

Main Article:

Advancing Transdisciplinary and Translational Research Practice: Issues and Models of Doctoral Education in Public Health

Linda Neuhauser

School of Public Health, University of California, Berkeley, CA 94720-7360, USA
lindan@berkeley.edu

Dawn Richardson

School of Public Health, University of California, Berkeley, CA 94720-7360, USA
drichardson@berkeley.edu

Sonja Mackenzie

School of Public Health, University of California, Berkeley, CA 94720-7360, USA
smackenzie@berkeley.edu

Meredith Minkler

School of Public Health, University of California, Berkeley, CA 94720-7360, USA
mink@uclink.berkeley.edu

Abstract

Finding solutions to complex health problems, such as obesity, violence, and climate change, will require radical changes in cross-disciplinary education, research, and practice. The fundamental determinants of health include many interrelated factors such as poverty, culture, education, environment, and government policies. However, traditional public health training has tended to focus more narrowly on diseases and risk factors, and has not adequately leveraged the rich contributions of sociology, anthropology, economics, geography, communication, political science, and other disciplines. Further, students are often not sufficiently trained to work across sectors to translate research findings into effective, large-scale sustainable actions.

During the past 2 decades, national and international organizations have called for more effective interdisciplinary, transdisciplinary, and translational approaches to graduate education. Although it has been difficult to work

across traditional academic boundaries, some promising models draw on pedagogical theory and feature cross-disciplinary training focused on real-world problems, linkage between research, professional practice, community action, and cultivation of leadership skills.

We describe the development the Doctor of Public Health program at the University of California, Berkeley, USA and its efforts to improve transdisciplinary and translational research education. We stress the need for international collaboration to improve educational approaches and better evaluate their impact.

Keywords: transdisciplinary; interdisciplinary; translational research; DrPH; doctoral education; public health

Suggested Citation: Neuhauser, L., Richardson, D., Mackenzie, S., & Minkler, M. (2007).

Advancing transdisciplinary and translational research practice: Issues and models of doctoral education in public health. *Journal of Research Practice*, 3(2), Article M19. Retrieved [date of access], from <http://jrp.icaap.org/index.php/jrp/article/view/103/97>

1. Improving Public Health: A Challenge to Research Practice

Improving the health of populations will be more successful if we address two critical challenges: understanding the underlying determinants of health, and translating that knowledge into effective, large-scale, and sustainable action. The determinants of such problems as obesity, violence, climate change, and lack of emergency preparedness, include multiple, complex factors such as poverty, culture, education, environment, and government policies. However, there is a concern that traditional health research and practice have tended to focus more narrowly on biomedical models that emphasize diseases and risk factors (Abrams, 2006; Rosenfield, 1992; Smedley & Syme, 2000), rather than on more powerful underlying social and ecological influences. To craft better solutions for society's health problems, we will need to leverage knowledge and experience from multiple disciplines (Stokols, Grzywacz, McMahan, & Phillips, 2003), such as sociology, anthropology, economics, informatics, geography, communication, and political science.

Maintaining rigid disciplinary perspectives not only limits our knowledge about health determinants, but also constrains our ability to apply research findings toward the development of successful interventions that can impact the health of a population. While there is little evidence about the uptake of research for effective action, Jensen (2003) estimated that even the most successful interventions rarely reach more than 1 per cent of the target population. Another review concluded that it may take 17 years to turn 14 per cent of original research into clinical

applications (Balas & Boren, 2000), and the time it would take for basic research to have an impact on a community or population level would be even longer. For example, there is considerable evidence about obesity and risk factors that contribute to it, but little evidence that this knowledge has affected a downturn in the epidemic. Our challenge is to develop a research practice that actively integrates knowledge from many disciplines and uses it to enable effective action within the cultural norms and organizational processes of specific settings (Bammer, 2005; Green & Glasgow, 2006; Sussman, Valente, Rohrbach, Skara, & Pentz, 2006).

Since the 1960s, there has been increasing focus on using a cross-disciplinary approach both to understand health determinants and to take effective action. *Cross-disciplinary* is an umbrella term for work that goes beyond a single discipline. This evolution parallels the radical changes to the nature of scientific inquiry and perception of knowledge in a *postpositivist* world. Scientific positivists, who hold that truth is knowable and generalizable, have been eclipsed by “critical realists,” who posit that it is impossible for humans to accurately perceive the real world and its causal forces, and that claims about reality must be subjected to the widest possible critical examination (Cook & Campbell, 1979).

Scientific knowledge is now generally equated with theory--a model or a “huge fishnet” of complex, mutually interacting relationships among constructs or variables (Cook, 1985; Green, 1990). Adhering to this new paradigm requires that multiple investigators and stakeholders exhaustively study phenomena from as many different perspectives as possible (Letourneau & Allen, 1999). Kahn and Prager (1994) comment that no one person or discipline can “know” everything, and thus scientific knowledge is inherently a “collective rather than an individual possession” (p. 12). For example, supporting the healthy development of children (“youth development”) requires insight and action from a broad spectrum of researchers and professionals involved in economics, health, social work, education, environment, politics, and many other areas.

In promoting heterogeneity and diverse disciplinary perspectives, the research process should use multiple theoretical frameworks, methods, settings, and interpretations of evidence--defined as “critical multiplism” (Cook, 1985). In opposition to the earlier tendency to conduct research under controlled conditions and to presume that findings are generalizable, critical multiplism specifies that inquiry be carried out, as often as possible, in natural settings using a mix of cross-disciplinary constructs, and both qualitative and quantitative methods. This is essential to reduce bias, and to approach knowledge in a world that is complex, uncertain, and changeable. What constitutes a healthy environment for young people in Beijing may differ greatly from that in a nearby rural area. Understanding healthy youth development in a way that can lead to practical action, in any setting, requires a combination of diverse perspectives and diverse methods. We present two examples of projects using these approaches.

In a youth development effort in Contra Costa County, California, USA, underprivileged

students (from 10 to 12 years old), working in small groups with high school and university students who were trained as facilitators, took photos to capture their views of positive and negative aspects of their school community and to identify shared concerns. Twelve of the 13 initial groups successfully developed social action projects that primarily focused on engaging their peers, teachers, administrators and other stakeholders to overcome institutional barriers and promote changes in the school environment (Wilson, Dasho, Martin, Wallerstein, Wang, & Minkler, 2007). The program outcomes showed that students increased their understanding of important societal issues, ability to solve social problems, and intention to register to vote.

In southern Belarus (in the Union of Belarus and Russia), 10 years after the Chernobyl disaster, populations continued to be exposed to high levels of radiation and children felt they faced an unhealthy future. To improve the situation, a team consisting of nuclear physicists, community psychologists, and adolescents assembled data from environmental readings, psychological evaluations, and art (children's drawings of their situations) to create an intervention that empowered adolescents to educate their communities about site-specific ways to reduce exposure to radiation (Neuhauser, 2005).

In the past 3 decades, Bammer (2005) notes that international health organizations have increasingly called for a shift toward a research practice that is cross-disciplinary and that can lead to practical benefits for people's health. In 1978, the landmark Alma Atta conference, sponsored by the World Health Organization and the United Nations Children's Fund, cited the importance of intersectoral action to bridge medical and social sciences (World Health Organization, 1978). The 1992 Earth Summit at Rio de Janeiro, Brazil, produced recommendations that scientific research be conducted in an interdisciplinary manner to address global environmental problems (United Nations, 1992, Article 35.9). Likewise, in 1999, the United Nations Educational, Scientific and Cultural Organization (2000, Introductory Note to the Science Agenda--Framework for Action, pp. 468 ff) concluded that researchers must collaborate with other players to ensure that knowledge will be effective in addressing the needs of societies.

Although cross-disciplinary and translational phenomena are distinct formal areas of scientific inquiry and application, a movement to closely integrate them is underway. Bammer (2005) proposes the term "integration and implementation sciences," while Stokols (2006) suggests "transdisciplinary action research" to promote a form of research practice that is both cross-disciplinary and translational in nature.

Over the past 2 decades, scholars and institutions worldwide have begun to define objectives and strategies for this kind of comprehensive research practice. In 1996, the Organization for Economic Cooperation and Development (1996) advocated for institutes of higher learning to collaborate across sectors to produce and transfer knowledge. The report, *Who Will Keep the Public Healthy? Educating Public Health Professionals for the 21st Century*, published by the

Institute of Medicine, USA, emphasizes the need to train public health professionals to be proficient in transdisciplinary research and to bridge academic and applied sectors (Gebbie, Rosenstock, & Hernandez, 2003). Derry and Fischer offer this rationale:

If the world of working and living relies on collaboration, creativity, definition and framing of problems and if it requires dealing with uncertainty, change, and intelligence that is distributed across cultures, disciplines, and tools--then graduate programs should foster transdisciplinary competencies and mindsets that prepare students for having meaningful and productive lives in such a world. (Derry & Fischer, 2005, p. 4)

In this article, our objectives are to: (a) describe the critical importance of advancing interdisciplinary, transdisciplinary, and translational research practice, (b) propose definitions and conceptual frameworks related to this area, (c) comment on general trends, models, and recommendations to improve disciplinary integration and research translation in public health doctoral training, and (d) describe the development of the Doctor of Public Health (DrPH) program at the University of California, Berkeley, USA, and its efforts to improve training in this area. We conclude with our reflections on what might be necessary to improve transdisciplinary and translational research practice.

2. Definitions

2.1. Definitions About Using Multiple Disciplines in Research

Although there is no consensus about the many existing terms that relate to different forms of research on health issues (Kerner, Rimer, & Emmons, 2005), we propose to follow the typology of research practice initially suggested by Rosenfield (1992) and later adapted by Stokols (2006) and Abrams (2006).

Level 1. *Multidisciplinary*: Researchers from different fields work independently or sequentially (with little interaction), each from his or her field, to address a common problem.

Level 2. *Interdisciplinary*: Researchers work jointly, but still from their own disciplines, to address a common problem.

Level 3. *Transdisciplinary*: Researchers work together from the outset to develop a shared conceptual framework that integrates and extends discipline-based concepts, theories, and/or methods to address a specific common problem.

The terms *interdisciplinary* and *transdisciplinary* are frequently used interchangeably (see Newell, 2001; Szostak, 2007; Youngblood, 2007). As noted earlier, *cross-disciplinary* is often used to include all three of the above types of disciplinarity in research practice. In the health arena, however, use of the term *transdisciplinary* is increasingly preferred to distinguish a higher level of disciplinary integration that “transcends” any individual discipline’s boundaries, and for which the outputs of the integration can be measured (Fuqua, Stokols, Gress, Phillips, & Harvey,

2004; Stokols, 2006). Although this typology is used primarily by researchers, it can also apply to a broad range of stakeholders across sectors. The development of a healthy built environment is an example of transdisciplinary work that merges urban planning, public health, sociology, architecture, and other disciplines to create novel frameworks, methods, and interventions.

Wickson, Carew, & Russell (2006) further differentiate transdisciplinary research from other cross-disciplinary efforts, stating that transdisciplinarity is characterized by a specific problem focus, an evolving methodology, and a collaborative effort. One prominent example of a transdisciplinary effort is the Transdisciplinary Tobacco Use Research Center (TTURC) initiative--a collaborative effort aimed at reducing tobacco use. These centers incorporate knowledge and expertise from multiple fields including life course health development, molecular biology, genetics, and ecology (Turkkan, Kaufman, & Rimer, 2000), develop new theories and methods, and collaborate across centers (Morgan et al., 2003). Adapted approaches might prove helpful to investigate other complex health-related problems, such as global warming.

2.2. Definitions About the Process of Applying Research for Health Improvements

Translation: An extended process of how research knowledge that is directly or indirectly relevant to health or well-being eventually serves the public (adapted from Sussman et al., 2006).

Dissemination: An active and strategically planned process whereby new or existing knowledge, interventions, or practices are spread (Kiefer et al., 2005). Dissemination is part of the process for translating research into action, and can be viewed as a two-way process that exchanges knowledge between those who conduct research and those who implement its findings (King, Hawe, & Wise, 1998).

3. Evolution of Transdisciplinary and Translational Conceptual Frameworks

As noted earlier, advances in transdisciplinary and translational health research have closely paralleled transformations in thinking about knowledge and scientific inquiry during the past half-century. Not surprisingly, this process has involved scholars from diverse disciplines in the sciences and humanities. In this section, we briefly describe selected research practice models relevant to health (for more comprehensive information, see Abrams, 2006; Bammer, 2005; Best, Hiatt, & Norman, 2006; Green & Glasgow, 2006; Lynch, 2006; Nash et al., 2003; Rosenfield, 1992; Stokols, 2006; Sussman et al., 2006; Syme, 2005).

Since the Second World War, increasing attention has been paid to the influence of a variety of social, psychological, and cultural factors on the occurrence of disease. The first formal training program in the field of *medical sociology* was established at Yale University in USA in 1957, which for the first time, involved explicit collaboration between social and biological scientists

(Syme, 2005). The maturation of this interdisciplinary program was evidenced by the publication in 2000 of the first textbook in the field that is now referred to as *social epidemiology* (Berkman & Kawachi, 2000). Syme and Frolich (2001) have reviewed the import of this and other texts describing a decade of thinking in this field.

Similarly, ecological perspectives have advanced transdisciplinary thinking in public health. Bronfenbrenner's (1979) ecological systems theory provides a sociocultural perspective focused on both individuals' and groups' histories and development within their social contexts. Overlapping ecological systems are viewed as working together in dynamic ways to influence individual and group development. The Life Course Health Development (LCHD) model considers that individual health is affected by interactions between multiple nested environments--genetic, biological, behavioral, social, and economic (Halfon & Hochstein, 2002). Social epidemiological, ecological, and life-course models are widely linked and used to examine the longitudinal effects of multiple factors such as "stress" (events of daily life that cause some measure of "wear and tear" on physiological systems--the cumulative impact of which is referred to as "allostatic load"; see McEwen & Seeman, 1999, p. 30), sense of job control (Marmot, Bosma, Hemingway, Brunner, & Stansfeld, 1997), and diet from infancy through late life.

The *social ecology* model (Stokols, 2000) is a commonly used framework for designing health research and interventions. It encompasses a broad range of disciplines and spans multiple levels, including individual, family, community, organization, and society. Social ecology models also incorporate elements of *systems thinking*, including notions of interdependence and "cycles of mutual influence" (Stokols, 1996, p. 286). Systems models (such as operations research and learning organizations) suggest that any component of a system (such as people or water quality) is greatly affected by the whole consisting of all the system components and their interactions. Complexity science (for example, the study of *complex networks*), which is informed by systems thinking (Bammer, 2005), draws heavily on mathematics and computing and is used to model complex systems, such as those involved in climate change or stem-cell reproduction.

Such inherently transdisciplinary models are clearly essential to understand the complex nature of factors that affect people's health. Applying these models requires inputs from different disciplinary, professional, and other sources. Therefore, almost by definition, participatory processes are at the core of transdisciplinary research and its implementation (see Bammer, 2005; King, Hawe & Wise, 1998; Stokols, 2006; Sussman et al., 2006). Action research, and participatory action research (PAR), which emerged in the 1940s and 1970s, respectively, have become increasingly popular (Stokols, 2006) and have guided researchers, practitioners, and the lay public in methods to collaborate across disciplines and during the translational process. *Community-based participatory research* (CBPR) is widely used as an overarching term for an approach to cross-disciplinary research (including action research and PAR) that reflects

equitable collaboration between community and academic partners who use action to effect positive change in communities as part of the research process (Israel, Schulz, Parker, & Becker, 1998; Minkler & Wallerstein, 2003).

Participatory processes are also key to translating research into action (Reason & Bradbury, 2001). Best, Hiatt, and Norman (2006) summarize the evolution of translational health research approaches. The dominant models from 1960 to the mid-1990s were linear. These models portrayed knowledge as a product, and presumed its passive transfer from researchers to users. Knowledge was seen as something that is generalizable across contexts. For example, the dominant model defined two phases of knowledge translation: (a) basic research to clinical applications, or “bench to bedside” and (b) dissemination from clinical to broader community applications. However, a number of anomalies in this view of knowledge transfer gradually sparked a research interest in modeling the knowledge dissemination process (King, Hawe, & Wise, 1998) incorporating ideas from the theories of diffusion of innovations as developed in communication disciplines (Rogers, 1982). As the process of social interaction within scientific research became more commonly understood, the focus of translational research moved to knowledge *exchange* in which knowledge was viewed as produced and integrated through the relationships of multiple collaborators. Such knowledge is considered context-linked and, therefore, attached to local cultures, economies, and settings (Green & Glasgow, 2006; Yancy, Ory, & Davis, 2006).

The latest, or “3rd generation” translational models, emphasize knowledge *integration*, wherein knowledge is viewed as tightly woven within priorities, culture, and contexts. In this whole-system perspective, relationships at all levels are key to access and integrate knowledge for decision-making (Best, Hiatt, & Norman, 2006). The evolving systemic translational models also include guidance about improved approaches to test the effectiveness of applying research findings in multiple contexts, such as the one proposed by Glasgow (2002). This marks a shift away from studying outcomes under controlled conditions, to testing outcomes in the varied and uncertain environments of the practical world.

Sussman and colleagues (2006) discuss multiphase models that include basic research, efficacy and effectiveness trials, dissemination/diffusion of knowledge to action, and a looping back to research. An important implication of such cyclic models is that translational research requires a mix of quantitative and qualitative methods to provide many views of knowledge throughout the research-action cycle (Green & Glasgow, 2006).

Although models have typically been labeled either primarily transdisciplinary (or interdisciplinary) or translational, *integrated* frameworks are now emerging: (a) Bammer’s (2005) integration and implementation science model links multiple frameworks and methods into an integrated approach, (b) Stokols’ (2006) transdisciplinary action research matrix describes how transdisciplinary research needs to be integrated into a collaborative action cycle

with three dimensions: analytic scope (biological to policy), organizational scope (intra-organizational to intersectoral), and geographic scope (local to global), and (c) Sussman and colleagues' (2006) model proposes how cross-disciplinary researchers and practitioners might collaborate at multiple translational phases to transform science into action.

4. Examples of Moving From Theory to Action

Given the array of models linking health research and activities affecting health, we may wonder if it is possible to close the ambition gap between abstract concepts and real benefits to people's health. Although such work is in an early stage, it is clear that transdisciplinary/translational thinking has catalyzed impressive health activities and has generated useful case studies to support training in this area. Consider the following examples:

(a) In Thailand, a team of economists, malaria experts, and health center personnel joined to develop new techniques to estimate the cost effectiveness of alternative strategies to control malaria (Kaewsonthi, 1989). This effort led to major program changes and improved outcomes.

(b) The [International Alliance of Research Universities](#) (IARU), a collaboration of leading universities worldwide, uses transdisciplinary approaches to explore issues and actions on major health and social issues, such as energy and the environment, and longevity and health.

(c) The [National Institutes of Health](#) (NIH), USA, has created a new initiative to reorient research to be more cross-disciplinary and translational (National Institutes of Health, 2005). NIH has also invested hundreds of millions of dollars in translational science centers throughout the country.

(d) In Mexico, PROGRESA, a large-scale community health and anti-poverty intervention serving 2.6 million families, was developed by a team spanning biomedical, social, behavioral, economic, and other disciplines, using what they describe as the best-practice methods, and has shown impressive results (Rivera, Sotres-Alvarez, Habicht, Shamah, & Villalpando, 2004).

Case studies, such as these, are providing evidence for the overall objective to evaluate transdisciplinary and translational research practice.

5. Evaluating Transdisciplinary and Translational Research

Evaluation of health research intended to be both transdisciplinary and translational is at an early stage. Overall, given a 2-decade head start, indicators and methods to assess translational processes and outcomes are further advanced than those for transdisciplinary work. Stokols and colleagues comment that the surge of interest and investment in transdisciplinary research is leading to evaluation methods and early findings about factors that enable, and those that hinder, this form of research practice (Stokols, Harvey, Gress, Fuqua, & Phillips, 2005). The US National Cancer Institute's "Science of Team Science" conference in October 2006 provided a

useful state-of-the-art review of current approaches to assess transdisciplinary research (Stokols, Taylor, Hall, & Moser, 2006; see also the [conference Web site](#)).

It is beyond the scope of this article to describe these evaluation approaches; we refer readers to the available literature on the various frameworks, methods, and evaluation findings (Abrams, 2006; Bammer, 2005; Glasgow, 2002; Green & Glasgow, 2006; Kahn & Prager, 1994; Kerner, Rimer, & Emmons, 2005; King, Hawe, & Wise, 1998; Glasgow, Lichtenstein & Marcus 2003; Morgan et al., 2003; Potter et al., 2006; Rosenfield, 1992; Stokols, 2006; Stokols et al., 2005; Sussman et al., 2006).

Kahn & Prager (1994) propose “five milestones” for successful transdisciplinary science: (a) listening across disciplinary gulfs, (b) learning language and ideas of other disciplines, (c) developing a common language for new conceptual development, (d) jointly developing new methods and measures, and (e) conducting research that reflects disciplinary integration.

Other recommendations to improve health-related transdisciplinary and translational work include such factors as incentives for participation, effective leadership for transdisciplinary processes, respect for others’ models and methods, institutional commitment and flexibility, regular face-to-face meetings, close collaboration between researchers and practitioners at all phases and levels, expertise in problem-based research and practice, strong multi-method research skills, and evidence of value-added outcomes.

6. Training to Advance Transdisciplinary and Translational Research Practice

Who will train the needed critical mass of researcher-practitioners, transdisciplinary scientists (Nash et al., 2003), or integration and implementation scientists (Bammer, 2005)? A radical shift toward greater integration among disciplines and greater integration between knowledge production and its application, calls for a similar educational transformation. In the previous section, we commented on personal skills, processes, and organizational factors that support this new direction. However, there is no comprehensive conceptual framework for such training (Nash et al., 2003) and consequently, no clearly defined curriculum, textbooks, or accreditation criteria (Bammer, 2005).

In addition, the majority of those who call for reorienting education toward a convergence of disciplines in the service of practical improvements in public health, acknowledge seemingly intractable barriers to overcome in both traditional academic and other research enterprises (Lynch, 2006; Morgan et al., 2003; Nash et al., 2003; Potter et al., 2006; Rosenfield, 1992; Stokols et al., 2005; Sussman et al., 2006). How can we train and motivate students and scientists who are now primarily rewarded for individual research in relatively narrow fields? How can we create partnerships between researchers and those who integrate knowledge for public benefit? Developing an integrated pedagogical framework and institution-specific training components is obviously a major undertaking and will require concerted international efforts.

As a good starting point, we recommend Ernest Boyer's "Four Scholarships" model (Boyer, 1990). Boyer, who specialized in adult education, proposed that university education should foster a stronger link between research and its translation into action. Training should include the scholarships of *discovery* (creating new knowledge), *integration* (synthesizing information from multiple disciplines and perspectives), *engagement* (bidirectional, collaborative approaches to solving important problems), and *teaching* (including student-driven and problem-based learning and *participatory pedagogy* between teachers and students). Boyer's view of the "engaged university" is closely aligned with emerging recommendations about transdisciplinary training. In addition, we suggest using Kahn and Prager's (1994) five milestones, mentioned earlier (in Section 5), as one way to assess the transdisciplinary quality of such training. The other transdisciplinary and translational factors mentioned in Section 5, although not incorporated yet into a formal framework, are also important elements to consider in reorienting education.

7. University Training

Currently, the most intensive efforts to understand factors that foster integrated transdisciplinary/translational work are taking place in specifically established research initiatives, rather than in degree-granting academic programs. For example, the transdisciplinary factors cited in Section 5 above are derived mostly from studies done at the previously mentioned Transdisciplinary Tobacco Use Research Centers (TTURCs). The training element involves guiding established scientists to engage in a collaborative process, although some students also participate. One finding has been that without some formal training, few scientists possess the essential skills to excel at this work (Stokols, 2006; Sussman et al., 2006). Therefore, it would seem advisable to begin this orientation during university training.

These centers have provided transdisciplinary training for students. Public health workers from Wuhan, China have come to the University of Southern California, USA to engage in TTURC studies and at the same time earn doctoral or masters degrees in fields that link medicine and social psychology (Nash et al., 2003). At the Warren Alpert Medical School of Brown University, USA, the Centers for Behavioral and Preventive Medicine train predoctoral and postdoctoral students, as well as faculty from diverse disciplinary backgrounds (Nash et al., 2003). In addition, the TTURC at the University of California, Irvine, USA, provides cross-disciplinary training for students and researchers who span schools of social ecology, social sciences, computer sciences, medicine, and others (Nash et al., 2003).

Although widespread formal transdisciplinary training is still limited, there are notable examples. The School of Social Ecology at the University of California, Irvine, USA, is a pioneering model of transdisciplinary training (Stokols, 1998). In Quebec, Canada, the Transdisciplinary Training Program in Public and Population Health Research encourages doctoral students and postdoctoral interns to pursue careers in applied research "by creating a community of interest among researchers in this field and by offering students training laboratories in a public health setting" (Public Health Agency of Canada, 2006, p. 12). The

program partners include five universities, six regional health departments, the Ministry of Health and Social Services, and other agencies. In Montreal, there is a postdoctoral fellowship that links social and political scientists to examine health inequalities and community approaches to action.

8. Doctor of Public Health Programs

The preceding examples describe university programs that incorporate explicit training in transdisciplinary and translational research practice. Although there are many important examples of transdisciplinary approaches in doctoral programs in general, the Doctor of Public Health (DrPH or DPH) programs may provide the best general foundation for such training because they typically include multiple disciplines and are focused on training health leaders who can bridge the gap between health research and the actual changes in public health practice. DrPH dissertations are more often directed at studying and addressing a real-world health problem rather than developing or testing a theory--as is more common in other kinds of public health doctoral research.

In addition to the overall evolution of public health thinking and action, there are important institutional forces that support transdisciplinary and translational training within DrPH programs. In the USA, the Council on Education for Public Health requires that schools of public health have professional degrees (such as the DrPH) to be accredited (Council on Education for Public Health, 2005). Further, the Association of Schools of Public Health has established a subcommittee that is exploring ways to define a common description of the DrPH degree, including competencies related to transdisciplinary and translational aspects of public health.

There is no comprehensive information about which DrPH programs have explicit transdisciplinary and translational objectives, although we are conducting such a survey in the USA. Available, but incomplete, information indicates that about one-third of the DrPH programs in the USA include all the disciplines in their school (rather than focus doctoral studies in one of the disciplines, like epidemiology), such as those at Johns Hopkins Bloomberg School of Public Health and Boston University School of Public Health. Some of the programs that specifically define transdisciplinary/interdisciplinary and/or translational orientations include the DrPH program at the University of Georgia College of Public Health, the DrPH Leadership program at the Fay W. Boozman College of Public Health, University of Arkansas (built around service learning in "pilot" communities), and the new DPH program at the City University of New York. The University of North Carolina, Chapel Hill participates in The Engaged Institutions Initiative of the nonprofit organization, Community-Campus Partnerships for Health. This has involved a detailed strategic planning process concerning diversity and translational research intended to develop evidence-based health policy to reduce health disparities. DrPH programs at the State University of New York, Albany and the University of California, Los Angeles also emphasize transdisciplinary and/or translational orientations. Note that the

preceding examples mention just a few of the DrPH programs that are advancing transdisciplinary and translational research practice.

Internationally, we could find only a few examples of DrPH programs that covered all the disciplines in their school of public health and that used descriptors such as “interdisciplinary,” “transdisciplinary,” or “translational” on their Web sites. A novel program at the London School of Hygiene & Tropical Medicine, UK is intended to work across disciplines to train leaders to link research and public health practice. The University of Tampere School of Public Health, Finland offers a Doctoral Program in Public Health that engages students in cross-disciplinary research and its translation to public health practice through a collaboration with several universities and public health entities. In addition, the University of South Carolina, USA and the University of North Carolina, USA, have a joint DrPH program with the Medical and Dental Educational Institute in Seoul, Korea.

As increasing numbers of institutions become aware of the potential for the DrPH degree, and as additional models of doctoral education emerge, more schools of public health are likely to incorporate this much-needed emphasis into their programs. In the next section, we discuss one such model: the DrPH program at the University of California, Berkeley, USA.

9. DrPH Program at the University of California, Berkeley, USA

In 1996, four discipline-specific DrPH programs at Berkeley were joined to create the current “schoolwide” program, which includes all subdisciplines ranging from epidemiology, biostatistics, and infectious disease to maternal and child health, nutrition, health and social behavior, and health policy and management. The new unified program is characterized by a cross-disciplinary orientation and a strong emphasis on creating university-community partnerships for both research and its application to improve health. It is aimed at developing public health leaders by combining traditional academic education with training in collaboration and leadership. During the past 3 years, with initial grant support from the W. K. Kellogg Foundation and The California Endowment, the program has been redefined to have a specific focus on transdisciplinary and translational research and practice. The program reflects Boyer’s “four scholarships” of discovery, integration, engagement, and teaching. It is also committed to a participatory design process in which faculty, students, staff, and community partners work in an ongoing and collaborative way to improve the program. Since 1998, 112 students have entered the DrPH program at Berkeley.

The Berkeley DrPH program is led jointly by an academic director and a community co-director who links the academic and the practice worlds. They work closely with a program director who oversees day-to-day operations. A DrPH management committee, consisting of representatives of all disciplines within the school and a community advisory board representing local public health leaders, provide guidance and serve as the bridge between program concepts and action. A student-led program committee helps design the curriculum and other program components.

Finally, further reflecting its commitment to community partnerships and to diversity of public health leadership, a field placement supervisor and a diversity director are integral parts of the program staff.

Students are selected for academic excellence in one or more fields, evidence of leadership and professional experience in a health-related field, and commitment to research that can be applied to benefit society. Each cohort is selected to include a mix of students from multiple disciplines both within public health and beyond (such as medicine, nursing, education, policy, business, media, and social work), as well as a diversity of interests and cultural backgrounds.

The program is continuing to build transdisciplinary and translational elements into the curriculum. In addition to standard public health doctoral course work (covering research methods and the subdisciplines mentioned above), the curriculum includes the goals, history, and methods of transdisciplinary and translational research, advanced leadership training, case-based learning, community-based participatory research, training in methods for analyzing mixed quantitative and qualitative data, a field residency, and a practical assignment called the “DrPH-in-Action” project.

The DrPH-in-Action project takes place during the 1st year and engages teams of students who collaborate with a local health department or other agency to identify an area of concern. Student groups also work outside of the USA--for example, one group is working with the Ministry of Health in Mexico. The students then explore the issue through the application of a social-ecological framework, as well as multiple meetings with relevant stakeholders. This collaborative process provides students with experience in transdisciplinary work and real-world problem solving.

As noted above, students also complete individual field residencies, during which they may work with a sponsoring agency to develop theory-driven program approaches to solve a problem, design and implement a program evaluation, or conduct collaborative research projects. Residencies also function as a way of helping students jointly identify, collect, and analyze dissertation data in a setting, such as a health department or government policy group that is oriented to making practical health improvements. Although hard outcomes data are not yet available, a detailed external evaluation conducted midway into the program’s transition suggested significantly increased satisfaction on the part of students, alumni, health department personnel, and other stakeholders (Samuels & Associates, 2005). Initial findings show that about half of the graduates take academic positions and most of the others take senior-level positions in government, community, private, philanthropic, and other sectors. Increasingly, despite institutional barriers, graduates are creating hybrid positions that link academic and practice worlds--such as through adjunct professorships.

10. Examples of Transdisciplinary Action Experiences

Because doctoral programs that integrate explicit transdisciplinary and translational training are relatively new, it is often difficult to get a flavor of the struggles and rewards of this way of learning. Dalke, Grobstein, and McCormack (2006) described their transdisciplinary experience linking biology, literary studies, and physics at the Center for Science and Society at Bryn Mawr College, USA. Following their example, we offer two of our experiences with DrPH-in-Action projects: one related to youth development and the other to emergency preparedness.

10.1. Youth Development

This project was developed in collaboration with our local Alameda County Public Health Department that serves roughly 1 million residents. Our team's aim was to assist the health department in identifying systemic changes that could improve the incorporation of youth development approaches (i.e. strategies to support youth living in difficult situations) into the activities of a broad range of existing health, social, educational, and public safety programs in the county. The student team had members trained in a wide range of disciplines, including medicine, mental health, disaster preparedness, epidemiology, health education, and program evaluation. The students' objective was to move beyond disciplinary boundaries to create a joint problem-solving approach. Here, we briefly mention our experience and learning in terms of Kahn and Prager's (1994) five milestones of effective interdisciplinary collaborations (see Section 5).

(a) *Listening across disciplines*: In this earliest phase, participants should have multiple conversations to converge on common interests. In our experience, program sponsors and students held numerous meetings to agree on objectives about research and action needed to support youth development. We were surprised by how challenging it was to achieve consensus, not due to different agendas, but because each of us interpreted concepts quite differently.

(b) *Developing a common language*: Defining the seemingly simple concept of "youth development" proved to be laborious because each of us had our own understanding of this term. Due to the limited time available, we opted to choose one of the existing definitions, which the health department also adopted.

(c) *Onset of major collaborative efforts*: Kahn and Prager (1994) suggest that this stage is "marked by a high degree of mutual tolerance" and this was certainly true in our experience. Most importantly, we agreed to step beyond our disciplinary training--especially related to research methodology--and to merge our research capabilities into a more effective, joint approach to examine youth development.

(d) *Conducting joint projects*: Abrams (2006) advises that transdisciplinary teams combine community-based participatory research with both policy and advocacy approaches to foster the translation of research into action. In keeping with this guidance and the project's strong

emphasis on collaborative youth development, we tried to incorporate youth voices into every phase of our project. Then, the team presented all findings to the health department to inform policy at the county level.

(e) *Conducting research that reflects disciplinary integration:* As noted above, after initial difficulties in joining our diverse perspectives and skills, our team used a mix of methods that included key informant interviews with youth, focus groups, and quantitative health indicator data. The end result was a far richer, more nuanced understanding of the issues faced by youth that, in turn, laid the groundwork for improved interventions.

10.2. Emergency Preparedness

This project was developed to address the devastating lack of emergency preparedness brought to light when thousands of mostly minority residents died during and after the 2005 Hurricane Katrina in Louisiana, USA. A DrPH cohort joined with health workers in New Orleans, Louisiana to conduct research on how emergency preparedness could be improved for vulnerable populations. The team also examined preparedness to meet the needs of vulnerable populations in Alameda County, California. Students “translated” research findings into a toolkit for local health workers and then disseminated it to California health departments.

The student team had a broad range of professional experience in public health, including the private sector, local, state, and federal health departments, and academic research. Their individual expertise included health communication, community organizing, HIV/AIDS, cultural and linguistic competency in health care delivery, and preparedness against emerging infectious diseases. Their collaborating partners included researchers and state and federal public health officials, community-based organizations, and advocacy groups.

Listening across the disciplines was a key element of the emergency preparedness project. Students conducted interviews with key stakeholders ranging from community members to federal, state, and city officials. As in the youth development experience, team members in this project found that developing a shared terminology was challenging. It was hard to define which populations would be considered “vulnerable” and thus in need of special attention, because the definitions were not consistent across organizations.

10.3. Lessons Learned

As Dalke, Grobstein, and McCormack (2006) suggest, working beyond one’s discipline can be daunting. Our team members frequently felt frustrated when moving past their disciplines with colleagues who had other scientific views and skills. In the youth development project, our team struggled with decisions about the level of rigor of the data collection and analysis. Team members with more research training advocated for a strict adherence to scientific standards;

others preferred a more pragmatic approach geared towards the needs of the community. The emergency preparedness team experienced similar tensions, particularly because one member of the team had expertise in *bio-preparedness* (i.e., preparedness against life-threatening emergencies) while others were new to the area. Consistent with the observations of Nash and colleagues (2003), we found that leadership and patience were essential qualities to engage successfully in this work and integrate multiple contributions to forge a common solution.

Similarly, we found that flexibility, open-mindedness, and a respect for differing viewpoints are required for successful transdisciplinary efforts, as others have suggested (Russell, 2000; Stokols, 2006; see also [International Center for Transdisciplinary Research](#)). This was especially important because both the student and community collaborators included people with diverse backgrounds spanning academia, government, and community sectors. To paraphrase a popular remark about coalitions: If a transdisciplinary group is comfortable, it is probably not a broad enough group. We have learned to expect and value the unexpected. At the outset, we did not have the benefit of all the evidence and guidance from the many authors cited in this article. We are now considering ways to incorporate their recommendations into our curricular process--including the many competencies described by Nash and colleagues (2003), Stokols (2006), Kahn and Prager (1994), and Rosenfield (1992).

We experienced other inherent challenges in conducting transdisciplinary and translational research, such as labor intensity, substantial time investment, and concerns that the hoped-for benefits might not emerge during the course of the project (cf. Abrams, Leslie, Mermelstein, Kobus, & Clayton, 2003; Morgan et al., 2003). In both the projects described above, team members felt that the one-semester timeline limited the extent of transdisciplinary or translational success that could be achieved, and they had to make compromises. For example, the youth development project relied heavily on qualitative data, but the number of focus groups conducted had to be reduced. For group members who felt strongly about fully representing the youth voice, this was difficult to accept, but we were able to supplement our findings with previously collected data. The emergency preparedness team was also quite constrained by the logistics of dealing with the immediacy of the disaster, the challenge of navigating the local and state political scene, and the lack of a supportive infrastructure.

Despite these obstacles, students recognized the benefit of working in cross-disciplinary teams and engaging in transdisciplinary/translational work to address complex real-world problems. The mix of expertise in student teams and among our partner collaborators provided a much richer understanding of the problem, more tools to assess it, and more effective interventions than would have been possible as individual researchers or practitioners. Although public health is inherently “multidisciplinary” because it bridges social sciences, physical sciences, and the humanities, explicit transdisciplinary goals and processes are critical to harness the potential synergy among these disciplines. The DrPH-in-Action approach is one way to integrate these abstract goals into a tangible, realistic experience.

11. Conclusions

In his witty commentary, “It’s not Easy Being Interdisciplinary,” John Lynch (2006) reminds us that in 1944 the eminent psychologist Josef Brozek and the pioneering epidemiologist Ancel Keys provided three recommendations to increase interdisciplinarity for health benefits: “(1) facilities for getting acquainted with the problems and methods of the neighbor fields, (2) study of the ‘science of science’ which provides the necessary philosophical perspective, and (3) development of social skills required for a stimulating and efficient scientific cooperation” (Brozek & Keys, 1944, p. 512). Their counsel can serve us well today as we face the challenges of understanding the profoundly complex factors that affect people’s health, and working collaboratively to address them.

During the past half century, our view of scientific inquiry has undergone a radical transformation. We have learned that it takes many disciplinary perspectives and partners to create knowledge and integrate it to improve health. We must now reorient our academic and research institutions in a more transdisciplinary and translational direction. We are beginning to understand the many factors that can support or hinder this transformation, but have far to go to create the necessary commitment and curricular and other institutional changes.

Transdisciplinary and translational research practice needs to be developed in various fields, not only in public health. It requires innovations in research education and opportunities for international partnership to incubate and showcase this kind of work. The principles of transdisciplinary and translational research practice ought to inform the design and assessment of educational programs and other collaborative activities in these fields.

References

- Abrams, D. B. (2006). Applying transdisciplinary research strategies to understanding and eliminating health disparities. *Health Education and Behavior, 33*(4), 515-531.
- Abrams, D. B., Leslie, F. M., Mermelstein, R., Kobus, K., & Clayton, R. R. (2003). Transdisciplinary tobacco use research. *Nicotine and Tobacco Research, 5*(Suppl. 1), S5-S10.
- Balas, E. A., & Boren, S. A. (2000). Managing clinical knowledge for health care improvement. In J. H. van Bommel & A. T. McCray (Eds), *IMIA Yearbook of Medical Informatics* (pp. 65-70). Stuttgart, Germany: Schattauer.
- Bammer, G. (2005). Integration and implementation sciences: Building a new specialization. *Ecology and Society, 10*(2), Article 6. Retrieved March 19, 2007, from <http://www.ecologyandsociety.org/vol10/iss2/art6/>
- Berkman, L. F., & Kawachi, I. (Eds). (2000). *Social epidemiology*. New York: Oxford

University Press.

Best, A., Hiatt, R. A., & Norman, C. (2006). *The language and logic of research transfer: Finding common ground* [Report]. Working Group on Translational Research and Knowledge Integration, National Cancer Institute of Canada, Toronto, Canada.

Boyer, E. L. (1990). *Scholarship reconsidered: Priorities of the professoriate*. Princeton, NJ: Carnegie Foundation for the Advancement of Teaching.

Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by nature and design*. Cambridge, MA: Harvard University Press.

Brozek, J., & Keys, A. (1944). General aspects of interdisciplinary research in experimental human biology. *Science*, 100(2606), 507-512.

Council on Education for Public Health. (2005). *Accreditation criteria: Schools of public health*. Retrieved August 9, 2007, from <http://www.ceph.org/files/public/SPH-Criteria-2005.SO5.pdf>

Cook, T. (1985). Postpositivist critical multiplism. In R. Shotland & M. Mark (Eds), *Social science and social policy* (pp. 25-62). Beverly Hills, CA: Sage.

Cook, T., & Campbell, D. (1979). *Quasi-experimentation: Design and analysis issues for field settings*. Boston, MA: Houghton Mifflin.

Dalke, A., Grobstein, P., & McCormack, E. (2006). Exploring interdisciplinarity: The significance of metaphoric and metonymic exchange. *Journal of Research Practice*, 2(2), Article M3. Retrieved March 3, 2007, from <http://jrp.icaap.org/index.php/jrp/article/view/43/54>

Derry, S., & Fischer, G. (2005, April). *Toward a model and theory for transdisciplinary graduate education*. Paper presented at the meeting of the American Educational Research Association (AERA), Symposium on Sociotechnical Design for Lifelong Learning: A Crucial Role for Graduate Education, Montréal, Canada. Retrieved March 19, 2007, from <http://l3d.cs.colorado.edu/~gerhard/papers/aera-montreal.pdf>

Fuqua, J., Stokols, D., Gress, J., Phillips, K., & Harvey, R. (2004). Transdisciplinary scientific collaboration as a basis for enhancing the science and prevention of substance use and abuse. *Substance Use and Misuse*, 39(10-12), 1457-1514.

Gebbie, K., Rosenstock, L., & Hernandez, L. M. (Eds). (2003). *Who will keep the public healthy? Educating public health professionals for the 21st century*. Washington, DC:

- National Academies Press. Retrieved October 23, 2007, from <http://www.nap.edu/openbook.php?isbn=030908542X>
- Glasgow, R. E. (2002). Evaluation of theory-based interventions: The RE-AIM model. In K. Glanz, F. M. Lewis, & B. K. Rimer (Eds), *Health behavior and health education: Theory, research, and practice* (3rd ed., pp. 531-544). San Francisco, CA: Jossey-Bass.
- Glasgow, R. E., Lichtenstein, E., & Marcus, A. C. (2003). Why don't we see more translation of health promotion research to practice? Rethinking the efficacy-to-effectiveness transition. *American Journal of Public Health, 93*(8), 1261-1267.
- Green, J. (1990). Three views on the nature and role of knowledge in social science. In E. Guba (Ed.), *The paradigm dialogue* (pp. 227-245). Newbury Park, CA: Sage.
- Green, L. W., & Glasgow, R. E. (2006). Evaluating the relevance, generalization, and applicability of research: Issues in external validation and translation methodology. *Evaluation and the Health Professions, 29*(1), 126-153.
- Halfon, N., & Hochstein, M. (2002). Life course health development: An integrated framework for developing health, policy, and research. *Milbank Quarterly, 80*(3), 433-479.
- Israel, B., Schulz, A., Parker, E., & Becker, A. (1998). Review of community-based research: Assessing partnership approaches to improve public health. *Annual Review of Public Health, 19*, 173-202.
- Jensen, P. S. (2003). Commentary: The next generation is overdue. *Journal of the American Academy of Adolescent Psychiatry, 42*(5), 527-530.
- Kaewsonthi, S. (1989). *Internal and external costs of malaria surveillance in Thailand* [Report No. TDR/SER/PRS/6]. Special Programme for Research and Training in Tropical Diseases, World Health Organization, Geneva, Switzerland.
- Kahn, R. L., & Prager, D. J. (1994, July 11). Interdisciplinary collaborations are scientific and social imperative. *The Scientist, 17*, 11-12.
- Kerner, J., Rimer, B., & Emmons, K. (2005). Dissemination research and research dissemination: How can we close the gap? *Health Psychology, 24*(5), 443-446.
- Kiefer, L., Frank, J., Di Ruggerio, E., Dobbins, M., Manuel, D., Gully, P. R., et al. (2005). Fostering evidence-based decision-making in Canada: Examining the need for a Canadian population and public health evidence centre and research network. *Canadian Journal of Public Health, 96*(3), I1-I19.

- King, L., Hawe, P., & Wise, M. (1998). Making dissemination a two-way process. *Health Promotion International, 13*(3), 237-244.
- Letourneau, N., & Allen, M. (1999). Post-positivistic critical multiplism: A beginning dialogue. *Journal of Advanced Nursing, 30*(3), 623-630.
- Lynch, J. (2006). It's not easy being interdisciplinary. *International Journal of Epidemiology, 35*(5), 1119-1122.
- Marmot, M. G., Bosma, H., Hemingway, H., Brunner, E., & Stansfeld, S. (1997). Contribution of job control and other risk factors to social variations in coronary heart disease incidence. *Lancet, 350*(9073), 235-239.
- McEwen, B., & Seeman, T. (1999). Protective and damaging effects of mediators of stress: Elaborating and testing the concepts of allostasis and allostatic load. *Annals of the New York Academy of Sciences, 896*, 30-47.
- Minkler, M., & Wallerstein, N. (Eds). (2003). *Community based participatory research for health*. San Francisco: Jossey-Bass.
- Morgan, G., Kobus, K., Gerlach, K. K., Neighbors, C., Lerman, C., Abrams, D. B., et al. (2003). Facilitating transdisciplinary research: The experience of the Transdisciplinary Tobacco Use Research Centers. *Nicotine and Tobacco Research, 5*(Suppl. 1), S11-S19.
- Nash, J. M., Collins, B. N., Loughlin, S. E., Solbrig, M., Harvey, R., Krishnan-Sarin, S., et al. (2003). Training the transdisciplinary scientist: A general framework applied to tobacco behavior. *Nicotine and Tobacco Research, 5*(Suppl. 1), S41-S53.
- National Institutes of Health. (2005). *Overview of the NIH roadmap*. Retrieved March 19, 2007, from <http://nihroadmap.nih.gov/overview.asp>
- Neuhauser, L. (2005). Working with youth as partners to reduce the effects of trauma: Models from Belarus, Russia and the USA. In J. Donnelly, A. Kovacova, H. Osofsky, J. Osofsky, C. Paskell, & J. Salem-Pickartz (Eds), *Developing strategies to deal with trauma in children* (pp. 116-123). Amsterdam: IOS Press.
- Public Health Agency of Canada. (2006). *Innovations in education for public health: A Nevis Consulting Group study*. Retrieved October 23, 2007, from http://www.phac-aspc.gc.ca/php-psp/pdf/innovations_in_education_%20for_public_health_e.pdf
- Newell, W. H. (2001). A theory of interdisciplinary studies. *Issues in Integrative Studies, 19*, 1-25. Retrieved August 25, 2007, from

<http://www.units.muohio.edu/aisorg/pubs/issues1/restricted/042/paper.pdf>

Organization for Economic Cooperation and Development. (1996). *The knowledge-based economy* [Report]. Paris: Author. Retrieved November 13, 2007, from <http://www.oecd.org/dataoecd/51/8/1913021.pdf>

Potter, M. A., Quill, B. E., Aglipay, G. S., Anderson, E., Rowitz, L., Smith, L. U., et al. (2006). Demonstrating excellence in practice-based research for public health. *Public Health Reports, 121*(1), 1-16.

Reason, P., & Bradbury, H. (Eds). (2001). *Handbook of action research: Participative inquiry and practice*. Thousand Oaks, CA: Sage.

Rivera, J. A., Sotres-Alvarez, D., Habicht, J. P., Shamah, T., & Villalpando, S. (2004). Impact of the Mexican program for education, health, and nutrition (PROGRESA) on rates of growth and anemia in infants and young children: A randomized effectiveness study. *Journal of the American Medical Association, 291*(21), 2563-2570.

Rogers, E. (1982). *Diffusion of innovations* (3rd ed.). New York: Free Press.

Rosenfield, P. L. (1992). The potential of transdisciplinary research for sustaining and extending linkages between the health and social sciences. *Social Science and Medicine, 35*(11), 1343-1357.

Russell, W. (2000, April). Forging new paths: Transdisciplinarity in universities. *WISENET Journal, 53*. Retrieved March 17, 2007, from <http://www.wisenet-australia.org/issue53/transdis.htm>

Samuels & Associates. (2005). *University of California, Berkeley DrPH program evaluation report*. Oakland, CA: Author.

Smedley, B. D., & Syme, S. L. (Eds). (2000). *Promoting health: Intervention strategies from social and behavioral research*. Washington, DC: National Academies Press. Retrieved October 23, 2007, from http://www.nap.edu/catalog.php?record_id=9939

Stokols, D. (1996). Translating social ecological theory into guidelines for community health promotion. *American Journal of Health Promotion, 10*(4), 282-298.

Stokols, D. (1998, May 21). *The future of interdisciplinarity in the school of social ecology*. Paper presented at the Social Ecology Associates Annual Awards Reception, University of California, Irvine, CA. Retrieved August 25, 2007, from <https://eee.uci.edu/98f/50990/Readings/stokols.html>

- Stokols, D. (2000). Social ecology and behavioral medicine: Implications for training, practice, and policy. *Behavioral Medicine, 26*, 129-138.
- Stokols, D. (2006). Toward a science of transdisciplinary research. *American Journal of Community Psychology, 38*, 63-77.
- Stokols, D., Grzywacz, J. G., McMahan, S., & Phillips, K. (2003). Increasing the health promotive capacity of human environments. *American Journal of Health Promotion, 18*, 4-13.
- Stokols, D., Harvey, R., Gress, J., Fuqua, J., & Phillips, K. (2005). In vivo studies of transdisciplinary scientific collaboration: Lessons learned and implications for active living research. *American Journal of Preventive Medicine, 28*(2) (Suppl. 2), 202-213.
- Stokols, D., Taylor, B., Hall, K., & Moser, R. (2006, October). *The science of team science: An overview of the field*. Paper presented at the National Cancer Institute conference on the Science of Team Evaluation, Bethesda, MD. Presentation slides retrieved November 13, 2007, from http://dcccps.nci.nih.gov/BRP/scienceteam/Team_Science_Overview_Stokols_etal.pdf
- Sussman, S., Valente, T. W., Rohrbach, L. A., Skara, S., & Pentz, M. A. (2006). Translation in the health professions: Converting science into action. *Evaluation and the Health Professions, 29*(1), 7-32.
- Syme, S. L. (2005). The social determinants of disease: Some roots of the movement. *Epidemiologic Perspectives and Innovations, 2*, 2-23.
- Syme, S. L., & Frohlich, K. L. (2001). The contribution of social epidemiology: Ten new books. *Epidemiology, 13*, 110-112.
- Szostak, R. (2007). How and why to teach interdisciplinary research practice. *Journal of Research Practice, 3*(2), Article M17. Retrieved October 20, 2007, from <http://jrp.icaap.org/index.php/jrp/article/view/92/89>
- Turkkan, J. S., Kaufman, K. J., & Rimer, B. K. (2000). Transdisciplinary Tobacco Use Research Centers: A model collaboration between public and private sectors. *Nicotine & Tobacco Research, 2*, 9-13.
- United Nations. (1992). *Report of the United Nations conference on environments and development*. Retrieved November 12, 2007, from <http://www.un.org/documents/ga/conf151/aconf15126-1annex1.htm>

- United Nations Educational, Scientific and Cultural Organization. (2000). *Science for the twenty-first century: A new commitment*. Retrieved October 20, 2007, from <http://unesdoc.unesco.org/images/0012/001207/120706e.pdf>
- Wickson, F., Carew, A. L., & Russell, A. W. (2006). Transdisciplinary research: Characteristics, quandaries and quality. *Futures*, 38(9), 1046-1059.
- Wilson, N., Dasho, S., Martin, A. C., Wallerstein, N., Wang, C. C., & Minkler, M. (2007). Engaging young adolescents in social action through photo voice: The Youth Empowerment Strategies (YES!) project. *The Journal of Early Adolescence*, 27(2), 241-261.
- World Health Organization. (1978). *Primary health care* (Report of the international conference on primary health care, Alma-Ata, USSR). Geneva, Switzerland: Author.
- Yancey, A. K., Ory, M. G., & Davis, S. M. (2006). Dissemination of physical activity promotion interventions in underserved populations. *American Journal of Preventive Medicine*, 31(4) (Suppl. 1), S82-S91.
- Youngblood, D. (2007). Multidisciplinary, interdisciplinary, and bridging disciplines: A matter of process. *Journal of Research Practice*, 3(2), Article M18. Retrieved December 23, 2007, from <http://jrp.icaap.org/index.php/jrp/article/view/104/101>

Received 17 May 2007

Accepted 21 September 2007

[Copyright © 2007 Journal of Research Practice and the authors](#)