EMERGING SUSTAINABILITY LEADERS: ASSESSING LONG-TERM IMPACTS OF SUSTAINABILITY EDUCATION

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ABSTRACT: We live in an era in which it is increasingly apparent that climate change is a threat to humanity. Worldwide, we are in need of professionals with the values, knowledge, and skills to implement solutions to the threat of climate change and other serious environmental issues resulting from humanity's current way of living on our planet. Efforts to create such professionals lack documentation of the long-term impacts of sustainability education. This presentation builds upon past research conducted with developing professionals during an undergraduate research experience (URE) focused on sustainable energy. Program participants from 2009-2014 were involved in a mixed methods study to explore impacts on their educational and career paths, involvement in sustainability careers, and evolving attitudes and perceptions of sustainability. Reporting on the qualitative portion of the study, key findings indicate that many past participants are working in sustainability-related careers and are all are actively engaged in sustainability roles that involve education and exemplify their leadership skills and dedication to the creation of sustainable societies. They are developing strategies to overcome the resistance they receive as sustainability-minded professionals.

Keywords: climate change, sustainability, environmental issues, sustainable energy, perceptions

Human activity is an increasing threat to our continued existence on planet Earth. If we continue on our current course, there is widespread agreement that the impact of our actions will result in an ecosystem that is uncomfortable at best and hostile to our survival at worst (IPCC, 2014). If we continue on our current course, by 2050

- there will be more plastic waste in the ocean than fish (World Economic Forum, 2016);
- temperatures will exceed the limits of historical precedents, meaning at any given location the coolest year's average temperature will exceed the average temperature of a location's hottest year during 1860-2005 (Mora, et al., 2013);
- twenty-five percent of the planet will experience serious drought and desertification (Park, et al., 2018);
- more than 5 billion people will suffer water shortages because of climate change, increased demand and polluted sources (WWAP, 2018); and
- the average world citizen will have the same air quality as the average East Asian citizen in 2005 (Pozzer, et al., 2012).

Also by 2050 the current generation of young professionals (adults in their 20s-30s) will be in the later stages of their careers (adults in their 50s-60s). Given that this group of professionals (and those who follow them) will be the ones shepherding humanity through its most difficult challenges, preparing them for it is a crucial task for today's educators. In fields such as science, technology, engineering and mathematics (STEM), the education of many future professionals is preparing them as technical and content

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experts in developing and implementing solutions to these challenges. This preparation should be bolstered by developing the leadership capacity to facilitate the social and cultural changes necessary to advance the development of sustainable societies (Wiek, Withycombe & Redman, 2011). This paper reports on research to investigate the experiences of a group of STEM-educated early career professionals who participated in a sustainability-focused undergraduate research experience (URE). It addresses the questions of are these young adults developing into the types of sustainability-minded leaders and decision-makers we need them to become and what types of experiences are they having along that journey?

Literature Review

The current study builds on previous research on undergraduate research experiences, both in general and specifically in that this research is a long-term follow-up study on participants whose experiences in URE have been previously reported (Erickson, Griswold, Hohn & Saulters, 2010; Griswold, 2017). It also contributes to the fields of Education for Sustainability (Cloud Institute for Sustainability, 2009) and situated learning in communities (Leve and Wenger, 1991), both of which examine the social nature of learning.

Many studies have explored short-term student benefits of URE. Common key findings are increasing knowledge of how to conduct research, growing confidence in research skills, clarifying future career and educational paths, and developing an identity as a scientist (Grimberg, Langen, Compeau & Powers, 2008; Hunter, Laursen & Seymour, 2006; Lopatto, 2007; Russell, Hancock & McCullough, 2007). Erickson, Griswold, Hohn and Saulters (2010) found that a URE focused on sustainable energy aided participants in developing clarity about their career pathways (pursuing graduate studies and jobs involving sustainability), expanding their concepts of sustainability both in terms of content and complexity and their ideas of their potential roles in sustainability to include serving as educators and advocates of sustainability. Griswold (2017) also reported on a broadening concept of sustainability, in which ideas about sustainability expanded from being focused on sustainable energy to perspectives on sustainability as a multidisciplinary field encompassing the environment, economics, and social issues. This study also supported Erickson, Griswold, Hohn and Saulters' (2010) initial findings on the educational and advocacy roles that participants saw themselves as both poised for and necessary to advance the development of sustainable societies. As a result of their participation in their URE, this group of future professionals began developing the sustainability mindsets needed to take on their future roles, as well as confidence and a sense of legitimacy in doing so.

There are fewer studies on the long-term impacts of URE. Harsh, Maltese and Tai's (2011) multi-institutional, mixed-methods study concluded that exposure to research, increased confidence in research skills and development of laboratory skills were viewed by participants as benefits with lasting impacts on their career paths. Yaffe, Bender, and Sechrest (2014) compared participants and non-participants in undergraduate research within a single institution. Key findings were increased clarity and confidence in pursuing science careers and higher levels of career satisfaction among those participating in URE. These studies provide evidence that the URE benefits identified

by short-term studies do indeed impact participants' choices about education and career paths. However, they are limited by their general focus on science and technical career paths. Research is needed on the long-term impact of UREs focused on supporting participants in developing sustainability mindsets and pursuing sustainability careers.

In order to move toward sustainability, humanity requires "an education that prepares people to be far-seeing enough, flexible enough, and wise enough to contribute to the regenerative capacity of the physical and social systems upon which they depend" (Cloud Institute for Sustainability, 2009). Education for Sustainability (EfS) should provide learners with a holistic understanding of the world and the place of humans in it, engaging them in lifelong learning that includes formal, non-formal and informal contexts (Blewitt, 2006). This type of learning has the capacity to be transformative and result in perspectives and actions that incorporate planet-wide consideration of impacts and outcomes (O'Sullivan & Taylor, 2004).

Situated learning in communities is relevant to EfS and URE because it is concerned with acculturation and social change (Leve & Wenger, 1991). Situated learning involves "the whole person rather than 'receiving' a body of factual knowledge about the world; an activity in and with the world, and on the view that agent, activity, and the world mutually constitute each other" (Leve & Wenger, 1991, p. 33). Newcomers learn from old-timers; not just practice, but culture. As newcomers transition to old-timers they develop the power and legitimacy to change the status quo if a more appropriate and useful way of operating is necessary (Leve & Wenger, 1991). Learning how to be a member of and a leader in a profession in a time when business as usual is no longer in our collective best interests will likely be a process of careful negotiation and possible conflict for upcoming professionals now and in the years ahead.

Methodology

As a long term follow up study, the setting of this research has roots in the past experiences of its participants and their current journey as life-long learners and sustainability leaders. Participants in this study shared the common experience of participating in a ten-week summer undergraduate research experience during 2009-2014 at a large Midwestern university. The URE was focused on sustainable energy and, in addition to having the goals of providing participants with experiences that improved their science, technology, engineering and mathematics knowledge and skills, sought to expand their concepts of sustainability as a multi-dimensional field encompassing environmental, social and economic issues. Program activities included mentored research, sustainability seminar, field trips, research meetings and culminating symposium, professional development seminars, brownbag discussions, group projects, reflective journaling, and a community-wide dialog on sustainability.

Seeking to learn about the long-term impacts of the URE on participants' careers and experiences as sustainability professionals and leaders, the 59 people who participated in this URE during 2009-2014 were invited to join this study. Eighteen participants completed a survey about their careers and attitudes toward sustainability and ten of the 18 participated in an interview (5) or a focus group (5) to share their experiences with sustainability after their URE. This article reports on the data from the focus groups and

interviews. Table 1 below provides an overview of the ten participants in the qualitative portion of the study. The follow-up study was conducted by the URE program evaluator, who interacted frequently with each participant during their URE experience and had limited to no interaction with participants after the conclusion of their URE. Participants are identified by pseudonyms.

Table 1.

Interview and focus group participant demographic details.

Name	Year of URE	Current Work	Career Sustainability Focus	Location in US
Kaley	2009	Process Engineer	None	Northwest
Rudi	2009	Earning JD	Nat. Res./Environmental Law	Midwest
Carl	2010	Building Systems Engineer	None	Northeast
Nicole	2010	Earning Ph.D.	Water Quality/Conservation	South
Caleb	2013	Community Ed.	Sustainable Food Systems	Northeast
Calvin	2013	Informal Science Ed.	Sustainability Education	South
Cace	2014	Solar Technician	Solar Energy	South
Elena	2014	Earning Ph.D.	None	South
Ella	2014	Earning Master's	Renewable Energy Policy	Northeast
Jaden	2014	Software Engineer	None	North

Findings

The findings below reflect participants' self-reported concepts of their role in creating sustainable societies and their experiences and challenges as sustainability-minded professionals operating in a variety of contexts.

Role in Sustainability

Participants reported a range of roles for themselves in advancing a sustainable society, all of which involve education. These roles included leading by example, being an advocate for or source of knowledge about sustainability in the work place or the public sphere, and serving as a bridge connecting different groups of stakeholders around sustainability issues.

Leading by example.

Jaden, Kaley, and Carl each work as engineers in fields not involving sustainability and describe their sustainability role as learning by example. Jaden, a software engineer at a

small startup company, lives in a large southern city where "sustainability is not on the forefront of many people's minds." To counter this, she started a recycling program in her office, where "people are starting to learn about what they can recycle and compost at home." She reported that "some employees have commented; you've made me think twice now about when I'm throwing something away. I think first about if I can recycle it." She also actively encourages her colleagues and friends to engage in more sustainable practices, such as not using disposable utensils and plates and participating in community cleanups. Kaley, a process engineer for a metal manufacturer, lives in a large coastal city in the Northwest, where companies are under pressure to decrease their emissions. She describes her role in sustainability as "living it out through example" and cites her decision to drive a Prius as one example. She furthers this impact by "talking through whoever I interact with why we've made the decision because of sustainability." Carl is a building systems engineer, who works in the Northeast where building codes and regulations incorporate sustainability through energy efficiency. He leads by example by seeking to live a less consumer-driven lifestyle and likes to:

> toot my horn that I'm still driving the same car that I was in college…instead of buying another vehicle, which takes more energy to create and then sometimes…have even less gas mileage. Trying to just show people that you don't need the newest and the best. Sometimes the same old reliable car works and good gas mileage can't be beat.

Being an advocate.

Elena, Cace, Rudi, and Caleb describe their role in sustainability as advocating for sustainability one-on-one and in public settings. Elena is a Ph.D. student in the biomedical field at a large university in a southern state and not focused on sustainability as part of her research. She describes her role in sustainability as being supportive of a lab manager's sustainability efforts and making sure that in her lab "other people are sticklers about recycling materials that we can recycle…to cut down on our waste." Cace, a solar technician in a southern state, said:

> I just try to live it out by being a part of the industry and trying to drive it forward and being able to talk intelligently about it at church or something. If people have questions about solar or about sustainability in general, being able to provide the benefits and give a full understanding…but actually talk about it, and try to teach briefly.

Rudi, who worked as a geologist for a large petroleum company in Alaska, is currently pursuing a JD in a Midwestern state. As she is in the midst of a career transition, she feels she is still figuring out her role in sustainability; however, in classes she said "I often try to cultivate discussions that can integrate these issues" as well as "try[ing] to be that advocate for it in that common space among our friends." After participating in his URE, Caleb changed his major from chemical engineering to sustainable food and farming systems due to a realization that he wanted to work more directly in communities impacted by non-sustainable practices. Working currently in an anti-hunger non-profit organization on the northeast coast, he shared that:

> having these conversations with people…is the role that I've been playing, whether with family members or friends or going to events and asking questions or things like that. As I have gone through school and my work now, I have taken those more informal conversations and made them into a role. What I try to bring to the conferences and trainings that I put together is these conversations about the issues from a social perspective, from a community-based perspective.

Bridging the divide.

Nicole, Ella, and Calvin work in university settings, either as graduate students or administrators. Each discussed their role in sustainability as serving as bridges or connectors between different spheres or groups of stakeholders. Nicole, earning a Ph.D. at a southern university, researches and is involved in outreach efforts in water quality and conservation in agriculture. She describes her role in sustainability as "being the bridge between the agricultural community and regulators [representing] federal [and] state government." Ella is currently earning a Master's in Public Affairs at a northeastern university after completing a fellowship at the Department of Energy in Washington, DC, where she promoted solar energy grant programs across the US. She stated:

> my role for creating a more sustainable society presently…is saying, we can't wait anymore. The action is in our hands, and it's time to go ahead and move forward with that. I always said in undergrad that I wanted to be the bridge between the scientist and the business people and the policy makers and I think that's what I want to continue to be is that bridge…trying to communicate complex motivation in a way that people can understand and act on.

Calvin is a high-level administrator at a research center at a university in a southern state and manages a URE program. His role in sustainability centers on informal science education and shared that;

> what makes me committed to trying to work toward better scientific literacy is so that as we develop policy people are tuning into what the consequences of those policies are. I think that scientific literacy is a necessary thing to develop to make it so that people can pursue policy decisions that are going to be environmentally conscious.

As the examples above show, the lines between these roles can be blurry. Jaden's role straddles leading by example and advocacy. Each participant also gave examples of their roles in sustainability in both personal and public realms, as well as either indirectly or directly indicating that sustainability is part of their identity. As people who actively and proudly embrace sustainability are still in the minority in the U.S., it is worthwhile to learn about their experiences in negotiating such identities in their respective contexts.

Negotiating a Sustainability Identity

While experiences in negotiating their identities as sustainability-minded professionals occurred in a variety of contexts, many participants reported similar themes related to the pushback or resistance the received. All who experience pushback provided examples of how they countered it. Many related the development of their sustainability identities to their URE.

Sustainability-supported contexts.

Each participant reported working in contexts where sustainability is given some value, however that value ranged from settings where the need or recognition that companies or leadership must comply with regulations or social pressure to settings with a specific focus on advancing or advocating for sustainability. Kaley and Carl reported working in corporations where valuing sustainability was a result of external forces, such as pressure or regulations that must be complied with. Both are living in states with policies that incorporate environmental protection into business practices more significantly than some parts of the U.S. Elena reported that her institution moderately supported sustainability efforts via a recycling program, but it was not a strong institutional value. Nicole, Cace and Caleb are working in settings where sustainability is a core value of their organizations, with Nicole earning a degree in a program focused on protecting water sources threatened by agricultural practices; Cace working for a company that installs solar power technology, whose leader is also involved in an industry organization that advocates for solar energy policy; and Caleb working for an organization that actively works to end hunger.

Identity and resistance.

All participants indicated directly or indirectly that sustainability is part of their identity through its focus in their careers, such as Rudi, Caleb, and Cace, or by taking actions to encourage others to act sustainably, such as Elena and Jaden. Nicole, Ella and Calvin have the most publicly visible sustainability identities, seeking to advance sustainable practices by serving as bridges between stakeholders and promoting mutual understanding of complex issues and decision-making. Most participants experienced resistance or pushback against their sustainability identities or actions, which took a variety of forms. A few noted the current political climate has made things more difficult. Ella, a recent federal government employee, in discussing her career plans after completing her degree said, “I might do a couple of years away from the [federal] government under the current situation” and plans to focus on working at state or local government levels rather than at the federal level and is considering running for elected office in the future. Those working in more public arenas, such as Caleb and Calvin, described pushback from the public as resistance based on social stereotypes or identifying with a particular ideology. Caleb, in his efforts to educate the public on anti-hunger initiatives shared his experiences with pushback as being related to people “blurt[ing] out the common stereotypes about social welfare programs” or that “they don’t need dependency on the government to survive.” Calvin works to increase the scientific literacy of the general public and shared that:

> He has met folks of one kind of political bent and they are almost anti doing things that are good for the environment. If they find out something is good for the environment they will, because of a sense of political opposition, choose not to do it.

Having experiences in countering resistance and pushback to sustainability ideas and actions has led to awareness that caution is needed in doing this type of educational work, particularly among those who seek to serve as bridges for sustainability. Nicole shared that currently:

> I'm much more aware of how I may come across to people who may not initially be open to hearing about sustainability…I try to present myself in a way that isn't the typical kind of person you might expect to be harping on sustainability. I try to come at in a way that's…reasonable and I try to…meet them halfway. I think how you communicate the message is so important.

In addition, many shared the recognition that progress toward sustainability must be tempered with economic benefit and that making choices to benefit the environment is not enough for many people, which is an insight derived from their work experiences. Carl, who works in building systems engineering, in describing his work with clients, shared "a lot of times its let's do code minimum…When they're putting up a building…it's all about…how can we do it the cheapest way possible." He seeks to counter this by "trying to work in sequences that might be better…to try and save a little bit more energy here and there. That is always a delicate act...that push and pull between saving energy and saving money." Ella described her experiences promoting the Department of Energy's solar energy programs and the pushback she received around the costs of solar energy. She shared that she "confronted a lot of people who [claimed], solar is so expensive" by informing them that "the cost of solar has gone down in some states 90% since 2011 and across the nation has gone done 70%." Cace, who works as a solar energy technician, describes his evolution from being more focused on the environmental aspects of sustainability to the social and economic, based on his experiences in the workforce.

> Investments in sustainability are investments. People have to find them viable and the environmental and green effect helps, but at the end of the day if there isn't a good ROI (return on investment), you're not going to make it.

There were also instances of personal pushback experienced by participants. This was generally experienced by those participants whose role in sustainability was leading by example or advocacy. Carl, who lives on the northeast coast and proudly still drives the same car he used as a college student shared that he receives "comments like why don't you lease a nice, new car? I think over here people like the flashy lifestyle. Sometimes I feel like I'm being pushed against or not really getting through to people."

Several participants shared the insight that they are aware that they aren't able to live as sustainably as they would like themselves, so their advocacy and education efforts are tempered and strategic to avoid being hypocritical. Nicole provided an example.

> I do so many things in my life that are not sustainable….driving a car, eating red meat, so I…feel it would be hypocritical for me to harp on certain things when I do a lot that I know isn't really contributing to sustainability. So, yeah, it's complicated.

There is also awareness that they are members of a generation that will be on the hook for making the difficult decisions and addressing the problems that prior generations have caused or not addressed. In discussing this, Rudi, who is struggling with redefining her role in sustainability based on her career transition, expressed how people in her generation feel about what they see as their responsibility.

> In the '90s, the world was using 50 pounds of raw material per day per person. And you're thinking 50 pounds of raw material a day for billions of people to sustain this life of consumerism and entitlement? It's hard to not feel a little bit overwhelmed. You can't solve it all, so what area do you focus on?

Foundations of identity.

Many participants acknowledged the role that their URE experience played in developing their sustainability identities and perspectives, and for some their career paths. For Caleb, it led to a change from a technical to a social career path, which he directly credits to the research project he worked on during his URE. He was responsible for translating the process of converting used cooking oil into biodiesel into terms that students from all different majors could understand. "That process of translation of making things more universally understandable was really intriguing to me and…led me away from the more technical side of chemical engineering and…into community-based educational solutions to issues." Calvin, who now administers a URE, shared that his URE solidified his interest in science literacy and outreach education. While he credits the experience with shaping his understanding of sustainability as a multidisciplinary field, he acknowledges "what was more important for me was the focus on sustainability…made is so that to me it seemed more legitimate to pursue paths of advocacy."

He also shared that in developing his own program, he received pushback from more senior colleagues on adding an element he experienced in his own URE, having students develop and deliver public outreach and education programs. Recalling the impact a similar experience had on him, he "did it in secret and then it worked out pretty well and now I'm not doing it in secret. Now we are formalizing that…and working with a few different communities and trying to get them more involved, too." Calvin explains the value of such experiences for students is the opportunity for them to:

> develop an understanding that they already do have enough expertise to start doing meaningful outreach and education work, which I think is kind of the big issue with science communication in general. The people that do have expertise at the undergraduate or graduate level don't have a sense of their own efficacy as

communicators or as having valid perspectives that are informed that could be useful to lay audiences.

Discussion

The participants in this study have shown that the early experiences that allowed them to learn about and explore sustainability had lasting impact on their careers, either solidifying their paths or opening up alternate ones. They credit their URE with shaping their sustainability perspectives and identities, and the roles in creating sustainable societies they have taken on (Erickson, Griswold, Hohn & Saulters, 2010; Griswold, 2017). For the participants in this study, their learning about sustainability has translated into them helping others learn about sustainability, which is infused into many aspects of their lives (Blewitt, 2006).

They have also shown us that there are several roles to play in helping to create sustainable societies and all are impactful. Jaden is actively involved in helping her colleagues think and act differently. Caleb infuses environmental sustainability into the trainings he conducts in the social sustainability realm. Calvin is creating URE that connect future professionals to community education programs.

Most are experiencing pushback against their sustainability education efforts, but none reported that they were deterred by this resistance. Instead they described several ways they have countered it. These methods are representative of the tenets of EfS (Cloud, 2009) and shed light on the old-timer/newcomer tensions described by Leve and Wenger, 1991).

- Tread lightly. They are becoming aware of the contexts they operate in and their limitations. They intentionally educate from non-biased or neutral positions, seeking to promote and disseminate accurate information.

- Remain humble. They acknowledge the difficulty and struggles they have living sustainably in our current system and recognize that others struggle as well.

- Money talks. They have become less idealized about our ability to act upon the sustainable solutions that we technically could put into place and are aware of the economic limitations and issues that are in the way. Their arguments and actions take this reality into account.

- Call out misinformation. They actively challenge and refute misinformation.

- Be sneaky, if you need to. Carl creates building system designs that nudge clients toward more sustainable decisions. When faced with pushback from the old timers in his organization, Calvin independently implemented programming that supported the professional development of the next generation.

- Accept responsibility. These early career professionals know that addressing our current and future problems is up to them.

Conclusion

The participants in this study are becoming the leaders we need them to be and are having experiences that are challenging them to grow and become even stronger advocates and activists. They have maintained and expanded the sustainability mindsets they developed as college students engaged in an undergraduate research experience focused on sustainable energy. Whether or not their current career paths are directly related to sustainability, they continue to play active roles in creating sustainable societies. These roles all have educational elements and most of their educational activities are informal, occurring in one-on-one or small groups in their work and personal settings. Given these factors, developing the communications skills and the confidence to have sustainability conversations is crucial. Education for Sustainability programs need to intentionally cultivate these skills.

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