The Science of Team Science: An Overview of the Field

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NCI Conference on the Science of Team Science: Assessing the Value of Transdisciplinary Research

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Overview

- Present working definitions of key terms: the science of team science (STS), team science (TS) initiatives
- Describe diverse attributes of TS initiatives and scientific teams with respect to their size, organizational complexity, disciplinary composition, major goals, and geographic scope
- Focus on large research, training, and translational initiatives that are intended to promote cross-disciplinary integration
- Outline major conceptual, methodological, and translational concerns of the STS field and research questions that warrant further study

What is The Science of Team Science?

- The <u>science of team science (STS)</u> is a rapidly emerging field concerned with understanding and managing circumstances that facilitate or hinder the effectiveness of large-scale research, training, and translational initiatives
- The STS field has grown steadily in recent years, partly in response to societal concerns about the cost-effectiveness and accountability of public and private sector investments in team-based initiatives
- The STS literature encompasses diverse <u>conceptual models and</u> <u>methodologies</u> that have been used to assess the antecedents, processes, and outcomes of cross-disciplinary research programs
- There is a <u>need to characterize the STS field more clearly</u> in terms of its major theoretical, methodological, and translational concerns

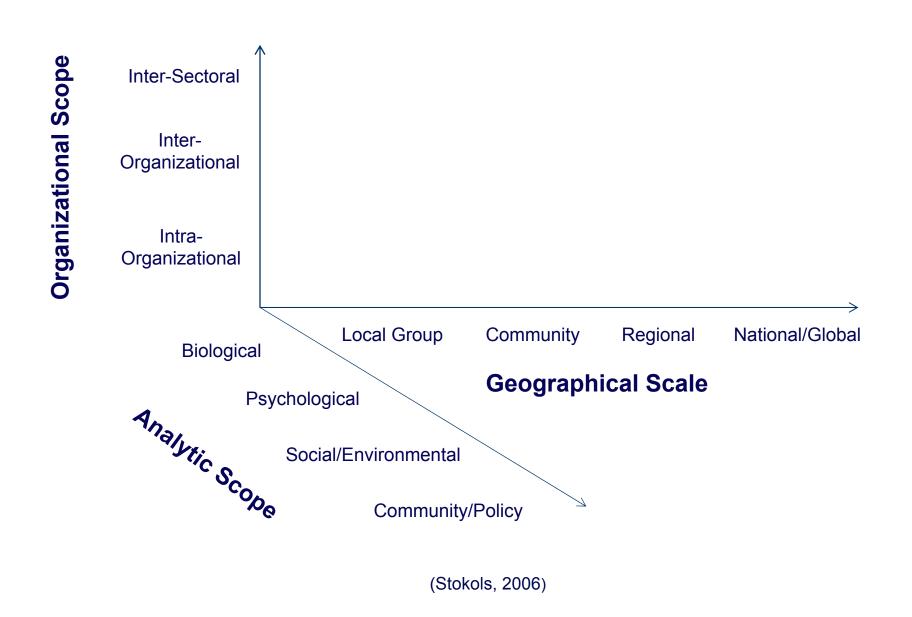
Team Science Initiatives--Key Features

- <u>Team science (TS) initiatives</u> are the principal units of analysis in STS studies--they include large research, training, and translational programs implemented by public agencies and non-public organizations
- TS initiatives are designed to <u>promote collaborative</u> and often cross-disciplinary approaches to analyzing research questions about particular phenomena

Diverse Attributes of Scientific Teams

- Research teams may be comprised of investigators drawn from the <u>same or different fields</u> (unidisciplinary vs. cross-disciplinary teams)
- Teams also <u>vary by size</u>, <u>organizational complexity</u>, <u>and geographic scope</u> ranging from a few participants working at the same site to scores of investigators dispersed across multiple geographic and organizational venues
- Research teams have diverse goals spanning scientific discovery, training, clinical translation, public health, and policy-related goals; the relative priorities among these goals vary from one initiative to the next

Organizational, Geographic, and Analytic Scope of Team Science Initiatives



Present Focus on Large Research Initiatives

- TS projects can include a handful of scientists working together at a single site, but we <u>focus here on larger and</u> <u>more complex initiatives</u> comprised of several investigators who work collaboratively on multiple projects and may be dispersed across different departments, institutions, and geographic locations
- <u>Large research initiatives</u> are solicited through specific requests for applications (RFAs), each with an average annual expenditure of \$5M and a duration of five or more years (Trochim et al., 2005)
- Large research initiatives often incorporate <u>training</u>, <u>clinical translation</u>, and <u>community health</u> components or "cores"

Emphasis on Cross-Disciplinary Initiatives

- This discussion focuses on initiatives intended to <u>promote cross-disciplinary (CD) collaboration</u>. CD teams strive to combine and in some cases integrate concepts, methods, and theories drawn from two or more fields
- Three different approaches to CD collaboration have been described by Rosenfield (1992):
 - → multidisciplinarity (MD)
 - □ interdisciplinarity (ID)
 - transdisciplinarity (TD)

Conceptual Concerns Within the STS Field

Defining Key Terms

- Team science (TS) initiatives
- ☐ The science of team science (STS)
- Types of cross-disciplinary (CD) collaboration
 (UD, MD, ID, TD research, training, translation)
- Criteria of program effectiveness (e.g., quality and scope of ID and TD integration)
- Readiness and capacity for scientific collaboration

Developing Theoretical Frameworks

- Antecedent-process-outcome models of scientific collaboration
- Typology of contextual influences on collaboration
- Identifying "high-leverage" determinants of collaboration readiness and capacity

Defining Qualities of Cross-Disciplinary Collaboration

- <u>Multidisciplinary</u> researchers in different disciplines work independently or sequentially, each from his or her own disciplinary-specific perspective, to address a common problem
- <u>Interdisciplinary</u> researchers work jointly, but from each of their respective disciplinary perspectives, to address a common problem
- <u>Transdisciplinary</u> researchers work jointly to develop a shared conceptual framework and methodological approach that integrates and transcends their respective disciplinary perspectives to address a common problem

Definition of Interdisciplinary Research in The NIH Roadmap Initiative

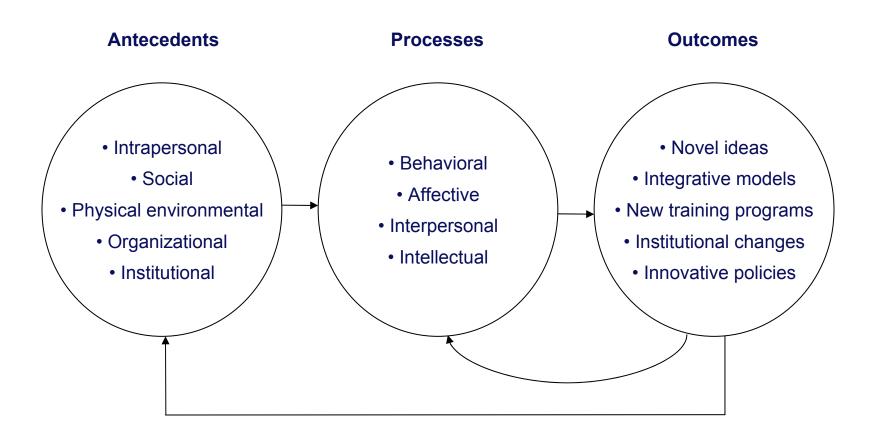
- "Interdisciplinary research integrates the analytical strengths of two or more often disparate scientific disciplines to <u>create a new hybrid discipline</u>. By engaging seemingly unrelated disciplines, traditional gaps in terminology, approach, and methodology might be gradually eliminated"
- Examples of interdisciplinary <u>hybrid fields</u>:
 - Genomics
 - Bioinformatics
 - Proteomics
 - Populomics
 - Psychoneuroimmunology

(Nihroadmap.nih.gov/interdisciplinary)

Defining and Measuring Program Effectiveness

- Traditional evaluative criteria of scientific quality emphasize conceptual validity, originality, methodological rigor, and the quantity of research outputs such as peer-reviewed publications
- <u>Criteria for evaluating TD team science</u> add the following considerations:
 - (1) the <u>quality and scope of cross-disciplinary</u> <u>integration</u> reflected in new conceptual models and methodological strategies
 - (2) the <u>impact of integrative intellectual products</u> in forging new avenues of scientific research, training, clinical applications, health policy, and improved health outcomes

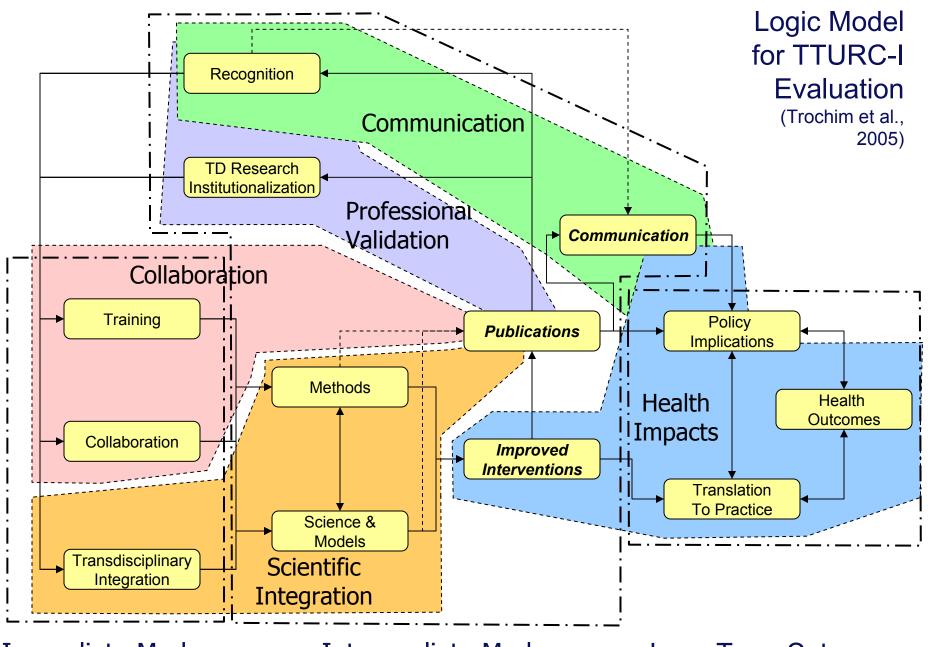
Conceptual Model of Transdisciplinary Scientific Collaboration



(Fuqua et al., 2002; Stokols et al., 2003)

Collaboration Readiness Factors

- Team members' history of collaboration on prior projects
- Institutional support for cross-disciplinary collaboration
- Leaders with collaborative orientation and experience
- Members share a strong commitment CD collaboration
- Spatial proximity of investigators' offices and laboratories
- Similarity of researchers' scientific worldviews
- Overlapping departmental identities of team members



Immediate Markers

Intermediate Markers

Long-Term Outcomes

Centers for Population Health and Health Disparities Conceptual Framework

CPHHD Initiative Flowchart

(Revised 12-14-04) Community Stakeholder - Investigator Incubator Investigator Development Translation of Policy Knowledge Methods Dissemination Community Practice Stakeholder Participation/ Models Integration Increased Publication Awareness Training Transdisciplinary Scientific Collaboration Integration Innovation Community Empowerment Transdisciplinary Activity/Capacity Building Interventions Health Outcomes (INPUTS) (ACTIVITIES) (OUTPUTS) (OUTCOMES) (OUTCOMES) Immediate Markers Intermediate Markers Short-term Outcomes Long-term Outcomes What we invest What we do, who we reach Learning & Action Ultimate Transformations Transdisciplinary Processes

Typology of Contextual Factors Influencing TD Scientific Collaboration at Each Level of Analysis

Intrapersonal

- Members' attitudes toward collaboration and their willingness to devote substantial time and effort to TD activities
- Members' preparation for the complexities and tensions inherent in TD collaboration
- → Participatory, inclusive, and empowering leadership styles

Physical Environmental

- Spatial proximity of team members' workspaces to encourage frequent contact and informal communication
- Access to comfortable meeting areas for group discussion and brainstorming
- Availability of distraction-free work spaces for individualized tasks requiring concentration or confidentiality
- → Environmental resources to facilitate members' regulation of visual and auditory privacy

Interpersonal

- Members' familiarity, informality, and social cohesiveness
- → Diversity of members' perspectives and abilities
- Ability of members to adapt flexibly to changing task requirements and environmental demands
- Regular and effective communication among members to develop common ground and consensus about shared goals
- Establishment of an hospitable conversational space through mutual respect among team members

Collaborative
Effectiveness of
Transdisciplinary
Science Initiatives

Societal/Political

- Cooperative international policies that facilitate exchanges of scientific information and TD collaboration
- Environmental and public health crises that prompt inter-sectoral and international TD collaboration in scientific research and training
- Enactment of policies and protocols to support successful TD collaborations (e.g., those ensuring ethical scientific conduct, management of intellectual property ownership and licensing)

Organizational

- Presence of strong organizational incentives to support collaborative teamwork
- Non-hierarchical organizational structures to facilitate team autonomy and participatory goal setting
- Breadth of disciplinary perspectives represented within the collaborative team or organization
- Organizational climate of sharing
- Frequent opportunities for face-to-face communication and informal information exchange

Technological

- → Technological infrastructure readiness
- Members' technological readiness
- Provisions for high level data security, privacy, rapid access and retrieval

(Stokols, Misra, Hall, Taylor, & Moser, 2006)

Methodological and Measurement Issues

- Strategic Evaluations of TS Initiatives those that apply evaluation resources efficiently to yield information about major contributions and limitations of particular programs, in a manner that is responsive to the needs of multiple stake-holder groups:
 - scientists and trainees
 - funding organizations
 - policy makers
 - translational partners

Methodological and Measurement Issues (cont.)

- Guidelines for Strategic Evaluations of TS Initiatives
 - Specify program theory underlying the evaluation
 - Use weighted measures of program success
 - Incorporate multiple methods of evaluation
 - Temporally sequence evaluative measures
 - Work toward convergent validation of evaluation data
 - Account for research design and sampling limitations

Translational Concerns Within the STS Field

- Translating research findings from TS initiatives into clinical and preventive practices
- Translating research findings from TS evaluation studies to enhance future collaborative initiatives
- Strategies for building greater capacity for scientific collaboration in TS initiatives
 - Collaboration readiness audits
 - Workshops and training modules
 - Formative evaluation for continuous quality improvement

Directions for Future STS Research

- Empirically assess assumptions and hypotheses of conceptual models (e.g., links between collaboration readiness factors and TS outcomes)
- Assess the impact of interpersonal processes and leadership styles on scientific collaboration
- Evaluate cyber-infrastructures and other institutional resources designed to support scientific collaboration
- Implement and evaluate strategies for enhancing scientific collaboration (e.g., collaboration readiness audits, training modules, formative evaluations of ongoing initiatives)
- Assess processes and outcomes of cross-disciplinary training (including ID and TD mentorship models)
- Facilitate the translation of TS research findings into effective clinical, community health, and policy innovations
- Enhance the transfer of knowledge across TS initiatives and evaluations and maximize potential synergies among multiple initiatives

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