

A Call to Action: Civic Science and the Grand Challenges of the 21st Century

A White Paper for the Civic Science Workshop at the National Science Foundation

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“We have frequently printed the word Democracy. Yet I cannot too often repeat that it is a word the real gist of which still sleeps, quite unawaken'd...a great word, whose history remains unwritten, because that history has yet to be enacted.”

Walt Whitman, *Democratic Vistas* (2003, p. 427)

A democratic society requires a democratic people with the habits, knowledge and dispositions to work together across differences to address common challenges and negotiate a shared way of life. Today, as the challenges our democracy faces are multiplying, democratic capacities are diminishing. We need a new way of doing business – and developing ourselves as heirs and architects of the great word, “Democracy.”

Science was once widely understood by practitioners and the larger citizenry as a wellspring of democratic energy and a constellation of democratic practices (Jewett 2012). Today, many fields of science are generating an explosive increase in our knowledge about the world. But the democratic energies and practices of science have receded from view. At the same time, society is beset with “knowledge wars”; politics is bitterly polarized; people feel powerless; and skepticism about public, economic, and civic institutions has dramatically increased. We are in danger of becoming a nation of democracy’s spectators, not democracy’s co-creators.

We are convinced that civic science—scientific inquiry that offers opportunities for participants to develop their capacity to work across differences, create common resources, and build a democratic way of life—offers hope beyond this impasse. Civic science is a framework and set of democratic and scientific practices that bring citizen scientists and lay citizens together in ways which build respect, that enhance capacities to act, and that generate positive public outcomes.

In the report below, we describe three case studies which show that civic science can bridge enormous differences. For instance, the Family Education Diabetes Series (FEDS) initiative, a supplement to standard health care for members of the American Indian community in the Twin Cities, addresses diabetes. Chronic conditions such as diabetes can be considered “wicked problems”— problems facing society that are daunting in their complexity. Such problems often generate high distrust between scientists and minority cultural groups (Fadiman 1997). FEDS was created through collaborative work between health scientists and providers and the Indian community—from early efforts in relationship-building and establishing mutual respect and trust, to brainstorming the program’s design, educational foci and format, public visibility, implementation, and ongoing modifications. Quantitative evaluations of FEDS have found significant improvement across key objective diabetes-related measures (e.g., weight, metabolic control). Qualitative evaluations (conducted within the culturally-consistent context of talking circles) have also found that the community-owned nature of the program—and the social support and interpersonal accountability that this encompasses—is perceived as the principal driver of these improvements and change (Mendenhall et al., 2010, 2012).

Building on such case studies, this report is a working document for the National Science Foundation Civic Science Workshop, October 2-3, 2014. We provide an overview of what civic science is. We describe several case studies on grand challenges of our day—sustainable agriculture, the achievement gap in education, and challenges of health care—which show commonalities of how to put civic science into action. Part of the workshop will explore and analyze these lessons, as well as a forthcoming case study on climate change. More broadly, we will examine obstacles to civic science in our funding, educational, and policy systems. And we will strategize about how obstacles can be overcome, and how we might organize an international civic science community of practice as a way to address the grand challenges of our time and awaken the potential of our democracy.

What is Civic Science?

Gwen Ottinger & Nicholas Jordan

Civic science is a method of inquiry into important contemporary issues that enriches democracy by bringing citizens from all backgrounds and disciplines – not just scientists – together in shared projects that analyze current conditions, envision a better future, and devise a pathway to that future. Civic science is both an approach to generating knowledge *and* a democratic practice. In civic science, scientists express democratic citizenship through their scientific work: they engage in democratic world-building efforts *as* scientists. Such efforts include democratic projects in which broad-based civic groups are working to impact complex problems in, for instance, agriculture, education, and health care, the three areas emphasized below. By linking scientific work to these democratic efforts, scientific inquiry expands, taking a crucial civic role. The fundamental scientific question of “how does the world work?” is situated in the context of democratic inquiry into a critical question—“What should we do in the face of complex problems?” Civic science, thus, integrates its work closely with the “purposive” disciplines of arts, humanities, and design, which ask fundamental questions about what is good and just, encouraging us to envision and debate ways of relating and living as civic agents.

Civic science is like “transdisciplinary” science (e.g., NRC 2014), but expands and enriches such frameworks by closely linking the practice of science to democracy and to other ways of knowing and learning from arts, humanities and design traditions and fields. Similarly, Civic Science is like community based participatory research (CBPR) and social movement-based “citizen science” in that it focuses on complex, pressing, real-world problems, and values diverse ways of knowing. However, in ways that usefully challenge theory and practice in CBPR, civic science intentionally and explicitly aims to promote democracy by framing scientific inquiry as an opportunity for participants to develop their capacity to work across differences, create common resources, and negotiate a shared democratic way of life.

As a democratic *and* scientific practice, we argue civic science has the unique potential to advance public deliberation, collective action, and public policy on pressing issues like energy security, climate change, sustainable agriculture, poverty, and health care. These and other “wicked problems,” require not only the insights of numerous academic disciplines and situated knowledge, but also approaches to governance that are not paralyzed by uncertainty and can adapt to new information as it emerges. Effective approaches to wicked problems must also explicitly engage purposive questions such as “what should we do?” to work through political stalemate. Civic science’s combination of knowledge production and democratic practice is thus clearly called for.

Civic science draws from research and theory in three areas: science and technology studies (STS), civic studies, and complex systems theory. Together, they provide the rationale for civic science and point to the benefits of pursuing civic science as an approach for furthering knowledge and democracy.

Science and technology studies argues that values are inherent in all scientific inquiry (e.g. Sarewitz 2004) and demonstrates that knowledge, ways of knowing, and the research efforts of non-scientists can contribute meaningfully to our understanding of wicked problems (e.g. Corburn 2005; Fischer 2000). This line of thinking establishes the need for policy-relevant science to be a collaborative, transdisciplinary effort. We argue that more recently emerging fields, which rely heavily on co-production of knowledge, such as “sustainability science,” demonstrate these tenets.

Civic studies posits that “civic agency” is essential to a well functioning democracy. This field—which includes not only the social sciences but also the humanities and political philosophy—views citizens as co-creators of civic life and stresses their collective capacity for negotiating and shaping social and political environments (Ostrom 1990; Calhoun 1992; Boyte 2011; Tufts Civic Studies Institute Curriculum 2013; Levine 2014). Civic studies provides a framework for conceptualizing how scientific inquiry can serve as a democratic practice, and for theorizing about the contributions of scientific practice to democratic culture.

Complex systems theory provides a framework for characterizing wicked problems and holds that adaptive and foresight-based governance approaches, in which scientists are central participants, are necessary to make progress on them (Liu et al. 2007). This theory strongly underscores the necessity of employing a democratic, agency-building approach to science in order to confront wicked problems.

Civic Science Case Studies: Overview

When we think about the grand challenges facing society today—the need for sustainable agriculture, the achievement gap in education, the need to create a healthy society, and climate change—there is a growing sense that business-as-usual isn't working. Nevertheless, cutting-edge science provides hope—the pace of discovery is rapid; innovative solutions have either emerged or are just on the horizon. This is evident in the **civic science case studies** we highlight below. Consider two examples:

- Within the field of sustainable agriculture, research shows that continuous living cover provides a pathway to achieving sustainable increases in production while enhancing environmental quality. Continuous living cover is achieved by the introduction of winter-annual and perennial crops at carefully-targeted spatial and temporal locations in agricultural production systems, so as to complement and augment crop production.
- Within the field of early learning, evidence shows we can combat the achievement gap in education by targeting early brain development and executive function skills—the ‘higher level’ skills of self-control and cognitive flexibility. New preschool curricula have been developed that use guided play and mindfulness training to enhance executive function in early childhood, preparing children for the K-12 system and yielding measurable life-long improvements in health and economic outcomes.

Although these scientific advances are exciting, our case studies also reveal key barriers to system-wide change. First, there are fundamental challenges of **complexity and scale**. With each example, it is hard to understand the root causes of ‘wicked’ problems locally because there are many interconnected elements that interact in complex ways. Similarly, it is hard to bring innovative ideas to scale to create system-wide change because the local details often shift from place to place.

There are also **structural barriers**, including how organizations function. Within each case study area, we see that organizations are often set up in silos to target specific pieces of the larger puzzle. Moreover, such organizations compete for limited resources. In such a system, there are few incentives for cooperation, and few possibilities for system-wide coordination. Our case studies highlight different efforts to overcome these structural barriers, for instance, by creating new ‘boundary’ organizations that target system integration.

System coordination is often attempted at the level of government organizations, but here there is a striking **lack of political will** to implement solutions. Across the scientific domains we highlight, federal funding has been in decline as our nation struggles through a period of bitterly polarized partisan politics. Our case studies emphasize the need to come together across partisan divides, and the need for all of us—citizen scientists *and* lay citizens—to develop new democratic skills, habits, and dispositions.

Finally, we do not share **one of the predominant ways of thinking about how citizens and communities interface with science**. In one common view, citizens and communities are perceived as clients, patients, or consumers who select from a menu of solutions provided by scientific experts that are often packaged as fixed and scripted “evidence-based programs.” Given the complexity of modern science, the complexities of context, and the normative as well as technical nature of the challenges we face, such programs often fail. They can rob people of opportunities to function as civic agents who name and frame their own problems and solutions. And they can reinforce a sense of powerlessness and a culture of grievance and entitlement. Such political and cultural attitudes are devastating, because evidence shows that change is most effective when it happens from within communities (Ostrom, 1994; Boyte, 2011). Our case studies highlight how the framework of civic science is changing the interface between science and society, between scientists and lay citizens. For instance, multiple case studies point toward the need to create “free spaces” (Evans and Boyte 1992) where diverse groups can come together on an equal footing to develop productive relationships across differences, to develop democratic habits, and to create sustained cultures of learning and innovation.

Note that the case studies below are in different stages of development. Some groups have been doing civic science ‘on the ground’ for years. Others are just getting started. We think this mix is exciting; it builds on past civic science successes, but it also highlights the potential moving forward, an issue we address in the final section of this ‘call to action’.

Civic Science and the Sustainable Intensification of Agriculture

Nicholas Jordan

Society is calling for “sustainable intensification” of agriculture, defined as production of more food, feed, bioproducts, and bioenergy, while also improving conservation of soil, water and biodiversity (Garnett et al., 2013; Heaton et al., 2013), and improving the social effects of agriculture, e.g., on public health, rural communities, and the welfare of agricultural workers. Unquestionably, sustainable intensification of agriculture is a grand challenge, with profound implications for life on this planet.

Unfortunately, business-as-usual approaches are making little progress toward sustainable intensification, which is a highly complex undertaking with interacting biophysical, socio-cultural, technological, economic, institutional, and political dimensions. The complexity of intensification is further compounded by intensifying global change, including climate variability, new pests and diseases, soil degradation, and water scarcity. Current agricultural research is dominated by biophysical science and technology development. Many promising technologies have emerged, but their adoption has been very limited, in large part because research systems have very little capacity to address socio-cultural, economic, institutional, and political factors that are critical to adoption.

In this difficult milieu, our Civic Science hub is exploring the potential of one highly-promising strategy for sustainable intensification, detailed below. In doing so, we are engaging with the socio-cultural, economic, institutional and political dimensions of sustainable intensification, as well as the biophysical and technological. We are using the humanistic discipline of design as a guiding methodology. We are engaging complexity and harnessing design in order to achieve our most important goal: helping rural communities build their civic agency to meet the challenges of sustainable intensification. Such agency is absolutely crucial, because sustainable intensification is not a “problem” to be “solved”. Rather, it is a perennial challenge for humanity, and will require civic capacity that enables a wide range of stakeholders to comprehend its complex and dynamic nature, take ongoing collective action, and learn from these efforts. Our commitments to engaging complexity, to design as an indispensable “way of knowing”, and to the development of civic agency are crucial to our civic agricultural science, and are major departures from usual practices in agricultural science. Below, we explain our strategy for sustainable intensification, identify critical challenges, and detail how we are meeting these challenges through civic science.

Our strategy for sustainable intensification begins with a fundamental expansion of agricultural production, achieved by adding “continuous living cover” to agricultural landscapes. Continuous living cover is achieved by the introduction of winter-annual and perennial crops at carefully-targeted spatial and temporal locations in agricultural production systems, so as to complement and augment annual crop production. A large base of evidence shows that this strategy can enhance yields of summer-annual crops, enable production of new commodities, enhance soils and wildlife, and improve water resources (Scheinost et al., 2001; Teasdale et al., 2007; Gopalakrishnan et al., 2009; Dale et al., 2010; Davis et al., 2012). Recent scenario analyses suggest that broad and substantial increases in total productivity are possible (Dale et al., 2010; Valentine et al., 2012).

The fundamental increase in agricultural production provided by continuous living cover does not result from growing more of our currently predominant crops, such as corn. Rather, increased productivity comes from new crop species, which must be commercialized in order to provide economic returns to farmers. Commercialization can be achieved by the emergence of a new agricultural bioeconomy (McCormick & Kautto 2013) that is producing new foods, feeds, bioproducts, and biofuels from a range of new crops and utilization technologies. The economic and environmental benefits of the new bioeconomy can revitalize rural communities and regions by creating new markets, new jobs in emerging sectors, and new revenues from spin-off benefits of continuous living cover, such as enhanced tourism and recreation (De Groot 2003). Thus, a new bioeconomy built from continuous living cover can support an increasingly *civic* 21st century agriculture (Lyson 2004) that provides a broad range of social and environmental benefits to agricultural communities, in addition to private wealth and prosperity. We hold that sustainable intensification must create an agriculture that is more productive, more sustainable in environmental terms, and, crucially, more civic.

We recognize that we are pursuing sustainable intensification in difficult circumstances. Many groups and sectors have large stakes in agriculture and its effects on food, land, water and energy, and these groups have a

long history of contention. Agricultural issues, such as global food security and sovereignty and the environment impacts of farming, receive little public attention, despite recent events such as the 2014 Lake Erie water crisis. Political will appears mixed; there is recognition that action is needed on certain agricultural problems, that genuine innovation is needed; and that large economic opportunities exist in an emerging bioeconomy, but there is little shared understanding of how to come to grips with these complex challenges. Agricultural innovation is slow and highly contested, and an anti-collaborative environment of distrust and suspicion is prevalent.

These barriers heighten the grand challenge of sustainable intensification. To make progress in the face of polarization and fragmentation, we are taking a place- and community-based approach. We are working to help rural communities increase their civic agency around agriculture, so that they can act democratically and concertedly to develop an agriculture that is more productive, more environmentally sustainable, and more civic. In our view, this civic agency must be exerted by multi-stakeholder groups—including agricultural groups, environmental groups, and civic groups—that together address the future of agriculture and the future of rural places. Most fundamentally, it is our commitment to developing such civic agency that makes our science “civic”. The key elements of our project include the following:

- Use emerging “big tent” bioeconomic technologies, which can address problems and opportunities that are salient to a wide range of stakeholders. Two such technologies are value-added processing of lignocellulosic biomass (e.g., the AFEX process, Dale et al. 2010), and new plant-breeding technologies such as genome editing (Runck et al. 2014). These technologies have high potential to enable rapid domestication and development of new crops that can produce new food, energy and bioproducts from agriculture, and also improve environmental and social outcomes of agriculture. Thus, there is potential for a wide range of stakeholders to support development and use of such technologies, and a strong incentive for collective action to implement and refine these technologies.
- Build a new bioeconomy from continuous living cover by state-of-the-art innovation methods (e.g., Leeuwis and Aarts 2011). Such innovation is comprehensive and systemic, addressing technological, biophysical and social aspects of bioeconomic development. In practice, such innovation requires the development and facilitation of multiple working groups that guide and govern bioeconomic development driven by big-tent technologies.
- Draw upon the power of arts, humanities and design to enable deliberation, via such approaches as participatory scenario planning, public narrative and participatory design (Schively Slotterback et al. in review). These activities provide a “way of knowing” that supports civic dialogue around the fundamental questions that underlie sustainable intensification such as “what kind of place and community do we want for ourselves and our children?”
- Create institutions (e.g., Landlabs, Jordan et al. 2013) that coordinate the innovation, deliberation, and governance that are needed to pursue sustainable intensification through continuous living cover and bioeconomic development. Landlabs are place-based, coordinated efforts to design and implement locally-adapted bioeconomies built from continuous living cover. Landlabs provide “free spaces” (Evans and Boyte 1992), in which the many different professions that are concerned with sustainable intensification can explore and together enhance the civic dimensions of their work.

Our Civic Science hub will integrate and leverage existing pilot Landlab projects in Minnesota, Iowa, and Wisconsin (Jordan et al. 2013) to create a network of projects addressing sustainable intensification through the approaches outlined above. Key functions of the network are to support rapid learning and effective experimentation (via action research etc.) on our application of Civic Science methods to a grand challenge in agriculture, via shared training, support for a community of practice, and organizing and conducting action research projects. The network would also be capable of strategic communications about civic science approaches to sustainable intensification, by becoming a trusted media source, organizing science pubs/cafes, and proactive communication with key influencers. The network would strive to gain sufficient clout to be taken seriously in dialogues with funding agencies, universities, and scientific societies regarding support for civic science approaches in agriculture. Finally, the network would focus on integration with undergraduate and graduate education in agricultural science and studies, so as to develop future civic scientists for agriculture.

Civic Science, Executive Function, and Early Learning: Erasing the Achievement Gap

John P. Spencer, Clancy Blair, Stephanie Carlson, Cybele Raver, Larissa Samuelson, Phil Zelazo

Summary: Research on the developing brain has shown that children's executive function (EF) skills provide a key foundation for learning and predict school readiness, academic achievement, and other important developmental outcomes. This research has also revealed ways in which the development of EF can be enhanced. We propose to create an *integrative EF framework* that brings together the science of EF skills, play-based ways of improving these skills, and a civic science perspective. Our goal is to create the political will and community agency to address the persistent poverty-related achievement gap in American schools and make enhanced early learning a reality. To address the lack of system-wide coordination among the many organizations involved in early learning, we will *create a boundary organization that adopts the integrative EF framework*. This organization will coordinate and bring to scale advances in policy, teacher training, and preschool curricula, and empower teachers, parents, and community members to innovate. To further foster this culture of agency, we will create *Learning Labs* that will enable scientists, teachers, and parents to prototype ideas and bring them quickly to scale. The goal is to create two-way relationships between citizen scientists and lay citizens, and empower communities to transform themselves to promote healthy brain development and erase the achievement gap.

A grand challenge of the 21st century is to foster the development of the next generation. Nowhere is this challenge more apparent than in the achievement gap between our nation's most economically vulnerable children and their advantaged counterparts. Despite billions of dollars invested, this gap remains alarmingly wide. As children enter kindergarten, those in the bottom 20% of the nation's income distribution score a full grade level behind those in the top 20% on early tests of math and reading knowledge and ability (Duncan & Magnuson, 2012; Reardon, 2013). This gap expands over time: low-income students face gravely low probabilities of completing high school and entering college relative to their more affluent peers (Bailey & DiBnarski, 2011). The educational gap faced by children in low-income neighborhoods is paralleled by gaps in health and well-being. Low-income children face substantially higher risk of mortality, mental health difficulty, and compromised health relative to children in more affluent neighborhoods, even after taking family factors into account (Xue, Leventhal, Brooks-Gunn & Earls, 2005). Recent neuroscience findings highlight that this achievement gap emerges early, with infants in very low-income homes showing significantly lower levels of brain activity, fewer opportunities for word-learning, and higher risk of later language difficulty than their high-income counterparts as early as 6 to 9 months of age (Fernald et al., 2013; Tomalski et al., 2013).

Importantly, investments in education can and do make a difference in improving those odds. When school systems provide higher quality educational opportunities, students have higher likelihood of not only completing high school but also of attending college and entering into higher-paying fields in science, technology, and business (Dynarski, Hyman & Schanzenbach, 2011). Critically, the science on the impact of *early* intervention programs is particularly clear: high quality early care and educational experiences substantially reduce if not eliminate poverty-related gaps in achievement (Campbell et al., 2002; Schweinhart et al., 2005; Gormley et al., 2008; Weiland & Yoshikawa, 2013). The social and economic benefits of such programs are substantial. Estimates suggest that for each dollar invested in early childhood education, eight dollars are returned in the form of outcomes such as a career-ready workforce, lower crime and incarceration rates, and better physical health (Heckman, 2006).

Given these data, the question is not whether to invest in young children, but why aren't we doing more? How is it that despite compelling evidence attesting to the 'value added' by high quality early education, the poverty-related gap in school readiness and school achievement persists? Here, the answer is complex but a way forward is emerging.

There is now a sufficient body of evidence on brain development, the effects of adversity on the developing brain, and the impact of early intervention to take action. This research has demonstrated that self-regulation and **execution function (EF) skills** provide a foundation for learning and adaptation across a wide range of contexts and are predictive of long-term outcomes. Children with poor EF skills have difficulty paying attention, following rules, learning from instruction, planning ahead, delaying gratification, adopting other perspectives, and ignoring distractions. They may also be more likely to cause behavior disruptions that impact the learning environment, interfere with their own learning, and interfere with the formation of positive relationships with teachers. There is also growing evidence that EF skills can be fostered and school readiness increased through structured child-directed, play-based experiences embedded with academic content,

experiences which enhance opportunities for children to develop their own sense of agency. Programs such as Tools of the Mind (Bodrova & Leong, 2007) and Montessori educational approaches have a particularly robust impact on EF, increasing children's self-regulatory skills and stimulating brain systems involved in complex learning and motivation (Blair & Raver, under review; Diamond et al., 2007; Lillard & Else-Quest, 2006; but see Wilson & Farran, 2012).

Although Tools of the Mind and Montessori provide a framework for what works, assuring high quality implementation—a necessary component of dissemination—remains a challenge. More generally, supporting children ages 0 to 5 is developmentally, sociologically, and politically complex. A fundamental challenge is to span the many contexts of early development from the home to neighborhoods to schools to the health care system. Here, there is a structural problem because the systems that support this period of development tend to be uncoordinated and heterogeneous at local, state, and federal levels.

There is also a fundamental barrier of political will. Forty states have stepped up to the plate to complement federal investment in early learning by funding universal prekindergarten (UPK), but progress has been slow. For example, while Georgia was the first state to offer UPK to 4-year-olds, efforts to extend those services to 3-year-olds have consistently failed to pass in the state legislature. And access to federally-funded services that support healthy development and learning for children ages 0-3 is even more limited (see U.S. Department of Health and Human Services, 2012).

In this context, how do we create a system that gives each child a chance for success? Civic science provides a path forward by bringing together citizen scientists and lay citizens to transform the landscape of early learning. Below, we describe a new approach to early learning that adopts a civic science perspective, building on our previous successes with initiatives such as 'Get Ready Iowa' (see Spencer, in press).

Innovation 1: Create an integrative EF framework for early learning

Research suggests that EF skills measured in childhood are an important determinant of school readiness, academic achievement, and other important developmental outcomes. Fortunately, research also shows that these skills are malleable. EF skills can be enhanced by practice (e.g., reflection training; Espinet et al., 2013), play-based curricula, and simple mindfulness exercises designed to help children calm down and sustain their attention. Thus, a first critical step is to embrace EF as the central target for efforts to enhance early learning and increase academic achievement.

But targeting EF in the context of high quality preschools is not enough because children grow within complex communities that extend beyond the preschool setting. We must also include parents as key stakeholders, extending the EF mindset into homes. Moreover, creating a unified vision that pursues EF skills through play and mindfulness requires resources and political will. Here, we must tap community innovators and add the central concept of civic science—civic science provides the tools to create the larger system that will support enhanced early learning.

Proposal: We will create an integrative EF framework that brings together the science of EF skills, play-based approaches to enhance these skills, and a civic science perspective to create the political will and community agency to make enhanced early learning a reality.

Deliverables: We will formalize the integrative EF framework in a full-length report, and then use Op-Ed pieces and other media (e.g., YouTube video targeting parents/community members) to broadly share this framework for early learning.

Innovation 2: Create a boundary organization to target system-wide change

Many private and professional organizations exist to impact early learning, but these organizations are poorly coordinated, with too many layers between funding sources, decision-making, and evaluation. As an example, there are convoluted and distal ties between federal funding for Head Start / Early Head Start, the contracted site grantees at the city level, subcontracted delegate agency heads at the CBO level (responsible for oversight and delivery of services), parent advisory boards, parent consumers, and scientists for Head Start / Early Head Start. This frustrates families and teachers, making it hard to have an impact on the most at-risk children.

Perhaps more importantly, the current system is designed to deliver non-overlapping services, creating a landscape where private and professional organizations compete for resources rather than working together to create change. Each early learning organization targets a particular piece of the system—teacher training, quality oversight, parent supports, community access to child care, and so on. This focus makes it hard to create system-wide change because change requires system-wide coordination, and these organizations were not designed with coordination in mind.

The stratification and isolation endemic in the current system also produces a deficit in skills—few people are trained to work across boundaries. We need to break out of our professional silos; we need more robust, coherent, and two-way channels of communication with stakeholders. This extends to science as well, where we have an urgent need for scientists trained to translate discovery into action.

Proposal: We will create a new boundary organization charged with spearheading system-wide change. This organization will adopt the integrative EF framework from Innovation 1. Critically, this group will target initiatives that reach multiple stakeholders, and coordinate efforts designed to impact different parts of the early learning system. Activities of the boundary organization will be guided by the concepts of civic science and directly tap the skills of civic organizers. Thus, the goal is to create sustained system-wide change by harnessing the power of communities to change themselves.

The boundary organization will span state lines, bringing together partners in Iowa, Minnesota, and New York. The organization will be coordinated by a Board of Directors, with local coordination handled by ‘hubs’ in each state. Local hubs will bring together scientists, civic organizers, and community partners to focus on coordinated efforts to bring the EF framework to fruition using the tools of civic science.

Deliverables: Here we highlight examples of the multi-pronged approach we will pursue to enhance early learning. Although these examples target different stakeholders, synergies will emerge because all efforts are being coordinated by a single organization.

- **Policy.** We will convey the integrative EF framework to legislators and make the case for investments in early learning in economic and social justice terms.
- **Teacher training.** Research in early learning is proceeding at a fast pace, yet innovations in learning sciences and developmental cognitive neuroscience are slow to enter pre-service teacher training and impact classroom practices. We will work with teacher education programs to take neuroscience to preschool (Dubinsky, Roehrig & Varma, 2013), bringing cutting-edge science directly to the teachers who need it. These efforts will be coordinated with leading Colleges of Education to co-design content for teacher training in light of the latest science. A key emphasis will be on giving teachers the scientific background and tools they need not only to remain informed about scientific advances but also to innovate in the classroom, tapping their own agency and creativity.
- **Preschool curricula.** Researchers have revealed what works in early learning and have developed tools to create and assess high quality preschools. Thus, we will support on-going efforts nationwide to encourage adoption of these proven curricula and help communities identify resources to implement these curricula. In addition, we will create a list of prioritized quality indicators and methods for effective assessment of preschool quality.
- **Tools for parents.** We will create a one-stop shopping website with information on EF skills and how to build them at home through play-based activities. This initiative will build on the Delta Center’s successful ‘Playing is Learning’ initiative (www.playingislearning.org) and the ‘Game of Games,’ a card game designed to build key skills through fun mini-games. Critically, we will use on-line tools to make this communication with parents two-way, tapping the creativity of parents to, for instance, enhance the effectiveness of play-based tools. In addition, we will create a rating system for quality preschools in local communities to enhance parent decision-making about which preschool their child attends.
- **Tools for communities.** Too often, we think about early learning as the job of the parent or teacher. This fails to tap community innovators—children’s museums, discovery centers, neighborhood centers, parks, and libraries. Moreover, this view fails to recognize that large scale change requires communities to recognize their own civic agency. Thus, we will bring an EF focus to the activities and curricula of museums and libraries building on the success of the ‘Playing is Learning’ initiative. We will also create a

scorecard for communities rating whether the community fosters the well-being of young children. Finally, we will integrate efforts by the policy and community teams, giving communities the skills needed to change policy at local and state levels.

Innovation 3: Learning Labs for fast prototyping, evaluation, and scaling of ideas

Too often, innovation is stymied because some of the main players in the system don't have the flexibility to innovate, there is nothing inherent in the system that rewards or inspires change, there are no mechanisms in place to evaluate innovation, and there is no system in place for such innovations to spread. Federal agencies have begun to acknowledge this reality and are moving to respond.

Proposal: We will establish Learning Labs throughout our EF network. This will allow us to test out new ideas rapidly, evaluate them, and then use the boundary organization to bring innovations to scale. These Learning Labs will be housed directly within participating preschools. They will be special rooms designed to train teachers, try out new curricula, new classroom layouts, and new e-learning tools. By housing these labs directly in preschools, Lab Teams will have ready access to children, and children will be comfortable participating within their 'home' environments.

Critically, Lab Team innovations might come from scientists, but they might also come from teachers within our network implementing proven curricula or from parents building EF skills at home. The idea is to create a space where stakeholders are empowered to innovate—what Evans and Boyte have called “free spaces” rich in civic integration. Successful ideas can be quickly evaluated and ported to another Learning Lab to examine generalizability. Successful innovations can then be spread nationwide via the boundary organization. In short, we will couple local autonomy and innovation with assessment and network-wide implementation.

Deliverables: We will establish a Learning Lab at each hub site in the network. Initial projects within the labs will try to isolate which components of Tools of Mind make this curriculum effective, and how to maximize the efficacy of other proven approaches to EF enhancement. We will also begin a project examining how to optimize the preschool environment. Recent research suggests that many preschool contexts are over-stimulating and promote distraction. We will examine the optimal balance between interest and distractibility, placing this issue in the context of a play-based curriculum.

Citizen Health Care

William Doherty and Tai Mendenhall, with Harry Boyte

Health care in the United States is in a bad way by almost any account: our spending is unsustainable and our health indicators are poor when compared to other developed nations (National Research Council and Institute of Medicine, 2013). Debates about the future of health care, including the role of the Affordable Care Act, are fierce and rampant. Moreover, the focus is almost exclusively on provider and payment systems, and the role of citizens is relegated to signing up for mandated health care insurance. The traditional medical model is a hierarchical one, with physicians and policy experts knowing what's best for patients. More progressive models are collaborative, with providers seeking to partner with patients to help them stay healthy and manage illness well (Mendenhall, Berge, & Doherty, 2014; Substance Abuse and Mental Health Services Administration [SAMHSA], 2013). What is missing, and sorely needed, is a civic science approach to health care transformation, in which concepts and practices of civic agency and the idea of harnessing the joint power of professionals and ordinary people to tackle the wicked problems of population health take center stage.

We use the term “citizen professional” to describe the kind of professional who sees health care as the democratic work of We-the-People, with professionals having important but bounded roles. Without discounting the role of medical and social science in health care, citizen professionals see the traditional professional expert and provider/consumer models as inadequate for the complex problems we face in health care today, many of which involve lifestyles and all of which are influenced by social and environmental factors outside of the purview of the health care system.

Through a series of projects documented in refereed journal articles and book chapters, we (Doherty and Mendenhall) and our colleagues have developed Citizen Health Care as a way for citizen professionals to engage in the work of health care transformation (Berge, Mendenhall, & Doherty, 2009; Doherty, Mendenhall, & Berge, 2010; Mendenhall, Berge, & Doherty, 2014; Mendenhall, Harper, Henn, Rudser, & Schoeller, 2014; Mendenhall, Seal, GreenCrow, LitterWalker, & BrownOwl, 2012). Here is a brief description of the model.

The starting point for a project is a *pressure point* for families and communities. Pressure points are serious health or social challenges that are important to a community but cannot be solved by traditional programs or professional service approaches. Pressure points are usually “wicked problems” with many causes and no clear, simple solutions, where simplistic good versus evil frameworks which characterize many discussions of public problems do not work well—and can often make matters worse.

The central premise of citizen professional work is that the greatest untapped resource for improving health and social well-being is the knowledge, wisdom, and energy of individuals, families, and communities who face challenging issues in their everyday lives. The ten core principles are as follows:

1. See all personal problems as public ones too: the I and the We.
2. Look to family and community resources first.
3. See families and communities as producers, not just clients or consumers.
4. See professionals as partners, not just providers.
5. Let community members drive programs rather than programs service communities.
6. Make sure every initiative reflects the local culture.
7. Grow leaders, then more leaders.
8. Make all decisions democratically.
9. Go deep before taking action.
10. Think big and act practically.

We have five key implementation strategies:

1. Identify a pressure point for professionals and for an identifiable local community.
2. Get buy-in from key institutional and community leaders.
3. Form a short-term consultation group, meeting 3-4 times with a few people who are connected to the community and have experience with the issue. If they buy into the pressure point and this democratic model of working on it, invite them to help recruit a citizen action group.
4. Form a Citizen Action Group of 8-12 people who plan the project.
5. The planning phase generally takes at least 15 meetings before taking action, and involves an organized, democratic process of going deep into the challenge, exploring community resources to address it, and developing an action initiative that is consistent with the model and is feasible within existing or readily accessible resources.

The resulting projects often involve sustained community action over years. These are usually connected to a community institution that embraces the philosophy. Some other projects are designed as short term “cultural organizing” initiatives aimed to naming a problem, activating new voices, and starting a cultural conversation locally or nationally. The citizen professional’s role is to facilitate the meetings, coach on the democratic model, and participate in the planning. This generally requires 6-8 hours per month of the citizen professional’s time.

Next we describe two of our Citizen Health Care Projects.

The FEDS: An American Indian Diabetes Project

American Indian (AI) community leaders and tribal elders in the Minneapolis/St. Paul area were worried about the ever-increasing prevalence of diabetes and its impact on their people. Its pervasiveness was made even more alarming by the sense of defeat that among many American Indian people: that diabetes is expected, it will disable you, and it’s not preventable. Providers working with American Indian community were frustrated with the failure of conventional care and educational programs.

Tai Mendenhall and leaders in the St. Paul Area Council of Churches' Department of Indian Work (DIW) approached this challenge with a community-based participatory research approach, using the Citizen Health Care model as a guide. Considerable effort was spent in designing a partnership with providers that was very different than conventional top-down models of care. American Indian community members succeeded in sensitizing clinical researchers regarding the process, pace, and importance of building trust within American Indian circles. As the team engaged in a series of meetings, discussions, and American Indian community events, this trust evolved. Researchers learned about AI culture, the diversity of tribes within this larger frame, spiritual and belief systems regarding health and "living in balance," and interpersonal propriety and manners. In turn, community members gained more understanding regarding how Western medicine is oriented, and thereby gained insights into providers' habit and perspectives in care delivery (Mendenhall et al., 2010).

The Family Education Diabetes Series (FEDS) was designed and implemented as a supplement to standard care for members of the AI community touched by diabetes. Patients, their families (spouses, parents, children), and providers (physicians, nurses, dieticians, mental health personnel) come together every other week for an evening of fellowship, education, and support. Generally 6-7 providers, 4-5 tribal elders, and 40-50 community members attend. Meetings begin with members checking and recording each other's blood sugars, weight, body mass index (BMI), blood pressure, and conducting foot checks. Participants cook meals together that are consistent with AI cultures and traditions, and a great deal of discussion is put forth regarding the meal's ingredients, portion sizes, and relevance to diabetes. Educational programs follow (which are designed according to participants' interests and wants), and take place in talking circles and a variety of lively activities (e.g., traditional and modern music, chair dancing and aerobics, drumming and singing, impromptu theater/role-plays). Instructional topics are similarly diverse, e.g., basic diabetes education, obesity, foot care, stress management, exercise, family relationships, retinopathy, dental care, and resources to facilitate access to medical services and supplies. FEDS evenings conclude with devoted time for informal sharing and support. These bi-weekly series are scheduled to last for three hours, but most participants arrive early and stay late.

Quantitative evaluations of the FEDS have found significant improvement across key objective diabetes-related measures (e.g., weight, metabolic control). Qualitative evaluations (conducted within the culturally-consistent contexts of talking circles) have found that the community-owned nature of the program—and the social support and interpersonal accountability that this encompasses—is perceived as the principal driver of said improvements and change (Mendenhall et al., 2010, 2012).

Clinical and lay participants in FEDS worked collaboratively throughout every stage of the initiative's development—from early efforts in relationship-building and establishing mutual respect and trust, to brainstorming the program's design, educational foci and format, public visibility, implementation, and ongoing modifications. The DIW and its clinical collaborators are now considering extending their efforts to create new programs in other areas of the community that are not readily reached by state- or reservation- sponsored care systems (e.g., inner-city, low-income American Indians). They also working to partner with local elementary and secondary magnet schools to create and implement culturally-engaging and developmentally-appropriate co-education and community/interpersonal support for youth, alongside new programs designed in partnership with and for adult American Indian men and fathers (who have historically not been well reached by conventional health care initiatives). FEDS has many elements of what Evans and Boyte call "free spaces"—egalitarian, sustained relational sites, grounded in community life, with many opportunities for civic skill building, self-organizing, learning respect for different ways of knowing and creating sustained relationships across differences (Evans and Boyte, 1992; Boyte, 2004).

Baby Boomers for Balanced Health Care (www.boomers4balancedcare.org)

Baby Boomers for Balanced Health Care is a small group of self-described citizen Baby Boomers who believe that health care spending is out of control and will bankrupt our country unless we all take responsibility for changing how we do health care. They aim to create a public conversation about a neglected dimension of the problem: the cultural belief that more health care is better health care. This belief contributes to **overdosing on health care**: too many unnecessary tests, procedures, and devices that can cause harm while financially depleting individuals' and communities' resources. Baby Boomers for Balanced Health Care is calling for a new mindset that values balanced health care—a kind of "**Goldilocks**" health care—not too much, not too

little, but just right.

The project was initiated by Bill Doherty, director of the Citizen Professional Center, and citizen physician Jim Hart. They approached citizen organizations in the Twin Cities to recruit engaged Baby Boomers to come together to reflect deeply on the more-is-better cultural dimension of the health care crisis in the U.S., since no other group seemed to be paying attention. They realized that it is difficult for government and other institutional leaders to address the problematic more-is-better norm without the fear of black lash (think death panels, rationing, and benefits cuts), a premise confirmed by subsequent interviews with provider groups, health plans, and business leaders,. Without new cultural norms, health care reforms generates backlash. Citizens groups must lead the way because no one else can.

After more than a year of biweekly planning meetings, the group's initial action steps are one-to-one stakeholder conversations, public forums, and partnering with other groups (including *Consumer Reports*, which has offered to support and publicize this grass roots work of cultural organizing). The project has begun to attract interest from local and national media who are being asked to wait until a grass roots conversation protocol, currently being piloted, is ready for distribution by the group and by *Consumer Reports*.

Since the project aims at stimulating cultural conversation, one of the evaluation tools will use Google searches and other methods of determining the cultural penetration of the name of the group and its key new terms: overdosing on health care and Goldilocks Health Care.

Why a Baby Boomers group? Here is the answer developed by the group: “We are a generation who came of age in abundance, witnessed medical miracles like the polio vaccine and heart transplants and came to believe that more is always better in many areas of life, including health care. We were wrong. Now that we are elders, we want to lead a cultural conversation about restoring balance in health care: smarter health care, not more health care.”

With 10,000 baby boomers turning age 65 each day and becoming Medicare-eligible, this is the generation that has to take the lead in create a culture that supports a culture of balance in health care decision making.

Challenges and Next Steps

Citizen Health Care projects face challenges common to civic science efforts, including lack of supportive structures, challenges with scaling and economic feasibility, and the entrenched hierarchical culture of medicine. We are working now on two issues we would appreciate the input of the group on: scalability and institutional buy-in. Scalability is a concern because of the time and skill set required for the citizen professional to engage with a citizen action group to develop a full-fledged project. A solution we are looking into is to offer interested professionals and community groups partly-scaled projects such as the basic structure of the FEDS, and then encourage creative adaptations to local needs and resources. We want to speed up the developmental planning of projects without compromising the democratic and community-sensitive nature of the work. For institutional buy-in, we have examples in the FATHER Project (run by Goodwill/Easter Seals) which has taken the idea of citizen leadership into the heart of their program, and Como Clinic (of the HealthPartners Plan) which has devoted staff support to a citizen patient leadership project.

We have found that Citizen Health Care projects inspire both ordinary citizens and progressive leaders in health care who understand that the current model is not working. Needed now are structures to move the democratization of health care in the U.S. from the aspirational stage, based on case studies, to something transformational.

Civic Science Hubs: A Way Forward

The civic science case studies described here illustrate how civic science can be put into action and the promise of this approach. But they also reveal common challenges facing scientists and citizens across diverse sectors of society. This raises a fundamental question: How do we push through these barriers?

One way forward is to organize a **network of civic science hubs**. Each hub would have a central organization for civic science that would bring together scientists and citizens working on *each* grand challenge

area. This would foster cross-talk among civic science teams, helping groups identify what works within a particular domain and generalizing these tools across domains. For instance, we anticipate that civic organizing skills could be effectively shared across teams—how to partner with community groups and create civic agency. Connecting civic science teams would help team members embrace new identities as citizens and agents of change—rather than as professionals working in silos—and to see new meaning in their work.

These hubs would then be connected across sites. This would create a network of connected teams working on the same challenges across sites, helping us to share innovations and bring ideas to scale. Several of the case studies are already pursuing the concept (e.g., LandLabs for sustainable agriculture).

We envision creating civic science hubs in four regions initially: Iowa, Minnesota, New York, and the DC-area. We have selected these regions to build on existing infrastructure and people-power at each site.

- Iowa—Spencer and his colleagues at the Delta Center at the University of Iowa have already launched multiple partnerships on early learning, forming relationships with community partners such as the Iowa Children’s Museum. The Delta Center also has strong ties with scientists working in healthcare at the University of Iowa Hospitals and Clinics who have expressed interest in a civic science approach to family and community health. Finally, multiple connection points exist with colleagues at Iowa State University in the areas of early learning and sustainable agriculture.
- Minnesota—The University of Minnesota and nearby Augsburg College are pioneers in civic science. Faculty at both institutions are playing an active role in our case studies, including Nicholas Jordan (sustainable agriculture), Stephanie Carlson and Phil Zelazo (early learning), and Bill Doherty, Tai Mendenhall, and Harry Boyte (health).
- New York—Faculty across multiple universities in New York are already playing key roles in our civic science case studies: Clancy Blair and Cybele Raver from New York University (early learning), Scott Peters from Cornell University (sustainable agriculture), and Sherburne Abbott from Syracuse University. We have started conversations with other colleagues at Cornell working on health and human development.
- DC area—we envision a civic science hub in the Washington DC area that would have a strong policy arm.

Organizing a network of civic science hubs—or an alternative way forward—will require substantial resources, including buy-in at the federal, state, University, and community levels. There would be a need for infrastructure at each hub site, including “free spaces” for teams to congregate, personnel, and support staff. Resources would be needed to facilitate coordination across the civic science network. And resources would be needed to support the work of each civic science team. Examples of such work are woven into the case studies.

Critically, investment of such resources is warranted. In our view, society is at a tipping point. Grand challenges continue to mount; we suffer from polarized and partisan politics; citizens are feeling powerless and our democracy is suffering the consequences. Business-as-usual is not working. Civic science provides a clear path forward. It is time to act and to awaken the potential of our democracy.

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