The Praxis of Team Science: Resources, Funding, and Support for Collaborative Research

UCF Grants Day: Strategies for Team-Based Research
April 9, 2012

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NUCATS Clinical and Translational Sciences Institute

INTRODUCTION

"Most of the work still to be done in science and the useful arts is precisely that which needs knowledge and cooperation of many scientists and disciplines. That is why it is necessary for scientists and technologists in different disciplines to meet and work together, even those in branches of knowledge which seem to have least relation and connection with one another."

- *French chemist Antoine Lavoisier, 1793 (see Macrina, F.L. 2005. Scientific Integrity : Text and Cases in Responsible Conduct of Research, 3rd ed, Washington, D.C., ASM Press)*

Holly Falk-Krzesinski

- Research Assistant Professor and Director, Research Team Support & Development, NU Clinical and Translational Science Institute (NUCATS), Northwestern University
- Founding President, National Organization of Research Development Professionals (NORDP)

Leading Team Science

Presentation Agenda

- Science of Team Science (SciTS)
- Praxis of Team Science
  - Research Team Support & Development
  - Collaboration Enhancement
  - Research Development & Team Science Grantsmanship
  - Training & Tools

SCIENCE OF TEAM SCIENCE (SciTS)

"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 and employ the most effective practices for productive cross-disciplinary collaboration and team science**

Why Teams

- Ability to learn more and faster
- Provide multiple skills/skill sets
- Interdependency of tasks/processes/methodologies
- 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
- Teams learn more and faster
- 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."

- *Remick, F. (2000). Barriers to Organized Interdisciplinary Research in a University Environment, in The Interdisciplinary Imperative: Interactive Research And Education, Still An Elusive Goal In Academia (Writers Club Press).*

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

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

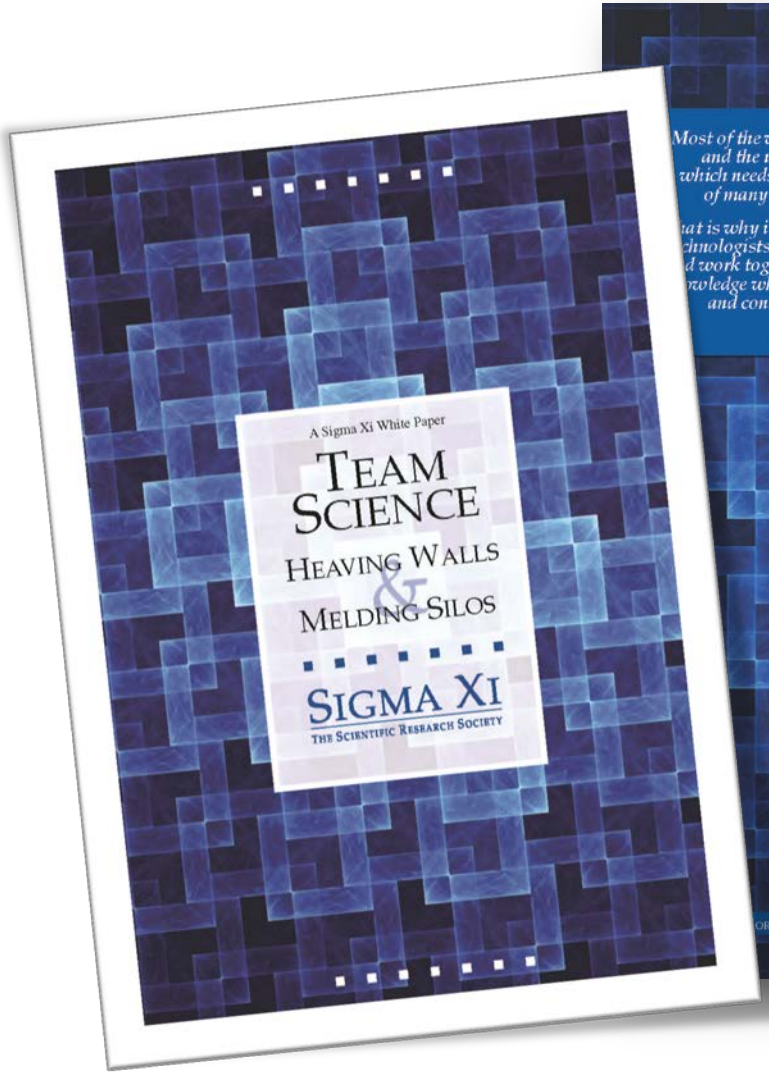
NORTHWESTERN UNIVERSITY

NUCATS Clinical and Translational Sciences Institute

RTS&D Consulting

- Supporting team development and investigator collaboration
  - Collaboration Enhancement: Collaborator identification, New collaboration facilitation, Collaboration tools & resources
  - Research Development: Funding opportunities, Catalytic events, Program development, Proposal development
  - Team Science Training & Tools…

Making an Impact



by Lynn E. Elfner, Holly Falk-Krzesinski, Kelly Sullivan, Andrew Velkey, Deborah L. Illman, Jerry Baker and Antonio Pita-Szczesniewski

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ANTOINE LAVOISIER, 1793

Once science was the nearly exclusive province of the lone researcher. Now scientists from disparate fields glean grains of knowledge that when combined may address important societal problems and complex scientific questions. Individuals still must master their respective fields, but their contributions within teams assembled to transcend disciplines increasingly add to the whole to make it greater than the sum of the parts. Worldwide, scientific research has taken a new approach to discover and apply knowledge from many seemingly unrelated disciplines to create completely new research and problem-solving approaches.

Intractable 21st-century global problems such as climate change, healthcare delivery, energy and water resources, food safety, defense, disease and natural disaster mitigation demand solutions fostered by teams that integrate their unique discipline-based perspectives and findings to form broadly generalisable answers. Even when the problems are not global, melding the concepts, methods and models of traditional, discrete fields embedded in academic silos increases the practical depths and expands the effective boundaries of scientific discovery and the opportunities for innovation. One result is the emergence of completely new, inter- or transdisciplinary fields such as neuroendochrinology, chaos and complexity, genomics, combinatorial science, bioinformatics and regenerative medicine.

In her survey of National Science Foundation engineering centers of excellence, Illman (2007) remarked, "History may look back on these last couple of decades as a time when science grew up and took on real-world problems instead of sticking to the safe and tidy world of the tractable, in which studies are undertaken because that are do-able, even if not directly useful."

In short, transdisciplinary team science is on the court competing effectively for funds and producing results that benefit science, society and the world's institutions and organizations like Sigma Xi. The science of team science (SciTS), itself, is an emerging research field gaining traction to provide evidence-based guidance about effective practices for team science for practitioners and funders.

History of Team Science

The concept and need for team science are not new. As early as 1793, the French chemist Antoine Lavoisier (Macrina 2005) was concerned that science and the useful arts needed a team approach with contributions from different disciplines, even from those not apparently related or connected. Brozek and Keys (1944) cite Jewett and King (1940)

ORG

Elfner, L.E., Falk-Krzesinski, H.J., Sullivan, K., Velkey, A., Illman, D.L., J., and Pita-Szczesniewski, A. (2011). Team Science: Heaving Walls & Silos. American Scientist 99, s1-8.

COLLABORATION ENHANCEMENT

"If more work is being done in teams and that work is of greater impact, then surely locating the right members for any team is more important than ever."

- *Carey, J. (2011). Faculty of 1000 and VIVO: Invisible Colleges and Team Science. In Issues in Science and Technology Librarianship.*

Collaboration Facilitation

- Complex research problems require cross-disciplinary collaborative investigation and scholarly activity, with more work being done in teams
- Effective practices and tools to support the efforts of researchers and research development professionals to initiate and nurture partnerships and secure collaborative extramural research funding are needed
- Collaboration facilitation necessary to reduce time spent *searching*, to *find* matches more quickly, and to help make non-intuitive matches—accelerate knowledge discovery

Expertise and Scholarship Sources

- Published journal papers/articles
- Published reviews
- Books, book chapters
- Newspaper articles about faculty
- News releases about faculty
- Editorials about faculty
- Editorials or commentaries written by faculty
- Patents and patent applications
- IP, not patents
- Invention disclosures
- Grant abstracts
- Citation indices
- Clinical trials
- Reported methodological expertise
- Teaching
- Course material
- Animal research protocols
- Human research protocols
- Advisory boards/councils
- Professional organizations
- Committee/service work
- Outreach activities
- Narratives (bios and research/program descriptions)
- Subject areas
- Keywords
- Creative works
- Conference papers & proceedings
- Conference presentations
- Reference works/entries
- Course evaluations
- Civic engagement
- Consulting
- Internet communications
- Software/algorithms
- Curated datasets
- Legal activities
- General press activities
- Legal proceedings and briefs
- Technical reports
- Awards (non-grants)
- Former advisors
- Former trainees

Current “Collaborator-finder” System

- Low capability (e.g., Google, LinkedIn, School-based systems, Holly’s brain)
- Connectivity is relationship based
- Serendipitous
- Tendency to return to previous collaborators
- Only active, not passive networking
- Especially difficult to go beyond own unit/scholarly domain
- Information tends to lag practice
- Individual knowledge vs. institutional knowledge
- Limited storage capacity; Memory capacity loss over time

Research Networking Tools

- Web-based knowledge management system for the research enterprise
- Faculty expertise/profile harvesting system
- Facilitate new collaborations through discovery of expertise
- Intellectual networking vs. social networking
- Northwestern Scholars: http://www.scholars.northwestern.edu/

Expertise Discovery & Data Repurposing

NIH CTSA DIRECT2Experts Institutions

SciVal Experts Community Institutions

VIVO institutions

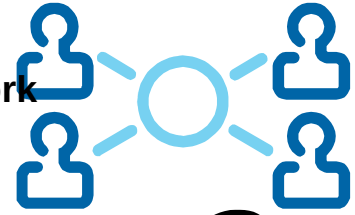
Funders, legislators, collaborators, trainees, candidates, reviewers, media outlets, public

Northwestern Scholars

- Research/Scholarship Interests & Activities
- Publications and Scholarly Works
- Grants
- Professional Networks

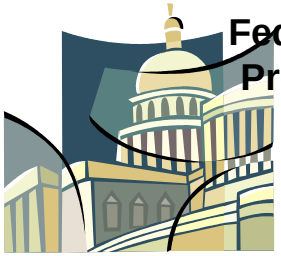
Grant Funding Opportunities

Faculty & Research Activity Reporting & Evaluation



Social Network Analysis Research

Data for Grant Applications



Fed-wide Profiles

Reference Management

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.

http://hana.ics.uci.edu/wizard/index.php

RESEARCH DEVELOPMENT

"Team Science is characterized by large cross-disciplinary collaborative research projects comprised of large teams of scientists, that often integrate research with broader goals including education, technology transfer, outreach and diversity enhancement…Research Development enhances the efforts of faculty to foster the development of collaborative, team-based science as well as compete for large research center and consortia funding opportunities."

– *National Organization of Research Development Professionals (NORDP) web site*

Applying the Science

- The *praxis* of team science
- Enhance efforts of faculty/investigators and foster the development of collaborative, team-based science as well as compete for large research center and consortia mechanisms
- Build resources/share effective practices that foster and enhance intra- and inter-institutional, cross-disciplinary research collaboration
- Identify funding opportunities to catalyze and support cross-disciplinary team-based research

NORDP
National Organization of Research Development Professionals

Team Science Initiatives

- Large research, training, and translational programs
- Collaborative and interdisciplinary scientific approach
- Extended multi-dimensional scope (analytical, geographical, organizational)
- Problem-, Project- or Product-oriented
- Urgent and Complex
  - Intellectual challenge and potential high payoff
  - Successive efforts not able to make progress
- Shared goal, facility, instrumentation, data set(s)
- **Complementary to, not mutually exclusive of, individual investigator-driven research**

Cross-disciplinary Team Science

- Complex Initiatives
  - Several collaborating investigators
  - Multiple projects
  - Dispersed
- Multiple Components
  - Research
  - Pilot Projects
  - Cores
  - Education/Training
  - Clinical /Industrial Translation
  - Community Health
  - Outreach

NIH Common Fund Interdisciplinary Research Consortia
http://commonfund.nih.gov/interdisciplinary/

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
  - DOT
  - Foundations

NORDP
National Organization of Research Development Professionals

http://www.nordp.org/funding-opportunities

Trans-NIH Opportunities

- NIH Roadmap/Common Fund (Division of Program Coordination, Planning, and Strategic Initiatives – DPCPSI)
  - Transformative R01 Program (T-R01)
- Office of Behavioral and Social Sciences Research (OBSSR)
- Office of Research on Women's Health (ORWH)
- Office of AIDS Research (OAR)
- Office of Disease Prevention (ODP)
- NIH Blueprint for Neuroscience Research
- NIH Obesity Research
- The Bioengineering Consortium (BECON)
- Biomedical Information Science and Technology Initiative (BISTI)
- Model Organisms for Biomedical Research
- Trans-NIH Mouse Initiatives
- Trans-NIH Xenopus Working Group

NEW!: NSF CREATIV

- Creative Research Awards for Transformative Interdisciplinary Ventures
- Pilot grant mechanism under the Integrated NSF Support Promoting Interdisciplinary Research and Education (INSPIRE) initiative
- Support bold interdisciplinary projects in all NSF-supported areas of science, engineering, and education research
- Only internal merit review is required
- Proposals must be interdisciplinary (>1 divisions/programs) and potentially transformative
- Up to $1,000,000 (total costs) over 5 yrs

Team Grant Proposals

- Integrated effort
- Coordination, interrelationships, cohesiveness, and synergy among the research projects and cores as they relate to the common theme
- Advantages of conducting the proposed research as a team initiative vs. independent research projects
- Mechanisms for regular communication and coordination among investigators in the program
- Appropriateness of leadership/management/administrative structures, and day-to-day operations of the program

Building Research Teams

- NIH Exploratory Center Grants (P20)
  - Support planning activities associated with large multi-project program project grants
  - Support for shared resources and several small exploratory research projects (R03-like)
  - Focused on a common research theme
- Canadian Institutes of Health Research (CIHR) Planning Grants program is similar
- NIH "Repurposed" R13
  - Scientific Meetings for Creating Interdisciplinary Research Teams (R13)
- NSF Research Coordination Networks (RCN)
  - Research Networks in the Mathematical Sciences (RNMS)
- New FSM Dean's Multi-investigator Seed Grant Program
- New CBC Exploratory Workshops Funding

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

Multiple PIs and Team Science

- 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

NIH Multiple PI/PD Leadership Plan

- Roles/areas of responsibility of the PIs
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- 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

Career Advancement and Team Science

"Because independent work in the prevailing of scientific identity, junior scientists establishing their careers need to recognize the importance of balancing collaborative and independent work."

- *Macrina, F.L. (2005). Collaborative Research in Scientific Integrity : Text and Cases in Responsible Conduct of Research, 3rd edn, Chapt. 8, pg 201. Washington, D.C., ASM Press*

Opportunities for Early Career Faculty

- Negotiate that an R01-like project on a P01 (PPG) counts as an actual R01 award
- Access to research cores
- Access to capital equipment
- Access to graduate student (and postdoctoral support)
- Access to admin resources
- Likelihood of earlier publication on higher impact manuscripts
- Women scientists who don’t collaborate are less productive

TRAINING & TOOLS

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

- *Fiore, S.M. Interdisciplinarity as teamwork - How the science of teams can inform team science. Small Group Research 39, 251-277. (2008)*

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**

Collaboration Readiness

- The extent that potential collaborators are motivated to work with each other.

Finholt, T.A., and Olson, G.M. (1997). From laboratories to collaboratories: A new organizational form for scientific collaboration. Psychological Science 8, 28-36.

Collaboration Motivators

- Necessary for innovation
- To avoid competition
- Shared interests
- Best serves problem-centric science
- To solve problems faster
- Necessary to pursue interdisciplinary research
- Lack of a special/specific skill set
- Having a special/specific skill set that others need
- Have a data set and/or tool others could benefit from
- Want/need to learn a new skill (set)
- Economic value (e.g., access to internal or external research support)
- Access to trainees
- Access to scientific resources (e.g. capital/specialized equipment or cores)
- Access to administrative support
- Apprenticeship/training opportunity
- Mentoring opportunity
- Need for a division of labor
- For recognition
- To extend my reach/build my network
- Natural affinity to help others, strong service attitude
- Like working with other people
- Intellectually stimulating with regards to my own research program
- Enjoy learning about new areas of science/scholarship
- Like sharing my passion
- It's fun
- A previous rewarding experience

Collaboration Deterrents

- Prefer being autonomous
- Value independence
- Value individual expertise
- Prefer hierarchical relationships
- Don't wish to express a need
- Don't want to become dependent
- Need to be viewed as independent
- Fear of rejection
- Preference for competition
- Conflict avoidance
- Time constraint(s)
- Concern about getting promoted/tenured
- Too hard to agree on a common goal
- Science is best served via individual investigator-driven research
- Lack of institutional recognition/reward for collaborative efforts
- Lack of external recognition/reward for collaborative efforts
- Loss aversion
- Threat to my power
- Threat to my status
- Prefer unilateral decision-making authority
- Difficulty determining the appropriate level of cross-disciplinary (multi/inter/trans) integration
- Interdisciplinary illiteracy
- Differences in the assumptions fundamental to science by different collaborators
- My impression of the validity of qualitative versus quantitative data
- Disparity in methods for acquiring and validating information
- Concern about authorship
- Concern that my referees won't be supportive
- Hard to find a funding mechanism to support collaborative research
- Hard to find funding mechanisms to sustain a collaboration
- Communications/IT infrastructure
- A previous disappointing experience

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

Mistrust in Collaborative Team Science

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

Gray, B. (2008). Enhancing transdisciplinary research through collaborative leadership. American Journal of Preventive Medicine 35, S124-S132.

Communication and Collaboration

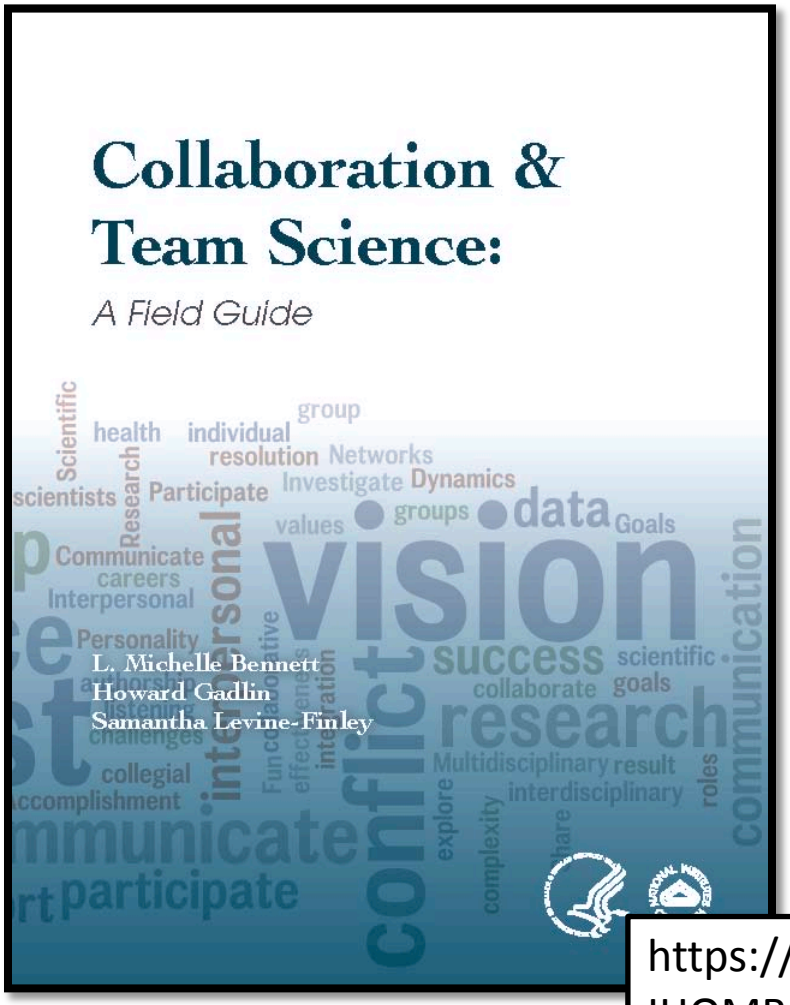
"Communication is elevated to the essence of collaboration."

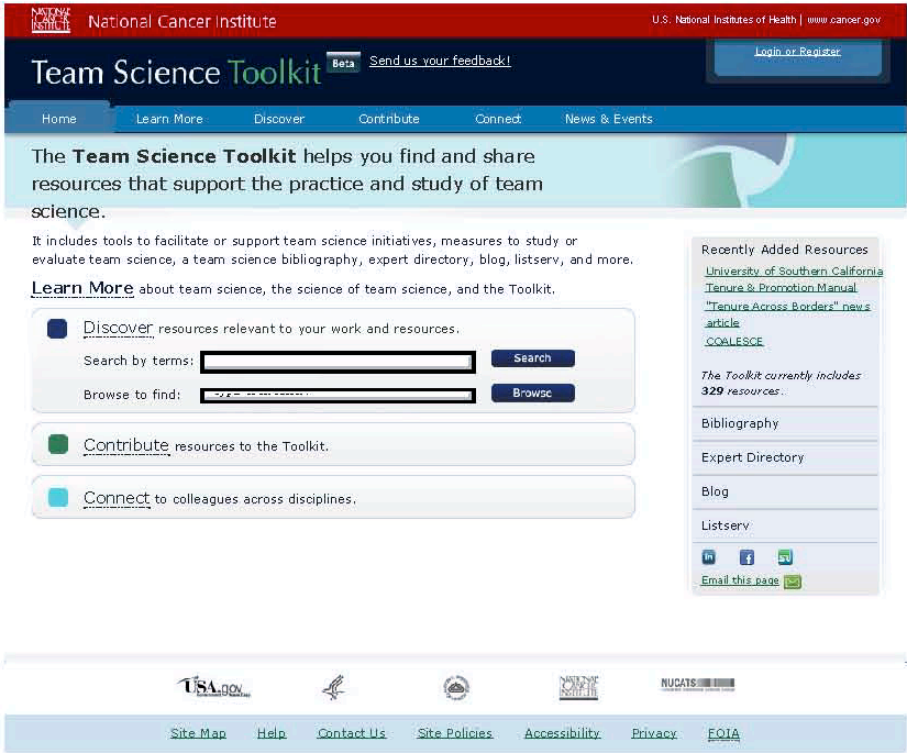
- *A Mesolevel Communicative Model of Collaboration. 2008. J. Keyton et al. Communication Theory 18(3): 376–406.*

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

NIH Resources





https://ccrod.cancer.gov/confluence/display/NIHOMBUD/Home

Partner Agreement

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

TeamScience.net

Team Science Online Learning Modules

www.teamscience.net

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CLINICAL AND TRANSLATIONAL SCIENCES INSTITUTE

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NORTHWESTERN UNIVERSITY

Science of Team Science Conference

http://www.scienceofteamscience.org

SciTS Conference 2012 ~ April 16-19

Chicago

Collaborative Communication

SciTS Conference Workshop

Monday, April 16 ~ 8:30 AM - 12:00 PM
$175/person **~** *Continental breakfast, refreshments, and lunch are included*

The Toolbox Project[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. Pre-formed groups of collaborators can participate together.

[1]Eigenbrode, S.D., O'Rourke, M., Wulfhorst, J.D., Althoff, D.M., Goldberg, C.S., Merrill, K., Morse, W., Nielsen-Pincus, M.A.X., Stephens, J., Winowiecki, L., et al. (2007). Employing Philosophical Dialogue in Collaborative Science. Bioscience 57, 55-64.
[2]Crowley, S., Eigenbrode, S.D., O'Rourke, M., and Wulfhorst, J.D. (2010). Cross-disciplinary localization: A philosophical approach. MultiLingual, September, 1-4.

Northwestern 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 graduate programs
- Literature review and discussion on practical experience
  - Focused on how the science of team science field provides empirically-grounded guidance to promote the effectiveness of science teams
- 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

Case Study

- Kong, H.H., and Segre, J.A. (2010). Bridging the Translational Research Gap: A Successful Partnership Involving a Physician and a Basic Scientist. J Invest Dermatol *130*, 1478-1480.
- 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?

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