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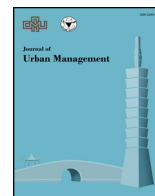
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Ellen Swallow Richards and the "Science of Right Living": 19th century foundations for practice research supporting individual, social and ecological resilience and environmental justice

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1. Introduction

Ellen Swallow Richards (1842–1911) was a pioneering sanitary engineer, social reformer, and educator whose transdisciplinary action research addressed the coupled social and ecological crises of the rapidly growing industrial cities of her time. She recognized humans as part of ecological systems, even though dominant narratives focused on subjugating nature. She believed that if women were empowered through education in science and technology, they could develop a more socially and ecologically responsible approach to economic growth. She established the field of *oekologie*, or the “science of right living,” to support communities in managing co-evolutionary social and ecological processes in dynamically changing, complex, home environments, from the scale of the household, neighborhood, city, and beyond (Clarke, 1973; Hunt, 1958; Swallow, 2014; Walsh, 2015).

Richards is ostensibly the first accomplished female environmental planner, urban ecologist, and environmental justice scholar-practitioner. Her prescient approach to integrated, transdisciplinary, multi-scalar action research is valuable today in supporting social and ecological resilience and environmental justice in the age of the Anthropocene (Crutzen, 2002). Yet, her important contributions are typically overlooked. Beyond the general tendency of planning history to omit the contributions of women, other “invisible” individuals and communities, and those who challenge the status quo (Sandercock, 1998), Richards has been often overlooked by individual fields because of the transdisciplinary nature of her work. At the time she developed her action-oriented, integrated, emancipatory approach to solving the complex problems of urban environments, academia was moving toward an emphasis on specialization and epistemic knowledge separated from context (Corburn, 2009). Her approach was marginalized by her contemporaries (Richardson, 2002). Moreover, since she did not fit into any one discipline, few disciplines claimed her myriad contributions as their own (Richardson, 2002).

1.1. A bewildering maze of enterprises

Richards’ expansive contributions spanned across disciplines and beyond academia. As noted by a 1910 article from *Follette* magazine a year before her death, “When one attempts to tell of the enterprises, apart from her formal teaching, of which Mrs. Richards has been a part or the whole, he is lost in a bewildering maze just as he is if he tries to follow the activities of her mind for a day and to count the various subjects to which her thoughts go with interest and understanding” (Follette, 1910, p. 11). Drawing on three of her biographies (Clarke, 1973; Hunt, 1958; Swallow, 2014), this dizzying array of lifetime accomplishments include:

- Becoming the first woman in the U.S. to receive a Bachelors of Science degree, from the Massachusetts Institute of Technology (MIT) in 1873;
- Conducting path-breaking research that led to the establishment of the first water quality laws and pure food laws in

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Massachusetts;

- Advancing workplace safety and indoor air quality through research, design, and policy;
- Expanding access to nutritional, affordable meals for working families through her establishment of the New England Kitchen for Working Families and the first healthy school lunch program for the Boston Public Schools;
- Exhibiting in the World's Fair 1893 in Chicago with the "Rumsford Kitchen";
- Advancing sanitary reforms through the municipal housekeeping movement and settlement house movement;
- Expanding access to science education for women (and by extension their students in public schools), through establishment of 1) an international distance learning network, 2) the Woods Hole Institute (and guaranteeing access for women scientists to its laboratory), and 3) the Women's Laboratory for the Study of Food, Air, and Water at MIT; and
- Becoming the first official female professor at MIT (hired in 1884 with a salary of \$600/year as part of MIT's chemistry faculty, after years of leading her self-funded Women's Laboratory).

It is fairly astounding to consider what Richards was able to accomplish, all before women were given the right to vote or earn doctoral degrees. However, past biographies have overlooked what may be her greatest contribution - the methods she employed to support her impressive efficacy. Her approach to her life's work – especially her approach to cultivating knowledge and power – enabled her to profoundly contribute to the world she inhabited. Her life is a case study that offers valuable lessons as we address the social and ecological challenges of the 21st century.

1.2. Not frenetic but *phronetic*

As the brief summary above suggested, Richards' interests seem scattered and far-ranging, certainly defying disciplinary limits. At first glance, her path could be considered frenetic, but under closer examination, it was clearly *phronetic*. Her approach to learning and research cultivated *phronesis*, Aristotle's term for practical wisdom, or "the (human) ability to recognize and actualize whatever is best in the most complex, various, and ambiguous situations" (Xiang, 2016, pp. 54, quoting A.O. Rorty (1988, p272)). More specifically, her approach cultivated ecological wisdom, or *eco-phronesis*, defined as "the master skill par excellence of moral improvisation to make, and act well upon, right choices in any given circumstance of ecological practice; motivated by human beings' enlightened self-interest, it is developed through reflective ecological practice" (Xiang, 2016, p. 55). This is situated knowledge, developed through experience and intimate awareness of one's home environment, in its full complexity. There are two primary ways to cultivate such knowledge and grow from novice to expert: 1) to learn from instances of exemplary practice (either through apprenticeship or through case studies) to understand how masterful experts engaged in practice, and 2) through one's own lived experience and reflective practice (Dreyfus, Dreyfus, & Athanasiou, 1986; Flyvbjerg, 2001). As such, since Richards is a master, it is important to examine her lived experience to understand how she developed the skills and practices that allowed her (and those around her) to be so successful.

This paper revisits the history of *oekologie* and the ideas and practices developed by Ellen Swallow Richards in order to offer insight into the challenges we face today in designing healthy communities. The paper is based on the author's review of existing historical accounts of Richards' life and work and selections of Richards' writing.

By examining Richards' approach as it evolved through the context of her life and its challenges, we learn about her methods for personal, social, and ecological resilience praxis. Through her successes in an era of rapid change, we gain insight about methods for advancing resilience and ecological wisdom in the 21st century. Through a study of Richards' experience, we can also anticipate potential pitfalls in future efforts to take an integrated, collaborative approach to improving the social and ecological health of our home environments from the scale of the house to the planet. Transferring and applying her experiences to our time, we can adjust our own theories, practices and possibilities for action inquiry and design to advance healthy and just development of our multi-scalar home environments.

2. Living, loving, and learning: Foundations of ecological wisdom

To understand Richards' ecological wisdom and methodology for the "science of right living," it is important to understand how she developed with the co-evolving, social, ecological, and technological systems in which she lived, loved, and learned. Through her experience, we can understand how she framed the challenges of the world around her and developed practices to enhance personal, social, and ecological resilience.

2.1. The development of Ellen Swallow Richards

Ellen Swallow Richards learned early in life about the connection between healthy ecosystems and healthy people. Born of frail health in a farmhouse in Dunstable, MA in 1842, she was particularly vulnerable to contagious illness. At a time when one-third of children died before the age of five, her parents chose to keep her close to home. She flourished there. The hills, streams, fields and animals surrounding her home became her living classroom – a place of regeneration where her body, mind, and spirit grew in strength. She developed a lifelong practice of keeping detailed diaries with observations on her surroundings and her interactions with them. Her grandfather (a naturalist), and her parents (both teachers) encouraged her curiosity about the natural world and a deep love for reading that quickly allowed her to teach herself. As the only daughter to help around the house and on the farm, she developed a strong capacity for efficient and skillful management of her indoor and outdoor environment. She also developed a thirst

for scientific inquiry that could not be satisfied on the farm (Swallow, 2014).

As she was completing high school in 1862, she observed a turbulent world with complex, interrelated personal, social, and ecological challenges. At that time, women suffered from structural barriers to meaningful work and vocational development. Deprived of the right to own property and the right to vote, they could only pursue higher education through the support of a father or husband. Although her parents were supportive of her education, they did not have the financial means to support it, and only one college in the country (Vassar College) offered courses in science to women. These barriers were especially difficult in this time of industrial development, when meaningful work increasingly depended on scientific literacy as families moved from farms into cities.

Richards also observed interrelated social and ecological problems. As the Civil War raged, communities were divided and local economies struggled. She came to observe how the larger patterns of industrialization and urbanization were alienating the “haves” from the “have nots,” and people from nature. She enrolled at Vassar in 1868, where she sought to use her education to address these problems. On her first train trip to Vassar, she observed these changes from her window and at stops in urban centers. In Albany, she walked along filthy streets polluted with garbage and sewage and witnessed the cramped conditions where the urban poor resided. She arrived in Poughkeepsie, NY seeped in questions about the world to which she belonged (Clarke, 1973; Swallow, 2014). How could humans learn and act together to better support their own wellbeing, that of diverse neighbors, and the natural world of which they were part?

Richards thrived during her time at Vassar, immersed in scientific study in a supportive environment of motivated women. She also developed a strong belief that the interrelated vocational, social, and ecological problems she observed could be addressed by empowering women with an education in applied science. She devoted her life to this pursuit. After gaining admission to MIT in 1871, she proved to be one of the institution’s most accomplished students and became the first woman in the United States to earn a degree in science on May 31, 1873. Richards married an MIT professor, Dr. Robert Richards, and later joined him in the MIT faculty. She used her positions of influence to expand opportunities for other women’s pursuit of science, so that they could solve the problems of home environments and educate future generations of Americans.

2.2. The development of a scientific approach to “Right Living” in living systems

Richards soon discovered that expanding access was not the only challenge. American universities of her time emphasized development of specialized fields of objective, epistemic science. Richards took a different approach. She believed that valid knowledge was that which could be applied to improve peoples’ lives. She dedicated herself to developing an adaptive, democratic approach to science with a normative aim to improve the health and quality of life of communities (Richardson, 2002).

For Richards, the critical area for inquiry and action began with the home:

[S]cience has to apply its knowledge to [improve] that unit of the community, the home; for upon the welfare of the home depends the welfare of the commonwealth. Upon this common factor should be lavished whatever knowledge and science this century has. (Clarke, 1973, p. 142).

Recognizing the power of women as scientists and the “home” as an important unit of analysis, it became the anchor point of her new science of *oekologie*. In 1892, addressing a crowd of leading Boston industrialists and their wives, she proclaimed:

“For this knowledge of right living, we have sought a new name. ... As theology is the science of religious life, and biology the science of [physical] life ... so let oekologie be henceforth the science of [our] normal lives ... the worthiest of all the applied sciences, which teaches the principles on which to found a healthy ... and happy life.” (Richardson, 2002, p. 27).

Richards’ *oekologie* was a normative, action-oriented, design science – indeed, the science of “right living.” Her ideas about right living included a foundational belief that all human beings should be able to live in a healthful environment in which they could reach their full potential (Clarke, 1973). The name *oekologie* was first coined by Ernst Haeckel in 1873 to describe a science that would study organisms in their home environment. Drawing on the Greek word for home, “oikos” and for study, “logos,” he imagined the field of *oekologie* (later known as ecology). With Haeckel’s encouragement, Richards developed *oekologie*. Her approach emphasized developing understanding of individuals and their interactions in home environments for the purpose of effective *management of the home environment* (literally “economy,” Aristotle’s term for management of the home and its resources). Accordingly, *oekologie* became known both as “home ecology” and “home economics.” (Clarke, 1973; Swallow, 2014).

3. Oekologie in action: A phronetic approach behind frenetic feats

Richards phronetic approach to *oekologie* emphasized an integral approach to the cultivation of wisdom and power to advance personal, social, and ecological resilience in multi-scalar home environments.

A sagacious observer of living systems throughout her life, Richards observed degenerative patterns occurring across multiple scales in nested systems – at the level of the individual, family, society, and the larger living world and its resources (See Fig. 1: Nested living systems). She saw that these patterns threatening social and ecological wellbeing were the result of human action (and inaction). Moreover, she believed this implied an ethical responsibility for conscious human beings to act in ways that would support healthy relationships conducive to flourishing social and ecological communities. In a convocation address she delivered to MIT graduates in 1910, she emphasized that “The quality of life depends upon the ability of society to teach its members how to live in harmony with their environment — defined first as family, then the community, then the world and its resources” (Swallow, 2014, p. 95).

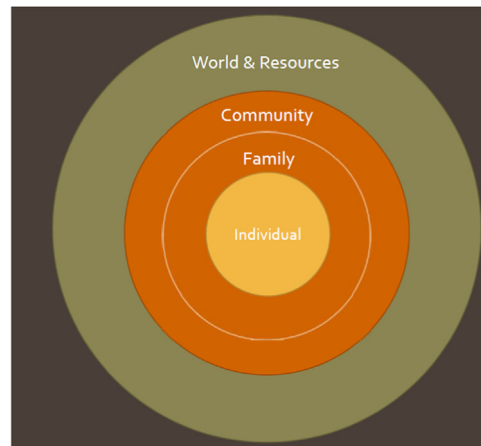


Fig. 1. Nested living systems.

She fully believed that each member of society could learn to be a positive contributor to the nested living systems to which they belonged. This would require the healing of three kinds of essential relationships she experienced being degraded around her:

1. **The relationship between the Self and the self**, related to the breach between one's **voice and vocation**, reflected in suffering for all who, like her, had experienced structural obstacles to self-expression and meaningful work;
2. **The relationship between the self and the "Other,"** related to the promulgation of myths of genetic superiority reinforced by the field of eugenics and reflected in growing social inequality and alienation; and
3. **The relationship between self and "Nature,"** related to myths that "man" was "above" nature, and not part of the living world and its resources, reflected in the rampant contamination of air, water, and food (experienced most acutely by the poor and disenfranchised living in deplorable conditions who viscerally experienced the connection between self and environment).²

The breaks in these relationships resulted, respectively, in vocational, social, and ecological alienation (See Fig. 2). The net effect is a disempowering experience where an individual feels alone and without internal or external assets or power. Richards believed that through a science education, she and others could restore these relationships, identify collective resources, and leverage them to create conditions where all could enjoy a healthy life.

Such a science education would empower individuals to transcend their biases and blind spots, engaging with greater awareness in their environments, at the personal, interpersonal, and ecosystem levels. Engaging with the curiosity of an open mind to understand systems dispassionately as if from the outside looking in (3rd person awareness), the compassion of an open heart to understand social systems from the view of others within them (2nd person awareness) and the courage of an open will to understand systems from their own agency within them (1st person awareness), they could garner the knowledge required to manage their home environments (see Fig. 3: Integrated awareness of living systems).³

Fig. 4 summarizes this phronetic approach, bringing the previous figures together. In this compilation, collective wisdom and collective energy are reflected by three "S"s – the **synthesis** of diverse knowledge (including a diversity of "street smarts" and "book smarts"); the **sympathy** that reflects emotional intelligence and experience of attunement required for solidarity; and the **synergy** of collective power.⁴ Synergy reflects a basis of power where "the whole" is greater than the sum of its parts. Often, power is seen as something one person gets by taking it away from another. Richards' life work reflects another basis of power – her power to care for herself, her neighbors, and the living world around her in turn built the power of others to do the same. As such, her applied science was to be practiced by households in their individual homes, in learning networks and neighborhoods, and broader ecosystems. Even when acting in one's own home, one could do so with a larger ecological and global awareness.

The following sections provide an overview of 1) Richards' approach to integrated levels of awareness, and 2) applications of her work operating at multiple scales. She used her own home as a living laboratory, financed her own scientific laboratory at MIT, and supported a network of living laboratories in the homes of women across North America and as far as Europe. She also conducted ecological field studies and provided ecological design services as a consultant.

² Richards did not refer explicitly to such divides, but the underlying concerns were evident in her work, as summarized in the previous paragraphs, and described in the details of her biographies (Clarke, 1973).

³ Again, Richards did not explicitly use the language of "open mind, heart, and will" to describe her work, yet this language helps interpret her approach. The language is used explicitly by Scharmer (2009) in *Theory U*.

⁴ Although the words "synthesis, sympathy, and synergy" accurately describe her approach, Richards did not use them to describe her work. However, the urban planner Patrick Geddes (1854–1932) used these words for his signature approach to planning.

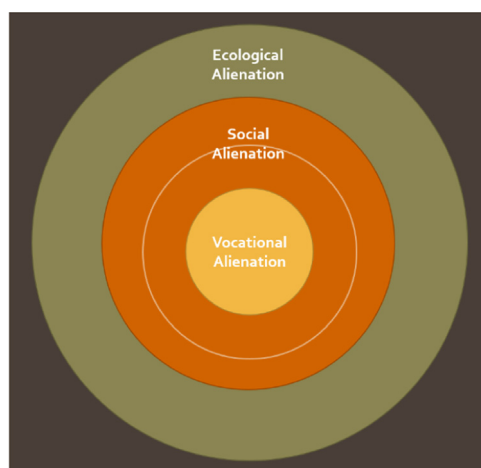


Fig. 2. Alienation and division in living systems.



Fig. 3. Integrated awareness of living systems.

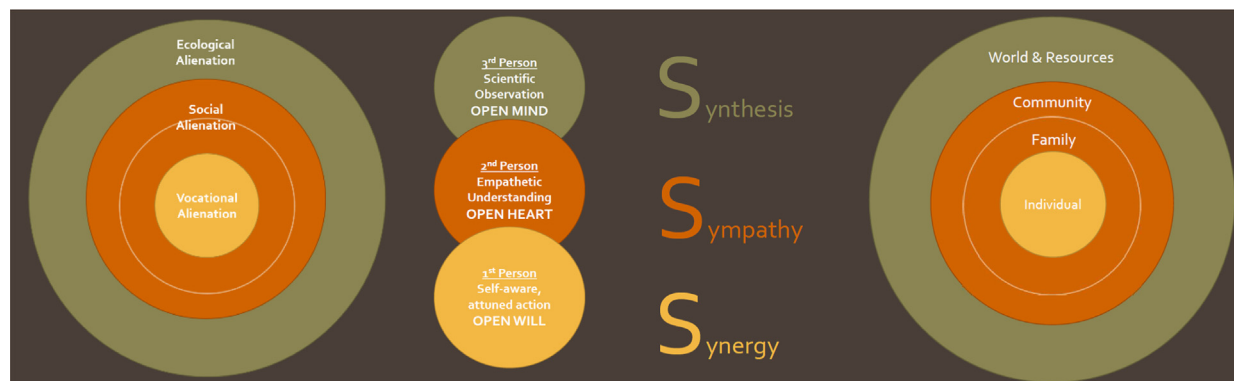


Fig. 4. A phronetic approach for ecological wisdom and collaborative action research in living systems.

3.1. Integrated awareness for ecological wisdom

Although Richards was an accomplished scientist, she understood that knowledge of abstract scientific facts alone does not constitute wisdom or the capability to creatively “translate reasoning into results.” (Swallow, 2014, p. 129). If individuals were to succeed in employing themselves as instruments for regeneration in their home environments, they would need to integrate first-, second-, and third-person awareness to cultivate knowledge and power from within, with one another in community, and through relationships in their larger ecosystems. Such an approach could tap the latent potential for regeneration in living systems.

3.1.1. First-person awareness: Cultivating insight and energy from within

Richards’ life is a testament to her belief that change starts at home, starting with oneself. The idea or assumption of human

potential was central to Richards' approach. She was an equality feminist in that she believed men, women, and all humans were created equal, even while each human being is unique with their own diverse gifts (Richardson, 2002).

Richards overcame many obstacles in developing her own potential. Depression was one of them, especially during the period between 1866 and 1888. Confronted by structural barriers to vocational opportunities and outlets for her productive energies, she became indifferent and exhausted. Life was different once at Vassar, surrounded by a supportive, collaborative environment that fed her curiosity and allowed her to develop expertise. In letters to her parents, her father expressed concern that she was working too hard. Her response: "Work is a sovereign remedy for all ills and a man who loves to work will never be unhappy" (Swallow, 2014, p. 31). She found that exerting effort in meaningful work in good company was actually an investment that led to further energy, rather than a state of depletion.

She gave a great deal of thought to how to manage her own reserves of energy, beyond just her management of time. She explained, "[r]emember human energy is the most precious thing we have... We ought to have within us a sense of spare energy, a force of abounding vitality. We ought to wake up in the morning and be glad there is a new day coming." (Swallow, 2014, p. 61). Over time, and in partnership with her husband, she developed a recipe for making a "FEAST" of life: "Food, Exercise, Amusement, Sleep, and Task" (Swallow, 2014, p. 61). They found that leading an active, balanced life gave them energy to achieve their goals.

To further cultivate a clear mind and energy in her own life, she began each day by five-thirty with a morning meditation. In the quiet of the morning, she set her intentions (which she called "visions") for the day. She would then share a cup of coffee with her husband and embark on a two mile walk around Jamaica Pond before they resumed work. Even while traveling, she incorporated the practice of an intentional outside constitutional. As the Chair of the Lake Placid Conferences, she would organize members for early morning climbs up an Adirondack mountain trail and discuss intentions for the day (Clarke, 1973, p. 175). She also studied the effects of food with various ingredients and nutrients on her energy and those she fed at her home (and even studied the amount of fuel required to prepare the food). Amusement for Richards typically included time outdoors, often with friends (Clarke, 1973; Hunt, 1958; Swallow, 2014).

3.1.2. *Second-Person Empathetic Understanding: Cultivating insight and power in relational networks*

Although Richards' direct contributions and accomplishments were impressive, the greater source of her power to make a difference came from her creation of and participation in social learning networks; her own power grew as she invested it in others.

Richards understood that she was not alone in experiencing depression as a result of structural barriers of the time. She and other women who had the privilege of higher education knew that most women in the country did not. Organizing themselves as the Association of Collegiate Alumnae, in 1873 they created the Society to Encourage Study at Home so that they could "give away what men had long refused to allow women to buy: a liberal education" (Swallow, 2014, p. 73). Also known as the "Silent University," it is considered to be the first university extension school in America, including a lending library of more than 2000 volumes and a catalog of correspondence courses led by women for women. (Clarke, 1973; Swallow, 2014).

Grounded in her belief in the right of women to study science and the power of study in community, Richards not only designed courses in a variety of laboratory sciences, she also developed a distributed, supportive learning network. She equipped her co-inquirers with their own laboratories, sending microscopes, test tubes, and specimens to women across the United States and Canada, and even as far as Europe. Often there were as many as a dozen women enrolled under one name as a study club. Through two-way, ongoing letter correspondence, Richards not only provided them with guided research plans, she also encouraged them to investigate all that interested them and coached them when they encountered barriers to their scientific pursuits (Clarke, 1973; Swallow, 2014).

This two-way correspondence helped Richards develop an empathetic understanding of the conditions experienced by women. As women shared their challenges, she learned about the high frequency of women's illness, poor health, and depression. In response, she wrote a book for them on *Health*, with her own recommendations for overcoming depression, including strategies for fostering mental stimulation and other prescriptions that had cured her including "Fresh Air, Pure Water, and Good Food with Sunshine." Through informal correspondence, she developed a qualitative understanding of the social and ecological conditions of women's environments, while at the same time building the capability and confidence of this network of women to improve their conditions (Swallow, 2014).

Moreover, her distributed learning network advanced her scientific studies. As members of her distributed learning network sent back results for the structured laboratory experiments, Richards was able to advance scientific understanding of home environments. She combined the local knowledge of the network with the expert knowledge she was rigorously expanding in her own home laboratory, the Women's Laboratory at MIT, and her global network of scientists. In this network, she served as an expert hub, compiling crowd-sourced findings and returning them to the network. For instance, she compiled results from environmental quality studies she had assigned her distance learners into the book, *Home Sanitation*. She distributed this publication through the network. Recipients were especially motivated to share it with others since their own professional work was contained within it (Clarke, 1973).

3.1.3. *Third-person awareness of ecosystem dynamics*

Richards brought scientific rigor to her work and encouraged others to also engage in systematic scientific study. Her deep interest in applying the facts of science to the problems of common life compelled her to interdisciplinary studies of chemistry, astronomy, botany, zoology, mineralogy, geology, geography, and behavioral science. She was particularly focused on analytical chemistry because it allowed her to quantitatively assess polluted air, water, food, and street waste for toxicity and disease-causing agents.

Her rigor made a difference. At MIT, the same professor who adamantly opposed her admission in 1871 soon learned that her chemical analyses far surpassed her peers. In 1872, he entrusted her to manage a high-profile, large-scale, two-year research project commissioned by the Massachusetts Board of Health. Not only did her success establish her as one of the world's finest water

scientists, her research identified hotspots of contamination throughout the state from industrial pollution, open sewers, and streets strewn with garbage and animal manure. The second water and sanitation study she led resulted in the world's first Water Purity Tables and the first state water quality standards in the United States (Clarke, 1973; Hunt, 1958; Swallow, 2014).

After graduating with her bachelors of science in chemistry from MIT in 1873, she continued employing applied science to advance environmental justice. Confronted by popular arguments that a higher education would compromise women's health, she conducted a scientific survey of the health of college educated women to disprove such assertions (Clarke, 1973, p. 89). She also employed scientific research to disprove popular scientific and theological arguments advanced by her academic peers about the problems of the industrial city. While theologians argued that the problems of the urban poor were due to moral depravity and God's will and scientists in the growing field of *eugenics* (literally, "good genes") claimed that root of these problems were due to genetic deficiencies of immigrants, Richards established the study of *euthenics* (literally, "good environments"). Through studies in the field and laboratory, she wrote dozens of scientific papers and fourteen books that demonstrated 1) the influence of pure air, water, and food on physical and mental health and capability, 2) the impacts of industrial development on human and environmental health, and 3) the ethical responsibility of humans to design in ways that enhance instead of degrade living conditions. (Clarke, 1973; Richardson, 2002).

3.2. Multi-scalar domains of action

Through her integration of objective knowledge, the sympathetic knowledge and relational power of social networks, and her willingness to use herself as an instrument of change and empower others, she was able to translate her knowledge into meaningful action to improve living conditions. Richards applied her integrated awareness of living systems to action from the scale of her own house to city- and state-wide policy reform.

3.2.1. Home as a space of regeneration

One of Richards' most radical precepts was that the home could be a powerful site of regeneration – a domain of action that positively contributes to the social and ecological well-being of living systems instead of depleting and degrading them. At the same time Aaron Montgomery Ward was distributing catalogs through the mail to build markets based on households as units of consumption, Richards was distributing microscopes. She saw the **household as a powerful agent of reform** – a site of generation and regeneration that would support people (individually and collectively) in reaching their full potential. Home life was also one of the only spaces where women were empowered to govern.

Always leading by example, Richards turned her home into a test house and living experiment, in partnership with her husband. She explained in an 1879 address, *Chemistry in Relation to Household Economy* to women in Poughkeepsie, "The ventilation and drainage of many of our houses could not well be worse. Why is it? Why do not our housekeepers keep pace with our machine shops?" (Hunt, 1958, p. 100). After moving into their home in 1875, she gave it a complete overhaul and began prototyping her own experimental designs. These included innovations in the fresh water and waste systems and mechanical and passive ventilation systems, many of which became industry standards. She also set up miniature botanical gardens by the windows and rid the home of carpeting, which was a problem for dust. She equipped her home as a complete lab with testing equipment to measure changes in air, water, and food quality. She studied everything from furnishings to foods, cleaning products, and a wide range of commercial items through controlled studies to test their efficiency and health values (Clarke, 1973; Swallow, 2014).

At a time when industry and government were not regulating products and processes for American consumers, Richards' home laboratory generated the most scientifically advanced knowledge about them and recommended regulations for them. She continually experimented in the kitchen to find the most healthful recipes and cooking techniques – she evaluated the results on the satisfaction of her guests, as well as the time and energy (she had a monitor on her gas supply) it took to prepare them (Hunt, 1958, p. 62). Young women seeking further education often moved in as boarders to support home-laboratory work.

Yet, far from being a cold, clinical environment, it also became a warm and popular gathering spot in which people experienced first-hand the effects of a truly healthy home. One visitor remarked,

"It was like breathing clearer air to come to it. Persons leading perforce a complex city life, beset with undertakings overtaxing time and strength, came here as a refuge, not only for dear affection, but for replenishment and rest – for actual strength. No house of leisure that I know gave the sense of quiet and tranquility that this house of keen and arduous work did – work which never paused and yet was never hurried" (Hunt, 1958, p. 66).

Eventually, Richards was able to expand her research, teaching, and practice beyond the living laboratory of her home by establishing the Women's Laboratory at MIT. She did so with the financial support of the American Association of University Women (of which she was a co-founder), investments from her own consulting work, and state of the art equipment she collected from her journeys overseas. The facility allowed her and her students to expand their analysis of air, water, and food quality. They exposed food fraud by testing ingredients, finding mahogany dust in cinnamon and arsenic in wallpaper (Clarke, 1973, 1973; Hunt, 1958).

Richards' reputation for excellence in applied science also supported consulting work, which often focused on early approaches to industrial ecology. For instance, when Richards discovered that her alma mater, Vassar College, was polluting the Hudson River with sewage produced on its campus, she worked with them on an ecological design that returned nutrients to the soil and protected the water supply. Although her solution was context-appropriate, she noted the lessons to be learned in other contexts:

"This is a valuable record of the possibility of sewage utilization without offense, and of the right principle in taking care of wastes

of an establishment by itself, instead of fouling a stream, to become a menace to the health of others, and an expense to helpless dwellers further down. It is thus in the line of modern economic and sociological investigation, a line which must be followed up if that land is to remain safely habitable.” (Swallow, 2014, p. 96)

3.2.2. Distributed learning networks and transferable knowledge

Richards’ home-based Center for Right Living, Women’s Laboratory at MIT, distance learning courses, consulting work, and leadership of academic associations such as the Lake Placid Conference all helped her cultivate ecological wisdom and capability for action among a diverse network of educated reformers. While her peers focused on developing epistemic knowledge of generalizable truths in specialized disciplines, she focused on developing phronetic knowledge of particular places that could be transferred through learning networks to be adapted and integrated in particular contexts by those who understood local conditions.

Richards’ legacy continued on after her passing in 1911 through the relationships she cultivated in her life time. Several of her students in the Women’s Laboratory went on to work with Jane Addams, John Dewey, William James, and other pragmatists who emphasized democratic approaches to science and learning through doing. She also directly influenced Jane Addams and the settlement house movement, especially after her engagement at the World’s Fair in Chicago in 1893. Addams shared many of Richards’ epistemological and methodological assumptions. Just as Richards turned her house into a living laboratory of learning through doing, Jane Addams also established a communal home where its many members engaged in transdisciplinary, action-research endeavors. Addams also emphasized the importance of sympathetic knowledge in developing practical wisdom for appropriate action (Hamington, 2014). Like Richards, Addams was also powerful in her ability to support and inspire others. The settlement house movement spread throughout the United States and was also tied closely to the municipal housekeeping movement, although the municipal housekeeping movement less significantly crossed divides of class, race, and ethnicity (Spain, 2002). These movements led to important policy reforms and infrastructure development in early cities (Hoy, 1980; Spain, 2002).

3.3. Demise of home ecology

Despite all of its practical successes and theoretical grounding, *oekologie* as practiced by Richards and her network was relatively short-lived. She was a pioneering interdisciplinary scientist, and her ideas and approaches were unorthodox from the beginning. Her applied, inquiry-driven, democratic approach to science was radical in her own scientific institution and others at the time on three fronts: 1) its applied and phronetic approach integrated multiple forms of knowledge, 2) its interdisciplinary approach incorporated social dynamics into theories of science and technology and put humans in control of their destiny, and 3) it had an explicitly normative agenda to build knowledge and power among disenfranchised people so that they could positively shape their environments (Clarke, 1973; Richardson, 2002). These were radical given that Richards conducted her research at a time when the academy was being shaped to favor pure or basic science (for the pursuit of epistemic truth) and the development of narrowly defined disciplines (Menand, 2010; Richardson, 2002).

Ultimately when *oekologie* was incorporated into academia, it went from home ecology to home economics. Instead of an experimental, experiential democratic science in the home, field, and laboratory, the science of home ecology became limited to study by experts in labs with results disseminated to consumers of knowledge (housewives). Home economics became a gendered scientific domain and a tool for reinforcing existing gender roles instead of liberating both women and men through a shared reform agenda to improve living conditions for all people throughout cities.

Unfortunately, instead of becoming a site of generation capable of helping the economy produce conditions conducive to thriving living systems, the household became limited to a domain of consumption designed to be distinct and separate from broader social and ecological systems (Kaika, 2004). Instead of holding industrial capitalism to higher standards, the household came to be the fundamental unit of the global economy, effectively designed to reproduce the capitalist economy in its existing form (Friedmann, 1987). Home ecology lost its context for social reform and its design-oriented and action-oriented praxis. It also lost its grounding in ecological field studies at the same time the discipline of ecology developed to the exclusion of humans. Overall, in the 1900s, academia began to emphasize specialized expertise and objective or technical knowledge production in laboratories, outside of the field and outside of normative goals (Corburn, 2009).

4. Looking forward: A science of right living for the 21st century

Revisiting the history of *oekologie* and the ideas and practices developed by Ellen Swallow Richards offers important insight into the challenges we face today in designing healthy communities. Looking back to look forward, three propositions drawn from Richards’ legacy are considered for practice research framework supporting resilience: 1) integrated awareness of systems builds power, potential, and resilience, 2) “home” is a legitimate area of inquiry, and 3) moving beyond generalizability, learning networks cultivate ecological wisdom and facilitate innovation transfer. For each proposition, contemporary analogues are also identified as ground to build upon moving forward.

4.1. Integrated awareness of systems builds knowledge, power, and resilience

Richards’ prescient approach to transdisciplinary, multi-scalar, integral, awareness-based, participatory action research is needed more than ever to cultivate the wisdom and power to regenerate the living systems of which we are part. Integration of first, second,

and third-person awareness has become more common in social learning and participatory action research (Reason & Bradbury, 2007; Torbert & Cook-Greuter, 2004; Torbert & Taylor, 2007). Such practices are foundational in the “Theory U” framework for awareness-based scientific inquiry led by Otto Scharmer of MIT’s Presencing Institute (Scharmer, 2009). This integral approach to developing actionable knowledge in living systems is also fundamental to regenerative design and development (Hes & Plessis, 2014).

4.2. Home as an area of inquiry

Richards was prescient in her recognition that having a stake in a system could be an advantage in developing knowledge for the benefit of humanity. While her contemporaries maintained that values compromised objectivity and validity, scholars today increasingly recognize that value-rationality and transparency are needed to generate science that matters for society (Flyvbjerg, 2001; Haraway, 1995; Innes & Booher, 2010). Ecological wisdom requires a deep understanding of place, in its rich social and ecological complexity. Richards encouraged her students and colleagues to own an ever-increasing understanding of home and the interdependencies of relationships we have with other human and nonhuman beings. Today, approaches such as community-based participatory research (Angotti & Sze, 2009; Corburn, 2009; Israel, Eng, Schulz, & Parker, 2005; Minkler, 2010), adaptive co-management/co-governance (Christian Rammel, 2007; Folke, Hahn, Olsson, & Norberg, 2005; Olsson, Folke, & Berkes, 2004), and sustainability science (Kates et al., 2001; Seager, 2008) have supported researchers and practitioners in developing actionable knowledge while also building the adaptive capacity of stakeholders to enhance the social and ecological well-being in the multi-scalar living systems they inhabit.

4.3. Learning networks for transferability and adaptive capacity

Richards’ distributed learning network and her participation in the place-based social movements of her day (e.g., municipal housekeeping and settlement house movements) reflect the value of transferability over generalizability and the importance of building adaptive capacity. Innovative ideas and feedback from place-based experiments were exchanged through learning networks. Inspired by their peers, local leaders adapted prototypes appropriate to their own contexts. Today, internet technologies have expanded opportunities for such cross-contextual sharing. Well-designed massive open online courses (MOOCs) have potential. For example, Otto Scharmer and his team at the Presencing Institute have created a global network of over 50,000 participants engaged in awareness-based action research, often in local hubs (Scharmer, 2015). New data infrastructure has also enabled the rise of citizen science, through which a distributed network of individuals can locally gather scientific data that is not only relevant to their own context, but also allows expert scientists to identify patterns across scales.

4.4. Remembering our way forward to regenerative praxis

As progress through the 21st century with unprecedented access to data, computing power, and social networks, it is important to remember our way forward through the legacy of Ellen Swallow Richards at the turn of the 20th century. Confronted by structural oppression and denied the right to vote, she persisted in developing an emancipatory approach to scientific inquiry that could cultivate the ecological wisdom and leadership networks needed to transform industrial capitalism.

Looking at the advances in contemporary domains of action inquiry, including social learning, environmental justice, and sustainability science, we may be inclined to see Richards as an exceptional woman ahead of her time. Yet, this view is a disservice to her legacy. Her myriad accomplishments were the outcome of a phronetic approach that cultivated ecological wisdom and leadership capacity. Moreover, she was extraordinarily attuned to her times – her approach helped her recognize patterns, possibilities, and constraints of an economic growth paradigm that emerged in her lifetime and continues today.

From Richards’ story and the demise of *oekologie*, we are also reminded that knowledge is produced within (and for) political economies. She was largely forgotten not only because she did not belong to a specialized discipline, but also because her phronetic approach challenged the same structures of power that perpetuate social inequities and ecological degradation today. As we plan for social and ecological resilience in an era of climate change, Richards calls us to embrace emancipatory research processes that build knowledge and power by giving it to those who have been excluded and exploited. She calls us to synthesize knowledge across disciplines, while integrating the awareness of our minds, hearts, and wills. She calls us into communities of inquiry where we can cultivate the ecological wisdom, collective power, and resilience required for a just transition to a regenerative economy that supports flourishing living systems.

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