Public Understanding of Chemistry

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CIVIC CHEMISTRY: HELPING COMMUNITIES ADDRESS CHALLENGES

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Introduction

In this brief, I argue that chemists can play an important role in democratic societies by getting more involved with citizen science and especially civic science. From the perspectives of both science and democratic self-rule, we live in interesting times. This is especially true for chemists and chemical educators who are interested in scientific literacy and the public perception of science. Many scientists have little appetite for advocacy, but considering the global lack of chemical expertise, helping communities address their chemistry-related concerns and challenges, especially underserved communities, is a great way for chemists to become more productively engaged. Improving the understanding, engagement, and well-being of our fellow citizens is difficult to argue with, as is helping other species and ecosystems, so every chemist should be aware of the benefits of civic science.

Abstract: This brief argues that chemists can play an important role in democratic societies by getting more involved with citizen science and especially civic science. Many scientists have little appetite for advocacy, but helping communities address their chemistry-related concerns and challenges, especially underserved communities, is a great way for chemists to become productively engaged. Civic science, which arises from local community concerns rather than academic research, offers an excellent framework to help. In addition to providing expertise that can directly improve the health or peace-of-mind of local communities, there are potentially beneficial synergies with policy and education that can occur when chemists become more involved in civic science. The implications for chemistry education are particularly noteworthy, as civic science assignments and projects could play an important role in connecting departments to their communities and attracting and engaging a broader range of students to the field.

Key Words: Civic chemistry, community, citizen science.

Challenges

Unprecedented increases in global population, consumption, and urbanization have led to a range of environmental challenges at scales from local to global. As they often involve incomplete data and value conflicts, many of these challenges are described as "wicked" problems, which democratic societies are not always able to effectively address [1]. One of the ongoing issues associated with such challenges is an unbalanced or unfair distribution of the benefits and harms our lifestyles or technologies create. It has been argued here [2] and elsewhere that mutual comprehension and trust are critical to forming effective bridges from science to the

community. Unfortunately, we are in the midst of an era of ideological polarization, mistrust of science and other institutions, and an apparent inability to effectively deliberate when politically contentious issues involve science, as so many do. For better or worse, chemistry does not have celebrity experts that the public trusts. As a result, when people become concerned with the potential effects of pollutants or wonder if certain chemicals are to blame for changes in their health or local environments, there are no obvious, reliable sources of information for them to turn to.

Solutions

It's worthwhile to consider the range of ways that the public can engage with science. I find it helpful to consider civic-citizen science as a spectrum. In general, citizen science projects are top down; that is, designed by and for researchers. These can often be considered as a kind of crowd-funded science [3], and examples abound, from the venerable Christmas bird count to game-like Foldit (https://fold.it/portal/) for analyzing protein structure. Civic science, conversely, arises not from scientists, but rather from community concerns and issues. Such concerns may not be on the radar of government and academic researchers, or can even conflict with them, as the messy and shameful Flint water crisis illustrated. Not surprisingly, pollution often disproportionally affects communities that lack political or economic power, making the lead pollution in Flint a worthwhile case study for chemists interested in public health regulation or environmental justice [4]. Both civic and citizen science research projects are growing, and advances in sensor, computing, and communications technology are making air and water monitoring increasingly practical for home and small community use. For example, a basic AirPi weather station (airpi.es/) is inexpensive, and associated modules can record and upload information including carbon monoxide, nitrogen dioxide, and smoke levels. Civic and citizen science projects will continue to see an explosion of available data from such sensors, in a range of environments.

Considering civic-citizen science as a spectrum – rather than a dichotomy – is more helpful, and community concerns can be guided by the interests and expertise of local scientists as well as vice versa. For many members of the public worldwide, chemicals are invisible and often worrisome, and chemists can help relieve concerns or focus them on the most relevant risks. For instance, one research project incorporated soil, water, and vegetable samples from trained local residents who were concerned about gardening near a mining site [5]. Research like this can involve reciprocal dialogue between researchers and the community; in a follow-up article, the researchers described the process as "co-created citizen science", and highlighted the reciprocal links throughout the process [6]. Whatever it is called, and wherever it ends up on the civic-citizen science spectrum, similar research could benefit many communities worldwide. To help increase the quantity and quality of such partnerships, chemists can take the initiative to seek out community networks and leaders. Many individuals may be hesitant to approach academics, or unaware of how to. Chemists can offer to help examine and address local issues of concern, and provide expertise, advice, direction, training, and even equipment or lab time. Such work can provide direct, immediate help, and is especially relevant for disadvantaged or neglected communities that lack the resources to hire experts themselves.

Synergies

In addition to providing expertise that can directly improve the health or peace-of-mind of local communities, there are some potentially beneficial synergies with policy and education that can occur when more chemists become involved in civic science. It certainly doesn't hurt to have chemists (and other scientists) become more democratically engaged. This does not imply advocacy for specific issues; rather, it involves working within our social systems and government, particularly at the local level, to help individuals and communities make more

sound decisions. Chemists have the potential to help at the individual, institutional, and political levels. For instance, you might join citizen science projects such as Florida Lakewatch (http://lakewatch.ifas.ufl.edu), which has been using volunteers to monitor water quality for over 30 years. In addition to simply collecting samples, chemists can help with skills, education, expertise, and even provide role models for others. You might deliberately engage with your community leaders or local politicians, offering to help with issues they feel are important. Or you might encourage your business, association, or society to become more engaged in similar ways.

Implications for Chemistry Education

One of the reasons we need more chemists to become involved with civic science is that our educational systems, here and abroad, have not done a good job of producing graduates with the range of qualities needed to effectively recognize and address the considerable environmental challenges they will face [7]. Tweaking the curriculum to cover basic socioenvironmental literacy, rather than more focused career training, is part of the ongoing debate of the merits of a liberal arts education. Incorporating civic science projects into chemistry education will help students see the real-world implications of their studies and expand their view of what careers in chemistry might entail. Chemistry programs often make the links to industry explicit; indeed, the notion of undergraduate education becoming more akin to job training is at least as controversial now as it has been in the past. Yet many programs are not effective at making the links to policy and community as relevant and do little to help students build interest and skills in these areas. Chemistry education programs could do a lot more by including civic science projects as service learning [8] or as part of ongoing partnerships with local community groups. Once again, there are many underserved communities that could benefit greatly from well-designed, long-term educational partnerships with chemistry programs. Such programs could draw a more diverse group of students into the field.

None of these are magical solutions. As popular as superheroes are these days, you probably won't be donning a lab coat and swooping in to save lives (although don't rule it out!). We shouldn't need to be superheroes [9]. Good governance, especially when wicked problems must be addressed, is not easy. It takes real work, the best information available, careful deliberation, and ultimately compromises by people whose values often conflict. One of the systemic problems of democracies and other forms of self-rule is a mutual distrust between citizens and important societal institutions [6]. By engaging more with civic science projects, by encouraging policy that facilitates such engagement, and by incorporating civic science into chemistry education, chemists can help improve these relations, and therefore the resilience and adaptability of the communities and societies they live in. These are important benefits in a changing world. By leveraging citizen and especially civic science, chemists can make a real difference.

Biography:
Bryan Nichols is an assistant professor of science and environmental education, a behavioral ecologist, and a science journalist.

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