LEADING TEAM SCIENCE:
CONSIDERATIONS IN ORGANIZING,
MANAGING & SUPPORTING CROSS-DISCIPLINARY SCIENTIFIC TEAMS

MICHR Mentoring Forum:
Mentoring Effective Team Scientists
July 10, 2012

Holly J. Falk-Krzesinski, PhD

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My Background

• A microbiologist by training, a social scientist in practice
• Basic research in academia, applied research in pharma
• Research Assistant Professor and Director, Research Team Support & Development, NU Clinical and Translational Science Institute (NUCATS), Northwestern University
• Former: Associate Director, IBiS Graduate Program, Northwestern University and Director, Research Training Program, Children’s Memorial Research Center
"Team research, especially interdisciplinary research, is characterized by synergies among experts that can transform both scholars and scholarship“

– John Cacioppo, PhD, the Tiffany and Margaret Blake Distinguished Service Professor in Psychology, The University of Chicago, from the Arete Initiative website http://arete.uchicago.edu/ (2010)
Research Team Support & Development

• A conduit to translate empirical findings from team science research into evidence-based direction about effective practices for cross-disciplinary scientific teams and funders of team science—a bridge between the *science* of team science and the *praxis* of team science

NUCATS
Clinical and Translational Sciences Institute

NORTHWESTERN UNIVERSITY
Leading Team Science
“Team science is beholden to scholars of teamwork to aid in this area of practice.”

– Stephen Fiore, PhD, (2011), INGRoup Conference 2011
Science Team Research

• There is an increased demand for team science initiatives in academia and by external funding agencies

• Coordination costs mean that team science takes more time, at least proximally; distal payoff in terms of acceleration

• Imperative then that we understand the most effective practices for productive cross-disciplinary collaboration and team science
Science of Team Science (SciTS)

• A new interdiscipline and rapidly emerging field in which Northwestern is a champion
• Concerned with understanding and managing circumstances that facilitate or hinder the effectiveness of large-scale cross-disciplinary, collaborative research, training, and translational initiatives
• Field has grown
  – Societal concerns
  – Cost-effectiveness
  – Accountability
Contextual Factors Influencing Team Science

**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 a hospitable conversational space through mutual respect among team members

**Organizational**
- Presence of strong organizational incentives to support collaborative teamwork
- Nonhierarchic 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 (e.g., sharing of information, credit, and decision-making responsibilities is encouraged)
- Frequent scheduling of social events, retreats, and other centerwide opportunities for face-to-face communication and informal information exchange

**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 (e.g., sound masking, closable doors and workstation panels) to facilitate members' regulation of visual and auditory privacy

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

**Technologic**
- Technologic infrastructure readiness including access to necessary bandwidth, electronic communication equipment, strong network linkages between remote sites, availability of technical support
- Members' technologic readiness (e.g., their familiarity with electronic information tools and protocols, and the effectiveness of their communication styles)
- Provisions for high-level data security, privacy, rapid access and retrieval

COMMENTARY

TEAM SCIENCE

A Multi-Level Systems Perspective for the Science of Team Science

Katy Börner,¹ Noshir Contractor,² Holly J. Falk-Krzesinski,³ Stephen M. Fiore,⁴ Kara L. Hall,⁵ Joann Keyton,⁶ Bonnie Spring,⁷ Daniel Stokols,⁸ William Trochim,⁹ Brian Uzzi¹⁰

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This Commentary describes recent research progress and professional developments in the study of scientific teamwork, an area of inquiry termed the “science of team science” (SciTS, pronounced “sahyts”). It proposes a systems perspective that incorporates a mixed-methods approach to SciTS that is commensurate with the conceptual, methodological, and translational complexities addressed within the SciTS field. The theoretically grounded and practically useful framework is intended to integrate existing and future lines of SciTS research to facilitate the field’s evolution as it addresses key challenges spanning macro, meso, and micro levels of analysis.
Q: One topic that should be part of a comprehensive research agenda for the science of team science is ...
Team Effectiveness Findings

- Provide multiple skills/skill sets
- Ability to learn more and faster
- Foster creativity
- Tendency toward speed and innovation
- Ability to address complex problems
- Success in challenging environments
Even More to Put Into Practice

• Increasingly difficult to make scientific discoveries
• More people required to find out new things
• Research increasingly done in teams, for virtually all fields
• Teams typically produce more highly cited research than individuals
• Teams that are more diverse are even more highly impactful
• More team science is done inter-institutionally
• Virtual communities produce higher impact work
• International collaboration shows a further boost in citation impact
• But, dispersed teams have a high rate of failure
• Women scientists who do not collaborate are less productive
TEAM SCIENCE

“...society’s problems do not fit neatly into the University’s departmental grid, nor are they rapidly divisible into subproblems...interdisciplinary research teams can readily respond to multi-discipline, problem-oriented research and public service opportunities.”

Cross-disciplinary Collaboration

- (Uni)Disciplinary research
- Combine or integrate from more than one field
  - Concepts, Methods, and Theories
- Three cross-disciplinary research orientations
  - Multidisciplinary
    - Independent, Sequential, Divisional
    - Exchange
  - Interdisciplinary
    - Joint, Interactive, Partnership
    - Dialogue, Exchange, Hybridization, Complementary
  - Transdisciplinary
    - Integrative, Interdependence, Immergence
    - Reciprocity, Discourse, Share Vocabulary, Extends
Science Facilitated by Team Science

• Problem-, Project- or Product-oriented
• Urgent and Complex
• Shared Goal between investigators from different disciplines/with different expertise
• Shared Approach through a common facility, instrumentation, data set(s):
• Intractability: Successive efforts not able to make progress
• Grand Challenge: Intellectual challenge and potential high payoff
• Complementary to *not mutually exclusive of* individual investigator-driven research
“Communication is elevated to the essence of collaboration.”

Challenges of Team Science

- Misunderstandings, disagreement, and conflict (not Groupthink)
- Mistrust
- Lack of recognition of others’ expertise
- Different paradigmatic assumptions
- Cultural differences
- Lack of process skills
- Institutional disincentives

Trust and Communication

• Societal, organizational, group, and individual factors enhance and undermine research integrity within collaborative, team science
• Thus it is critical to focus on issues of trust and communication when building and participating in research teams
Communication and Team Science

• Establishing collaboration
  – Formalizing collaboration
  – Determining terms of collaboration

• Maintaining Collaboration
  – Continually developing trust
  – Managing conflict
  – Use of distributed collaboration technologies

• Termination Collaboration
“…the achievement of major [transdisciplinary] innovations hinges on whether leaders have the capacity to enable deep diversity to thrive while simultaneously forging integration across disciplinary boundaries within their teams.”

Conditions for Team Effectiveness

• Essential
  – Real team; bounded, stable
  – Compelling direction; clear, consequential
  – Sound team structure; composition norms

• Enabling
  – Supporting organizational context; rewards
  – Available expert coaching; leadership & peer coaching

Assembling the Team

- Expertise \( (q) \) = Incumbents/Newcomers
  - Incumbents – established reputation in field
  - Newcomers – “rookies” w/ little experience

- Diversity \( (p) \) = Tendency to repeat previous collaborations

- Relative size \( (S) \) = Team Size & Degree connectedness

Assembling the Team

• Higher fraction of incumbents is better, they contribute expertise and know-how to the team (but only up to a point)

• More diversity is better, teams that are less diverse typically have lower levels of performance (don’t repeat collaborations with the same team members)

• Team size evolves with time, probably up to an optimal size

• Teams formed by individuals with large but disparate sets of collaborators are more likely to draw from a more diverse reservoir of knowledge
Team Composition

Team of Experts ≠ Expert Team
## Expertise & Coaching

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- You must have the right mix of expertise
- Must also receive intervention to help use the collective expertise well
Implications for Team Leadership

• Decide if team is necessary, if so, what type of team
• Get the essential and enabling conditions in place and keep them there (60%)
• Launch the team well (30%)
• Coach at the margins to help ensure the team takes full advantage of its favorable performance circumstances (10%)
• Appropriate leadership = Team effectiveness & Member satisfaction
Critical Leadership Tasks

• Cognitive
  – Involves the management of meaning, introducing a mental map of desired goals and methods for getting there

• Structural
  – Providing focus and defining objectives, recruiting necessary expertise, and ensuring project’s accountability (e.g., deadlines, deliverables)

• Processual
  – Improving how collaborators interact

Cognitive Tasks

• Visioning
  – Alignment of team members self concepts and individual scientific aspirations with larger team mission
  – Promote divergent thinking, risk-taking, and challenges to established methods

• Framing
  – Mental model construction that provides a sense-making device for members
  – Motivation to work productively together
  – Develop a common language

• Judgment
  – Make discriminating decisions about numerous issues: personnel, project, resources
Structural Tasks

• Coordination and information exchange
  – Within the team
  – With external stakeholders
  – Boundary spanners

• Brokerage
  – Crossroad between groups
  – Building linkages and increasing information flow among previously unrelated parties
  – Conflict-handling for dispute resolution in the group
  – Ameliorate power and status differences among diverse groups
Processual Tasks

• Process Dynamics, Interpersonal Skills
  – Designing meetings
  – Determining ground rules
  – Identifying tasks to move the partners toward their objectives
  – Building trust among collaborators
  – Ensuring effective communication
  – Garnering buy-in from members and their institutions

• Project Management
  – Goal-setting
  – Planning
  – Coordinating information exchange
  – Monitoring progress
Multiple Leaders

- Valuable for larger, more dispersed teams with multiple sites
- Ensures that separate units builds buy-in and commitment to overarching team goal
- Must design effective coordination and information exchange
- Increase sustainability of collaborations when research results need to be disseminated to community participants
NIH Multiple PI/PD Leadership Plan

- Administrative processes and PI responsibilities
- Roles/areas of responsibility of the PIs
- Fiscal and management coordination
- Process for making decisions on scientific direction and allocation of resources
- Data sharing and communication among investigators
- Publication and intellectual property (if needed) policies
- Procedures for resolving conflicts
Team Science Funding

- NIH & NSF
  - Mechanisms
  - Specific Programs
  - Research Centers
  - Collaborative Admin Supplements
  - Joint Programs
  - Intern’l Collaboration
  - Capacity Building

- DOE
- NASA
- DoD
- ED
- NEH
- USDA
- Foundations

http://www.nordp.org/funding-opportunities
Team Development Activities

• Identify and engage potential collaborators and assemble the team
• Develop partnerships, a collaborative research agenda, shared conceptual framework
• Consider how to expand the # and type of investigators working on the problem
• Promote mentoring, conflict management, cross-talk, integration
• Disseminate findings, sustain the collaboration
• Evaluate process and outcomes
Discussion Questions


- What was the nature/impetus for the collaboration?
- What factors helped the team build trust?
- What factors threatened that trust?
- How did the team use communication effectively?
- What communication issues were problematic for the team?
- How did the team manage conflict?
- What strategies did the team employ to share credit?
- What role, if any, do power and hierarchical relationships play in this case?
TRAINING AND TOOLS FOR
TEAM SCIENCE

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Holly J. Falk-Krzesinski, PhD
THE FUTURE OF TEAM SCIENCE

“…a generation of scientists must be trained to both understand and embrace team science.”

Team Science Training

• Imperative then that we understand the most effective practices for productive cross-disciplinary collaboration and team science

• Equally important that we **train** individual investigators, institutional leaders, and funding agencies to **employ** them
Empirical, Competency-based Learning


Graduate Education to Facilitate IR Collaboration

• Identifying Individual Competencies and Developmental Strategies
  – What are the *individual competencies* (knowledge, skills, and attitudes) needed for effective interdisciplinary research collaboration?
  – What specific graduate education *strategies and learning experiences* will facilitate the development of the identified competencies?
Team Science Needs Teamwork Training

• We argue that science training should not solely focus on taskwork competencies – rather, it should include teamwork competencies
• Specifically, team generic competencies are critical
  – Cross-disciplinary science teams are more and more common
  – These transportable skills can enable more effective teamwork in a variety of team contexts
• One particularly important team-generic competency is interpersonal skill (IPS)
  – An umbrella term for “goal-directed behaviors, including communication and relationship-building competencies, employed in interpersonal interaction episodes characterized by complex perceptual and cognitive processes, dynamic verbal and nonverbal interaction exchanges, diverse roles, motivations, and expectancies”
  – A comprehensive taxonomy of IPS organized around two overarching dimensions: interpersonal communication and relationship-building
Team Science Graduate Course

- Launched through the MSCI program and Graduate School at Northwestern University in Fall 2010
  - Graduate (MS and PhD) students in STEM and medicine (MSCI, MPH, Clinical Fellows) graduate programs
- Literature review and focus on the SciTS field
  - Examine the trend toward team science collaboration in research some of the reasons why
  - Focused on how team research provides empirically-grounded guidance to promote the effectiveness of science teams
- Offers practical guidance about how best to engage in team science
  - Pursue complex science questions
  - Work effectively with team members
  - Produce high impact research outcomes that help meet society’s needs

“The course will make you rethink the insular culture of science you were brought up to believe in.”

Dr. Bernard R. Bendok, MD, FACS, Team Science student
Team Science Course Topics

- Cross-disciplinary Research, Team Science, & Science of Team Science (SciTS)
- Evaluating Team Science
- Team Leadership and Team Composition
- Sociotechnical Coordination of Distributed Teams
- Collaboration Readiness and Integrity in Collaboration
- Communication and Conflict Management
- Team Cognition and Learning for Cross-disciplinary Collaboration
- Diversity Issues in Collaboration and Team Science
- Training for Team Science
- Institutional Structure and Policy for Team Science
Collaboration & Team Science: 
A Field Guide

NIH Resources

https://ccrod.cancer.gov/confluence/display/NIHOMBUD/Home
NIH Partner Agreement

- Overall Goals & Vision
- Who Will Do What
- Authorship, Credit
- Contingencies & Communicating
- Conflict of Interest
Leadership Series

- Leadership Skills
- Collaborative Communication
- Collaborative/Center Funding Opportunities and Grant Proposal Development
- Cognition and Conflict Management
- Negotiation and Networking
- Reward System Discussion
The Toolbox Project\textsuperscript{1,2} Collaborative Communication Workshop provides a philosophical yet practical enhancement to cross-disciplinary, collaborative science. Rooted in philosophical analysis, the Toolbox workshop enables investigators, research development professionals, project managers, and collaborators to engage in a structured dialogue about their research assumptions and cross-disciplinary collaboration. This yields both self-awareness and mutual understanding, supplying individuals with the robust foundation needed for effective collaborative research. Led by Toolbox Project Facilitators, Workshop participants will engage in small group discussion and share respective views in response to a number of probing statements about science motivation, methodology, confirmation, objectivity, values, and reductionism.


# Toolbox Questionnaire

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<tr>
<th>Philosophical domain and issue</th>
<th>Core question</th>
<th>Probing Statements</th>
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<tr>
<td>Motivation</td>
<td>Does the principal value of research stem from its applicability for solving problems or its potential for making basic discoveries?</td>
<td><strong>Epistemology</strong></td>
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|                               |              | 1. Applied research is more important to me than basic research.  
|                               |              | *Disagree* 1 2 3 4 5  *Agree* |
|                               |              | 2. Cross-disciplinary, collaborative research is better suited to addressing applied questions than basic questions.  
|                               |              | *Disagree* 1 2 3 4 5  *Agree* |
|                               |              | 3. My research primarily addresses basic questions.  
|                               |              | *Disagree* 1 2 3 4 5  *Agree* |
|                               |              | 4. The importance of our project stems from its applied aspects.  
|                               |              | *Disagree* 1 2 3 4 5  *Agree* |
|                               |              | 5. The members of this team share similar views concerning aspects of basic and applied research.  
|                               |              | *Disagree* 1 2 3 4 5  *Agree* |
Collaboration Success Wizard

- On-line diagnostic survey for geographically distributed collaborations. The survey probes factors that may strengthen or weaken the collaboration. The Wizard provides both personal and project-level reports to help build successful and productive collaborative projects.

Thank You

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