire a vision and then get out of the way so that people can work their own magic in realizing that vision. He always gave me space to think big and take risks in order to raise the bar of excellence. And he kept me grounded and focused by asking me a simple question from time to time: "Are you having fun, Nina?" For all these reasons, Dave will forever be my hero.

As many of you know, Dave won the prestigious Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring from the White House in 1997. He donated the prize money for student scholarships. Dave was Principal Investigator on about a dozen externally



sponsored awards, all to support the mission of broadening participation in STEM education. He had millions of dollars of funding from the National Science Foundation and the New York State Department of Education, as well as from various foundations and companies. He brought programs like the Louis Stokes Alliance for Minority Participation (LSAMP), the Alliance for Graduate Education and the Professoriate (AGEP), and Science Education for New Civic Engagements and Responsibilities (SENCER) to Stony Brook, distinguishing Stony Brook as a national leader for diversity, equity, and inclusion.

Dave was the Chair of the Department of Technology and Society (DTS) in the College of Engineering and Applied Sciences for 15 years. He was very proud of the department's interdisciplinary research and scholarship and dedicated his life work to ensuring the department's success by building a robust faculty. Dave was pivotal in the successful establishment of SUNY Korea; DTS was the first department to offer classes in SUNY Korea and attracted lots of students from all over Asia. Above all else, Dave loved being a professor! A true math nerd. He taught classes on decision-making, science policy, and problem-solving. His passion was helping students achieve their biggest dreams, and he was a staunch advocate for access to opportunities for advancement and success. He had an impact on tens of thousands of students over his career.

Dave's reach was so deep and so wide that I vow to do my part to honor his memory by ensuring his life's work continues to grow and flourish.

Dave's aura radiated a color that was not of this world. His frequency vibrated gently, yet he inspired an unshakable confidence and security in all who knew him. He had an ethereal generosity that permeated his every thought and his every action. As we each reflect on our own special relationship with Dave, I know we share a deep sorrow, an immense gratitude, and an infinite pride for having his magical presence in our lives. Dave's magic is most certainly eternal.

In Dave's honor and memory, Nina Maung-Gaona

A Tribute for David Ferguson

Lauren Donovan
Office of the Dean, College of Arts and Sciences,
Stony Brook University

I had the pleasure and privilege of working with Dave Ferguson for more than seven years. I miss him very much. He was truly unique, epitomizing the kind of authentic and strategic leadership that is too rare. He was kind, yet he would not hesitate to be frank and get his point across. He was thoughtful in his words and actions, and always made one feel like their opinion mattered. In all my years working with Dave, I never heard him raise his voice. He was respectful in his demeanor and behavior and always took the time to listen. Even if he was having a stressful day, Dave's first question to others was "How can I make your day better?"

Dave had a knack for surrounding himself with colleagues who shared his values and approached situations as he would—with compassion, discernment, and kindness. He demonstrated that you didn't need to be loud and abrasive to make an impact, and I, and many colleagues, did our best to copy his example.

Dave's accomplishments over his long career as a scholar, teacher, and administrator were far greater than most of us could fathom. However, Dave rarely spoke about himself, though he would be the first to congratulate someone and celebrate the achievements of others. You could sense his true pleasure when students or colleagues succeeded. Dave was a very genuine and generous person who is deeply missed as a colleague and a friend.

That generosity and un-hierarchical sensibility, so often cited by anyone who worked with Dave, can overshadow the fact that he was an immensely effective, strategic, and successful academic leader who generated and oversaw millions of dollars in external funding, primarily to support minority students in STEM fields. My own sense is that the two qualities, his generosity and his effectiveness, were inextricable and constituted his "superpower." In any project it was clear that Dave listened to everyone and was sincerely interested in their perspectives and experiences, regardless of their status. Like a true scientist, he did not exclude any reasonable point of view or possible solution that might contribute to the overarching goal, which was always to support and empower students. He would ask "What is your hypothesis?" and he was not afraid to experiment and take up the ideas and suggestions of others. He truly enjoyed learning from other people, other disciplines, other cultures, and he was energized, and not intimidated, by the originality and creativity that he found all around him. Unsurprisingly, he attracted similarly generous, creative, and confident people to his teams.

The lessons I learned from Dave, about listening, respecting diverse perspectives, and always remembering the core mission of higher education, have deeply impacted my current work today as the Dean of Arts and Sciences' liaison to 10 university research departments and centers. This position requires listening, synthesizing, and navigating and representing honestly diverse constituencies with sensitivity, good humor, and an open-minded spirit. Dave's example has been a lasting gift that I will always carry with me.

Memorial Tribute for David Ferguson

Patricia Aceves, Ed.D.
Assistant Provost & Director (Retired), Center for Excellence in Learning & Teaching (CELT),
Stony Brook University

Isaac Newton must have had someone like Dave Ferguson in mind when he wrote, "If I have seen further it is by standing on the shoulders of Giants." Dave's vision, dedication, and advocacy for teaching and learning at Stony Brook University brought the first Center for Excellence in Learning & Teaching (CELT) to life in 1998, and he served on the search committee that hired me in 2009. For the next ten years he was a mentor, advocate, and friend to me and the Center; his door was as open as his willingness to share his wisdom.

I recall fondly several anecdotes about Dave that highlight how he made the world a better place. During the interview dinner with my search committee, I listened intently as Dave told a story about an experience he had as a grad student; and with a straight face, his deep, solemn voice, and not a hint of what was coming, he delivered one of the funniest punchlines I'd ever heard. The group erupted in laughter and I laughed so hard I had tears running down my face. Over the years, I found his humor was always at the ready when needed.

I served with Dave on a number of standing committees and was always amazed at how he kept up with his busy administrative, teaching, and research schedule and still found time for service. In one such committee meeting, the group was deep in conversation around a sticking point regarding how best to move forward on a particular issue. On this day, Dave did not appear to be engaged in the conversation and when I glanced over at him, he sat with his head bowed and his eyes closed. But when a question arose that we struggled with, Dave piped up with an insightful response as if he had been pondering the question all along. In that moment, I saw but a glimpse of his genius and the Superman ability he had to juggle his many passions and responsibilities.

In the last encounter I had with Dave a few months before he passed, I'd asked him to speak at a CELT ribbon cutting ceremony, as he was the founder of our Center, but he graciously declined. He stated that he wanted me and our staff to be the focus of the event. Even though we were standing on his shoulders, he was comfortable in the knowledge that his work would carry on in the hands of the next generation of passionate teachers and educators. When you spent time with Dave Ferguson, he made you feel as if you and your cause were the only things that were important, and I have no doubt that was true.

Memorial Tribute for David Ferguson

Paul Siegel
STEM Smart Co-Director, Retired, Department of Technology and Society,
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Since Dave's passing on July 12, 2020, not a day has gone by when I haven't thought of him. Dave was many things to me: professor, mentor, cheerleader, traveling companion, and friend. He was the most self-effacing man I have ever known, and he was also one of the smartest men I have ever known. I owe my career in academia to Dave. It was Dave who gave me permission to pursue the many grant opportunities that led to the creation of the STEM Smart program and its myriad opportunities in an all-encompassing variety of STEM majors.

Today, there are hundreds of students of color and from underserved communities who are now holders of advanced degrees due to the programs that Dave created with a little help from his friends. Dave's work helped to change the face of science and engineering and bring about an increase in diversity in the Academy. My interactions with Dave occupied just a small space of his presence, but he had the ability to make you feel like you were the only one who mattered when you talked with him. Whenever Dave heard news about the accomplishments of our STEM Smart students his face would light up with joy, and I believe that is a measure of his greatness. He wouldn't think of taking credit for that student's achievements—he was just joyful that another student had enjoyed academic success.

Tonight, I'll raise a Heineken in his honor and memory.

TEACHING & LEARNING

Critiquing the Learning Design of a SENCERized Team-Based Activity

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Abstract

A team-based learning activity is presented that was created to support a university-level course with an integrative theme of environmental sustainability. Students in a General Education *Environmental Biology* course were asked to relate academic concepts to real-world scenarios by creating a hypothetical ecoresort on an island that had suffered severe habitat degradation. The Earth Charter helped guide student understanding of how to balance ecological, social, and economic needs. Furthermore, the SENCER approach to educational practice helped teach the science through complex social issues. Student-generated media (in the form of a webpage) helped learners integrate and showcase their gains in knowledge and skills. The "ecoresort activity" is critiqued against educational best practices, by aligning its design with Fink's Taxonomy of Significant Learning and Merrill's Principles for Instructional Design. Finally, practical recommendations (with an accompanying facilitator's guide) are provided that should help STEM educators calibrate interacting variables during technology-enhanced course designs: permeable learning spaces, assessment strategies, and social learning settings.

Introduction

This article describes a team-based learning activity, where students collaborate in small groups to design an ecoresort and build a website to market their hypothetical resort (see the Appendix for a complete facilitator's guide). The process of designing the resort can launch additional larger discussions—for example, about how our recreational choices deplete, endanger, conserve, or restore natural resources. Students are given the opportunity to consider what should drive their choices of location, transportation, lodging, food, and healthcare when designing a facility in a fragile ecosystem. The activity addresses the concept of "environmental sustainability" and incorporates scientific concepts in ecology, such as habitat loss and population decline of animal and plant species, and social/technological issues surrounding energy systems and renewable and non-renewable resources. It raises civic questions about the role of science when local communities assess and manage the environmental impact of their own growth and development.

Following the description of the activity, learning design is critiqued through three lenses: Fink's Taxonomy of Significant Learning, Merrill's Principles for Instructional Design, and the SENCER Approach to Educational Practice. Practical recommendations are then made to guide learning design. Thus, the purpose of this article is to provide STEM educators with the knowledge, skills, and abilities they'll need to incorporate learner-centered activities into their technology-enhanced learning experiences.

Background Information

Environmental sustainability is the integrative theme of the course for which this ecoresort activity is a major component (SENCER Model Course link: http://ncsce.net/environmental-biology-ecosystems-of-southwest-florida/). Within this general education course for non-science majors, learners explore introductory concepts related to ecosystem services, natural resource use, and economic growth (at the expense of the natural world). The "triple bottom line" provides a useful framework to help students guide their thoughts, although there are other ways to approach learning about environmental sustainability. For example, student participation in Earth Charter–related activities throughout their academic journey may be beneficial in myriad ways (http://www.earthcharterinaction.org/content/). The Earth Charter is a movement that promotes "respect and care for the community of life, ecological integrity, social and economic justice, and democracy, nonviolence and peace" (Earth Charter, 2021).

The flagship initiative of the National Center for Science and Civic Engagement is Science Education for New Civic Engagements and Responsibilities (SENCER), an organization that aims to connect science education with civic engagement to promote student participation in science, technology, engineering, and mathematics (STEM) education (SENCER, 2016). SENCER's mission is to "strengthen student learning and interest in STEM by connecting course topics to issues of critical local, national, and global importance" (SENCER, 2016). This ecoresort activity (which originated as part of a SENCER Model Course) connects to several SENCER ideals, by "extracting from the immediate issues the larger, common lessons about scientific processes and methods" (Table 1) (SENCER, 2016).

This SENCER-aligned activity explores an issue of social and scientific significance, the impact of tourism on island ecology. The metaphor of an island can be expanded upon to include explorations into global issues (Island Earth). One way to connect learning to students' daily lives is to align class activities with something meaningful to their social lives. For some of our students, a dream spring break vacation includes spending time in a tropical island resort. What might students' reactions be to the notion that their choice of vacation destination (as tourists) may be contributing to the tension between economic development and ecosystem preservation? This question serves as a potential springboard from which to explore a wicked problem, such as human impacts on the natural world. Learners can investigate how tourists are a blessing and a curse for community members at tourist destinations. Clearly, tourism brings revenue. But tourism has many possible negative impacts as well, including the depletion and pollution of terrestrial, aquatic, and atmospheric natural resources (Garces-Ordoñez, Díaz, Cardoso, & Muniz, 2020; Leposa, 2020; Lowe & Sealey, 2002; Singh, Bhat, Shah, & Pala, 2021).

When designing courses, educators usually align course outcomes with the desired knowledge, skills, and attitudes they want learners to demonstrate upon successful completion. Fink (2003) described a taxonomy that integrates these elements and adds an additional element of learner metacognition (thinking about one's thinking). Merrill (2002) described five core principles that promote active learning and are grounded in problem-based learning. Fink's Taxonomy of Significant Learning and Merrill's Principles for Instructional Design provide two evidence-backed and relevant lenses to critique this SENCERized learning activity.

What Students Will Be Able to Do

By exploring current environmental events and investigating and debating sustainability issues, students will be able to

- Conduct basic research related to current environmental issues such as energy consumption, food availability, freshwater supply concerns, waste generation, and habitat restoration.
- Generate evidence-based decisions about the degradation of natural capital that results in human-dominated systems.
- Develop business plans that incorporate environmental sustainability as a fundamental bottom-line consideration, while addressing social needs, economic interests, and cultural awareness of community members and/or tourists.
- Work in teams to demonstrate effective communication, collaboration, and critical thinking skills.
- Connect issues of civic importance to their daily lives and decision-making processes.

Scientific Concepts Addressed and Related Civic Issues

When development "is greater than the environment's ability to cope … within acceptable limits of change," (www.unep.org) the depletion and pollution of terrestrial, aquatic, and atmospheric natural resources are one result, and this is the subject of a great deal of scientific attention in ecology and conservation biology. The ecological destruction stands in contrast to the economic benefits that can accrue to communities that invite tourism into such ecologically delicate areas. Local and national governments may tolerate, and even encourage, tourism's environmental impacts if the construction of resorts brings economic benefits such as jobs and tax revenue.

By investigating this question in depth, students explore the complexity of "sustainable" tourism and the tradeoffs involved. Students grapple with the question of whether the goals of environmental protection and economic prosperity are compatible, and, if the answer is no, design tourism facilities that attempt to serve economic and ecological goals at once.

FIGURE 1. This graphical representation describes the ecoresort project's fundamental learning path. A blended learning design facilitates individualized asynchronous activities within the learning management system that are carefully choreographed with team-based application activities in synchronous and face-to-face settings. Within a technology-enhanced learning environment, contextualized learning around a wicked problem helps learners practice, gain real-time feedback, and continuously reflect on their learning.

The Activity

This collaborative assignment uses a hypothetical case study and student-generated media to make course material relevant to a variety of students' academic majors, personal interests, daily lives, and decision-making processes. Students develop a plan for establishing and managing an ecoresort, and then publicize it via a student-created website. The activity can be conducted in a variety of learning spaces, including fully online, blended, and face-to-face settings. The basic learning path for the activity incorporates a technology-enhanced learning environment, so that a carefully choreographed blend enriches learner engagement (Figure 1). While the instructor can take this activity in several different directions, the basic outline is presented in Table 1.

This activity is applicable to a wide range of disciplines and academic levels (Table 3), and instructors can incorporate the activity in multiple ways. For example, they might

- Use this as a capstone project for the course.
- Divide the tasks into weekly modules that students complete one by one in a longitudinal fashion throughout the course.
- Pick and choose the tasks most relevant to course needs and focus only on those, by scaling back the project requirements. For example, parts of this activity could complement lessons and readings related to students' ecological footprints.

TABLE 1. Ecoresort Activity Alignment with SENCER Ideals

Relevant SENCER Ideals (retrieved from https://sencer.net/sencer-ideals/)
SENCER connects science and civic engagement by teaching "through" complex and unsolved public issues "to" basic science.
SENCER invites learners to put scientific knowledge and methods to immediate use on matters of relevance to them.
SENCER reveals both the power and the limits of science in addressing the great challenges of our time.
SENCER helps all learners connect civic issues of local concern to national and global "grand challenges."

TABLE 2. Descriptions of the Ecoresort Project's Basic Phases

PROJECT PHASE	DESCRIPTION
Collaborating	Working in teams, students brainstorm ways to "restore" degraded island habitat and relate key concepts covered in class (i.e., ecosystem services, natural resources, habitat loss, freshwater supply, etc.) to the decisions they'll need to make about the human impacts behind their sustainable restoration project. Essentially, they are scaling down the entire planet to an island, which allows learners to make better sense of complex environmental processes and social issues.
Researching	The teams conduct research on course-related academic concepts and real-time social issues. In doing so, they locate peer-reviewed scientific literature that will be incorporated into their explanations, inspire their designs, and factually support their ideas.
Creating	Each team creates a webpage that markets and addresses an assigned task list, including both operational and ecological considerations. For students with a business background, a formal business plan (i.e., Business Model Canvas: https://en.wikipedia.org/wiki/Business_Model_Canvas) could be implemented within the project-based learning opportunity to enrich the interdisciplinary composition of teams.
Integrating	By using free website-building software (for example, www.weebly.com) students create webpages that showcase their ecoresort features while simultaneously integrating key course content.
Practicing	In advance of summative assessments and presentations, low-stakes formative knowledge checks with feedback may be provided via a learning management system.
Presenting	At the end of the semester (or conclusion of the activity), each team delivers an oral presentation to the rest of the class.
Reflecting	Students complete continuous individualized critical reflections throughout the exercise.
Evaluating	Each student provides feedback on their group members' performance, effort, and contributions. Additionally, students provide feedback on each of the group presentations. Lastly, students complete a Student Assessment of their Learning Gains (SALG) survey (via www.salgsite.org).

TABLE 3. Alignment of Ecoresort Activity with Appropriate Courses

Courses into which this activity could fit	
High School	**AP Environmental Science**
College/University	**Non-science major introductory-level General Education** Environmental Science Environmental Biology Marine Science **Freshman-level science major** Environmental Science Special Topics on Environmental Sustainability

- Use the project as the primary teaching tool for the entire course. For example, instead of lecturing, guide the students through the course by using this as a project-based learning opportunity within scheduled class time.
- Use as part of a study abroad class and include a segment related to respecting the cultural needs of an indigenous population.
- Include a service-learning component, where students are given opportunities to connect their coursework to serving the needs of the community. Students should be given continuous reflective assignments that help them relate the goals of this project to the community service tasks they are performing.

Each of these approaches can yield learner successes. And given the flexibility, the instructor may adjust the percentage of the overall grade to match the needs of the curriculum. Likewise, the island location can be modified to suit the needs of the course, depending on the geographic location that is most relevant to students and their campus/university.

What If Projects Were Worth More Than a Letter Grade?

In collaboration with the local chamber of commerce, students could potentially conduct sustainable practice audits for the community as service-learning projects. For example, during these audits, students could work with community partners (local businesses, informal learning centers, schools, etc.), where they could relate service-learning opportunities to course content by accomplishing the following duties:

- summarize their on-site observations;
- identify environmentally friendly and non-friendly practices at the partner site;
- provide recommendations to the community via an outreach session.

This information could ultimately be used by the chamber of commerce to recognize tourist-oriented businesses that adhere to sustainable tourism practices. Students could also work with the local government and help the town develop a certification program for "sustainable" tourist establishments.

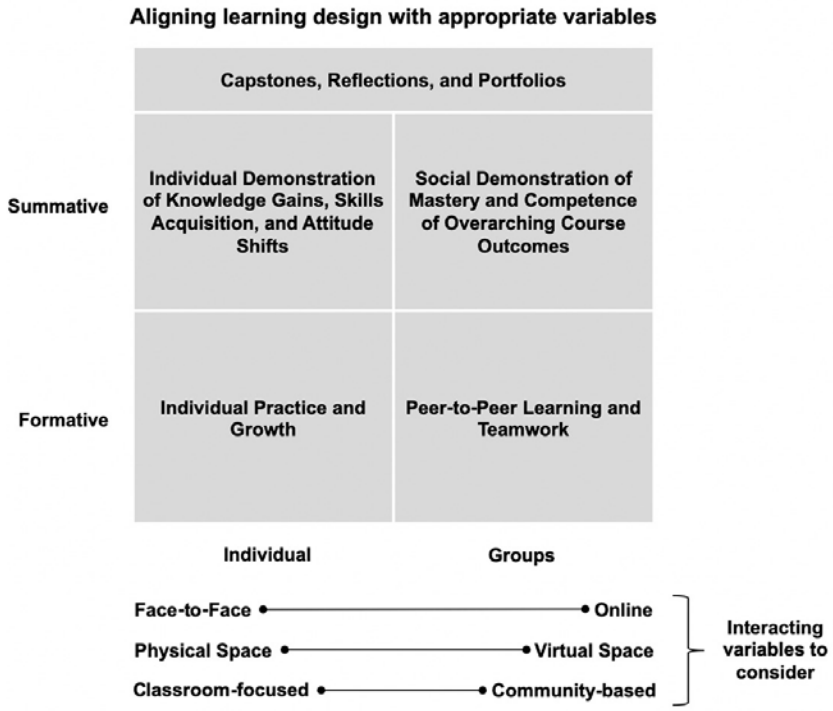
This activity also has the potential to connect students with informal science education centers in their area. Using YouTube videos and quick response (QR) codes, students can create interactive "exhibits" focused on a sustainable practice for regional venues of informal science education (e.g., science and nature centers). QR codes could be displayed on site so that visitors can scan them with a smartphone and view students' projects. An entire class could create any number of these types of videos, which would likely be welcome in budget-limited informal science education institutions.

Enriching Citizen Engagement with Social and Civic Problems That Have Underlying Scientific Issues

Because tourism, in some form, is an experience most students have in common, this activity is likely to be of immediate interest and relevance to them. In a discussion of the environmental impacts of tourism, instructors can teach "through" larger issues such as conflicting economic and environmental interests "to" the underlying science on the environmental impacts of human activity on ecosystems. In addition, the instructor has the opportunity to engage students with broader civic questions such as

- Who is responsible for ensuring that we have clean air to breathe, clean water to drink, and healthy ecosystems to support life?

FIGURE 2. Consideration of interacting variables helps yield effective and efficient formative and summative assessment opportunities in both individualized and peer-to-peer learning settings. Capstone projects, critical reflections, and longitudinal portfolios provide high-impact opportunities for meaningful learning. Instructors should align learning intervention goals with the activity's role in the course.



- What public policies promote or impede environmental sustainability?
- What are the tradeoffs between economic development and environmental sustainability, and how should these tradeoffs by determined? Who should be involved in the decision-making processes?
- In light of the extreme environmental challenges faced in underserved communities, describe your thoughts about social justice, equity, and economic opportunity.

Why This Learner-Centered Activity Works Well

Meaningful learning is optimized when instructional strategies are implemented that manage intrinsic cognitive load, limit extraneous load, and maximize capacity for germane load (Kirschner, Kirschner, & Paas, 2006; Mayer, 2011). These strategies include sequencing curricula, scaffolding content, and encouraging metacognitive behaviors (Deans for Impact, 2015). Critical reflection by learners is also a key part of meaning-making during the learning process (Dewey, 1933; Dewey, 1938; Rodgers, 2002). Several frameworks exist to help analyze the ecoresort activity, by critiquing how its instructional design is aligned with accepted educational best practices. Fink's Taxonomy of Significant Learning and Merrill's Principles for Instructional Design are two such frameworks (Table 4).

This team-based learning exercise is aligned with educational best practices, as determined by its alignment with two different instructional design frameworks. Active learning yields autonomous opportunities that may increase learner motivation. Multi-tiered assessments (formative and summative) help learners monitor their learning gains and skills development. Additionally, authentic and real-world scenarios promote emotional connections for learners. Team-building and collaboration help foster the conditions needed for inclusive settings where all learners can contribute. Furthermore, this learner-centered activity promotes cognitive, behavioral, socio-cultural, and affective engagement.

From a practical standpoint, learners are provided opportunities to engage academic content individually and in social groups (Figure 1). They are provided a variety of low-stakes and higher-stakes assessment opportunities within a variety of permeable learning spaces. When used as a capstone project, this learning experience provides learners with opportunities to demonstrate mastery and competence in critical course outcomes in a social setting (Figure 2). The ecoresort project helps learners acquire discipline-specific knowledge and provides opportunities for them to integrate their knowledge gains. Furthermore, learners are able to demonstrate appropriate mastery of skills. Lastly, this activity provides an opportunity for learners to explore their attitude shifts toward issues of social and scientific importance.

TABLE 4. Critique of the Ecoresort Activity through the Lens of Educational Best Practices

INSTRUCTIONAL DESIGN FRAMEWORKS	HOW THE ECORESORT PROJECT ALIGNS	LEARNER OUTCOMES	LEARNER ENGAGEMENT (Cognitive, Behavioral, Affective)
Fink's Taxonomy of Significant Learning			
Foundational Knowledge	Critical information is provided with the anticipation that learners will retain and recall well into the future.	Lifelong learning	C,B
Application	Learners engage in critical, creative, and practical thinking to solve authentic and relevant problems, by using their ecoresort as a contextual case study.	Critical thinking	C,B
Integration	Learners make connections between academic content and their personal lives, by investigating social and scientific issues of global significance.	Self-awareness	A
Human Dimension	Learners collaborate with others in peer-to-peer learning opportunities, which fosters affective engagement in course content as they learn about themselves through these interactions.	Teamwork	C,B,A
Caring	Learners interject their own unique interests, emotions, passions, and values into project deliverables.	Motivation	A
Learning How to Learn	Learners incorporate self-regulated learning skills, teamworking skills, and researching skills to accomplish tasks.	Curiosity	C,B,A
Merrill's Principles for Instructional Design			
Problem-Centered	Learners are acquiring knowledge in the context of real-world problems, specifically by investigating challenges with environmental sustainability.	Civic mindedness	C
Activation	Learners are using their prior knowledge from class activities and life experiences as a foundation upon which to build new knowledge.	Resourcefulness	C,B,A
Demonstration	Learners observe relevant case studies and encounter contextual information within the overall curriculum.	Creativity	C,B
Application	Learners apply their new knowledge by solving novel problems related to their island's ecology and ecoresort requirements.	Question-asking	C,B,A
Integration	Learners reflect continuously, participate in discussions, and present their ideas in both small and large group settings.	Confidence-building	C,B,A

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About the Author

David Green specializes in advancing learner-centered curricula in health sciences, medical education, and STEM education. He has taught award-winning university-level courses, mentored undergraduate and graduate students, and facilitated faculty development initiatives that support innovation and creativity. He enjoys evaluating the effectiveness of high-impact educational opportunities by continuously monitoring critical program-level and student-level success metrics. As a Leadership Fellow with the National Center for Science and Civic Engagement and a Collaborating Partner with the Learning Spaces Collaboratory, he actively champions conversations centered on the intersections of physical, community-based, and technology-enhanced learning spaces. David holds a Doctor of Education from the University of Southern California Rossier School of Education.

APPENDIX A:

Facilitator's Guide

Timeline

The actual duration and time requirements are dependent upon how the instructor chooses to implement the project within their overall course design. As previously explained, this activity could be accomplished as a mini-activity within a single class session or it could serve as a longitudinal capstone project for an entire 15-week semester. Each student group would complete these general project phases:

- Planning, brainstorming, and team-building
- Research
- Webpage design
- Presentation
- Outreach/dissemination
- (Continual) Knowledge checks and formative feedback
- (Continual) Critical Reflection
- (Optional) Community-based service-learning project

Prior Knowledge Required

This activity is geared for first-year non-science majors. Thus, the average student in class has little to no content background when this project is assigned.

Considerations

- Student and instructor skills development with free website-building software
- Intentional connections to course academic content
- Local informal science education center site visits (to help explain regional ecosystems, ecology, and human impacts in an experiential manner)
- Online databases, search engines, and library support
- Digital presentation support (face to face or online)
- Group dynamics, peer-to-peer learning challenges, and grading team deliverables

Context and Concepts for Instructors

- This assignment constitutes a component of a SENCER Model course, described at http://ncsce.net/environmental-biology-ecosystems-of-southwest-florida/
- The following assessment materials are attached as supplemental digital content:
  - *Student version of the assignment*
  - *Simplified grading rubric*
  - *Midpoint assessment*
  - *Group assessment, final evaluation*
- To help foster authentic, emotional connections, consider introducing this exercise by showing students a picture of an island in Bimini (pre-development) that is pristine and serves as an important shark nursery. Then, show that same island with a picture that displays habitats completely bulldozed because a developer came in to build a resort. Next, explain that the developer departed following an economic downturn and this degraded island is all that is left. From that point, introduce the project goals, background information, and deliverables. Here is the link to a video that could be shown as an introductory exercise, to be followed by a discussion about key concepts: "Fabien Cousteau Presents: Bimini - Paradise in Peril".

- Because students become active producers of content rather than passive learners, they will use their higher-order thinking skills and are more likely to retain key academic concepts on which the assignment is based. Some of the instructions are intentionally left vague to help promote student creativity, enhance investigation, and enrich problem-solving. For example, common questions from students include the following:
  - *What is the size of the island?*
  - *What is the budget for our proposal?*
  - *What materials do we have available to us?*

  These are all fine questions, and an instructor could choose to answer them in any number of ways. But minimizing the constraints and not providing all information allows students to reflect broadly on sustainable practices that they have encountered in their classes.
- To avoid the use of large amounts of paper and ink that are consumed in printing hard-copy brochures, students create a webpage to publicize their resorts. Free and relatively easy-to-use resources are available that maximize inclusion and minimize extraneous cognitive load. Instructors may want to familiarize themselves with the webpage builder in advance and provide a brief tutorial in class.
- Students generally want to present their products to the class. Thus, an oral presentation opportunity for students is usually built into the final grade. For efficiency and livelier presentations, students focus on three key points (their Earth Charter learning module, the triple bottom line Venn diagram, and one "coolness" factor), rather than talking about their entire webpage.

Additional Resources

The following resource from the KQED QUEST project (http://science.kqed.org/quest/) relates to this assignment:

Taylor, Helen. (2012). *Help the Sea on Your Next Overseas Vacation*. Retrieved from http://science.kqed.org/quest/2012/07/02/help-the-sea-on-your-next-overseas-vacation/

The following resources also contain useful information:

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APPENDIX A:
Facilitator's Guide (continued)

Student Version of the Assignment

Team Project: Ecoresort and Sustainability

Learning Objectives

By the end of this team-based learning exercise, you will be able to:

- Conduct basic research related to current environmental issues such as energy consumption, food availability, freshwater supply concerns, waste generation, human health, and habitat restoration.
- Generate evidence-based decisions about the degradation of natural capital that results in human-dominated systems.
- Develop business proposals that incorporate environmental sustainability as a fundamental bottom-line consideration, while addressing social needs, economic interests, and cultural awareness of community members and/or tourists.
- Collaborate in teams to demonstrate effective communication, collaboration, and critical thinking skills.
- Connect issues of civic importance to your daily lives and decision-making processes.

Introduction

Imagine the world in 2030! Given your new knowledge of environmental sciences, your consulting firm was asked to create a pitch proposal for a sustainable eco-friendly island resort, while simultaneously mitigating ecological damage and restoring disturbed areas. You have several endangered species that must be protected on your island; they need access to upland and freshwater habitat, estuarine habitat, and offshore coral reef habitat.

As a team, complete a summary of your ecoresort proposal by building a webpage that addresses in detail all the questions listed below. You'll need to align with the concepts covered in class related to sustainability of natural resources, economic services, and ecological services. In short, what world do you want to create for humanity in 2030?

Tasks

- Elect a Board of Directors for your business and assign positions related to your majors.
- What is the company name of your resort?
- Why do people come to your resort? How many visitors do you receive annually? What recreational opportunities do you offer them? How do you mitigate environmental damage left behind from these recreational activities?
- How does your resort obtain the following?
  - Water
  - Food
  - Energy
- How does your resort get rid of waste?
  - imply shipping it to another location or dumping it in a landfill is not acceptable.
- What is the transportation plan?
  - On the island
  - Between the island and other places
- Describe housing that is available to employees. Where is it located? How does it minimize ecological impacts?
- How will you address public health issues? In what ways will you manage healthcare for your employees and guests?
- What types of wildlife areas have you included in your restoration plan?
  - Watershed
  - Inland, terrestrial, and freshwater reserves
  - Mangrove, salt marsh, and estuarine preserves
  - Marine and reef protected areas
- In what ways will you establish wildlife corridors? Why did you choose this type of ecological habitat restoration plan? Explain how this restoration plan preserves biodiversity.

- Choose a key indicator species found on your island and describe its total way of life (or niche) and its interactions with the biotic and abiotic components of the ecosystem. Make sure this organism has access to all the wildlife areas outlined above. Describe the organism's interactions in each ecosystem type.
- How will you protect your island from climate change impacts, including sea level rise, while maintaining ecological integrity and connectivity?
- Develop a learning module focused on the "4 Guiding Principles of The Earth Charter." Explain, *in detail*, how your resort will provide education and outreach to the local community regarding your sustainable development plans.
- How do you minimize the overall ecological footprint of the eco-resort? (Refer back to the ecological footprint exercise from earlier this semester to help gather ideas!)
- Create a digital "map" that illustrates the components and layout of your ecoresort.
- Generate a digital Venn Diagram that includes the following: Environmental Responsibility, Social Well-being, and Economic Growth. Explain how your resort relates to each of these underlying themes and to sustainability and the triple bottom line.

Team Project Deliverables

- Create a webpage that answers and advertises all the points outlined above in a highly descriptive and creative manner. Market your island resort as if you were an actual Board of Directors representing a major green-friendly resort. The actual layout of the webpage is entirely up to the team, but this advertisement must completely relate, in detail, all the above information, and you must demonstrate a thorough understanding of all concepts.
- Your team will collaborate in class and online (via Google Docs and/or the Canvas Learning Management System). Then, you'll submit your project via an online webpage. Here are a few options for your team to consider using:
  - https://sway.office.com/
  - https://sites.google.com/
  - www.weebly.com
- Please create a free account and provide me with your team's username and password information.

Due Date

- 2DEC20XX (Each team will also present their webpage to the class on this day.)

Please Note

- This project will be conducted in teams of three students that you will choose. Again, your team will evaluate and rate your participation and performance, which will ultimately be used to determine your individual final grade on the project. For full credit, your team must present a professional product that completely addresses the items outlined above.
- Creativity is highly encouraged! You must, however, perform all tasks outlined on this document and submit a project that includes alignments with the discussions of the topics covered in class this semester. Simply answering the questions above may not necessarily guarantee a desired grade. You must demonstrate complete and detailed understanding of the crucial concepts covered this semester in class and from the readings.
- Keep in mind that this is worth XX% of your final average, so that amount of effort must be put into the final product and deliverables. There will be no opportunity for late and/or make-up work.

Simplified Grading Rubric

Group:	Ecoresort Name:		
Students:			
	Possible Points	Points Earned	Comments
I. Resort Background Info	**10**		
Board of Directors	*2*		Yes = 2
Resort Name	*2*		Yes = 2
Visitor Information	*3*		Yes = 3
Ecological Footprint from activities	*3*		Yes = 3
II. Resort Infrastructure	**30**		
Energy, Food, and Water	15		15 = Very Good; 12 = Good; 9 = Fair
Waste removal	*5*		5 = Very Good; 4 = Good; 3 = Fair
Transportation Plan	*5*		5 = Very Good; 4 = Good; 3 = Fair
Employee Housing	*5*		5 = Very Good; 4 = Good; 3 = Fair
III. Wildlife and Ecology	**25**		
Wildlife area types	*10*		10 = Very Good; 8 = Good; 7 = Fair
Wildlife area corridors	*5*		5 = Very Good; 4 = Good; 3 = Fair
Key Indicator Species and Niche	*10*		10 = Very Good; 8 = Good; 7 = Fair
IV. Overall Ecological Footprint of Resort	**10**		
Annual visitor info addressed	*10*		10 = Very Good; 8 = Good; 7 = Fair
V. Map of Resort	**5**		
Map Included	*5*		Yes = 10
ORAL PRESENTATION			
VI. Venn Diagram	**15**		
Includes all three sustainability themes	*15*		Excellent Description 15, 14, 13, 12, 11, 10, <10 Poor
VII. Education and Outreach	**5**		
Describes program designed to educate	*5*		5 = Very Good; 4 = Good; 3 = Fair
w/ strong relationship to G.P.'s of E.C.			
VIII. Oral Presentation	**10**		
Evaluation of presentations kills	*10*		

Continues on next page >

Simplified Grading Rubric (continued)

Group:	Ecoresort Name:		
Students:			
	Possible Points	**Points Earned**	**Comments**
VII. Education and Outreach	**5**		
Describes program designed to educate	*5*		5 = Very Good; 4 = Good; 3 = Fair
w/ strong relationship to G.P.'s of E.C.			
VIII. Oral Presentation	**10**		
Evaluation of presentations kills	*10*		
IX. Webpage Presentation	**40**		
Organization and Flow	*10*		Great 10, 9, 8, 7, 6, 5 Fair
Transition between Topics	*10*		Great 10, 9, 8, 7, 6, 5 Fair
Creativity in Design	*10*		Great 10, 9, 8, 7, 6, 5 Fair
Professionalism in Final Product	*10*		Great 10, 9, 8, 7, 6, 5 Fair
Total Score:	=_____/ 150	(_____%)	*Please see comments on back.*
X. Group opinion	**Group Avg.**	**Deduction/Addition**	**Individual Final Score**
1			
2			
3			
4			
5			
6			

Midpoint Assessment

Group Project Mid-point Assessment

Instructions: Please answer each question honestly. Your responses will be kept by me and are completely confidential. Circle the number on the scale that best applies to your views. This is an excellent opportunity for me to help your group, if you need it!

Your name: _____

Group Case Study Location: _____

1) Our Group is making good progress on our project:

0	1	2	3	4	5
Have not started			Satisfactory		Excellent progress

2) Our group is collaborating and working well together:

0	1	2	3	4	5
Not at all			Somewhat well		Excellent collaboration

3) Each group member is contributing equally to the project:

0	1	2	3	4	5
Not at all			Satisfactory		Excellent contributions by all

4) I am learning a great deal about the content of this course because of this project:

0	1	2	3	4	5
Not learning			Some learning		Excellent learning opportunity

Free-write responses (use back of handout if needed):

(a) Please write any additional comments about group dynamics that you would like to bring to my attention:

(b) Please share with me how this project is impacting your learning:

Final Feedback: Ecoresort Team Project

INSTRUCTIONS

Thank you for your participation in this team project. Please take a moment and provide us with authentic feedback. Your thoughts and perspectives are useful to us as we prepare future courses. This short survey is anonymous and will take about five minutes to complete.

Let's get started!

I. GENERAL FEEDBACK

I will recommend this project to my friends.

Circle one number that best describes your response on the 10-point scale below.

1	2	3	4	5	6	7	8	9	10
Not likely									Likely

And please explain your answer:

APPENDIX A:
Facilitator's Guide (continued)

Final Feedback: Ecoresort Team Project (continued)

II. PROJECT FEEDBACK

To what extent do you agree with the following statements?

Please place an "X" in the box that best represents your choice from the agreement scale for e
of the prompts.

	Strongly disagree	Disagree	Agree	Strongly agree
This project held my interest.				
The project helped me to learn.				
What I learned from this project is relevant to my daily life.				
The project helped me to value what might be needed to live in an environmentally sustainable manner.				
The project helped me apply my knowledge gains to an authentic scenario.				
I will apply the information I learned to my own life.				

APPENDIX A:
Facilitator's Guide (continued)

Final Feedback: Ecoresort Team Project (continued)

III. YOUR LEARNING

When thinking about what you learned during this project, how would you rate the degree to which each of the following factors contributed to your learning?

Please place an "X" in the box that best represents your choice from the agreement scale for each of the prompts.

	Not at all	Low	Medium	High
The project topics				
Conversations with my team members				
My prior knowledge				
The online course materials (RLOs, online assignments, etc.)				
The face-to-face activities (labs, in-class activities, etc.)				
The "ecoresort" contextual situation				
The textbook				
The ability to be creative				
The personalized nature of the project				

Final Feedback: Ecoresort Team Project (continued)

IV. OUTCOMES

When thinking about what you learned during this project, please rate your degree of confidence by circling one number that best describes your response on each of the 10-point scales below.

a. I can conduct basic research related to current environmental issues such as energy consumption, food availability, freshwater supply concerns, waste generation, human health, and habitat restoration.

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Cannot do at all									Highly certain can do

b. I can generate evidence-based decisions about the degradation of natural capital that results in human-dominated systems.

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Cannot do at all									Highly certain can do

c. I can develop business proposals that incorporate environmental sustainability as a fundamental bottom-line consideration, while addressing social needs, economic interests, and cultural awareness of community members and/or tourists.

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Cannot do at all									Highly certain can do

d. I can collaborate in teams to demonstrate effective communication, collaboration, and critical thinking skills.

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Cannot do at all									Highly certain can do

Final Feedback: Ecoresort Team Project (continued)

e. I can connect issues of civic importance to my daily life and decision-making processes.

1	2	3	4	5	6	7	8	9	10
Cannot do at all									Highly certain can do

V. FREE RESPONSE

Please describe what you enjoyed most about this project:

Please describe what you would like to see added to future iterations of this project:

Please add any general comments you may have:

APPENDIX A:
Facilitator's Guide (continued)

Final Feedback: Ecoresort Team Project (continued)

Thank you for your thoughtful feedback. We are grateful for the time you spent completing our survey.

Your first and last name:	**Your team's ecoresort name:**

Please rate the performance for each team member by circling the appropriate number value for each prompt below.

Student Name:					
Please rate this member's effort toward each of the following project components:	No effort	Below average effort	Average effort	Above average effort	Excellent effort
Conducting research	1	2	3	4	5
Project organization	1	2	3	4	5
Attending group meetings	1	2	3	4	5
Project preparation	1	2	3	4	5
Webpage production	1	2	3	4	5
Overall contribution and effort	1	2	3	4	5

Student Name:					
Please rate this member's effort toward each of the following project components:	No effort	Below average effort	Average effort	Above average effort	Excellent effort
Conducting research	1	2	3	4	5
Project organization	1	2	3	4	5
Attending group meetings	1	2	3	4	5
Project preparation	1	2	3	4	5
Webpage production	1	2	3	4	5
Overall contribution and effort	1	2	3	4	5

Student Name:					
Please rate this member's effort toward each of the following project components:	No effort	Below average effort	Average effort	Above average effort	Excellent effort
Conducting research	1	2	3	4	5
Project organization	1	2	3	4	5
Attending group meetings	1	2	3	4	5

APPENDIX A:
Facilitator's Guide (continued)

Final Feedback: Ecoresort Team Project (continued)

Project preparation	1	2	3	4	5
Webpage production	1	2	3	4	5
Overall contribution and effort	1	2	3	4	5

OPEN-ENDED FEEDBACK ABOUT TEAM DYNAMICS

Please feel free to add any additional information about team dynamics in the space below.

PROJECT REPORT

A Community Outreach Chemistry Lab Success in a Pandemic

STEVEN BACHOFER
Saint Mary's College of California

MARQUE CASS
Alameda Point Collaborative

Abstract

This project report highlights a simple yet effective outreach lab benefiting the community partner, specifically the Alameda Point Collaborative (APC) youth program and Saint Mary's College students in a general science course. Building on a partnership focused on reciprocity, a portable lab experiment (Mattson Microscale Gas Chemistry lab) was proposed. Given the pandemic, the major challenge was working through how to incorporate the community engagement without being physically present at APC. To address this, the Saint Mary's students created an instructional video to be viewed in advance of the activity as a replacement for the formal lab handout, which allowed us to participate without being onsite. With the lab chemicals and materials delivered in advance, APC staff did a pilot run to facilitate a more successful joint lab. When both populations (APC youth and SMC students) met through a Zoom meeting, the lab resulted in a successful experiment and a shared learning experience. This lab experience raised everyone's spirits even during the pandemic. In this report, the two authors provide reflections on the student gains and wish to emphasize that civic learning can still occur even in a pandemic.

Introduction

Can one really do a community outreach chemistry lab during a pandemic? How can college students be truly involved and engaged performing outreach when their classes are taught remotely? Can a community partner feel supported when colleges keep pressing onward in the midst of the pandemic?

The students in a Saint Mary's College environmental science course and their stalwart community partner, the Alameda Point Collaborative (APC) ventured together to answer the three questions above and continue a partnership where reciprocity has always been a focal point. The Urban Environmental Issues (UrbanE) course had previously done educational outreach lab work with APC, but because of the pandemic, it needed to be done remotely. This project report discusses their shared laboratory experience.

The UrbanE class studies environmental chemistry issues and investigates the redevelopment of Alameda Point, the former Alameda Naval Air Station (NAS). Since Alameda NAS became a Superfund site in 1999, the course content was regularly aligned with clean-up activities. Several course labs have followed site characterization and clean-up methods (X-ray fluorescence soil screening and a thermal reaction, which mimics how *in situ* chemical oxidation (ISCO) is used to clean up the groundwater onsite) (Bachofer, 2010). Beyond utilizing Alameda Point as a study site, the community engagement aspects of the course have involved some direct service for a community partner, the Alameda Point Collaborative. APC provides services to the homeless on the former Alameda NAS, assisting them with housing, job training, and social services to empower individuals who were formerly homeless. In the past, students have performed educational outreach experiments for the APC youth. This past year, an educational outreach project with APC teens was selected as appropriate in a pandemic.

Educational outreach projects have been a part of many previous course iterations. The outreach labs have ranged from inviting APC youth to Saint Mary's College to do an experiment, implementing a chemistry lab for the local middle school, and learning the chemistry of garden nutrient kits. These outreach projects were typically done in Alameda. Thus, planning to share a lab experience with the APC teens was somewhat routine, yet this year's challenge was to do this lab remotely.

The Alameda Point Collaborative claimed, restored, and reinvigorated the base housing and facilities including one building initially used as a Native American health clinic, which was repurposed as a teen center. The central mission of the APC Teen Center is to inform, inspire, and educate the local youth to become productive members of their community and world. Due to the pandemic, the Teen Center itself took on new role as a remote learning hub for the APC teens. The center needed a full Wi-Fi upgrade and a new fence surrounding the building to provide some privacy and safety, and all the sinks, toilets, and dispensers were changed to be hands-free along with added temperature detectors so that the APC teens could have a COVID-safe instructional space.

Outreach Lab Methodology

Pre-planning

Professor Bachofer and Mr. Cass discussed several laboratory experiments that might be sufficiently portable and educational during the summer of 2020. To give the UrbanE students a vested interest in the outreach, there were a few Mattson gas generation labs as options. The UrbanE students were encouraged to select a gas generation lab similar to their first lab preparing carbon dioxide. The oxygen gas generation lab had a fun aspect of testing the oxygen gas with a smoldering splint (think lighting something on fire, safely) and it was selected.

The oxygen gas generation lab was designed for students ranging from middle school to college. The instructional materials are freely available via the Mattson Microscale Gas Generation website (Mattson, 2019). This resource has three introductory gas labs to prepare either carbon dioxide, oxygen, or hydrogen. The procedure for gas generation and equipment to prepare each gas are nearly identical, except for the reagents. The oxygen gas generation used only hydrogen peroxide, H_2O_2, as a reactant and potassium iodide, KI, as a catalyst. The reaction time required to generate a full syringe of oxygen gas

was approximately 10 minutes. This gas was transferred into a test tube and upon adding a smoldering splint, re-ignition occurred.

$$\text{Chemical Reaction} \quad H_2O_2\ (aq) \xrightarrow{KI} O_2\ (g) + H_2O\ (l)$$

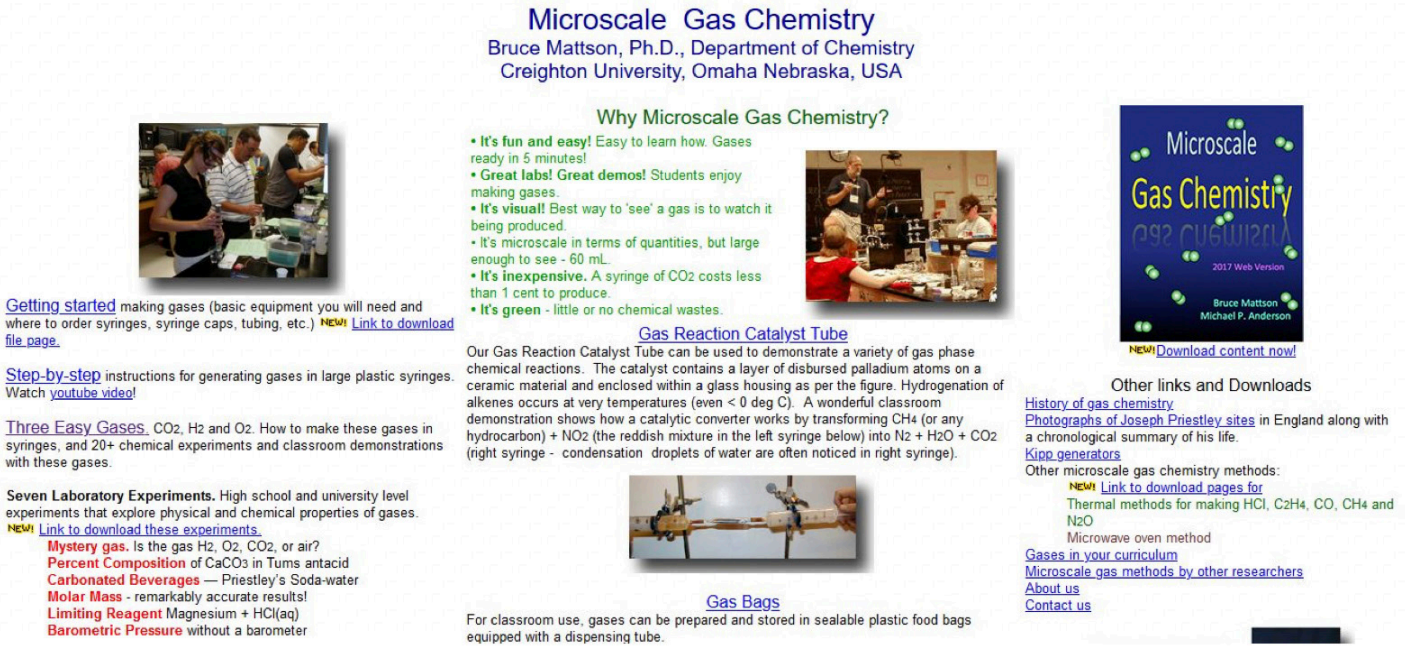
Professor Bachofer had previously used this lab with visiting middle school students on educational field trips to the College, so it was known to be very safe. As the lab equipment and consumables were affordable and easily transportable, APC needed to only provide a safe working space and access to water for syringe work. This implementation built on previous educational labs, so again the only real challenges were the restrictions imposed to keep everyone safe from the corona virus.

UrbanE Student Preparation

The UrbanE students performed a gas generation lab as one of their labs. Three lab periods were devoted to delivering the outreach lab to the APC teens. Specifically, the UrbanE students' carbon dioxide gas generation lab gave them hands-on experience. The UrbanE students generated CO_2 gas following procedures from the Mattson website (Mattson, 2019). During the two planning lab periods, the UrbanE students were asked to recall what was most helpful for them when they did the lab remotely. This reflection activity led them to propose that a video be created, along with a one-page instructional sheet replacing the formal lab handout that they had used. Two sets of students agreed to be filmed doing a setup and generating oxygen gas, one student edited the videos, and another few students revised a bulleted set of directions. They were confident that this would provide multiple instructional tools to make the lab a success. In the meantime, Professor Bachofer and Mr. Cass worked on the final logistics—how long these two groups would meet and the exact date and time (the lab would last approximately one hour and the course class time matched the Teen Center's workday). Cass and Bachofer also planned a discussion for the APC teens on what college is like, and Cass coordinated a starter set of questions. This would prepare both groups of students to have a discussion.

This outreach lab was aligned with productive educational civic engagement aspects outlined by W. Robert Midden (2018). Elvin Aleman and his coworkers also noted that undergraduates exhibit significant gains in

FIGURE 1. This image shows the Mattson Microscale Gas Chemistry web resources and clearly indicates that numerous gas reaction experiments could be explored. The three easy gases (CO2, O2, & H2) are in the left column of materials. Retrieved from http://mattson.creighton.edu/Microscale_Gas_Chemistry.html.



learning when planning educational service-learning projects designed to inspire the next generation of scientists (Godinez Castellanos et al., 2021). Remote hands-on instruction has become a more critical tool during the past year, and many straightforward lab experiences can be instructional and fully portable as noted by Jodye Selco (2020). All of these authors have indicated that faculty can easily provide guidance to undergraduates, and that implementation of hands-on and civic engagement activities empowers all students (Midden, 2018; Godinez Castellanos et al., 2021; Selco, 2020).

Unfortunately, there was not time to request formal institutional review board approval of this project, which means that this article cannot include any student response data. The results and conclusion sections will have only the authors' reflections and insights on the effectiveness of this activity.

Results

After the delivery of individualized laboratory materials, Mr. Cass and other APC staff performed a pilot run using the UrbanE students' video to guide them. This preparation gave them intimate knowledge of the experiment and made the joint lab day a tremendous success.

The APC teens did the experiment a total of three times, twice on the day of the joint Zoom session, plus another time approximately a week later. The experiment was considered a success when the iodide catalyst caused the hydrogen peroxide to decompose forming the oxygen gas. The APC teens, however, evaluated the experiment as a success only if one reignited a smoldering splint in the oxygen gas, generating a burst of flames! With that definition, there was only 50% success on the first trial, yet on second trial, there was 100% success. Only one detrimental incident occurred when the glass test tube broke and one APC teen got a minor cut. The successful demonstration of oxygen gas reactivity with a smoldering splint overshadowed this minor incident, and all students gained from the shared lab experience.

When all were on the Zoom call, a further dialogue began during the second trial's 10-minute gas generation time. Mr. Cass asked the UrbanE students about the challenges of going to college and learning under COVID conditions. This discussion was instructional as the UrbanE students shared their thoughts about college in general and their learning in a pandemic. It gave the APC teens some idea how college could still be accomplished in a pandemic. This outreach lab was so successful that two groups arranged for a subsequent shared meeting so that the UrbanE and APC teens could share thoughts on the challenges of recycling various materials, providing a second linkage to their course content.

There were two big successes from this outreach lab. The APC teens noted that the UrbanE student videos did help them do the experiments and come away with some renewed confidence that doing science, specifically chemistry, was possible. The UrbanE students recognized that they could use their new knowledge to positively impact others.

Co-Instructor Reflections

Mr. Cass's Reflection

In my case, there was a personal reason why this experimental format was beneficial, besides all of the obvious educational reasons. During my interview for Teen Center coordinator, in December 2018, I was playing basketball with some of the APC teens who also happened to be present during the experiment. We chatted while we played and when I asked "What do you guys want to be when you grow up?" one of the students responded to me that he wanted to be a chemist when he grew up. On the day of our experiment, that student reminded me of our conversation in 2018 and how the opportunity to try the experiment firsthand was satisfying.

Recently, I asked what they remembered about the experiment. I was surprised to find that they were able to give me the step-by-step instructions and they remembered a lot about why and how the experiment worked. They noted that they hadn't read the instructions initially, but to finally see the splint ignite was great. In fact, the syringe lab was really interesting and was worth doing over with them. They also commented that the experiment could teach students something deeper than just chemistry: that you can fail at something over and over again but if you keep doing it, eventually you'll get it right.

Prof. Bachofer's Reflection

The impact of this educational outreach lab was quite remarkable. The UrbanE students came away from the hour-long Zoom session impressed and exhilarated that the APC teens had conducted a very successful experiment. The student reflections were filled with positive thoughts and nearly all began with a note that they were initially unsure that we could accomplish this outreach. The students were graded on their contributions to both the outreach lab and discussion. Marque Cass's most impactful question was, "What are you as Saint Mary's UrbanE students likely to take away from this course?" This prompted many students to remark in their reflections that they would be more committed to helping their communities in the future. Again, the reciprocity of this educational outreach was apparent.

The community engagement made this environmental science course more meaningful for the Saint Mary's UrbanE students, and it truly heartened the faculty member in these exhausting times. The major takeaway is that educational outreach can be done in a pandemic and it will truly enrich you and your community.

Key Points to Ensure Success

- The college and the community partner were committed to listen and to make plans that would benefit each other.
    - The planning was done in advance and follow-up through emails ensured the project progressed on schedule.
    - The instructor and the supervisor aligned their work expectations to benefit both student groups.
- The lab experiment yielded an easily observable reaction. The lab materials were also very affordable.
- The students were empowered to do tasks connected to the educational content of their courses and recognized that each community was a significant contributor.

Acknowledgement

At Saint Mary's College, this Urban Environmental Issues course serves as a general education science course with an integrated community engagement component. It assists students to fulfill two core curriculum requirements with one course. Via CILSA (Catholic Institute for LaSallian Action), the institution supports faculty and community partners in their efforts to organize and implement the latter curricular objective. This does not eliminate the work that is required to implement it. However, CILSA does assist with the administrative challenges (MOUs), helps to maintain more durable college/community organization partnerships, and provides the faculty with additional training on effective implementation.

About the Authors

Steven Bachofer teaches chemistry and environmental science at Saint Mary's College and has worked with the Alameda Point Collaborative for more than 15 years through his affiliation with the SENCER project. He has also co-authored a SENCER model course with Phylis Martinelli, addressing the redevelopment of a Superfund site (NAS Alameda).

Marque Cass has been in the field of education since before his graduation from UC-Davis, where he earned a BS in Community and Regional Development with an emphasis in Organization and Management. Since January 2019, he has been the youth program coordinator for Alameda Point Collaborative, doing mentoring and advocacy work for formerly homeless families. More recently, he has been elected a community partner liaison with Saint Mary's College, working to help create stronger networks between organizations.

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PROJECT REPORT

Farming Practices as *Funds of Knowledge*

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Abstract

This study examines farming practices across regions as *funds of knowledge* that may be integrated into K–12 curricula and instruction. *Funds of knowledge*, as conceptualized by Moll, Amanti, Neff, and González (1992), include the knowledge students bring from their families and home communities to the classroom, and serve as resources to enhance curricular relevancy, concept and skill development, learner and family engagement, and a positive learning environment. Examples of funds of knowledge include. *Funds of knowledge* include home language use, family values and traditions, caregiving practices, family roles and responsibilities, and professional knowledge, among other factors identified by González, Moll, and Amanti (2005). This qualitative study interviews four participants with U.S. and international farming experience to invite reflection on practices across cultures and regions. Constant comparative analyses of interviews (Merriam & Tisdell, 2015) highlight ways culture and farming are connected and present farming practices as important funds of knowledge. This inquiry offers valuable implications for elementary curricula and instruction.

Introduction

This study examines farming practices as funds of knowledge that may be integrated into K–12 curricula and instruction. *Funds of knowledge*, as conceptualized by Moll, Amanti, Neff, and González (1992), include the knowledge students bring from their families and home communities to the classroom, and serve as resources

to enhance curricular relevancy, concept and skill development, learner and family engagement, and a positive learning environment. *Funds of knowledge* include home language use, family values and traditions, caregiving practices, family roles and responsibilities, and professional knowledge, among other factors identified by González, Moll, and Amanti (2005). This research has sought to develop theory and practical approaches for educators to learn about the funds of knowledge of language learner families, and all learner families, in their school communities and to "re-present them on the bases of the knowledge, resources, and strengths they possess, thus challenging deficit orientations that are so dominant, in particular, in the education of working-class children" (Moll, 2019, p. 131). Collaborations among teachers, parents, and students are needed.

Historically, U.S. public schools have not acknowledged the "strategic and cultural resources" or "funds of knowledge" that U.S.-Mexican multilingual learners have brought to the classroom from their home environments (Velez-Ibenez & Greenburg, 1992). Research offers creative approaches for integrating learner *funds of knowledge* into curricula and instruction. Alvarez (2018) invited bilingual first graders to author autobiographical stories sharing about life in a town on the Mexican-American border. Stories demonstrated self-perceptions as adding to family well-being. *Humanizing pedagogies* have drawn on students' *politicized funds of knowledge* to support critical thinking, literacy skills, and political participation in achieving social equity for all by connecting their lived experiences to school curricula (Gallo & Link, 2015). This study builds on previous research demonstrating family farming experience as valuable student knowledge to engage in elementary science classrooms (e.g., Harper, 2016). Moll (2019) includes farming as one of the careers in the primary and secondary sectors of the economy that learners may bring to the classroom from marginalized working-class homes, and he encourages educators to create opportunity for learners of all backgrounds, including farming families, to "display, elaborate, and share" their experiences as a learning resource and rich knowledge base (p. 131).

Need for the Research

In Fall 2017, 10.1% of students in U.S. public school K–12 classrooms were identified as English Language Learners (ELLs), an increase from 8.1% in 2000 (U.S. Department of Education, 2017–18). These statistics also reflect the population of ELLs in a sample Midwest county, indicating that diversity of student populations exists not only on the borders and coasts, but is integral to the nation. In the Bartholomew County School Corporation in South Central Indiana, of approximately 1,200 students, just over 10% of the K–12 school population identified as English Language Learners (ELLs) (Johannesen, 2019). Of multilingual families in the U.S., about 77% reported speaking Spanish at home, with other common home languages including Arabic, Chinese, and Vietnamese (Bialik, Scheller, & Walker, 2018). Migrant language learning families make up a significant percentage of U.S. agricultural workers. In an article on immigration and farming, Kurn (2018) reflected that "immigrants are deeply involved in this complex journey from seed to plate … an indelible part of rural America, contributing to the economic and cultural fabric of these communities" (para. 2). Farmworkers Justice found that around 70–80% of farmworkers are immigrants, while the United States Department of Agricultural (USDA) found that 60% of all agricultural workers are immigrants (Kurn, 2018, para. 4). The above statistics demonstrate the need to prepare teachers and teacher candidates to support ELLs, farming and migrant families in U.S. schools. Classrooms need curricula and instruction that affirm and engage student backgrounds and knowledge as resources for all in the classroom, including farming knowledge. Moreover, teacher preparation programs need to prepare teacher candidates with curricular resources and instructional capacities for this.

Purpose

This study seeks to "re-present" (Moll, 2019, p. 131) farming knowledge across cultures and regions as *funds of knowledge*. To do this, the study examines connections between culture and farming practices, including similarities and differences across the U.S. and international regions. This study further considers how these farming practices as *funds of knowledge* may be integrated

into elementary curricula and instruction and in teacher preparation contexts seeking to prepare teachers to support multicultural, multilingual learners. A model lesson plan (Appendix A), developed in a teacher preparation course for integrating *funds of knowledge* into curricula and instruction, is shared.

Methods

This qualitative study engaged constant comparative analysis (Merriam & Tisdell, 2015) to examine similarities and differences across farming practices and consider how culture and farming shape one another, from the perspectives of participants who have farming experience in the U.S. and in one or more international regions. Collected data included 30–45-minute interviews with four participants identified through a purposive selection process (Merriam & Tisdell, 2015) that involved asking the county's soil and water conservation district for suggested participants. The first three participants were identified through this route. The fourth participant was identified by inviting volunteers through a social media outreach posted by one of the two researchers conducting the study. All four participants were selected to participate in the study because they had farming knowledge and experience in a U.S. region and in an international region culturally, ecologically, and politically distinct from their own. In the interviews participants were asked to consider how culture *shapes* and *is shaped by* farming practices in the U.S. and in international regions where they farmed. The interview protocol is included in Appendix B. Constant comparative analysis was used to identify themes and sub-themes that emerged from the interview data; the themes were not predetermined. This analysis process involved recording participants' responses to each of the five interview questions, then coding responses focused on the U.S. context or the international context, to identify similarities and differences. The next layer of analysis involved reviewing this chart for key themes that emerged, including theme-based comparisons the participants made about the U.S. and international contexts in which they farmed. Finally, thematic findings were considered for how farming practices as regionally and culturally distinct *funds of knowledge* might inform and be integrated into K–12 curricula and instruction, and how this integration might play a role in supporting multicultural, multilingual learners and in meeting Teaching English to Speakers of Other Languages (TESOL) Teacher Preparation Standards.

Findings: Farming Practices as *Funds of Knowledge*

The findings from this qualitative study build on previous research by suggesting that culture *shapes* and *is shaped by* farming practices, and demonstrate specific ways in which U.S. farming practices contrast with farming practices in international settings. Analyses of participant interviews resulted in findings highlighting the following themes: *automated vs. manual labor, individual vs. social farming, climate impact on food cultivation, institutionalized vs. personalized practices,* and the *politics of land ownership*. Each of these themes highlights how farming involves *funds of knowledge* embedded in the communities and cultures of practice.

Automated vs. Manual Labor

Across interviews, participants emphasized distinctions observed in automated farming in the U.S. and manual farming practices in international developing regions, specifically the Philippines, Bolivia, Peru, and Ecuador. One participant reflected on the necessity to be well versed in technology to farm in the U.S.: "Here in the U.S. we are so reliant on technology and the data it gives us" (Peru-Ecuador-U.S. Farming Participant). She noted the similar use of automated practices in Canada, the Netherlands, and England. In contrast, she reflected on practices in Ecuador, where farming was "super hands-on" and where farmers had the opportunity to obtain technology, "but they choose not to, and would rather have their cows they know personally, and 20 cows they milk every day" and yet "here in the U.S. we might have 10,000 cows on a big farm" (Peru-Ecuador-U.S. Farming Participant).

Individual vs. Social Farming

Another theme that surfaced across interviews is the noted distinction between individual and social farming practices. The participant with experience in the Philippines described farming there as a social enterprise that brought together family and community members. In contrast, he reflected that much of the farming that took

place in the U.S. tended to be individually experienced. He noted that in the Philippines, there were "family groups working together in the gardens and fields" and that farming was "part of their social life, so there was a connection there with the culture" that "happens a lot less in the farms here" because "we are just more spread out" (Philippines-U.S. Farming Participant). Another participant, who had farming experience in Bolivia, reflected on his family's difficult transition to farming abroad but said that their intentional development of friendships resulted in their "farm not walking away on them," or having items taken. This farmer described his transformation in discovering the importance of community to support one another. He emphasized near the end of the interview, "Get to know your neighbors and the services they can offer for free. That is priceless" (Bolivia-U.S. Farmer Participant), and he encouraged this practice across professional fields and across international regions—in the U.S. as much as in Bolivia.

Climate Impact on Food Cultivation

Only one participant emphasized the importance of climate in shaping agriculture and the kinds of foods that can be cultivated, and thus the kinds of foods that are enjoyed most often by the local culture. This farmer referenced his experience in the Philippines to highlight that "where we live determines the climate and what is possible to grow" (Philippines-U.S. Farming Participant). This then influences the kinds of foods that are enjoyed at family and community gatherings, holidays, and other cultural celebrations.

Institutionalized vs. Personalized Practices

All participants described distinctions between institutionalized farming practices in the U.S. and more personalized farming practices in international regions, particularly the Philippines, Peru, and Ecuador. The participant with experience in Ecuador and Peru described the value farmers hold there for knowing "each cow, personally," in contrast to her experience in the U.S. She reflected, "In America we are taught *Go big and do what makes it easier,* but in Peru [the focus is] *take care of yourself, take care of the land, take care of others*" (Peru-Ecuador-U.S. Farming Participant). She said that in Peru there are more "diverse, small field" crops and that farmers "care more about their native plants and what they can grow well," but in the U.S., there are "mass farming or commercial farms that plant all the same crop … 100 acres of potatoes and they are exported" (Ecuador-Peru Farming Participant). This participant felt there was more "pride in what [Ecuadorians and Peruvians] grow because they know it is feeding their neighbors and the community," while in America, it just seems more of an industry" (Peru-Ecuador-U.S. Farming Participant). This participant referenced her observations of farming practices in Canada, the Netherlands, and the United Kingdom that minimized "Go big or go home" practices putting smaller farms out of business. For example, a quota system in Canada requires farmers to purchase rights to the amount of milk a farm will produce—aside from the cost involved in producing that milk. Thus, bigger farms have greater incentive to veer from large-scale farm development. This middle ground seemed ideal to her, as Ecuador's system led to underproduction of milk for the people, yet America's big farm efficiency led to 100 family farms closing their doors in one year. One of the participants with experience in Bolivia emphasized the political challenges they faced in accessing the resources they needed to sustain their living situation. He felt similar challenges will be faced in the U.S. if big business farming pushes out smaller farms, leading to lease farming, and minimizing a farmer's ability to understand and respect the land being cultivated. Likewise, another participant noted that most U.S. farm families are "looking for the next generation to farm that same ground," so it is "critical to preserve that land, so their kids and grandkids can make a living from the land" (Philippines-U.S. Farming Participant). Without personal connection to the land, the process of land ownership can become complex, both financially and politically driven.

The Politics of Land Ownership

The two participants with farming experience in Bolivia continued to emphasize throughout the joint 1.5-hour interview the complex politics involved in land ownership in Bolivia and increasingly in the U.S. One of these participants reflected on observing land permit applications being stacked in one pile for those with "the right connections" and in another pile for those without such connections. He relayed the fear expressed by American Mennonite farmers in Bolivia when a new political leader

entered office, and the negative consequences this would have for their ability to access the resources needed to farm and make any profit on their produce. This participant reflected, "governments and institutions are just a way for whoever has control to have legitimacy to look the other way on the people who they want to get ahead" (Bolivia-U.S. Farming Participant). The same farmer expressed concern over the rising trend in big business farming in the U.S., leading to land rentals and pushing smaller generational family farms out of business.

Discussion and Implications

This study offers insights into important connections between culture and farming practices, and demonstrates ways that farming practices are *funds of knowledge* integral to communities and their cultures. These findings are important for teachers seeking to support multicultural, multilingual learners who may immigrate to a new region and bring a farming background with them, and learners who might gain new knowledge from classmates with a farming background. This study recognizes farming practices as meaningful *funds of knowledge* that learners and their families may bring to K–12 classrooms, as emphasized by Harper (2016). This study also recognizes that student familiarity with farming will vary based on the family, school, district, and region, and teachers will need to adjust accordingly. More broadly, this study builds connections across local and international cultures to promote glocalization as a valuable societal aim for K–12 schools and society, as supported by Patel and Lynch's research (2013). This study reveals specific connections across culture and farming practices regarding the use of *automated vs. manual labor, individual vs. social farming, the impact of climate on food cultivation, institutionalized vs. personalized farming,* and the *politics of land ownership*.

Implications for Elementary Curricula and Instruction

This study demonstrates ways culture and farming shape one another and reveals farming practices as a significant *fund of knowledge* that students and their families may bring to a classroom and to a school community. Understanding similarities and differences across regional farming practices can support teachers in integrating this knowledge into curricula and instruction. Moreover, foundational understandings about agriculture connect to important climate-related content. The following themes from this study align with content covered in the Next Generation Science Standards, particularly Interdependent Relationships in Ecosystems: Environmental Impacts on Organisms taught in Grade 1, 2, and 3; Weather and Climate in Kindergarten and Grade 3; Earth and Space Systems in Grade 1, 2, 4 and 5; and Structure and Function in Grade 1 and Variation in Grade 3. For example, climate impact on cultivation addresses NGSS 3-ESS2-2: Obtain and combine information to describe climates in different regions of the world, and 3-LS4-3: Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all. Examination of institutionalized and personalized farming practices and the use of land meets NGSS 4-ESS3-2: Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans, and 5-ESS3-1: Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment. The following themes address topics covered by the National Council for the Social Studies Standards, including Culture; People, Places, and Environments; Science, Technology, and Society; Global Connections; Civic Ideals and Practices. The potential thematic connections to these standards are many, and we encourage educators to explore them in depth.

Automated vs. Manual Labor

Teachers might guide elementary students in examining both the values and limitations of automated and manual farming practices in the U.S. and in one or more international regions. Such instruction might draw on this study by asking students to debate the pros and cons of using automated farming equipment for different types of farming work such as harvesting crops and milking cows, and to consider how their own values interact with the cultural values of the regions where these farming practices are implemented. One group of students might be asked to learn about and argue for the cultural value of knowing every cow, as in some smaller farms, while another group may be asked to learn about and argue for the business value of producing high volumes of milk in big farms.

Individual vs. Social Farming and Climate Impact

Teachers might partner with the community by inviting parents, older siblings or students, instructional aides, or other members of local multicultural, multilingual communities to visit their classroom and share about their own or their family member's experiences with social farming practices in international regions. This sharing might articulate the benefits of farming together to feed the local community, as well as nutritional benefits and traditional celebrations that are based around specific locally cultivated crops. The speaker might also share any challenges navigated in a family unit and/or local community when members are farming together. Related to culturally cherished foods, the teacher might guide students to research the climate of different regions, how this shapes the kinds of foods grown there, and specific dishes and recipes that become integral to cultural gatherings, holidays, and traditions.

Institutionalized vs. Personalized Practices and Land Politics

Teachers might connect two themes of this study, by helping students examine how institutionalized and more personalized approaches to farming shape and are shaped by the politics of land ownership. Student groups might each take a country and examine how the national and local policies of land ownership shape attitudes toward the land and the practices therein. They might also examine how local farmers and their farming needs and practices influence (or not) local and national policies on land use and ownership. As students compare similarities and differences across regions, the teacher will need to guide students to continually contextualize farming and policy practices with broader local and national cultural influences. Students can be guided to view and understand this new information as *funds of knowledge* they may use to support their own local and global understandings.

Implications for Teacher Preparation

This study offers valuable implications for institutions of teacher preparation, and suggests that the integration of farming knowledge as *funds of knowledge* into teacher preparation coursework is valuable for multicultural, multilingual classrooms. Both local and international learners and their families benefit from connecting with and learning about local and international farming knowledge and practices. Such knowledge is a window for introducing complex cultural, ecological, and political topics, including *automated vs. manual labor, individual vs. social farming, climate impact on food cultivation, institutionalized vs. personalized practices,* and the *politics of land ownership*. Preparing teachers to integrate farming knowledge as culturally shaped *funds of knowledge* into curricula and instruction supports teacher candidates in meeting the Council for the Accreditation of Educator Preparation (CAEP) Elementary Teacher Preparation Standards, particularly using knowledge of diverse families and communities to plan inclusive learning experiences that build on learners' strengths and address needs (Standard 1b); integrating cross-cutting concepts in the content area of science (Standard 2c); differentiating plans to meet the needs of diverse learners (Standard 3d); supporting student motivation and engagement through culturally relevant and interesting content (Standard 3f); and collaborating with peers and other professionals to create developmentally meaningful learning experiences for all (Standard 5a).

Preparing teachers to integrate *funds of knowledge* into curricula and instruction also supports teacher candidates in meeting TESOL PreK–12 Teacher Preparation Standards, including guiding students to engage in discourse across the content areas (Standard 1a); planning for culturally and linguistically relevant, supportive environments (Standard 3a); utilizing relevant materials and resources to support learning (Standard 3e); and collaborating with the broader community as a resource to support student learning (Standard 5a). A model lesson plan, *Farming Practices as Funds of Knowledge for Multilingual Learners*, is provided in Appendix A. Local and international farming practices as *funds of knowledge* serve as a window to better understand students' diverse backgrounds. It is important to prepare teachers to engage this important form of cultural knowledge to affirm and learn from diverse learners.

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APPENDIX A:

Lesson Plan: Farming Practices as Funds of Knowledge for Multilingual Learners

Teaching Context

Grade Level(s): 5th
Number of Students: 20–25
Multilingual Learners: 50–75%

Lesson Planning

Indiana Science Standard 5.ESS.3:
Investigate ways individual U.S. communities protect the Earth's resources and environment.

Learning Outcome:
Students will COMPARE how communities in three regions practice sustainable farming.

Indiana Social Studies Standard 5.2.8, Roles of Citizens:
Describe group and individual actions that illustrate civic virtues, such as civility, cooperation, respect, and responsible participation.

Learning Outcome:
Students will DESCRIBE sustainable farming practices in three regions as *funds of knowledge.*

WIDA ELD Standard 3 and WIDA ELD Standard 5:
English language learners communicate information, ideas and concepts necessary for academic success in the content areas of Science and Social Studies

Language Objectives:
Students will IDENTIFY and DESCRIBE similarities and differences in sustainable farming practices as *funds of knowledge* in Honduras, Guatemala, and the U.S. (Indiana).

Lesson Instruction

Lesson Introduction:
Share with the class three pictures of *sustainable farming* practices, in Honduras, Guatemala, and the U.S. Ask if anyone knows or can guess what *sustainable farming*, means. Repeat student ideas in English and Spanish and write ideas in both languages on the board. Provide a definition for sustainable farming in English and Spanish. Explain that sustainable farming is important for all countries as everyone needs access to sustainable, nutritious food. Note the class will learn about *sustainable farming practices* in three different countries today: *Honduras, Guatemala,* and *the U.S.—Columbus, Indiana!* Introduce the book, *The Good Garden: How One Family Went from Hunger to Having Enough* (Milway, 2010). Ask the class to examine the title and picture on the front cover to predict what the book may be about. Explain the book is about one family's work in Honduras to begin sustainable farming practices, by creating a garden to provide sustainable food security for local families.

Learning Activities:

Pass out the Venn Diagram graphic organizer.

I DO: Model for students how to complete the *Honduras* section. Read *The Good Garden* in English, with Spanish translation by the instructional aide. Complete this sentence frame on the board: "In Honduras, sustainable farming can include ____ and ____."

APPENDIX A:

Lesson Plan: Farming Practices as Funds of Knowledge for Multilingual Learners (continued)

WE DO: Invite the instructional aide to share in English and Spanish about sustainable farming practices on her grandparents' farm in *Guatemala*. As a class, complete this sentence frame on the board: "In Guatemala, sustainable farming can include ____ and ____."

YOU DO: Play video a local farmer in *Columbus, Indiana* created about sustainable farming practices that many farmers use in Indiana. Invite students to pair-share and complete this sentence frame by speaking and writing, in English OR another language: "In Columbus, Indiana, sustainable farming can include _____ and _____."

Lesson Conclusion:
Invite pairs to verbally respond to the following questions: *What are similarities across the sustainable farming practices in Honduras, Guatemala, and Indiana? What are differences?* Students will be invited to use their Venn Diagrams and the following sentence frames to respond: "One similarity in sustainable farming practices across the three regions is _____." and "One similarity in sustainable farming practices across the three regions is _____." Ask students how these practices relate to the concept, *funds of knowledge*, shared in the previous lesson. Conclude that the sustainable farming practices discussed today are *funds of knowledge* of the cultures and families within those regions, including their agricultural, environmental, and professional knowledge.

APPENDIX B:

Interview Questions: Farming Practices as *Funds of Knowledge*

Interview Introduction:
We are conducting this interview as part of a study to learn more about farming practices as *funds of knowledge* and how these may be integrated into K–12 classroom curricula and instruction. Dr. Luis Moll, from the University of Arizona, studied and describes *funds of knowledge* as the knowledge that students bring from their families and homes to the classroom, which can be used to teach concepts and skills in the classroom curricula. Dr. Harper of the University of Georgia encourages reciprocal construction of classroom knowledge in which families' farming practices are engaged as valuable *funds of knowledge* in science.

Funds of knowledge can include a variety of understandings, such as cultural traditions, values, beliefs, languages, professional skills, farming practices, recipe nutrition, etc.

Interview Questions:

1. Explain any farming practices that are valuable to your culture and may represent *funds of knowledge* within your culture.

2. Explain any views toward the ecology and the land that are important in your culture and may represent *funds of knowledge*within your culture.

3. Do you feel your culture and farming practices are connected? Explain your response.

4. Do you feel your culture may *shape* farming practices in your region of origin? Explain.

5. Do you feel your culture is *shaped by* farming practices in your region of origin? Explain.

PROJECT REPORT

Promoting STEM Learning through a Multidisciplinary SENCER Framework at a Minority-Serving Institution

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Abstract

The Prospect Park Biodiversity Project was a SENCER collaboration project between the Departments of Biological Sciences, Chemistry, and Mathematics at the New York City College of Technology. The goal of this project was to enhance students' participation and learning in STEM disciplines through a civically engaged framework. The project utilized the eco-complexity of Prospect Park Lake in Brooklyn, New York for an interdisciplinary study on the water quality. The project, which involved ten students and four faculty mentors, integrated microbiology, chemistry, and mathematics perspectives using active-learning pedagogies, including hands-on exploration and collaborative learning.

Introduction

The Prospect Park Biodiversity project was initiated by four faculty—a microbiologist, a biochemist, and two mathematicians—at the New York City College of Technology (City Tech). Located in downtown Brooklyn, City Tech is a public, open access, non-residential, minority-serving institution. With students representing the demographics of Brooklyn and the Metropolitan New York

City area, it is one of the most racially and ethnically diverse higher education institutions. The intention of the project was to promote STEM learning among women and underrepresented minority students through an interdisciplinary collaboration in a SENCER (Science Education for New Civic Engagements and Responsibilities) framework (Figure 1). The main goals were to accomplish the following:

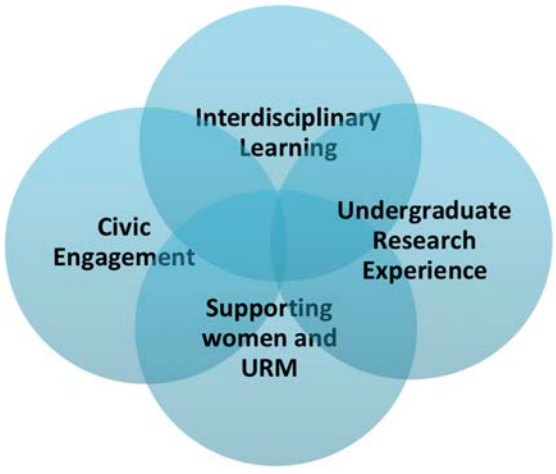
1. To promote STEM learning through a hands-on collaborative interdisciplinary experience.
2. To create an undergraduate research experience for students.
3. To heighten students' awareness of community resources and their civic responsibilities.
4. To encourage STEM learning and research among women and underrepresented minority students.

According to Heidi Jacobs' manual, "interdisciplinary" is defined as a "knowledge view and curriculum approach that consciously applies methodology and language from more than one discipline to examine a central theme, issue, problem, topic, or experience." She recognized the growing need for interdisciplinary content and emphasized "linkages" and "relevance" rather than fragmentation or polarity in curriculum design (Jacobs, 1989). Studies have shown that an interdisciplinary framework for teaching encourages cognitive thinking and real life problem-solving (Husni & Rouadi, 2016; Cowden & Santiago, 2016). Pedagogy in Action, a project of the Science Education Resource Center (SERC) and the National Science Digital Library (NSDL) that shares and disseminates pedagogical practices, points out that interdisciplinary teaching helps foster the development of self-efficacy and multi-dimensional thinking, such as recognizing bias and understanding moral and ethical considerations (Pedagogy in Action, 2021). Shifting away from the traditional discipline-focused learning, today's education values interdisciplinary learning in multi-perspective contexts and the transferability of skills across disciplinary boundaries (Murray, Atkinson, Gilbert, & Kruchten, 2014).

Research also shows that active-learning pedagogy enhances the success of underrepresented minority students in STEM. Ballen, Wieman, Salehi, Searle, and Zamudio (2018) found that active-learning pedagogy (ALP) disproportionately positively benefited underrepresented minority (URM) students in science classes. While the non-URM (white and Asian) students showed little or no difference in course performance using ALP compared with the traditional lecture, the URM students showed an increase in science self-efficacy and sense of social belonging in classes that employed ALP, resulting in better grades and academic performance for URM students (Ballen et al., 2018). For active-learning pedagogies, Cattaneo (2017) used key words such as discovery-based, project-based, learner-centered, interdisciplinary, collaborative, etc., all considered high-impact STEM education practices for promoting deeper understanding and critical thinking, and for building STEM identity and belonging (Betz, King, Grauer, & Montelone, 2021; Kuh, 2016; Repko, 2006; Singer, Montgomery, & Schmoll, 2020).

The SENCER framework was chosen because we believe in SENCER's mission of connecting STEM learning to real-world problems and the issues of local, national, and global importance as well as teaching students about their civic responsibilities (SENCER). The site of our study was Prospect Park, which was selected not only for its vast biodiversity and eco-complexity, but also for its vital role in the life and vigor of the community as "Brooklyn's Backyard." With 10 million visits a year, the Park provides events, concerts, and recreational and educational programs to help promote healthy, balanced living for its community. With one lake, the Park supports wildlife habitat of over a hundred species of birds

FIGURE 1. Supporting and Integrating Active STEM Learning



and other fauna and offers resting, feeding, and breeding grounds for migratory birds (Prospect Park Alliance, n.d.).

Project Design

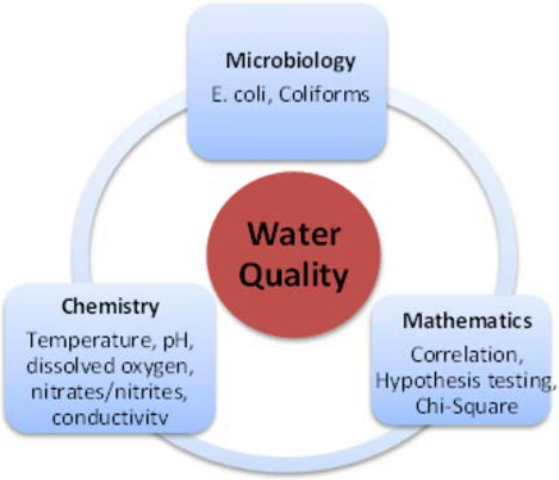
The four faculty designed an interdisciplinary project involving students from the following three courses: Microbiology (BIO3302), General Chemistry 2 (CHEM 1210), and Statistics (MAT 1372). Students selected for the project would also enroll in the Honors and Emerging Scholars Programs, undergraduate research programs at City Tech. Of the ten undergraduate students, seven (70%) were female, seven (70%) were identified as underrepresented minority; five (50%) were female in the underrepresented minority group. Altogether, nine (90%) of the ten participants were either female or underrepresented minority students. They came from various STEM and health majors including Biomedical Informatics, Chemical Technology, Computer Science, Computer Engineering, Liberal Arts and Sciences, and Nursing. The project had three main components:

1. Disciplined specific research with the faculty mentor: Students worked individually with the faculty mentor of their discipline to review literature and study the background of the project.
2. Group work and interdisciplinary activities: Students and faculty from all three disciplines worked collaboratively in team meetings, laboratory experiments, field trips, etc.
3. Project presentations and conference participation: Students were encouraged to disseminate their research results at local and national venues. This is integral to STEM identity building.

The project attempted to investigate the key question "What is the water quality in Prospect Park Lake?" The project activities were hands-on and exploratory, and encompass the scientific process from the microbiology, chemistry, and mathematics perspectives. The students worked as a team throughout the whole project. They went on field trips to Prospect Park, made observations of the park habitat, and collected water samples from the lake. A map of Prospect Park Lake is provided in Figure 2, showing the water collection sites numbered 1–5 in red. These accessibility sites were defined by the Prospect Park Alliance. Next, 50-ml water samples were collected in sterile tubes from the five sites in the lake. To avoid bacterial growth, the water samples were stored at 4°C in a cooler. After water collection, the team of students reconvened in the laboratory and performed chemical and microbial analysis (Figures 3 and 4).

FIGURE 2. Map of Prospect Lake (Copyright Brooklyn Public Library; Center for Brooklyn History) and Images from Water Collection Sites

FIGURE 3. Integration of Data from Chemistry, Microbiology and Mathematics



The Microbiology Perspective

As a result of an extensive literature search, students found that one of the most-used parameters to monitor environmental water quality is the level of enteric bacteria (coliforms), usually occurring in the intestines of humans, animals, and birds. The presence of coliforms, such as *Escherichia coli (E. coli)* and *Enterobacter spp.* is an indicator of fecal contamination (Coulliette, Money, Serre, & Noble, 2009; Tortora & Funke, 2013). This could be of serious concern because the higher levels of coliforms show potential presence of pathogens (bacteria, viruses, etc.) and other pollutants (Bergman, Nyberg, Huovinen, Paakkari, Hakanen, & the Finnish Study Group for Antimicrobial Resistance, 2009).

In our research, following collection of water samples, the students performed tenfold serial dilutions, and 1 ml from each dilution was inoculated, using nutrient agar and MacConkey agar plates (Gavalas & Cook, 2015). Nutrient agar is a general-purpose medium, supporting growth of wide range of microorganisms. MacConkey agar is a selective and differentiating medium for cultivation of coliforms (*E. coli and Enterobacter spp.*) After incubation at 37°C for 48–72 hours, the number of bacteria was determined by the colony forming units (CFU) assay. The colonies were counted manually, and the results shown as the number of CFU in 100 ml of water. Additionally, Simmons Citrate agar was used to differentiate between *E. coli* and *Enterobacter spp.*

The Chemistry Perspective

The chemistry perspective focused on examining water quality in terms of dissolved oxygen, conductivity, concentration of nitrates and nitrites, pH, and hardness of water. Chemical analysis was performed on the water samples in the following manner: a) a Fischer Scientific Traceable Conductivity Meter was used to measure the conductivity; b) the dissolved oxygen (DO) was measured using the Winkler Method (data are reported as an average of three trials); and c) LaMotte multi-factor test strips were used to measure the water pH and nitrate or nitrite levels. All analyses were done at room temperature. Distilled water was used as reference sample (where the dissolved oxygen levels were recorded to be 6.6 ppm and the conductivity 2.3 μS/cm [microSiemans/cm], both acceptable values).

The Mathematics Perspective

The mathematics perspective provided students with the tools to examine the experimental data, think critically, and make scientific connections between the data and the water quality. Students used Excel spread sheets for data analysis. Students learned to formulate alternative and null hypotheses based on practical problems and assessed the data critically using chi-squared test and correlation coefficient.

Results and Discussion

The Prospect Park Lake provides a wide variety of habitats with multiple wildlife species. The results from our water sample analysis are presented in Table 1. The students identified the potential sources of fecal contamination to be domestic dogs and wildlife. A variety of birds were observed along the lake (specifically at sites 1, 4, and 5), such as ducks, geese, and swans (members of Anatidae family). It has been shown that some birds can excrete high amounts of coliforms, which may be a potential risk for pathogens. An earlier study has demonstrated that the density of aquatic birds affects the total number of bacteria in lakes, as birds are a natural source of coliforms, including E. coli (Hoyer, Donze, Schulz, Willis, & Canfield, 2006).

TABLE 1. Microbiology and Chemistry Quantitative Data from the Water Analysis

Site # of water sample	Temperature at collection site (° Celsius)	Total number of bacteria (CFU/100ml)	Number of coliforms (CFU/100ml)	Dissolved oxygen (ppm)	Conductivity (μS/cm)	pH
1	17	1,000,000	12,500	8.0	87.4	7.5
2	15	1,100,000	10,500	5.1	85.7	7.4
3	16	2,300,000	21,500	5.4	103.6	7.3
4	14	350,000	8,500	7.3	110.4	7.2
5	19	600,000	5,500	7.5	114.1	7.3

Reference Sample: Distilled water (dissolved oxygen levels 6.6 ppm; conductivity 2.3 μS/cm; pH 7). Estimated Nitrate/Nitrite: 0 (same for collected water samples)

Furthermore, the students observed the presence of multiple freshwater turtles at site 3, which most likely contributed to the highest numbers of total bacteria and coliforms at that site. Another factor resulting in the large number of bacteria at sites 2 and 3 could be the water stagnation, with lack of aeration and water currents, and the fact that these sites of the lake are very narrow. In contrast, the low number of total bacteria and coliforms at sites 4 and 5 could be explained by the water dynamics and free flow, as well as the location of the sites at the widest part of the lake. Other potential factors that affect the total number of bacteria are the temperature and weather conditions. Our results indicate that the sites in which the number of coliforms was higher are the areas with significant concentration of wildlife. Thus, it seems that the water contamination is due to the inhabitants of Prospect Park Lake. Moreover, the samples obtained from sites 4 and 5, which are from the area used for recreation purposes such as fishing and boating, showed the lowest bacterial levels. The numbers of coliforms at all sites of the lake, however, were above the safety standards established for boating and fishing (1000 CFU/100ml) by the U.S. Environmental Protection Agency (EPA) (2017).

Conductivity and dissolved oxygen are two important water quality parameters. Conductivity measures the ability of a solution (such as water) to conduct electricity and can be correlated to salinity level. Higher conductivity values indicate more dissolved ions (which are necessary to conduct electricity) such as phosphate or chloride anions, or calcium or sodium cations (EPA, 2012a). Prospect Park Lake appears to be on the lower end of conductivity; lakes and river water in the U.S. are typically 50–1500 μS/cm (EPA, 2012a). The level of dissolved oxygen in water is temperature dependent. Colder water typically has higher levels of dissolved oxygen (EPA, 2012b). Stagnant water contains less dissolved oxygen. This was observed in sites 2 and 3, as the water was stagnant. These two sites also had the lowest dissolved oxygen levels. According to the United States Geological Survey (USGS) (2018), as organic matter decomposes, "bacteria in water can consume oxygen," which may also point to why the

FIGURE 4. Selected Images of Faculty and Students at Collection Sites and Performing Laboratory Analyses

levels of bacteria at sites 2 and 3 are high and dissolved oxygen levels relatively low, as well as to their moderately strong negative correlation coefficients (see mathematical analysis below). On the other hand, most enteric bacteria (coliforms) are facultative anaerobes. In the presence of oxygen, they perform oxidative metabolism (respiration), whereas if dissolved oxygen levels are low, they switch to fermentation and still survive. As noted previously, the high bacterial counts at site 1 could be attributed to birds along the lake. For aquatic life (i.e., fish) to be sustained, the dissolved oxygen level in water should be above 5 ppm. Overall, the water quality of Prospect Park Lake (based on dissolved oxygen level) shows potential to support some aquatic life.

The undergraduate students made use of Excel spread sheets to record, organize, and analyze data. Students were tasked with finding the correlation between several parameters using correlation coefficients. The correlation coefficient, r, takes on a value between −1 and +1; an r value close to 1 implies a strong positive correlation between two parameters, an r value close to −1 implies a strong negative correlation, and an r value close to zero implies weak or no correlation. We found a moderate negative correlation between the total number of bacteria with dissolved oxygen (r=-0.64353) and the number of coliforms with dissolved oxygen (r=-0.52226); a correlation between bacteria and dissolved oxygen is expected as explained in the paragraph above. Comparisons of other parameters yielded insignificant correlations. A chi-squared test on the number of coliforms revealed statistically significant variations in coliform counts between various sites for all sample data (p-value < 0.0001), meaning that the variations in the coliform counts were too large to have occurred by chance alone. Other factors such as animal activities and water conditions (stagnation or open lake) may have contributed to the coliform counts, as previously discussed.

This project led to two poster presentations at City Tech's Semi-Annual Poster Sessions for Honors and Emerging Scholars, two oral presentations and a poster presentation at the Mathematical Association of America (MAA) Metropolitan New York Section Annual Conference, an oral presentation at the SENCER Regional Conference hosted by City Tech, a poster presentation at SENCER Summer Institute (SSI) and a student publication in the City Tech Writer (our college journal for exemplary student writing) (Gavalas & Cook, 2015).

A highlight and an eye-opening event for the students was the SENCER Summer Institute. Here are comments by students reflecting their experience:

> *My SSI trip was one of highlights of my summer. And it was my first time attending an out-of-state conference. Although my team and I were the youngest participants, I really enjoyed showing the audience our poster. Many of them commended us for our work.... I watched many presentations by other attendees and even got to learn interesting facts about the National Park Service. It was amazing to hear what they do to preserve our country's national parks.*

> *My peers and I had the opportunity to meet the other attendees, and learned about the topics of their projects.... I had an amazing time, thank you Professors for the opportunity.*

> *My group and I presented our poster and communicated with attendees of various backgrounds. It was interesting to see the poster presentations that (other) professors and students worked on.*

Conclusion

Collaboratively, faculty members from biology, chemistry, and mathematics designed an interdisciplinary SENCER project on Prospect Park biodiversity. Our investigation revealed that the coliforms in Prospect Park Lake exceeded the safety standards for secondary human contact (boating and fishing) (1000 CFU/100ml) established by the U.S. Environmental Protection Agency (EPA, 2017). The water quality in the lake is considered "threatened" (e.g., supports recreational use but exhibits a deteriorating trend) because of contamination with coliforms and other pollutants. In the last decade, the Prospect Park Alliance worked diligently to engage the community, expand its volunteer force, and secure funds for restoration and environment protection projects. We recognize the importance of their work and how much more still needs to be done.

In addition to the SENCER framework, the project achieved its four goals: (1) The project activities were interdisciplinary, collaborative, and hands-on. All students regardless of disciplines were engaged in the activities; computer science and engineering students learned about biodiversity and performed laboratory tests alongside biology and chemistry students; biology and chemistry students learned to formulate and test scientific hypotheses using Excel alongside computer science students. (2) All students were required to enroll in the undergraduate research program and worked with faculty mentors an average of two hours per week. Research activities included one-on-one research with the faculty mentor as well as joint work with all faculty and students in the team. (3) All students had to read literature regarding water quality and its importance before starting the activities. In addition, all students worked collaboratively to prepare posters and presentations, resulting in seven presentations and one student publication. (4) Nine of the ten participants were women or underrepresented minority students in STEM or in a health major. All participants successfully completed the program. Faculty and students shared the sentiment and appreciation for the richness and meaningfulness of the experience. Future work may include an expansion or repetition on a regular basis for the benefits of civic engagement and educational values.

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PROJECT REPORT

Evaluating Knowledge Transfer after a Science Café:
A Qualitative Approach for Rural Settings

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Abstract

Science Cafés are informal community gatherings that aim to facilitate the engagement of scientific researchers with the general public. These events have been implemented worldwide in rural and urban settings. This article evaluates two Science Café series, held in rural Iowa communities. Evaluation of Science Cafés typically consists of participant surveys to measure satisfaction with the presenter, interest in the topic, or solicit topic suggestions for future events. This paper presents results from a qualitative evaluation that aimed to better understand how the information presented at Science Cafés was shared with others in the community following the event. Results suggest that participants share information in both formal and informal settings following a Science Café, especially those who self-identify as "champions" of an issue. This research suggests that future evaluations examine rural social networks to better understand the broader community impact of these events.

Introduction

Science Cafés are informal community gatherings that aim to facilitate the engagement of scientific researchers with the general public. These events have been implemented worldwide in rural and urban settings. The University of Iowa's Environmental Health Sciences Research Center (EHSRC) has hosted Science Cafés since 2013, mostly in rural communities in Iowa. Evaluation of Science Cafés typically consists of participant surveys to measure satisfaction with the presenter and interest in the topic or to solicit topic suggestions for future events.

This paper presents results from a qualitative evaluation that aimed to better understand how the information presented at Science Cafés was shared with others in the community following the event.

Background

Science Cafés are casual events designed to engage members of the public with science and scientists. These interactive gatherings can be in a coffee house, bar, library, or community space. They typically involve a presentation by one or more speakers with a scientific research background, followed by a group discussion and questions (NOVA Education, 2020). The bi-directional communication, in which audience members discuss the topic and pose questions, allows researchers to learn about public perceptions, concerns, and curiosity for their area of expertise. The community benefits from participation as they learn about science in their everyday lives and see the value of research and STEM (S. Ahmed, DeFino, Connors, Kissack, & Franco, 2014; S. M. Ahmed et al., 2017). Science Café events should emphasize "participation" over "popularization," to better "demythologize science communication, bringing it out of the cathedra and into everyday life" (Bagnoli & Pacini, 2011). Science Café events are held across the globe and many are now recorded and posted online so that they are broadly accessible to the general public.

The first Science Café was held in 1997 at a wine bar in Leeds, England and was modeled after the the French Cafés Philosophiques, forums held in cafés to discuss philosophical issues (Nielsen, Balling, Hope, & Nakamura, 2015). This format of gathering in a public space to socialize and discuss science has been adopted all over the world in a somewhat grassroots fashion (NOVA Education, 2020). A Science Café is one model of scientific communication with the public that encourages public participation and exploration of emerging issues in medicine, science, technology, the environment, and globalization. The global nature of the Science Café movement is "part of a wider participatory trend" that aims to engage the public with the processes of science (Nielsen et al., 2015, p. 15). However, events are also "adapted to local contexts" to shape and define forms of interactions and dialogue between scientists and their immediate constituencies (Nielsen et al., 2015, p. 3).

Evaluation is a standard component of Science Café events, consisting primarily of participant satisfaction surveys (Einbinder, 2013). Researchers have found that the events are effective at encouraging the discussion of scientific issues among members of the public (Navid & Einsiedel, 2012), including among youth (Hall, Foutz, & Mayhew, 2013; Mayhew & Hall, 2012). The Clinical and Translational Science Institute of SE Wisconsin also evaluated the impact of attendees' understanding of health and scientific information using a Likert scale assessment of participants' reported level of confidence across a five-item instrument. They found that attending a Café increased participants' confidence in health and scientific literacy (S. Ahmed et al., 2014). In addition, Science Cafés are seen as a mechanism to improve the ability of scientists to communicate with the public by providing an opportunity to practice explaining scientific concepts to a general audience (Goldina & Weeks, 2014). This is particularly important for those scientists who may see public engagement as "troublesome or time-consuming" (Mizumachi, Matsuda, Kano, Kawakami, & Kato, 2011). One key challenge of evaluating Science Cafés, or other "dialogue events" aimed at increasing public engagement with science, is understanding the extent to which they increase individual participants' knowledge about scientific concepts (Lehr et al., 2007). Furthermore, Science Café events may hold greater value as interactions that broadly improve relationships between scientists and society through accessible engagement, rather than serving merely as a mechanism to teach specific ideas, such as in formal scientific lectures or courses (Dijkstra, 2017).

Public Health in Rural Settings

In the US, rural communities disproportionately suffer from a number of adverse health outcomes, including higher rates of obesity and earlier mortality, as well as higher rates of smoking and lower physical activity than their urban counterparts (Garcia et al., 2017; Matthews et al., 2017). Further, recruiting and retaining health care personnel is difficult in rural areas (Asghari et al., 2019; Lafortune & Gustafson, 2019; Thill, Pettersen, & Erickson, 2019) In addition to addressing structural and geographic disparities in rural areas, the social context

must also be considered when delivering effective public health interventions in these settings (Gilbert, Laroche, Wallace, Parker, & Curry, 2018). Factors including demographic shifts due to immigration (Nelson & Marston, 2020), poverty (Thurlow, Dorosh, & Davis, 2019), and the necessary engagement of rural residents with extractive industries, such as agriculture or mining (Kulcsar, Selfa, & Bain, 2016), also contribute to health disparities and require interventions that take into account the social and cultural components unique to rural communities.

There has long been an understanding that social networks may be associated with mortality risk (Berkman, 1986) and spread of disease (Bates, Trostle, Cevallos, Hubbard, & Eisenberg, 2007), but they may also provide a framework for behavioral interventions (Eng, 1993; Yun, Kang, Lim, Oh, & Son, 2010). In addition, social transmission of knowledge has been documented in relation to ethnobotanical knowledge (Lozada, Ladio, & Weigandt, 2006; Yates & Ramírez-Sosa, 2004) and agricultural practices and innovations (Flachs, 2017; Stone, 2004). Despite this, evaluations of public health or science-related events do not regularly assess the potential for knowledge dissemination by participants following the event's occurrence. Our evaluation aimed to understand the potential for knowledge transmission through social networks following Science Cafés to better assess their potential community-level impact.

Research Setting

At the University of Iowa, the NIEHS-funded Core Center, the Environmental Health Sciences Research Center (EHSRC), and the Institute for Clinical and Translational Science (ICTS) have been organizing Science Cafés since 2013 in various small Iowa towns, most consistently focusing on two communities. Community One, a town of 4,435 residents with a small liberal arts college, and Community Two, a slightly larger town, with 10,420 residents and an alternative business school. Both communities also have a robust agricultural economy that includes produce, livestock, and grain farmers. The Science Café events involve one presenter, usually a researcher or faculty member from the University of Iowa, and the coordinating staff from the EHSRC. The researcher delivers a presentation about 20–30 minutes in length, followed by questions from the audience and discussion. There are no Powerpoint or other slide shows; however, in some cases the presenter may put together a handout that includes two or three slides or graphics with main points from the presentation. Because the events are meant to allow considerable time for discussion and questions from the audience, there are no formal learning objectives or knowledge tests for participants. Most presentations reflect the environmental health focus of the EHSRC. However, the standard evaluation questionnaire distributed after each event solicits suggestions for additional topics from the participants; these topics are then prioritized for future events. Participant suggestions have led to presentations on topics such as wolf habitat in the Midwest, obesity, and healthy sleep habits.

The Science Café location in Community One is a local coffee shop in the center of town, while in Community Two it is the public library. Both of these venues have strong relationships with the EHSRC and support the events by posting flyers for upcoming Cafés. The library in Community Two includes the events on their programming calendar, sends out announcements via Listserv, and sometimes sends press releases to the local paper. The EHSRC regularly advertises in the local paper of Community One. The age of the attendees varies from college students to elder retirees, with retirees being the largest group of consistent participants. There is a core group of about eight participants in each community who attend all of the Cafés, while other attendees vary based on the topic.

This paper presents a novel evaluation of the EHSRC Science Cafés by examining the extent to which participants share what they learned with others. Rather than simply assessing how satisfied or interested participants were in the topic, or assessing individual knowledge, this evaluation seeks to better understand how information travels through communities and social networks, recognizing the importance of social networks as described above, and the implications for broader scientific literacy and environmental health literacy. Given the rural context of the EHSRC Science Cafés, this paper reflects on the implications of knowledge sharing in the rural landscape.

Methods

In the spring of 2019, the EHSRC Community Engagement Core (CEC) staff added several questions to the standard written evaluation that is administered after each Science Café. In addition to asking participants about how far they traveled for the Science Café, how they learned about the event, examples of what they learned during the Café, and to rate their level of satisfaction with the content, participants were asked, "Do you plan to share this information with friends, family, or others? If so, how will you share?" The evaluation also asked if we could follow up with a phone interview in the future. These additional questions were posed at all six Science Café events in spring 2019. The project description was submitted to the University of Iowa's Institutional Review Board, where it was deemed not to fit the criteria for human subjects' research. This work was funded by the National Institute of Environmental Health Sciences, P30 ES005605.

A 13-question instrument was designed for use via Computer Assisted Telephone Interview (CATI) system. Science Café participants who had indicated their willingness to be interviewed provided their phone numbers on the evaluations and were contacted within two weeks of the Science Café event. The interview reminded participants of their response to the original question, "Do you plan to share this information with friends, family, or others? If so, how will you share?" and asked whether they had in fact shared information from the Science Café and with whom and how they shared it. In addition, participants were asked to describe any other instances when they shared information from any Science Café and who in their communities they felt would most benefit from attending Science Café events.

Interviews were conducted by trained interviewers at the Iowa Social Science Research Center on the campus of the University of Iowa. The CATI system allows for interviews to be transcribed as they are conducted. Following the interviews, written transcriptions were provided to the research team for analysis.

The interview transcripts were coded using both deductive and inductive approaches. The research team read the transcripts and developed an initial set of deductive codes based on the categories of people with whom information was shared: friends/family, social group, professional contacts. A second round of inductive coding generated novel codes from the data and illuminated concepts specific to the population and conditions under which information was shared (e.g. agricultural occupations or cancer survivor) (Legard, Keegan, & Ward, 2003).

Research

Science Café Attendance

In spring 2019, attendance at the Science Cafés ranged from eight to 31 participants (see Table 1). Travel to the events ranged from less than one mile up to 35 miles (one attendee in Community One) with most attendees traveling one mile or less to attend. This suggests the audience for Science Cafés is mostly local residents. In both communities, the highest proportion of attendees report that they are "retired" or "semi-retired": 38% (n= 12) in Community One and 32% (n= 14) in Community Two. Other occupations identified include farmer, educator, student, medical professional, and self-employed person.

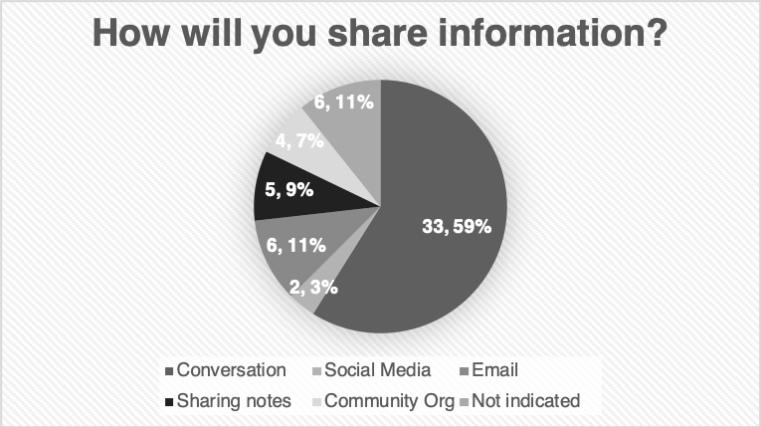
TABLE 1. Science Café Topics and Attendance

LOCATION	TOPIC	ATTENDEES
Community 1	Iowa Agriculture	31
	Iowa Air Quality	27
	Tuberculosis	8
Community 2	Cancer	28
	Clean Energy	28
	Air Pollution	17

Results from Written Evaluations

Over the course of three Science Cafés in Community One, we received 32 evaluations from a total of 66 participants. In Community Two, we received 44 evaluations from 73 participants. In this paper, we have combined all evaluation results to present the results across both communities.

FIGURE 1. Responses to "How will you share information?"



In response to the question "Do you plan to share this information with friends, family or others?" 56 respondents indicated "yes," nine indicated "no," and 11 did not respond to the question. The majority of respondents (33) who said "yes," indicated that they would do so through conversations with family or friends. Others also indicated social media (two), email (six), and by sharing "notes" (five). Four indicated they would share through a community group or organization (see Figure 1).

The written evaluation also included a question asking for examples of something the participants learned. Among the responses to this open-ended question were some very specific items, such as "how to count pollen + p2.5-p10 measurements + pollen fragments" following a presentation on air pollution, to more general statements or perceptions of the content. Following a presentation on Iowa agriculture, one participant wrote, "I loved being reminded that conventional ag and diversified small ag are a venn [sic] diagram and have things in common" and another wrote, "intersection of local and global ag in formal and informal ways." After a presentation on air quality, someone responded: "I learned about air control."

Results from Interviews

Over the course of the spring 2019 Science Café events, 26 indicated on their evaluation form that they were willing to be interviewed. Of those, we were able to contact and interview 18 individuals, ten women and eight men. Given the relatively narrow focus of the interview guide, this number should be sufficient to reach saturation, the point at which no new themes emerge from the data (Guest, Bunce, & Johnson, 2006).

Consistent with the responses in the initial evaluations, most participants shared information in conversations with family or friends:

- I have a friend that I get together with once a week and we chat. We were at lunch and I talked about how Iowa is one of the worst states for cancer. We are also the best research state for cancer, I was kind of bragging on us. (Participant #4)
- I talked about it by word of mouth to a ton of people (Participant #8)
- The bottom line for the lecture after going through many ideas is that the future is solar, and I had a friend who asked me about it and I told him that. (Participant #17)
- I have a friend in Cedar Rapids that I have shared the information with (Participant #15)

Others indicated that they shared information strategically with family or friends who might be particularly interested in it or benefit from it. In some cases, the information was directed at someone who lacked knowledge about the topic: "It was a casual conversation with a friend we were talking about. She's new to being in a rural area which brought up the different types of agriculture with which she wasn't familiar with and I was able to share" (Participant #10).

Conversely, information was shared with people who had very specific knowledge of the topic, such as in the case of a cancer survivor or someone remediating mold in a home:

- I shared some points with my mother who is a cancer survivor (Participant #13)
- We were cleaning a house because it was dusty and the new occupants, one of them, has a dust allergy, and I said I was just at the Science Café on air quality and the question was "What is one thing we can do ourselves on air quality?" and the teacher said basement mold and the person I was talking to said the moldy basement was a bigger issue than the dust and I was able to confirm what they said with the advice of an expert. (Participant #26)

Others noted that the topic was relevant to their professional life and so they discussed it with colleagues in

a professional capacity. In this context, student status is considered a professional setting:

- I brought it up in class and told them what it was about. (Participant #8)
- Since I'm a farmer I'll sometimes relate something that came out of there to someone else in the same profession. (Participant #11)
- Friends who are water quality testers like me, we all agreed that we need to be referencing data and all of us generally agreed that this ups the game of water quality of Iowa and is the proof that we need to show that we have to turn things around. (Participant #16)

Finally, a couple of respondents referenced formal social or community groups that they shared information with:

- [with] the breakfast club…I told it to my husband, my friends at the book club, and several other people. (Participant #5)
- I work with the local Sierra Club so it was an interesting background to have. (Participant #21)

In some cases, respondents referenced their own reputations or positions within the community, indicating that the Science Café information provided additional weight or legitimacy to areas of concern that they have been known to discuss:

- Informally as always. They're used to me talking about local ag at this point. (Participant #14)
- It was about agriculture and I am a farmer so it is my life. (Participant #9)
- I talk about it in my community and how we can implement it in our community. I also talk about compost and trash a lot so I might be a little excited about it. (Participant #14)

Most respondents indicated that they shared information verbally or through casual conversations. A few, however, noted that they shared information via written notes, video, or online mechanisms:

- I take notes and I give the whole thing to my husband and my friends. (Participant #5)
- Well that is odd that you called because just an hour ago I was talking to someone about it. The fellow had a graphic on the information. It turns out the 5,000 pigs put out the sewage amount of 20,000 people. I'm going to take the map that he showed and make it a poster size and put it around town so that people see it because they need to. (Participant #20)
- A friend put a video that I made up on a forum. I didn't spread it but she did. (Participant #20)

Discussion

These results shed light on the diversity of social settings and groups that individuals in small rural communities may encounter and engage with. One challenge of conducting community outreach or participatory research in rural communities is that low populations make it difficult to generate impactful numbers of participants or attendees at events. However, responses indicated a wide number of settings, both formal and informal, in which information was shared. These included book clubs, breakfast clubs, the local Sierra Club chapter, and with family members, fellow students, and colleagues. In some cases, participants sought out individuals who they knew would be interested in the information (e.g., a parent who is a cancer survivor). In other cases, interview respondents indicated that they were asked about the event, or the topic came up, and they had information to share.

Notably, the content gleaned from Science Café events provided legitimacy and evidence for several participants in their interactions, particularly in formal settings such as the workplace or a community organization. For example, content from a water quality event generated a longer discussion among community water testers about the importance of good data and evidence in water quality discussions. In other contexts, such as cancer-related research, the Science Café material provided information about resources in Iowa, allowing the participant to "brag" about research productivity in the state. Knowledge sharing among social networks can be an important conduit for information transmission, particularly in rural areas (Burch, 2007; Mtega et al., 2013). Even relatively small events like these Science Cafés can enhance knowledge in formal settings, broadening the initial reach of the event

and informing professional networks as well as informal social groups.

In addition, several participants indicated that they are known for being interested in a topic, as evidenced by comments such as "I talk about composting and trash a lot" and "They're used to me talking about local ag" as well as "I am a farmer, so it's my life." The literature related to program development in sustainable food systems suggests that many new endeavors are initiated by "champions" who engage with the community and promote their cause (Bagdonis, Hinrichs, & Schafft, 2008). Likewise, other evaluation strategies have examined the qualities of people who support initiatives in quality improvement (Demes et al., 2020). Recognizing that these highly engaged "champions" may participate in other events, gleaning information and resources to pass along in other settings, is a potentially new way to think about how content from a Science Café event might reach additional community members. Future evaluations in these communities could include social network analysis or mapping to better understand the social and professional channels through which information may be distributed (Wasserman & Faust, 1994).

While most participants shared information verbally by reporting that they described the content of the Science Café to others, some developed additional materials or used other media. One participant stated that they took written notes, which they shared, and another described developing posters and videos for distribution. This was an unexpected product and suggests there may be additional opportunities to engage with Science Café participants to co-develop products or materials related to the events' content. Providing content in a way that participants can reproduce and share, such as an electronic version of the standard handout or graphics, could further encourage participants to develop follow-up materials after the event.

In this small study, respondents' diverse reports of what they learned, in conjunction with the wide array of approaches to sharing information, suggest that Science Cafés may serve as more than simply sites where the public learns about scientific concepts. Among participants in this study, some were inspired or reminded about the intersections between systems (such as conventional and alternative agriculture), some became excited about, and advocates for, cutting-edge cancer research in their communities, or they used the content to champion projects in local organizations. When viewed from this perspective, Science Cafés have a great deal of potential to improve the relationships between scientists and society. This study contributes a new approach for evaluating Science Café events. Future research could link pre-determined learning objectives with an evaluation of how those objectives are communicated more broadly.

Conclusion

This study suggests that evaluating small events in rural communities can benefit from learning not only who attends and their levels of satisfaction, but also how they may recount and communicate the information they learn with their social and professional networks. Recognizing that participants may be leaders in local groups, champions for causes, or may glean information that is particularly relevant for a friend or family member can help organizers develop programming that can be tailored to and/or shared in a variety of media. In addition, being attentive to those who are motivated to develop additional outputs, such as posters or video, can help organizers expand the reach of what is otherwise a relatively small event. Understanding how science may be communicated via social networks can assist in developing programs with the potential to have a broad community impact, beyond the setting of one individual event.

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APPENDIX A:

Science Café Evaluation Questions

1. Name
2. Profession
3. Email
4. Are you already on the mailing list?
5. Are you willing to be contacted via phone for a brief interview? If so, please list phone number.
6. How did you learn about the event?
    - Email from school/professor
    - Flyer
    - Newspaper
    - Email list from EHSRC
    - Other (please describe)
7. Please rate the following as excellent, good, fair, or poor:
    - Presentation
    - Group discussion
8. Examples of something you learned:
9. Do you plan to share this information with friends, family, or others? If so, how will you share?
10. Are there any topics you would like to learn about in a future Science Café?
11. Do you have any suggestions for how we can improve the Science Café?

APPENDIX B:

Phone Interview Questions

Hello, may I speak with (first name, last name)? This is __ calling from the University of Iowa, and you are being contacted because you had previously indicated at a recent Science Café event that you were willing to be interviewed.

On the evaluation form at the most recent Science Café you attended, we asked you: Do you plan to share this information with friends, family, or others? If so, how will you share?

You responded: SOME FORM OF YES

1. Why did you indicate you would share information? For example, it was interesting, relevant, important, you had someone in mind, etc.
2. Did you discuss the information you learned at the Science Café in person, by email, or by telephone with anyone? Answer options: Yes, No, I don't know/remember, Refused (If no, go to question 6)
3. How many people?
4. Can you describe that interaction or discussion?
5. What was the outcome of the interaction? For example, did the person indicate interest, say they learned something new, disagree or take issue with the information?
6. (If answered no to question 2) Why have you not talked about the Science Café with anyone? For example, you didn't think of it, it wasn't important information, you are not comfortable sharing, etc.
7. (If answered no to question 2) Do you think you'll talk about it in the future?

FOR ALL: Now I'd like to ask you about the Science Cafés in general.

8. About how many Science Café events have you attended?
9. Have you ever talked about past Science Café content with friends, coworkers, or family members following the event? Answer options: Yes, No, I don't know/remember, Refused (If no, go to question 12)
10. Can you tell me about or describe a conversation you've had with friends, coworkers, or family members about a Science Café?
11. Do you think the information you shared was new to the person or people you spoke with?
12. (If answered no to question 9) Why have you not talked about the Science Café with anyone? For example, you didn't think of it, it wasn't important information, you are not comfortable sharing, etc.
13. Who in your community would most benefit from the information shared during Science Café events?

On the evaluation form at the most recent Science Café you attended, we asked you: Do you plan to share this information with friends, family, or others? If so, how will you share?

You responded: SOME FORM OF NO

1. Why did you indicate you would not share the information? For example, not interesting, relevant, important, no one to share with, etc.

2. Did you discuss the information you learned at the Science Café with anyone? Answer options: Yes, No, I don't know/remember, Refused (If no, go to question 8)

3. How many people?

4. Can you describe that interaction/discussion?

5. Did you communicate about the Science Café by email or telephone with anyone?

6. Can you describe that interaction?

7. What was the outcome of the interaction? Did the person indicate interest, say they learned something new, disagree or take issue with the information? (Go to question 9)

8. (If answered no to question 2) Why have you not talked about the Science Café? For example, didn't think of it, wasn't important information, not comfortable sharing.

9. Do you think you'll talk about it in the future?

FOR ALL: Now I'd like to ask you about the Science Cafés in general.

10. About how many Science Café events have you attended?

11. Have you ever talked about past Science Café content with friends, coworkers, or family members following the event? (If no, go to question 14)

12. Can you tell me about or describe a conversation you've had with friends, coworkers, or family members about a Science Café?

13. Do you think the information you shared was new to the person or people you spoke with? (Go to question 15)

14. (If answered no to question 11) Why have you not talked about the Science Café? For example, didn't think of it, wasn't important information, not comfortable sharing.

15. Who in your community would most benefit from the information shared during Science Café events?

For those who responded: UNSURE OR BLANK

Intro language—they are being called because they indicated at a recent Science Café event that they were willing to be interviewed.

You recently attended a Science Café presentation,

1. Did you discuss the information you learned at the science cafe with anyone? (If no, go to question 7)

2. How many people?

3. Can you describe that interaction/discussion?

4. Did you communicate about the Science Café by email or telephone with anyone?

5. Can you describe that interaction?

6. What was the outcome of the interaction? Did the person indicate interest, say they learned something new, disagree or take issue with the information? (Go to question 8)

7. (If answered no to question 1) Why have you not talked about the Science Café? For example, didn't think of it, wasn't important information, not comfortable sharing.

8. Do you think you'll talk about it in the future?

FOR ALL: Now I'd like to ask you about the Science Cafés in general.

9. About how many Science Café events have you attended?

10. Have you ever talked about past Science Café content with friends, coworkers, or family members following the event? (If no, go to question 13)

11. Can you tell me about/describe a conversation you've had with friends, coworkers, or family members about a Science Café?

12. Do you think the information you shared was new to the person or people you spoke with? (Go to question 14)

13. (If answered no to question 10) Why have you not talked about the Science Café? For example, didn't think of it, wasn't important information, not comfortable sharing.

14. Who in your community would most benefit from the information shared during Science Café events?