Team Science:

An Evidence-based Primer

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Vice President, Strategic Alliances, Global Academic Relations

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INTRODUCTION

"The universal increase of team science, its increasing impact, and boundary-spanning creative capacity all point to team science as central to the future of scientific and technological advancement."

– *Professor Benjamin Jones, Northwestern University, SciTS Conf 2013*

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Brief Bio

- Research Information/Publishing (4+ yrs)
  - Vice President, Strategic Alliances, Global Academic Relations, Elsevier
- Academia (20+ yrs)
  - Adjunct Lecturer, School of Professional Studies, Philanthropy & Nonprofit Program, Northwestern University
  - Senior Lecturer and Research Assistant Professor, Northwestern University
    - Assistant Chair, Molecular Biosciences; Associate Director, IBiS Graduate Program (Arts & Sci), Northwestern University and Administrative Director for multiple NIH T32's
    - Director, Office of Research Development (Central Admin)
    - Director, Research Training Program, Children's Memorial Research Center
    - Director, Research Team Support & Development, NUCATS Institute, Northwestern University (Med Sch)
    - Director/Co-director
      - BioOpportunities, BioSurvival Skills, Pathway to the Professoriate
      - Navigating the Professoriate, Chicago Collaboration for Women in STEM
  - Undergrad, PhD, Postdoc training
- Pharma (2.5 yrs)
  - Anti-infective research, Abbott Laboratories
- Other Nonprofit Experience (6+ yrs)
  - Editor-in-Chief, AWIS Magazine
  - Founding President, National Organization of Research Development Professionals (NORDP)

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Collaboration, Networking and Teams

- Connecting researchers and resources in pursuit of large collaborative projects
- Compiled and curate a 2.1K+ reference Team Science resource library
- Published primary research findings that inform effective collaboration, especially for science teams
- Developed and taught one of the very first-ever Team Science graduate courses, co-developed an online Team Science course
- Chaired the Science of Team Science Conference for 3 years
- Paid team science consultant for almost two dozen US universities
- Involved in 3 national team science panels (US, UK, and Canada)

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TEAM SCIENCE DEFINED

"…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).*

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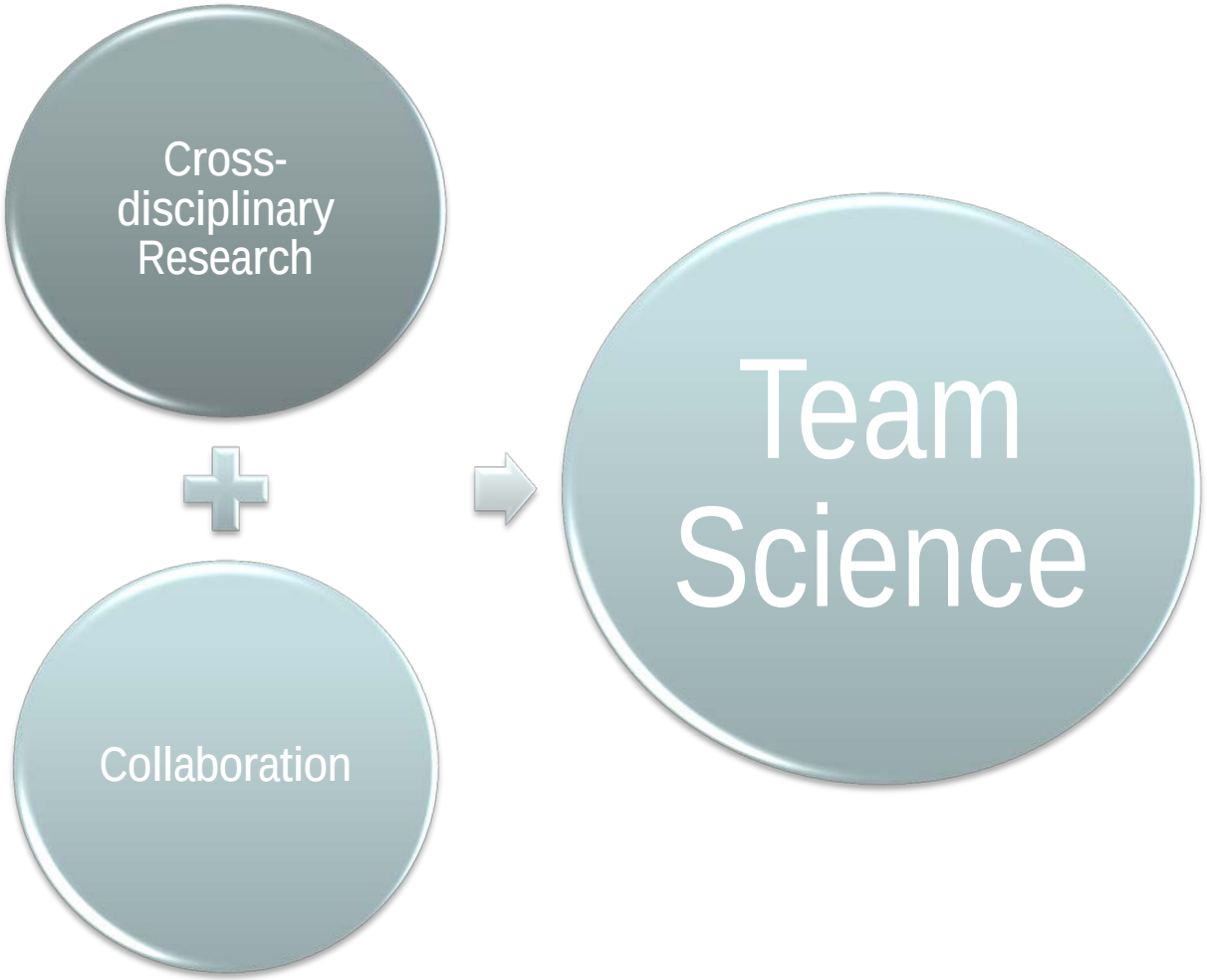
What is Team Science?



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Cross-disciplinary Collaboration

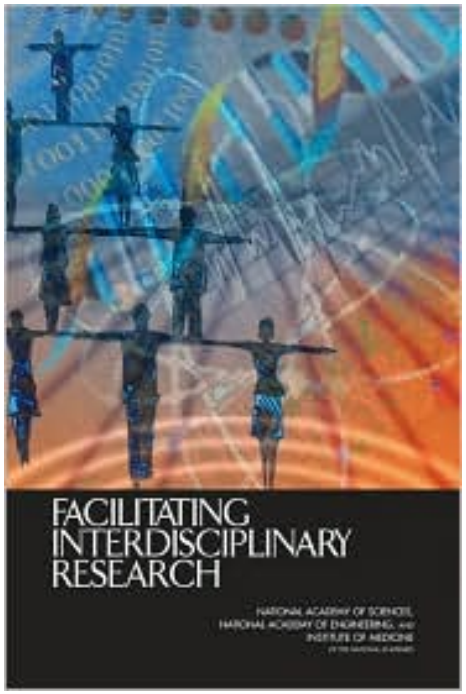
- (Uni)**Disciplinary** research
- Three **Cross-disciplinary** collaborative research orientations
  - Combine or integrate from more than one field
    - Concepts, Methods, and Theories
  - *Multi*disciplinary
    - Independent, Sequential, Divisional
    - Exchange
  - *Inter*disciplinary
    - Joint, Interactive, Partnership
    - Dialogue, Hybridization, Complementary
  - *Trans*disciplinary
    - Integrative, Interdependence, Emergence
    - Reciprocity, Discourse, Share Vocabulary, Extends

NIH Defines Interdisciplinary Research

- "Interdisciplinary research (IR) integrates the analytical strengths of two or more often disparate scientific disciplines to create a new hybrid discipline. Traditional gaps in terminology, approach, and methodology might be eliminated."
  - Genomics
  - Bioinformatics
  - Proteomics
  - Psychoneuroimmunology

NIHRoadmap.nih.gov/interdisciplinary

NAS/NSF Define Interdisciplinary Research



- Interdisciplinary research (IDR) is a mode of research by teams or individuals that integrates information, data, techniques, tools, perspectives, concepts, and/or theories from two or more disciplines or bodies of specialized knowledge to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline or area of research practice.

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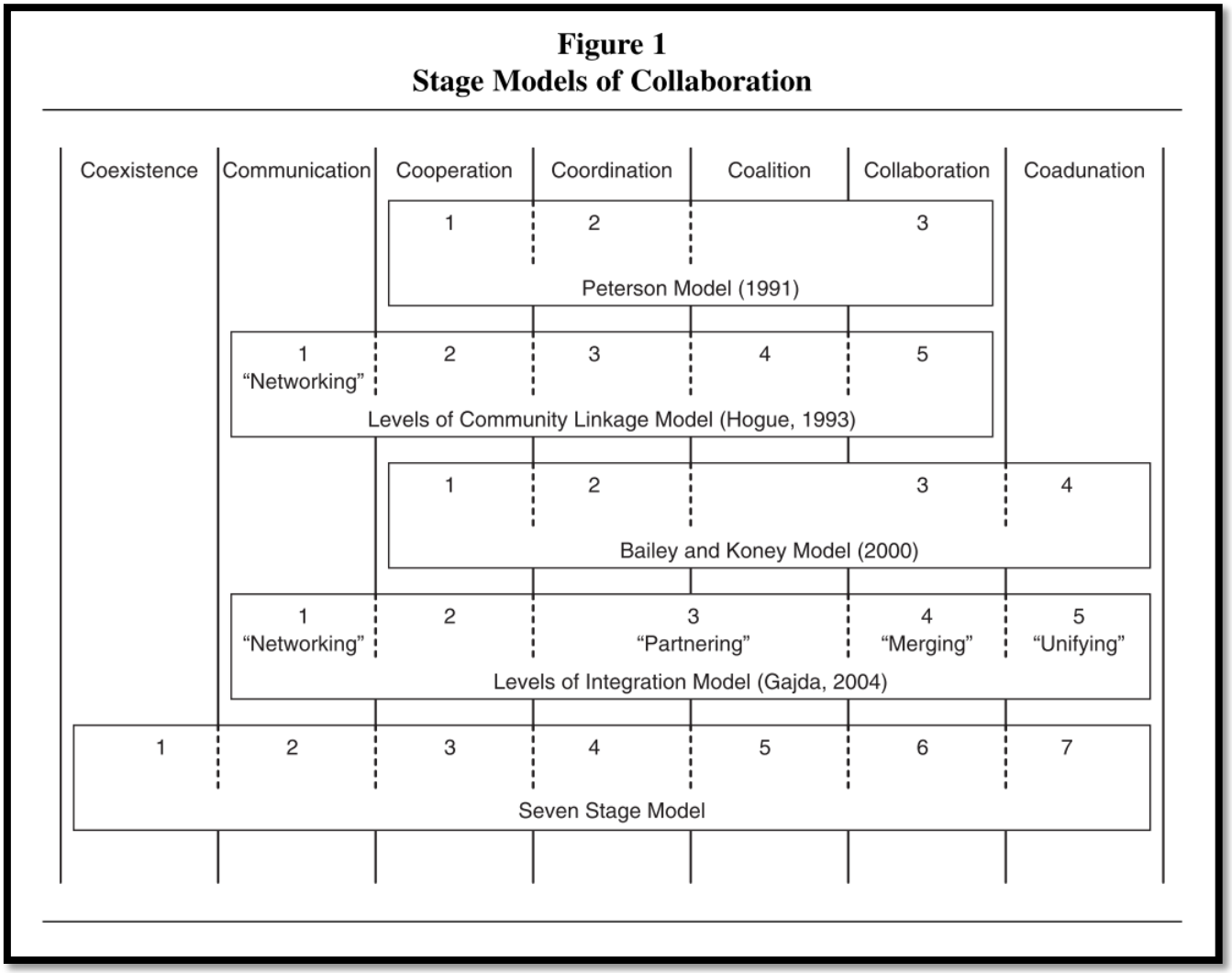
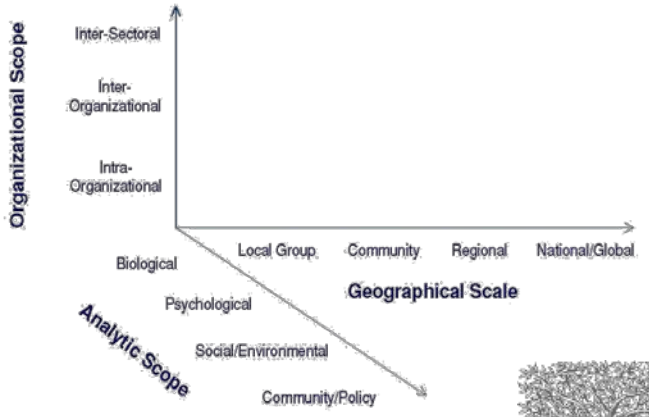
Collaboration



Frey, B.B., Lohmeier, J.H., Lee, S.W., and Tollefson, N. (2006). Measuring collaboration among grant partners. Am. J. Eval. 27, 383–392.

Team Science Initiatives

- Large research, training, and translational programs
- Funded by universities/research institutions, federal agencies and foundations
- Collaborative and interdisciplinary scientific approaches
- Extended multi-dimensional scope



Stokols, D. (2006). Toward a Science of Transdisciplinary Action Research. American Journal of Community Psychology 38, 63-77.

Science Facilitated by Team Science

- Outcome-oriented investigations
  - Problem/project/product-oriented research vs. knowledge-producing science
- Urgent and Complex
- Shared
  - Shared Goal between investigators from different disciplines/with different expertise
  - Shared Approach through a common facility, instrumentation
  - Shared Data Set access
- 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

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*

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Science of Team Science (SciTS)

- A new interdiscipline and rapidly emerging field
- 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

Figure created in Wordle

Uniqueness of Team Science

- Dimensions of Team Science that create unique profiles and challenges:

Diversity	HOMOGENEOUS	HETEROGENEOUS
Integration	UNIDISCIPLINARY	TRANSDISCIPLINARY
Size	SMALL (2)	MEGA (1000S)
Proximity	CO-LOCATED	GLOBALLY DISTRIBUTED
Goal alignment	ALIGNED	DIVERGENT OR MISALIGNED
Boundaries	STABLE	FLUID
Task interdependence	LOW	HIGH

Slide from Kara Hall, NCI, NIH, adapted from the 015 NRC team science report

Science to Practice

- 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
- So that we can train individual investigators, institutional leaders, and funding agencies to **employ** them

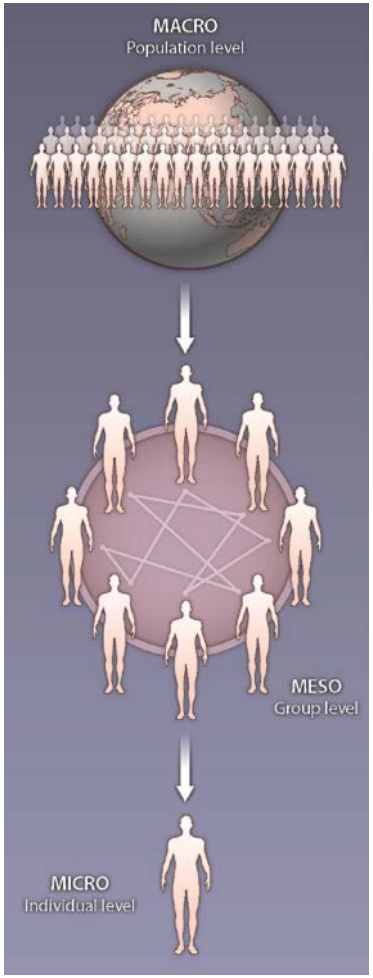
Team Effectiveness Findings

- 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

Evidence Informing 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
  - Teams are more likely than solo authors to insert novel combinations of science into familiar knowledge domains; Papers of this type are twice as likely to be highly-cited works
  - 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

Multi-level Team Science



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 Uzzi[10]

Published 15 September 2010; Volume 2 Issue 49 49cm24

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.

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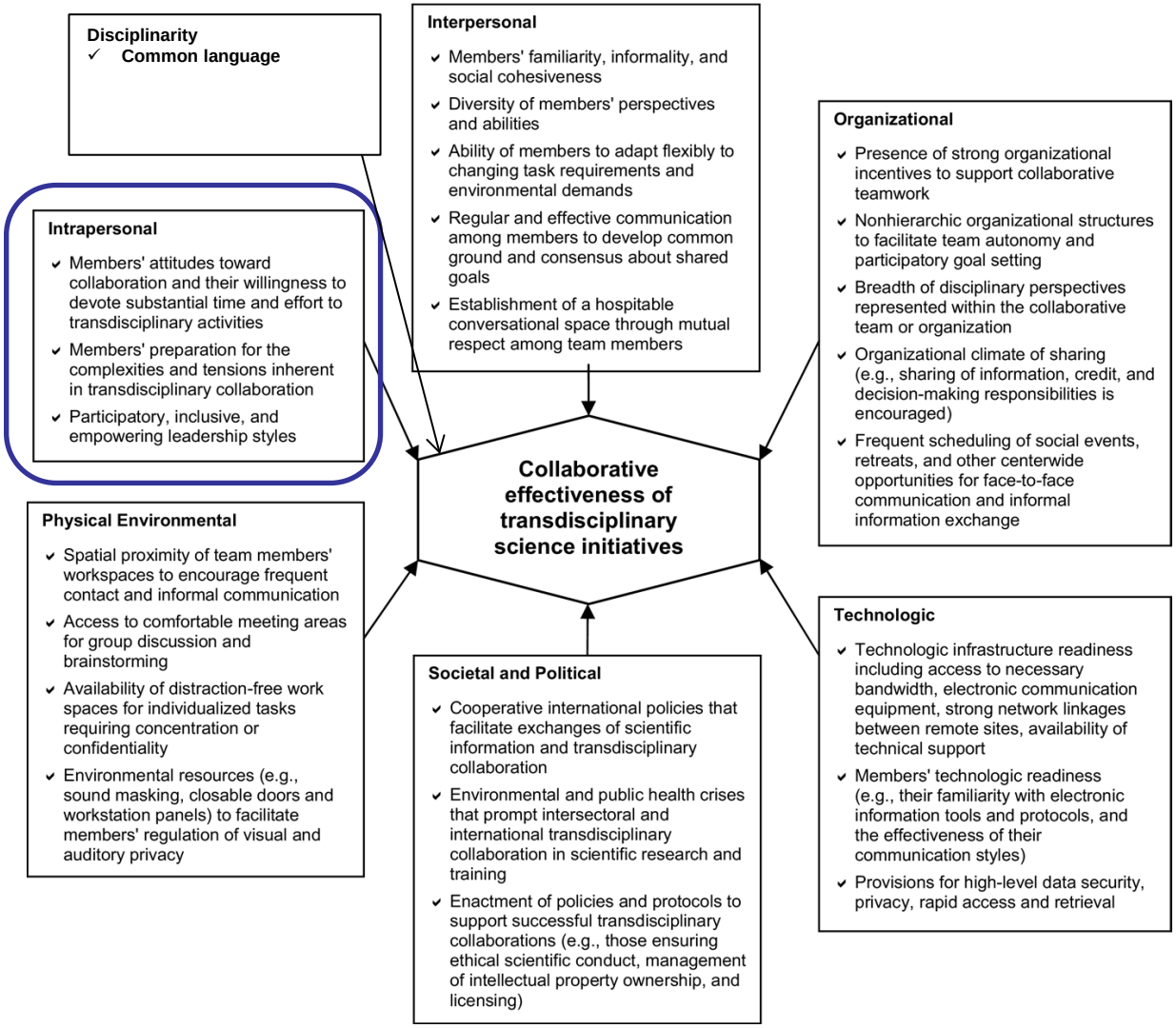
Contextual Factors Influencing Team Science



Stokols, D., Misra, S., Moser, R.P., Hall, K.L., and Taylor, B.K. (2008). The ecology of team science - Understanding contextual influences on transdisciplinary collaboration. American Journal of Preventive Medicine 35, S96-S115.

Collaboration Motivations and Deterrents

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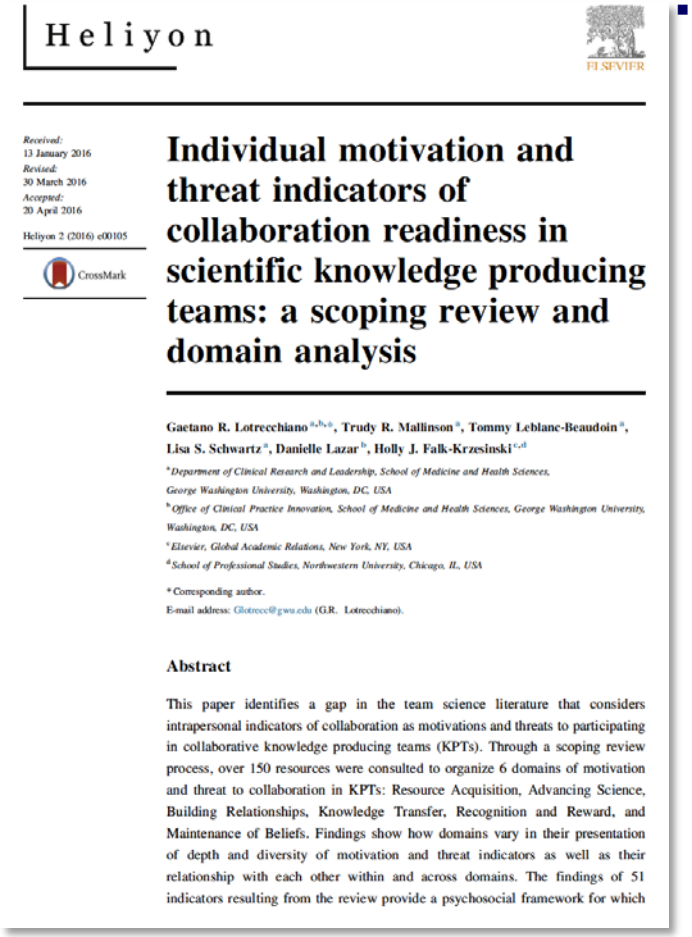
Collaboration Motivations and Deterrents



Heliyon

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CrossMark

Individual motivation and threat indicators of collaboration readiness in scientific knowledge producing teams: a scoping review and domain analysis

Gaetano R. Lotrecchiano [a,b,*], Trudy R. Mallinson [a], Tommy Leblanc-Beaudoin [a], Lisa S. Schwartz [a], Danielle Lazar [b], Holly J. Falk-Krzesinski [c,d]

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[b] Office of Clinical Practice Innovation, School of Medicine and Health Sciences, George Washington University, Washington, DC, USA
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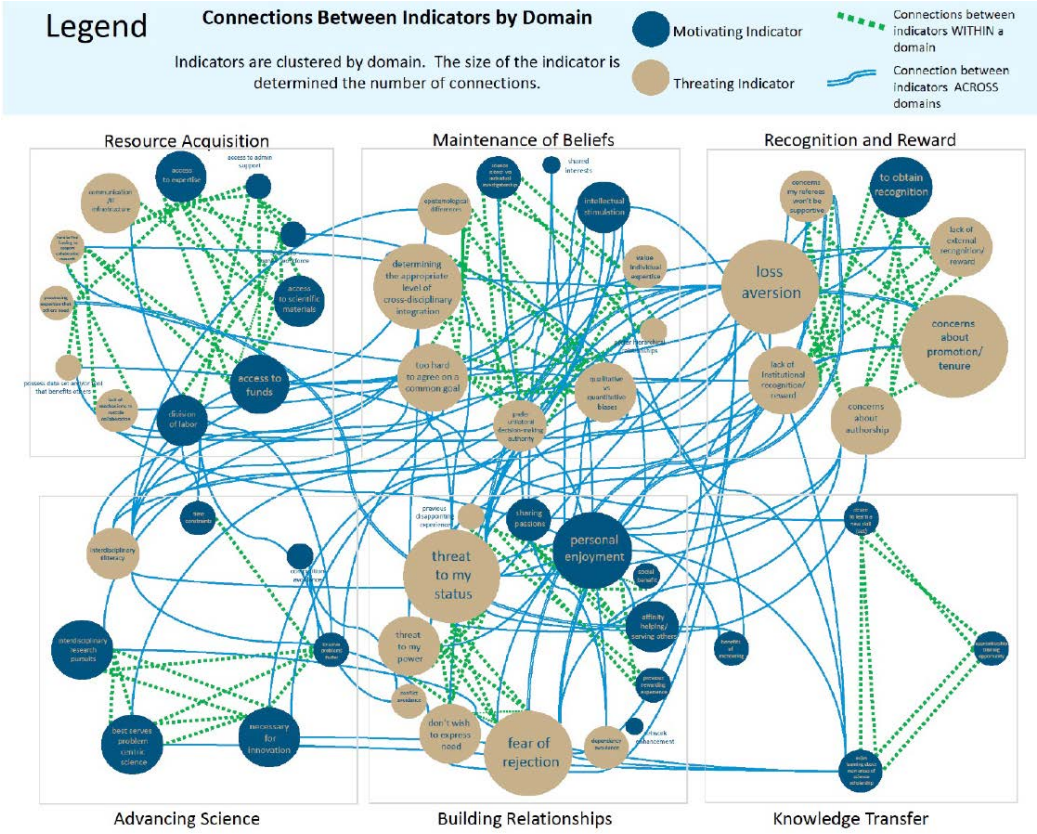
Abstract

This paper identifies a gap in the team science literature that considers intrapersonal indicators of collaboration as motivations and threats to participating in collaborative knowledge producing teams (KPTs). Through a scoping review process, over 150 resources were consulted to organize 6 domains of motivation and threat to collaboration in KPTs: Resource Acquisition, Advancing Science, Building Relationships, Knowledge Transfer, Recognition and Reward, and Maintenance of Beliefs. Findings show how domains vary in their presentation of depth and diversity of motivation and threat indicators as well as their relationship with each other within and across domains. The findings of 51 indicators resulting from the review provide a psychosocial framework for which

- Knowledge about a hierarchy of the 50 MATRICx items of motivation and threat as found in the multidisciplinary literature.

MATRICx



Lotrecchiano, G., Mallinson, T., Leblanc-Beaudoin, T., Schwartz, L., Lazar, D., & Falk-Krzesinski, H. (2016). Motivation and threat indicators for collaboration readiness in knowledge generating teams (KPTs): A scoping review and domain analysis. *Heliyon 2*(5), article 00105.

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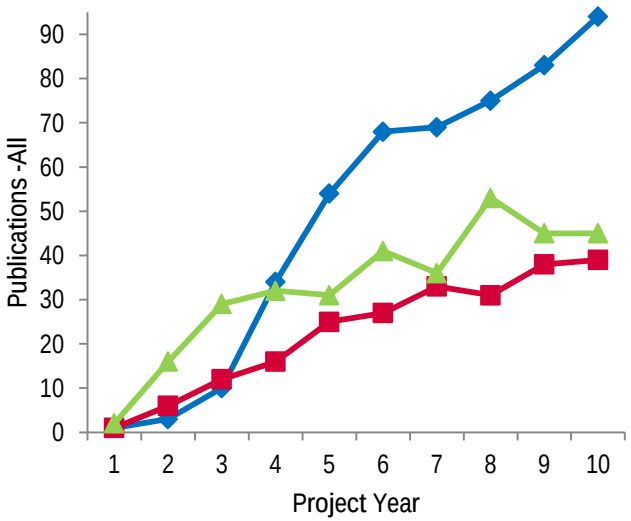
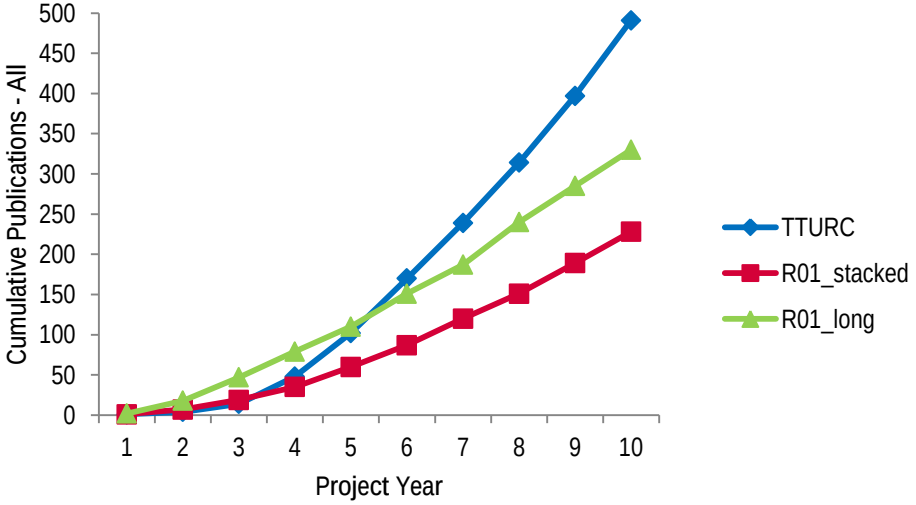
Team Science vs. Individual Science

Quasi-experimental design comparing number of publications of TD initiative with matched R01 projects from the tobacco field over 10-year period

Annual Publications



Cumulative Publications



TD center publications have longer start up period compared to R01s but become more productive over time

Centers initial lag in number of publications is eliminated around Project Year 4.

Note: The longitudinal R01 (LR01) award comparison group (n21) was designed to match the 10-year duration and consistent institutional infrastructure and resources of the six TTURCs. The stacked R01 (SR01) award comparison group (n39) was designed to match the duration and funding periods of the 39 TTURC subprojects.

Hall, K.L., Stokols, D., Stipelman, B.A., Vogel, A.L., Feng, A., Masimore, B., Morgan, G., Moser, R.P., Marcus, S.E., and Berrigan, D. (2012). Assessing the Value of Team Science: A Study Comparing Center- and Investigator-Initiated Grants. American Journal of Preventive Medicine *42*, 157-163.

LEADERSHIP & TEAM SCIENCE

"…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."

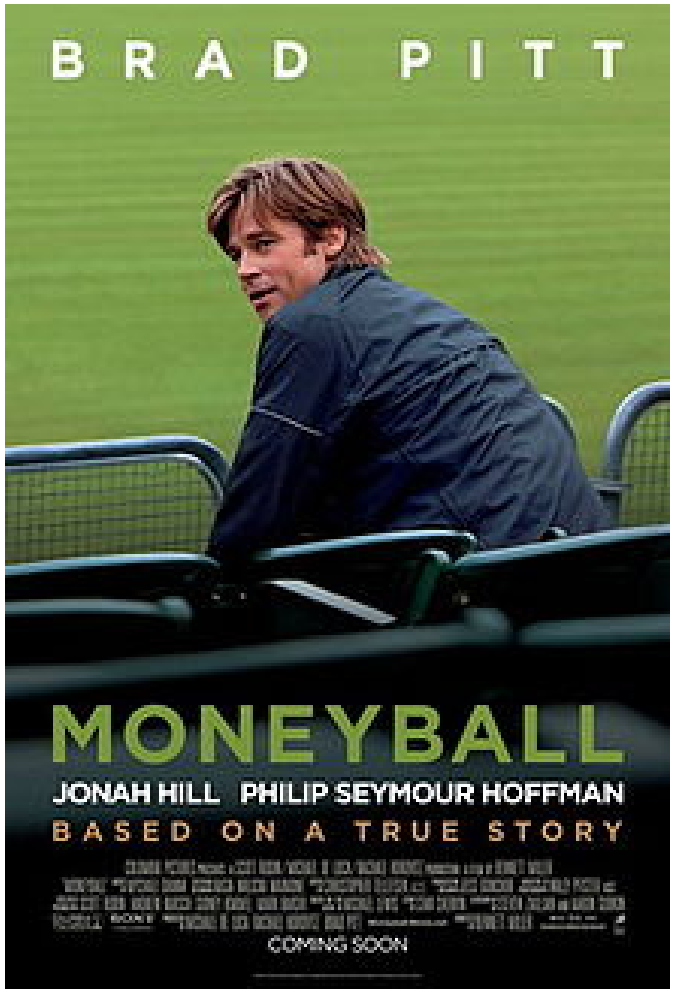
- *B. Gray. Enhancing Transdisciplinary Research Through Collaborative Leadership. Am J Prev Med 35(2S):S124–132 (2008)*

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

Team Composition

Team of Experts ≠ Expert Team



Expertise & Coaching

	Expertise +	Expertise -
Coaching +	Best Performance	OK Performance
Coaching -	Significantly Impaired Performance	Poor Performance

Hackman, J.R. (2011). Collaborative Intelligence: Using Teams to Solve Hard Problems .

The Right Mix

- Right mix of expertise and team-players
- Intervention/coaching to help use the collective expertise well

Hackman, J.R. (2011). Collaborative Intelligence: Using Teams to Solve Hard Problems .

Assembling the Team

- Higher fraction of incumbents vs. newcomers 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 only repeat collaborations with the same team members
- Teams formed by individuals with large but disparate sets of collaborators are more likely to draw from a more diverse reservoir of knowledge, and thus perform better…

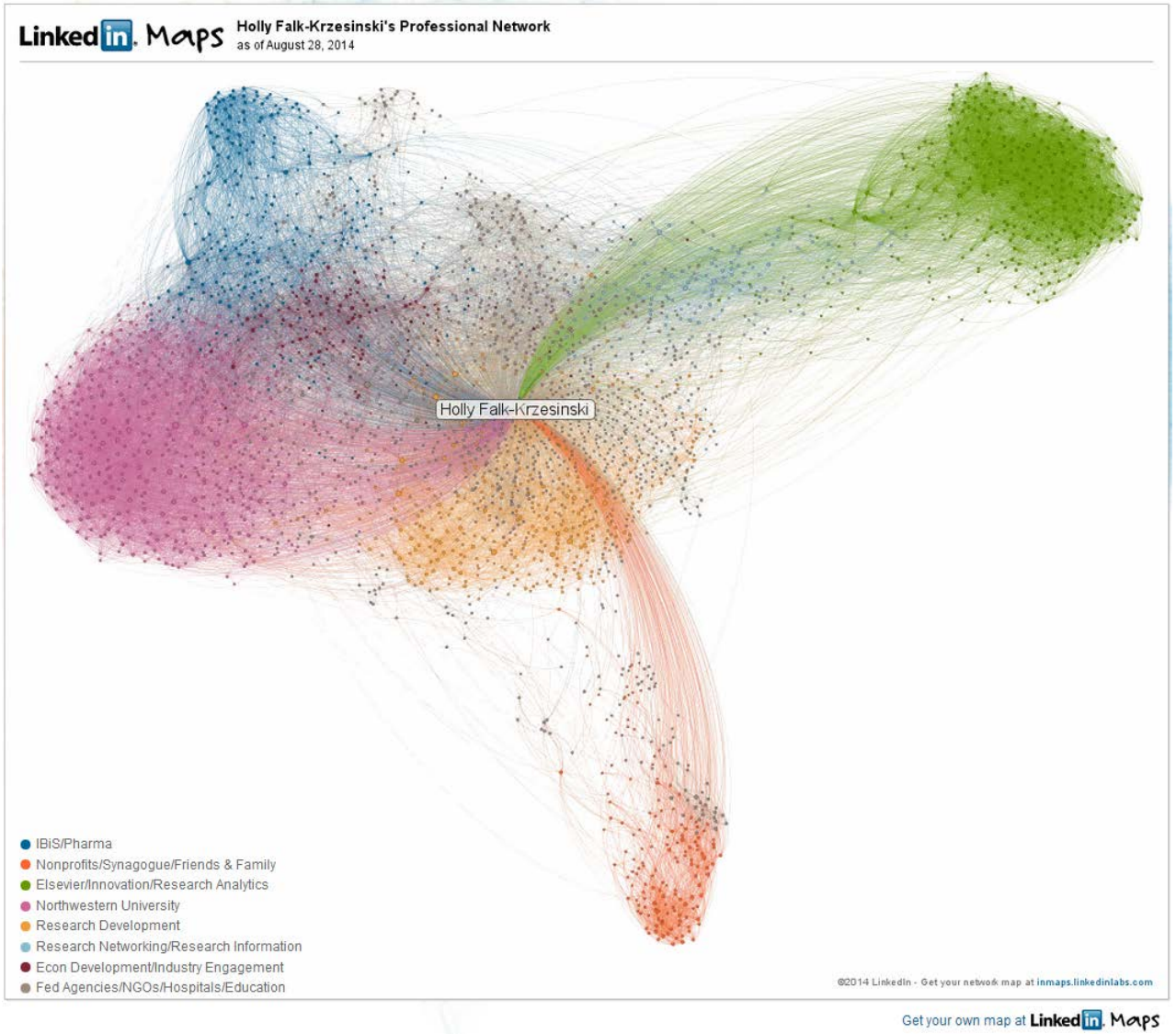
Guimerà R, et al. (2005). Team assembly mechanisms determine collaboration network structure and team performance. *Science*.

Teams, Innovativeness and Impact

- Highest impact science is grounded in conventional combinations of prior work, combined with novel combinations
- Papers of this type were twice as likely to be highly-cited works
- Teams are 37.7% more likely than solo authors to insert novel combinations into familiar knowledge domains

Brian Uzzi, et al. Atypical Combinations and Scientific Impact. Science 342, 468 (2013)

Know Your Network



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Teaming: Flexible Team Work

- Characteristics
  - Complex and uncertain situations, full of unexpected events
  - No two projects alike, people have to get up to speed quickly on new topics
- Advantages
  - Individuals acquire knowledge, skills and networks
  - Responding quickly to new challenges
  - Nimble and innovative
  - Ability to solve cross-disciplinary challenges

Edmondson, A.C., Teamwork on the Fly: How to Master the New Art of Teaming, Harvard Business Review, April 2012, pgs 1-10

Teaming Activities for Leaders

- Project Management
  - Scoping out the project
  - Structuring the team
  - Sorting tasks
- Team Leadership
  - Emphasizing purpose
  - Building psychological safety
  - Embracing failure and conflict
- Teaming Behaviors
  - Speaking Up
  - Experimenting
  - Reflecting
  - Listening Intently
  - Integrating

Edmondson, A.C., Teamwork on the Fly: How to Master the New Art of Teaming, Harvard Business Review, April 2012, pgs 1-10

Tools You Can Use:

Practical Team Science Guidance

Holly J. Falk-Krzesinski, PhD
Vice President, Strategic Alliances, Global Academic Relations

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COMMUNICATION & TEAM SCIENCE

"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.*

Trust and Communication

- Societal, organizational, group, and individual factors enhance and undermine trust and research integrity within collaborative, team science
  - Misunderstandings, disagreement, and conflict (*not* Groupthink)
  - Lack of recognition of others' expertise
  - Different paradigmatic assumptions
  - Cultural differences
  - Lack of process skills
  - Institutional disincentives
  - All lead to Mistrust
- Thus it is critical to focus on issues of communication to promote trust when building and participating in research teams

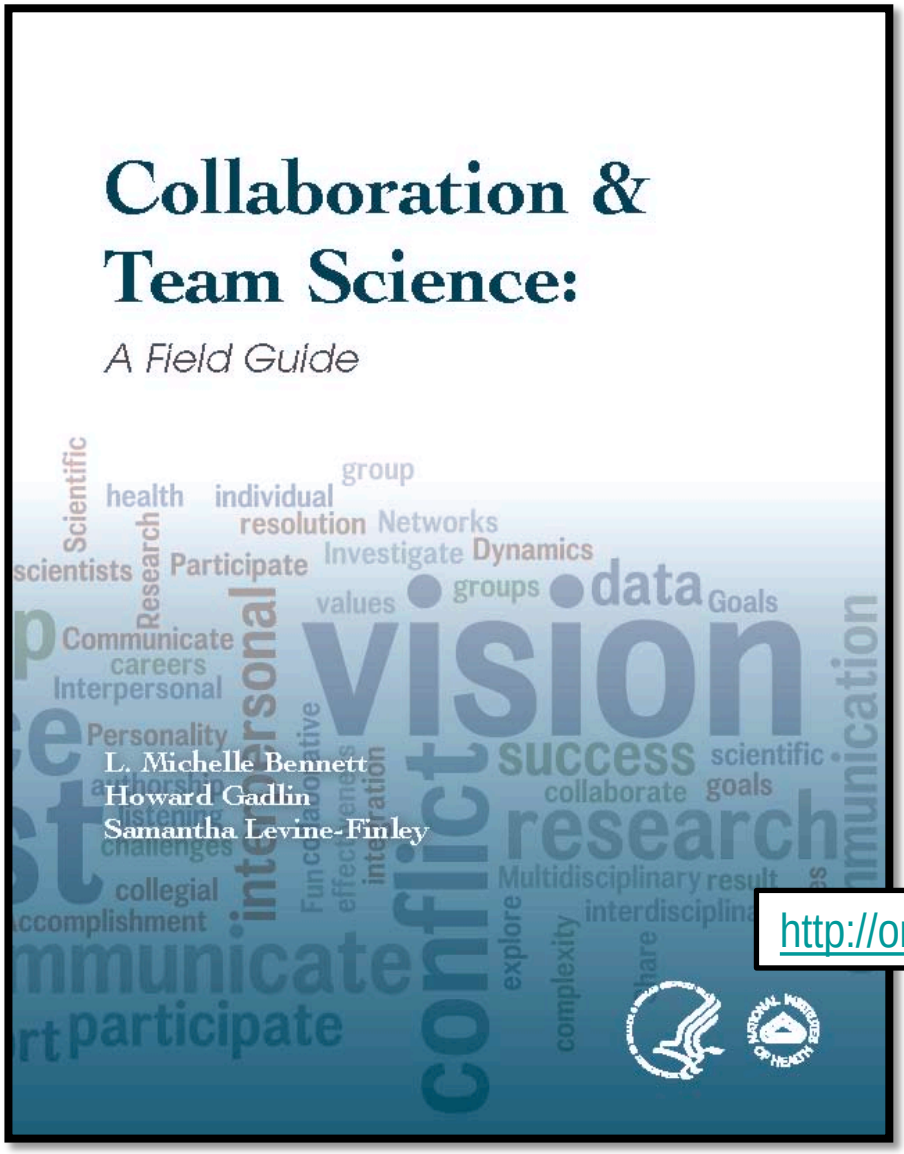
Gray, B. (2008). Enhancing transdisciplinary research through collaborative leadership. American Journal of Preventive Medicine 35, S124-S132.

Trust in the Team

- Face-to-face interaction in the team is essential
- High-tech (aka “lean”) communication, such as email and videoconferencing, strips away personal interaction needed to breed trust
- Teams need to be able to get together initially to build trust, and periodically to “recharge” trust

Rockmann, K.W., and Northcraft, G.B. (2008). To be or not to be trusted: The influence of media richness on defection and deception. Organizational Behavior and Human Decision Processes 107, 106–122.

A Field Guide/Partner Agreement



- Overall Goals & Vision
- Who Will Do What
- Sharing/Storing Reagents & Data
- Authorship, Credit
- Contingencies & Communicating
- Conflict of Interest

http://ombudsman.nih.gov/collaborationTS.html

See also Bennett, L.M., and Gadlin, H. (2012). Collaboration and Team Science: From Theory to Practice. J Invest Med 60, 768-775

Toolbox Project

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.

[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.*

Toolbox Questionnaire

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

[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.*

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

EVALUATING TEAM SCIENCE

"We want to identify and support the best science…there is good evidence that counting publications is not sufficient…The challenge is to get the community to identify what data form the basis for decisions made…In the past we relied on personal judgments and close networks of people in a certain field that knew each other and each other's work. Nowadays, with the boost in international collaborations and team science as well as the interdisciplinary nature of science, these types of personal evaluations are no longer sustainable."

– *Julia Lane, PhD, Senior Managing Economist American Institutes for Research, Scientific Evaluation and Metrics – an Interview with Julia Lane. Research Trends. March, 2012*

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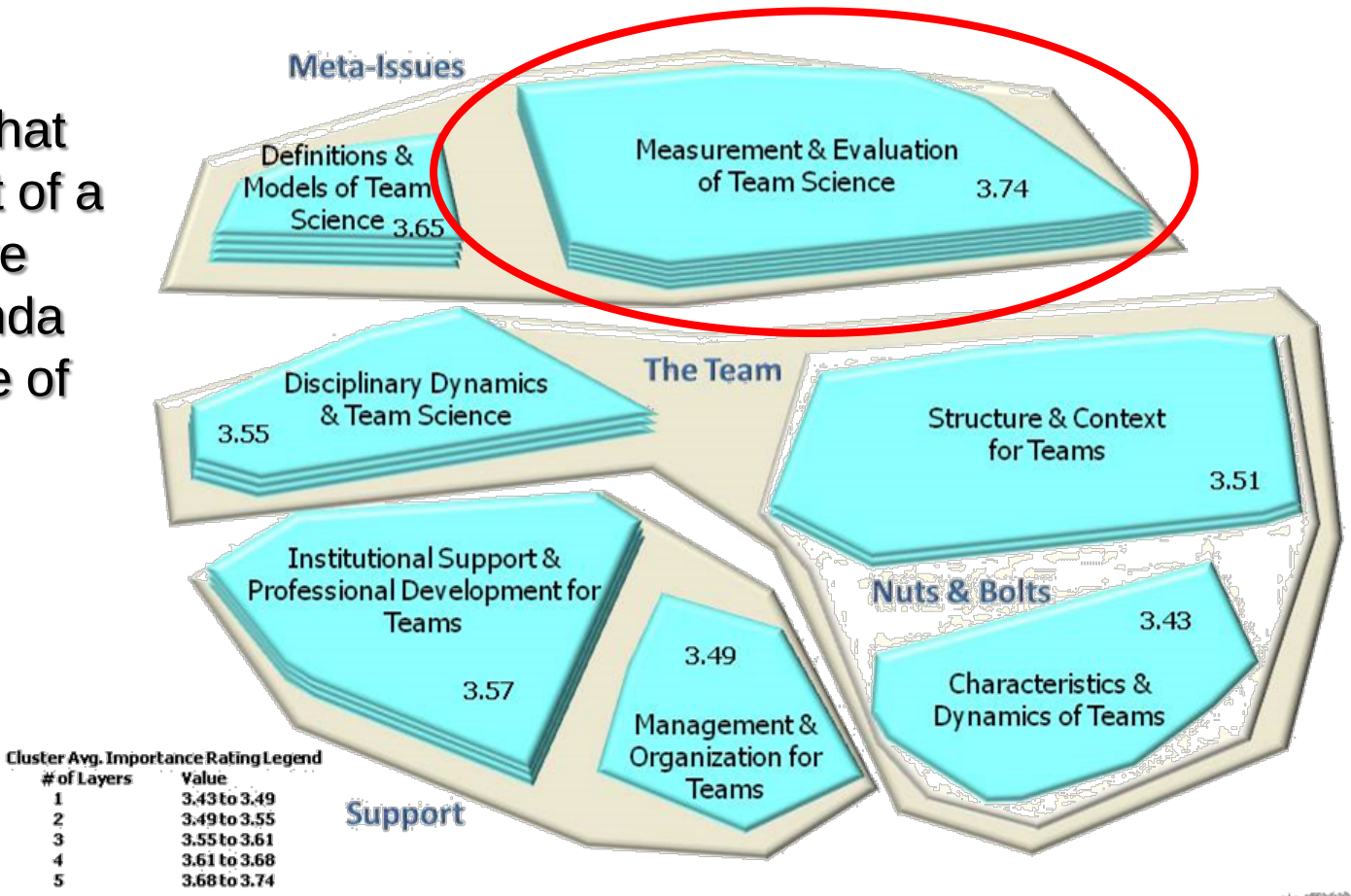
SciTS Research Roadmap

Q: One topic that should be part of a comprehensive research agenda for the science of team science is …



Falk-Krzesinski, H.J., Contractor, N., Fiore, S.M., Hall, K.L., Kane, C., Keyton, J., Klein, J.T., Spring, B., Stokols, D., and Trochim, W. (2011). Mapping a Research Agenda for the Science of Team Science. Research Evaluation 20, 143-156.

Levels of Collaboration Survey

Levels of Collaboration Survey

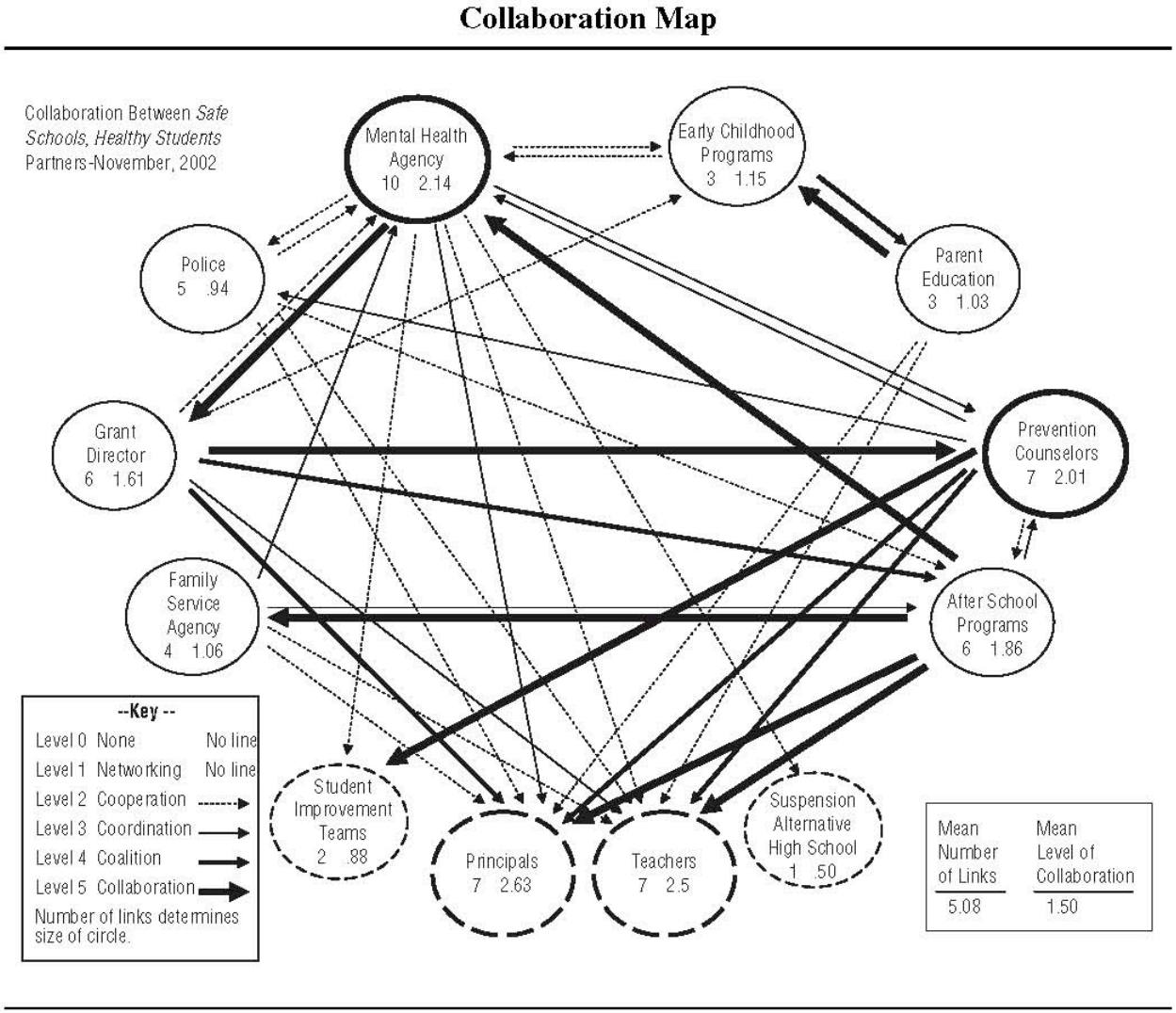
This form is designed for those who work in one of the organizations or programs that are partners in the *Safe Schools, Healthy Students* initiative. Please review these descriptions of different levels of collaboration.

- On the response section at the bottom of the page, please circle the name of the organization or group with which you are associated.
- Using the scale provided, please indicate the extent to which you currently interact with each other partner. (Skip your own row.)

	Five Levels of Collaboration and Their Characteristics				
	Networking 1	Cooperation 2	Coordination 3	Coalition 4	Collaboration 5
Relationship Characteristics	-Aware of organization -Loosely defined roles -Little communication -All decisions are made independently	-Provide information to each other - Somewhat defined roles -Formal communication -All decisions are made independently	-Share information and resources -Defined roles -Frequent communication -Some shared decision making	-Share ideas -Share resources -Frequent and prioritized communication -All members have a vote in decision making	-Members belong to one system -Frequent communication is characterized by mutual trust -Consensus is reached on all decisions

Safe Schools, Healthy Students Partners	No Interaction at All	Networking	Cooperation	Coordination	Coalition	Collaboration
Mental Health Agency	0	1	2	3	4	5
Early Childhood Programs	0	1	2	3	4	5
Parent Education Program	0	1	2	3	4	5
School District Prevention Counselors	0	1	2	3	4	5
After School Programs Director	0	1	2	3	4	5
Student Improvement Teams	0	1	2	3	4	5
Principals	0	1	2	3	4	5
Teachers	0	1	2	3	4	5
Police Department	0	1	2	3	4	5

Visualizing Collaboration



Measures for Assessing and Improving Collaborations

CTSA Clinical & Translational Science Awards

Search for: Search

ABOUT US | CONSORTIUM | TOOLS | EVENTS

Developing Measures for Assessing and Improving Collaborations Workgroup

The purpose of this Workgroup is to identify and evaluate the measures used to assess the value, quality, productivity and impact of collaboration and engagement. Existing measures will be identified and assessed for their psychometric properties (reliability, validity, sensitivity/responsiveness).

Key Deliverable:

(1.) A toolkit of reliable and valid measures of different constructs/variables related to collaboration and engagement [value, quality (subjective); productivity, impact (objective) of collaboration and engagement] and

(2.)A set of prioritized recommendations regarding new/adapted measures that will need to be developed

Leadership

Name (CTSA HUB)

Beth Tigges (University of New Mexico)

Doriane Miller (University of Chicago)

Usha Menon (University of Arizona)

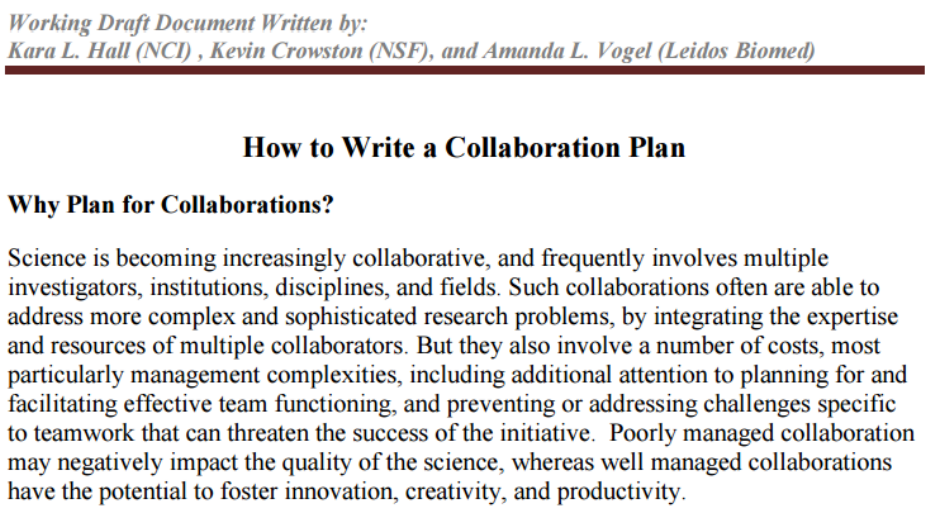
TEAM SCIENCE GRANTSMANSHIP

"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)*

Collaboration Planning

1. Rationale for Team Approach & Configuration
2. Collaboration Readiness
3. Technological Readiness
4. Team Functioning
5. Communication & Coordination
6. Leadership, Management, & Administration
7. Conflict Prevention & Management
8. Training
9. Quality Improvement Activities
10. Budget & Resource Allocation



Working Draft Document Written by:
Kara L. Hall (NCI) , Kevin Crowston (NSF), and Amanda L. Vogel (Leidos Biomed)

How to Write a Collaboration Plan

Why Plan for Collaborations?

Science is becoming increasingly collaborative, and frequently involves multiple investigators, institutions, disciplines, and fields. Such collaborations often are able to address more complex and sophisticated research problems, by integrating the expertise and resources of multiple collaborators. But they also involve a number of costs, most particularly management complexities, including additional attention to planning for and facilitating effective team functioning, and preventing or addressing challenges specific to teamwork that can threaten the success of the initiative. Poorly managed collaboration may negatively impact the quality of the science, whereas well managed collaborations have the potential to foster innovation, creativity, and productivity.

https://www.teamsciencetoolkit.cancer.gov/Public/TSResourceBiblio.aspx?tid=3&rid=3119

http://www.teamsciencetoolkit.cancer.gov/public/TSResourceBiblio.aspx?tid=3&rid=3261

Grant Proposal Fodder

Team Development Activities

- Beyond the NIH Leadership or NSF Management Plan
- Identify and engage potential collaborators and assemble the team
- Develop partnerships, a collaborative research agenda, shared conceptual framework
- Consider how to expand the *number* and *type* of investigators working in the collaboration
- Promote mentoring, conflict management, cross-talk, integration
- Disseminate findings, sustain the collaboration
- Evaluate process and outcomes

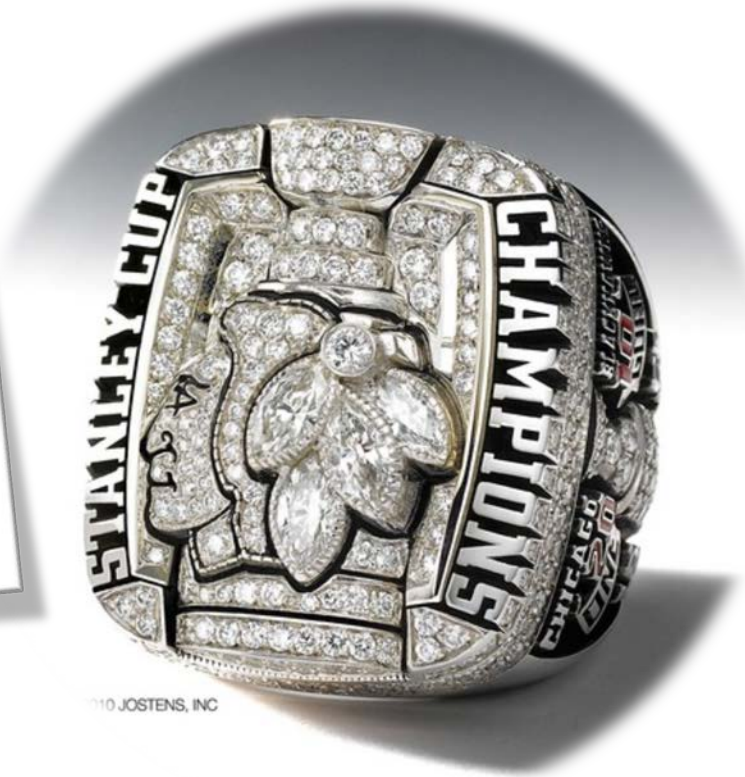
RECOGNITION & REWARD FOR TEAM SCIENCE

"We will need to find better ways to do team science and reward it if we are to solve large overarching problems. Everybody on the team needs to get the same big gaudy championship ring…"

- *AG Gilman. Silver Spoons and Other Personal Reflections. Annu. Rev. Pharmacol. Toxicol, 2012*

Go, Hawks, Go!

"Blackhawks' Stanley Cup rings will be handed out to **players**, **coaches**, **equipment managers**, **trainers** and **medical staff**…during a private ceremony."



Individual vs. Contributory Assessment

- Emphasis on individual accomplishments
  - 1st/last author positions
  - PI status
  - Individual impact factor
- Collaborative factors generally not considered
  - Individual/group production
  - Extent to which an individual enables a team
  - Team size

Petersen, A.M., Riccaboni, M., Stanley, H.E., and Pammolli, F. (2011). Persistence and Uncertainty in the Academic Career.

Focus on Promotion & Tenure Policy

- NAS Facilitating Interdisciplinary Research Report, 2004
  - Academic survey respondents indicated that P&T criteria were the greatest impediment to interdisciplinary research in their campus
- Council of Environmental Deans and Directors Report, 2005
  - "Lured into the collaborative research needed for progress in an interdisciplinary field, scholars are later held to the standards of specific disciplines"
  - Need to develop new [recruitment, retention, promotion & tenure] procedures for handling interdisciplinary scholars
- University of Chicago Academic Medical Center Study, 2008
  - "Recognize all forms of scholarship as equally legitimate bases of academic tenure"
  - Subsequent change of P&T policy language that specifically addresses collaboration scholarship
- Creating interdisciplinary campus cultures: A model for strength and sustainability, J. T. Klein, 2010
  - Interdisciplinary career life cycle
  - Hiring, P&T
  - Ongoing faculty development

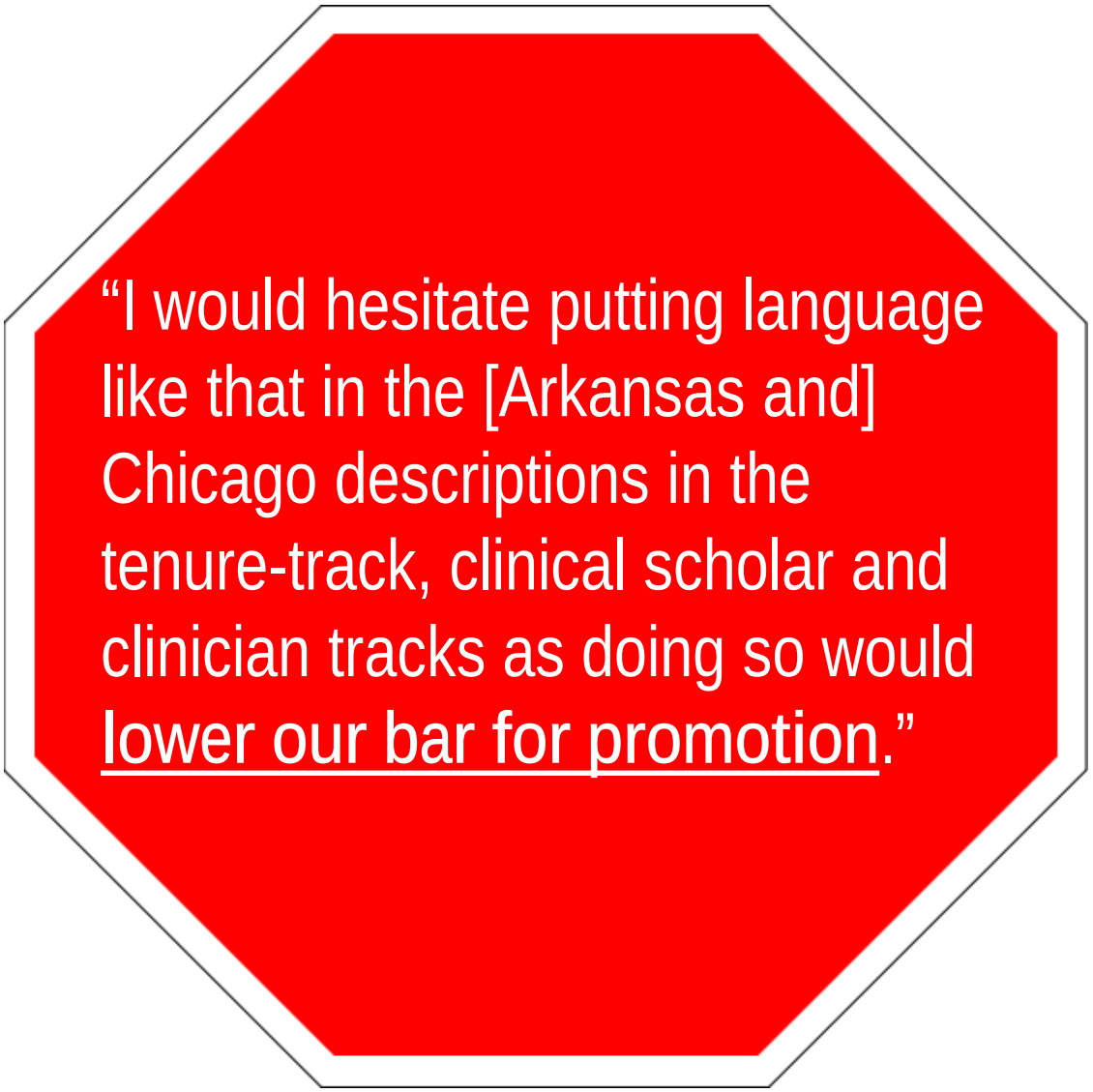
Team Science APT Study

- "I am interested to know if your **institution's current APT policies or guidelines include any specific language regarding collaborations/collaborative activity, multi/interdisciplinary research and scholarship, and/or team science.**"
- Offered to **share** all responses with all respondents, in raw form
- Deposit collected APT policy language to the NIH's **Team Science Toolkit**
- Use the policy information to guide the development of a **publishable analysis** aimed at understanding the relationship between codified policy relevant to collaboration, multi/interdisciplinary research and teaching, and team science and the implementation and **realization of policy through processes, practices, and perceptions**

The Responses

- Responses from 43 institutions
- Central Admin and/or Medical School
- 33 institutions shared policy excerpts
- Other responses
  - No response
  - Not applicable
  - Responded, but no such policy language exists
  - And one that may surprise you…

Still Resistance



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The Analysis

- Qualitative document analysis of the 33 policy excerpts
  - Grounded theory approach, data marked with codes (open coding)
  - Codes were compared, contrasted, and sorted into larger themes (axial coding)
- Overarching Emergent Themes
  - Recognition of Team Science
  - Criteria for Evaluating Team Science
  - Process of Evaluating Team Science

Recognition of Team Science

- 18 of 33 institutions
- Highlighted the significance and prevalence of collaborative and/or cross-disciplinary scholarship in advancing science, and the need to consider such scholarship in P&T decision-making

Criteria for Evaluating Team Science

- 27 of 33 institutions
- Criteria for evaluating participation in Team Science
- Included definitions and/or described demonstrations of contributions to team-based work, e.g., demonstrations of leadership in and impact of team-based work
- How to recognize these contributions in P&T evaluations
- Expectations and requirements regarding authorship, publications and grants

Process of Evaluating Team Science

- 16 of 33 institutions
- Included guidelines for faculty on how to prepare their dossiers to demonstrate the value of their contributions to science teams
- Some policies provided models of CVs, candidate statements, and letters from collaborators while others provided explicit guidelines to committee members on how to review the dossier materials
- Others provided general guidelines on the importance of reviewing these sources of evidence for contributions to science teams

Project CRediT

- A high-level classification of the diverse roles performed in the work leading to a published research output in the sciences.
- 14 unique Contributor roles
  - When there are multiple people serving in the same role, a degree of contribution may optionally be specified as ‘lead’, ‘equal’, or ‘supporting’
- Purpose to provide transparency in contributions to scholarly published work, to enable improved systems of attribution, credit, and accountability, **especially for team science**

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Project CRediT at Elsevier

CellPress

At Cell Press we endorse the "CRediT" taxonomy of contributor roles and encourage authors to use this taxonomy when providing an Author Contributions section for research papers. Below, we provide the taxonomy as well as an example of a recent Author Contributions section reorganized to use this format. A recent paper by Brand et al. (2015) outlines the background for Project CRediT.

Term	Definition
Conceptualization	Ideas; formulation or evolution of overarching research goals and aims
Methodology	Development or design of methodology; creation of models
Software	Programming, software development; designing computer programs; implementation of the computer code and supporting algorithms; testing of existing code components
Validation	Verification, whether as a part of the activity or separate, of the overall replication/ reproducibility of results/experiments and other research outputs
Formal Analysis	Application of statistical, mathematical, computational, or other formal techniques to analyze or synthesize study data
Investigation	Conducting a research and investigation process, specifically performing the experiments, or data/evidence collection
Resources	Provision of study materials, reagents, materials, patients, laboratory samples, animals, instrumentation, computing resources, or other analysis tools
Data Curation	Management activities to annotate (produce metadata), scrub data and maintain research data (including software code, where it is necessary for interpreting the data itself) for initial use and later reuse
Writing – Original Draft	Preparation, creation and/or presentation of the published work, specifically writing the initial draft (including substantive translation)
Writing – Review & Editing	Preparation, creation and/or presentation of the published work by those from the original research group, specifically critical review, commentary or revision – including pre- or postpublication stages
Visualization	Preparation, creation and/or presentation of the published work, specifically visualization/ data presentation
Supervision	Oversight and leadership responsibility for the research activity planning and execution, including mentorship external to the core team
Project Administration	Management and coordination responsibility for the research activity planning and execution
Funding Acquisition	Acquisition of the financial support for the project leading to this publication.

Reproduced from Brand et al. (2015), Learned Publishing 28(2), with permission of the authors.

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CRediT for Credit

Q7 In your view, what is the likelihood that the CRediT taxonomy will be recognized by the appointment, promotion, or tenure system of review at the institution(s) with which you are affiliated?

Answered: 35 Skipped: 3

	Extremely likely	Very likely	Neither likely nor unlikely	Not very likely	Extremely unlikely	N/A	Total	Weighted Average
(no label)	5.71% 2	31.43% 11	34.29% 12	20.00% 7	8.57% 3	0.00% 0	35	2.94

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TRAINING FOR TEAM SCIENCE

"…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 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
- Offers practical guidance about how best to engage in team science

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

TeamScience.net

www.teamscience.net

NUCATS
CLINICAL AND TRANSLATIONAL SCIENCES INSTITUTE

Supported in part by: CTSA grant 3UL1RR025741 Multidisciplinary Clinical and Translational Science Program (PI: Philip Greenland) and National Library of Medicine contract N01-LM-6-3512 from the Office of Behavioral & Social Sciences Research, (PI: Bonnie Spring)

NORTHWESTERN UNIVERSITY

http://teamscience.net/intro/index.html

References: Hesse, B.W. (2011). COALESCE (CTSA Online Assistance for Leveraging the Science of Collaborative Effort). JAMA: The Journal of the American Medical Association *306*, 1925-1926.

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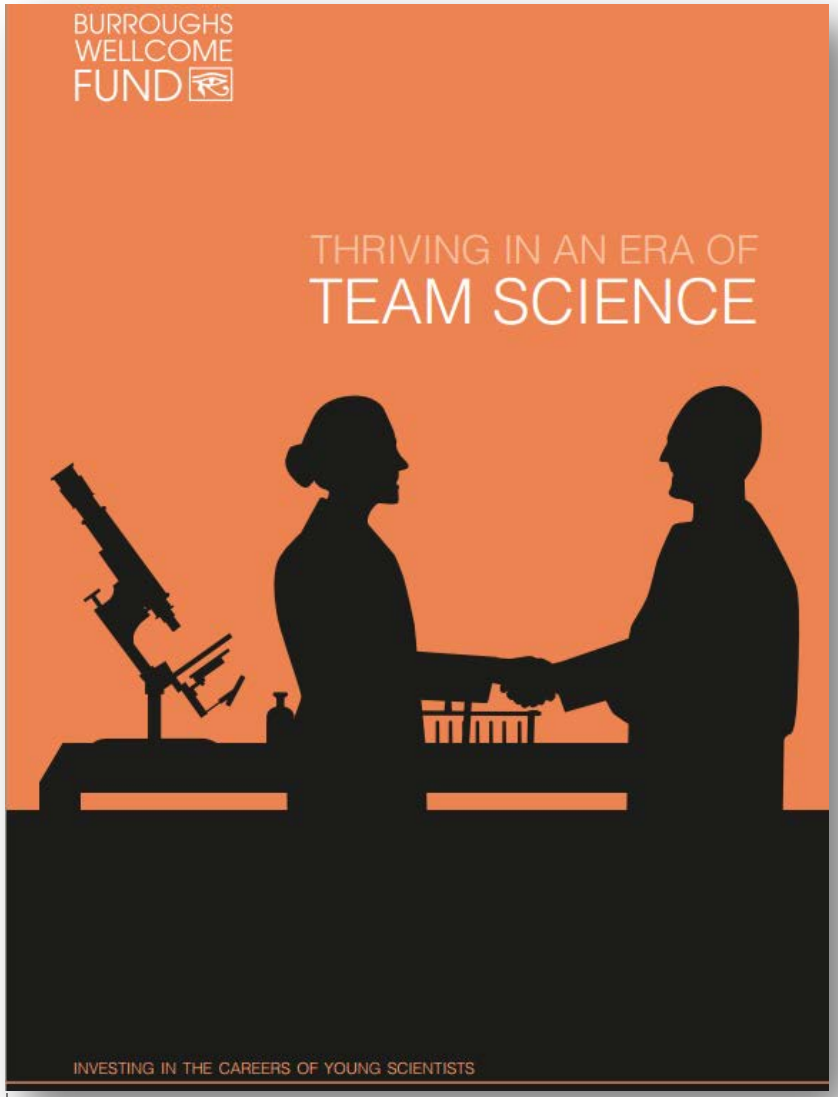
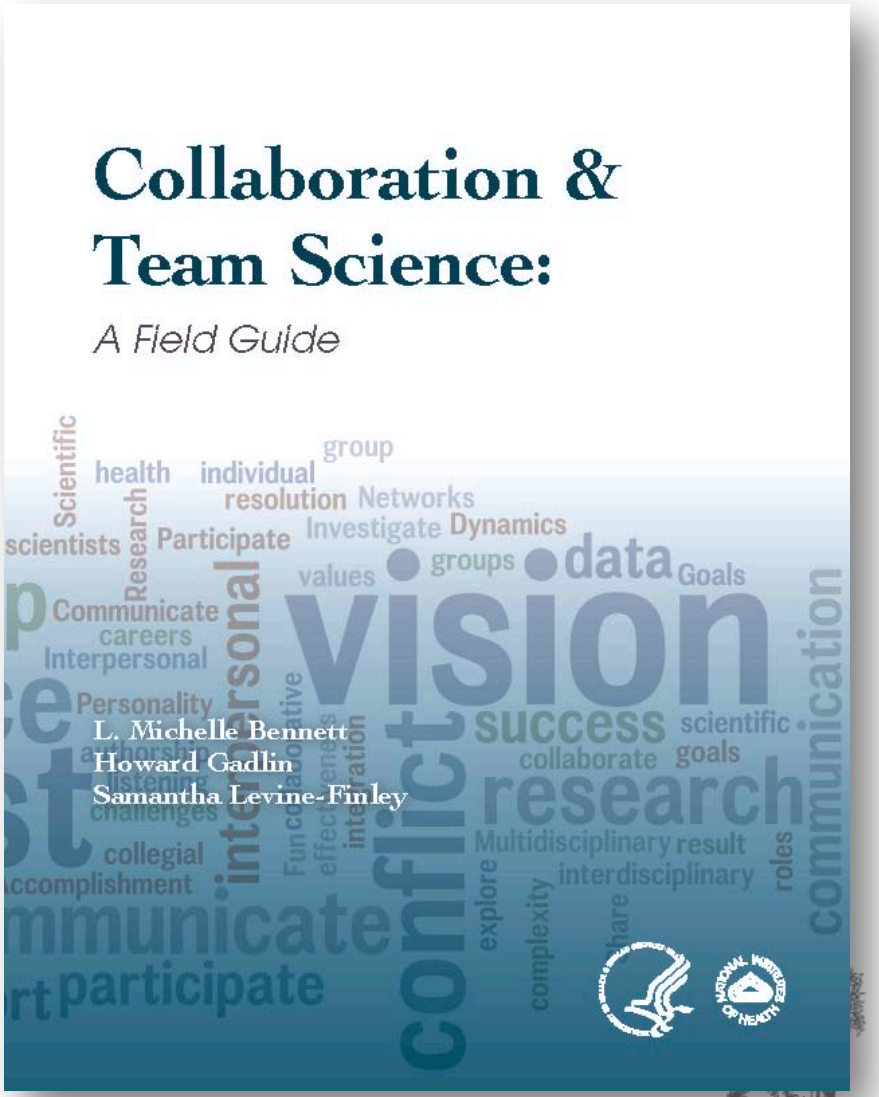
Case Studies





Case Study Group Discussion

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Portable Team Science Training

Case Study Approach:

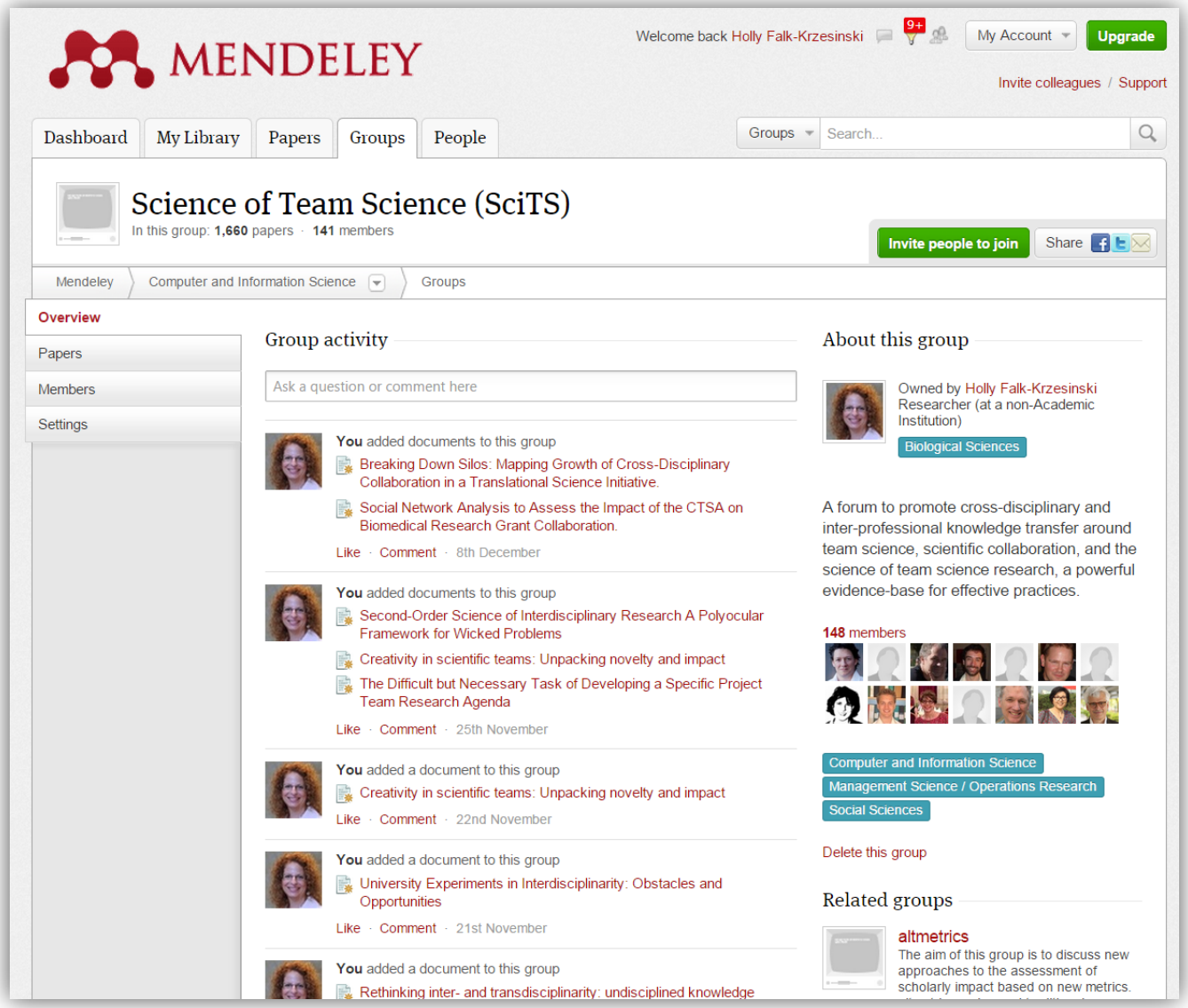
- Kong, H.H., and Segre, J.A. (2010). Bridging the Translational Research Gap: A Successful Partnership Involving a Physician and a Basic Scientist. J Invest Dermatol *130*, 1478-1480
- What was the nature/impetus for the collaboration?
- What factors helped the team build trust?
- What factors threatened that trust?
- How did the team use communication effectively?
- What communication issues were problematic for the team?
- How did the team manage conflict?
- What role, if any, do power and hierarchical relationships play in this case?
- What strategies did the team employ to share credit?

IN THE END

"Collaboration is a journey, not a destination."

- *Gajda, R. (2004). Utilizing Collaboration Theory to Evaluate Strategic Alliances. American Journal of Evaluation, 25(1), 65–77.*

Mendeley SciTS Group



http://www.mendeley.com/groups/3556001/science-of-team-science-scits/

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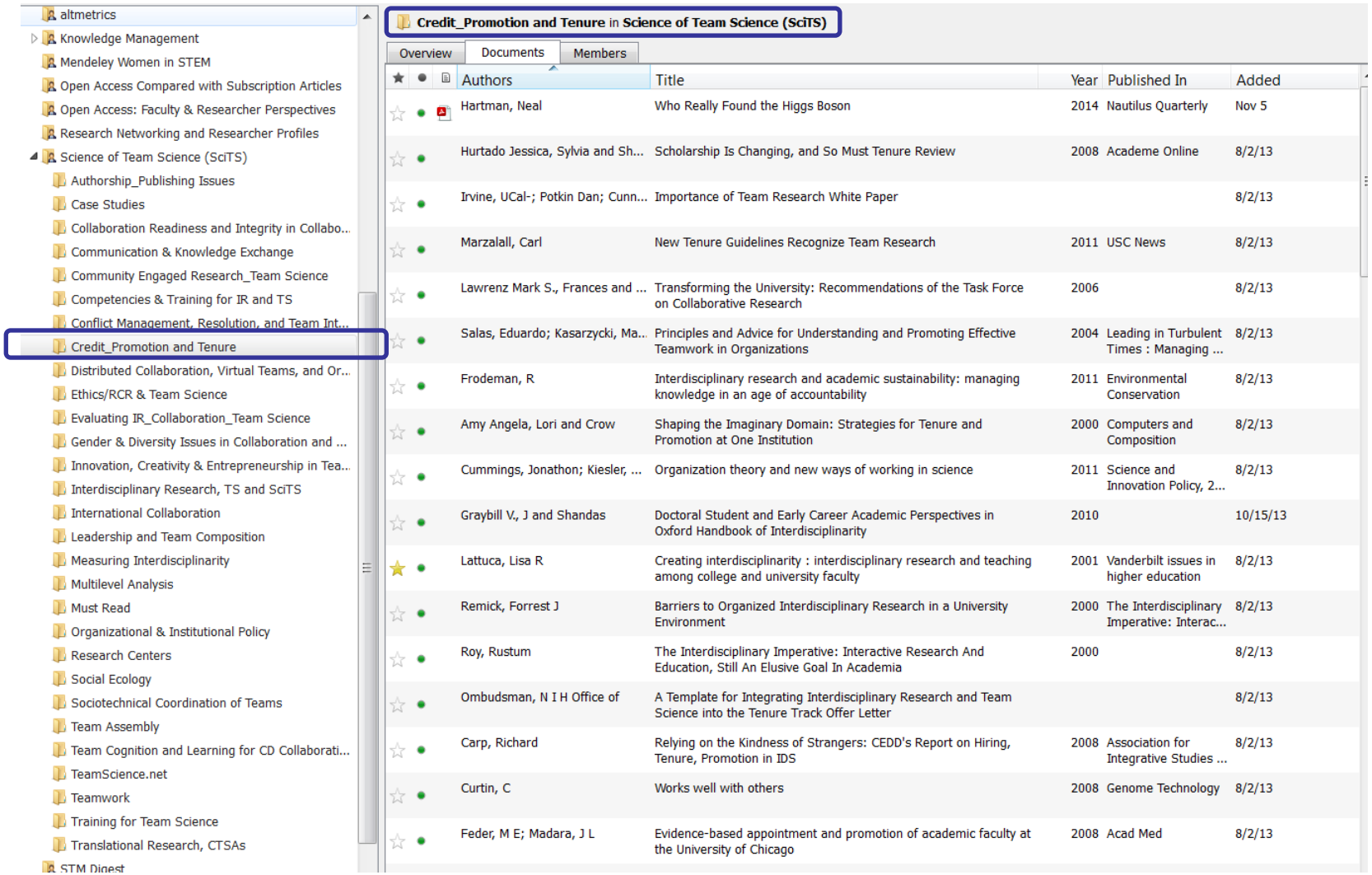
Groups of Documents



http://www.mendeley.com/groups/3556001/science-of-team-science-scits/

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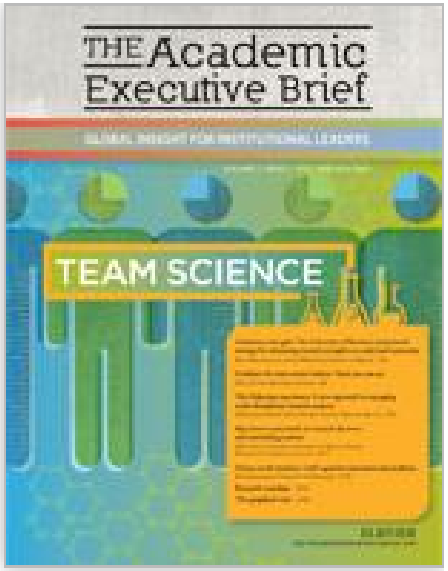
The Academic Executive Brief

TEAM SCIENCE
Volume 2, Issue 2 – 2012

In our new issue, academic leaders around the globe share their knowledge of and experience with team science. Authors from the United States, Germany, Malaysia, and India explore team science in terms of institutional and national influence, team science tools and leadership, team formation and research networking systems.



DOWNLOAD PDF

http://academicexecutives.elsevier.com/volume-2-issue-2-2012

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SciTS Listserv

- The **Science of Team Science (SciTS) listserv** facilitates conversation among individuals who are engaged in, studying, or managing team science, in the US and internationally. The listserv is maintained collaboratively by the SciTS Team at the National Cancer Institute, Division of Cancer Control and Population Sciences, Behavioral Research Program (http://cancercontrol.cancer.gov/brp/scienceteam) at the NIH.
  - TO SUBSCRIBE: Send an email with a blank subject line to: listserv@list.nih.gov. The message body should read: subscribe SciTSlist [your full name]. Please do not include the brackets. For example, for Robin Smith to subscribe, the message would read: subscribe SciTSlist Robin Smith. You will receive a confirmation email.
  - TO POST TO THE LISTSERV: Send an email to SciTSlist@list.nih.gov. Any subscriber may post to the list.
  - TO VIEW THE ARCHIVES: To view the archives of all previous postings, go to: http://list.nih.gov/archives/SciTSlist.html
  - TO RECEIVE MESSAGES IN A DAILY DIGEST: The default setting sends you each message as it is posted to the listserv. To receive one daily digest, instead, go to: http://list.nih.gov/cgi-bin/wa.exe?SUBED1=SciTSlist&A=1 and select “digest” as your subscription type.
  - TECHNICAL PROBLEMS WITH YOUR SUBSCRIPTION? Contact the list administrator, Judy Kuan, at: kuanj@mail.nih.gov. Please be sure to state that your email is in reference to the SciTS listserv.

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Science of Team Science Conference

http://www.scienceofteamscience.org

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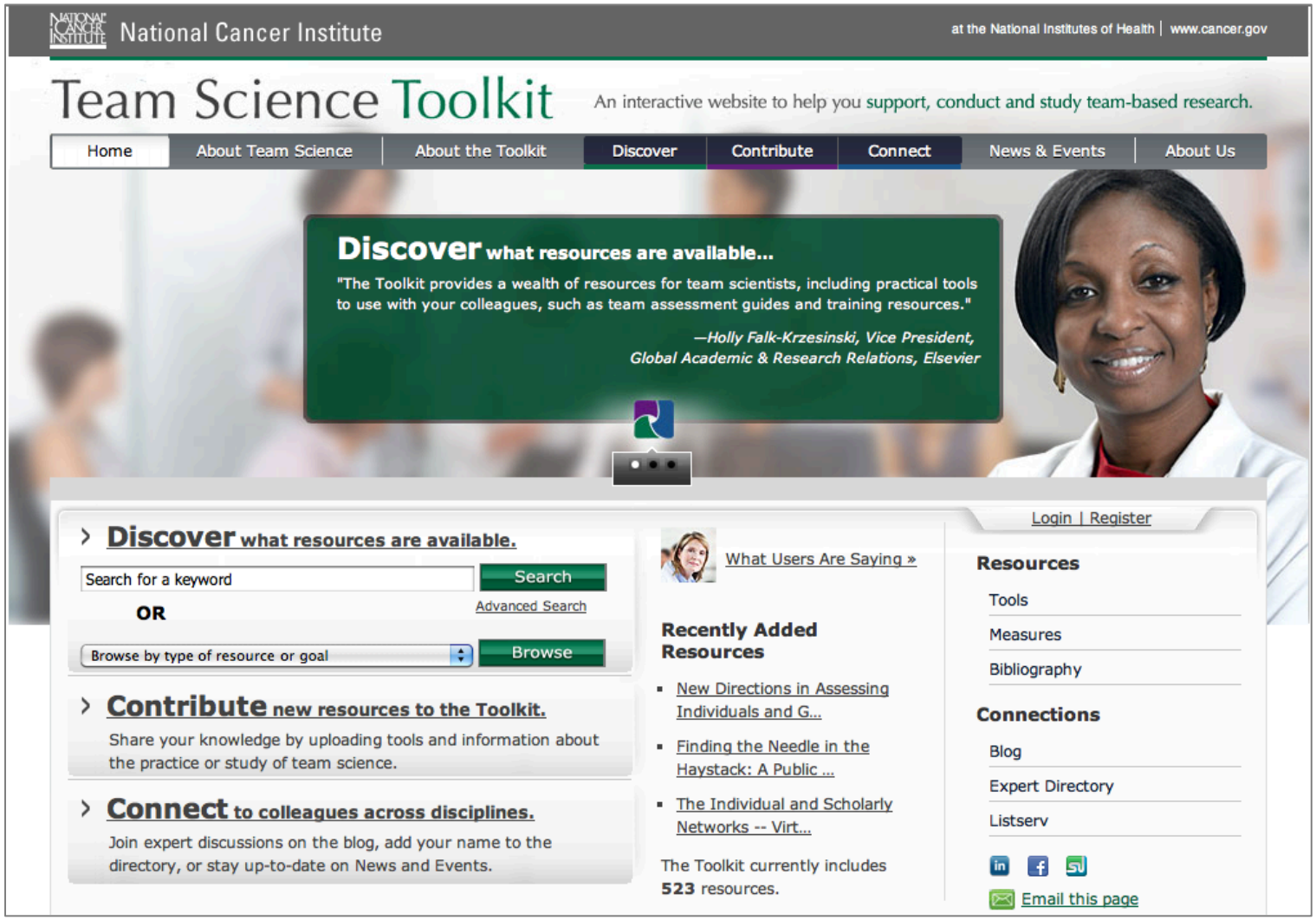
Team Science Toolkit



www.teamsciencetoolkit.cancer.gov

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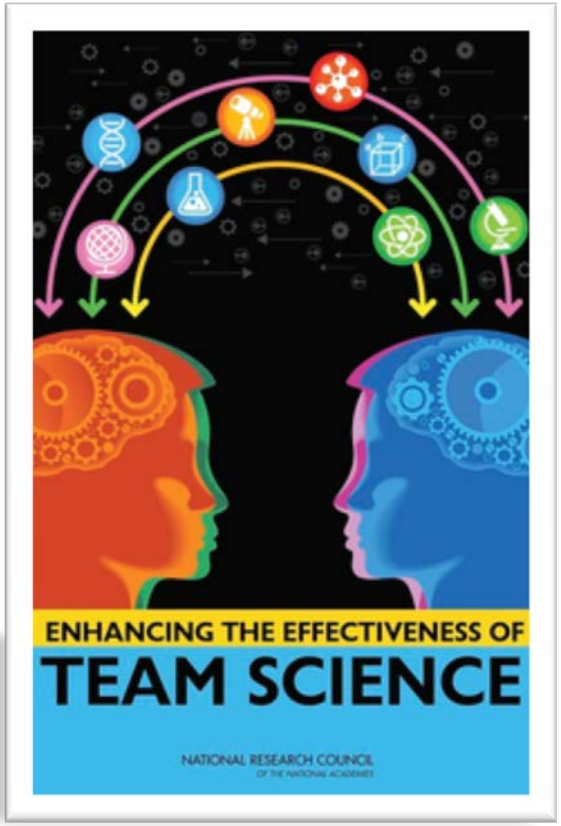
National Academies Consensus Report



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DIVISION OF BEHAVIORAL AND SOCIAL SCIENCES AND EDUCATION

Thursday, December 11, 2014

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The Science of Team Science

Project Scope

The NRC will conduct a consensus study on the science of team science to recommend opportunities to enhance the effectiveness of collaborative research in science teams, research centers, and institutes. The science of team science is a new interdisciplinary field that empirically examines the processes by which large and small scientific teams, research centers, and institutes organize, communicate, and conduct research. It is concerned with understanding and managing circumstances that facilitate or hinder the effectiveness of collaborative research, including translational research. This includes understanding how teams connect and collaborate to achieve scientific breakthroughs that would not be attainable by either individual or simply additive efforts. The committee will consider factors such as team dynamics, team management, and institutional structures and policies that affect large and small science teams. Among the questions the committee will explore are:

- How do individual factors (e.g., openness to divergent ideas), influence team dynamics (e.g., cohesion), and how, in turn, do both individual factors and team dynamics influence the effectiveness and productivity of science teams?
- What factors at the team, center, or institute level (e.g., team size, team membership, geographic dispersion) influence the effectiveness of science teams?
- How do different management approaches and leadership styles influence the effectiveness of science teams? For example, different approaches to establishing work roles and routines and to the division of labor may influence team effectiveness.
- How do current tenure and promotion policies acknowledge and provide incentives to academic researchers who engage in team science?
- What factors influence the productivity and effectiveness of research organizations that conduct and support team and collaborative science, such as research centers and institutes? How do such organizational factors as human resource policies and practices and cyberinfrastructure affect team and collaborative science?
- What types of organizational structures, policies, practices and resources are needed to promote effective team science, in academic institutions, research centers, industry, and other settings?

Sponsored by the National Science Foundation and Elsevier, the project began in October, 2012. A report will be issued in late 2014 or early 2015.

Members

Dr. Nancy J. Cooke, *Chair*, Arizona State University
Dr. Roger Blandford, Department of Physics, Stanford University

NSF

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Academy of Medical Sciences Report

The Academy of Medical Sciences

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You are here: Home > Policy > Policy projects > Team science

Team science

This project sought to understand the current incentives and disincentives for individual researchers participating in 'team science', and how to improve reward and recognition for their contributions.

Status
Ongoing

Summary | Scope of project | Working Group Members | 2012 roundtable | Image competition

'Team science' is becoming increasingly common across all fields of research. Teams spanning different specialties/disciplines and geographical centres are often needed to tackle contemporary

Downloads

Team Science report - March 2016

Download

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Fostering Collaboration

https://www.elsevier.com/research-intelligence/resource-library/ERI-Collaboration_Brochure

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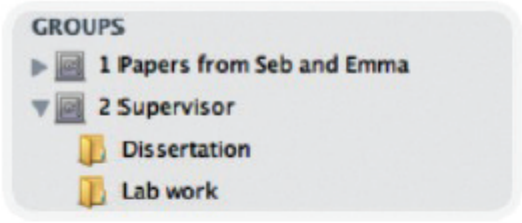
Elsevier Research Intelligence Portfolio

The rich functionality of the **Elsevier Research Intelligence** (ERI) portfolio helps institutions quickly identify expert collaborators from across disciplines and institutions, facilitating more effective and productive partnerships.

Powered by data from **Scopus®** and the semantic **Elsevier Fingerprint Engine™**, the ERI portfolio allows institutions to:

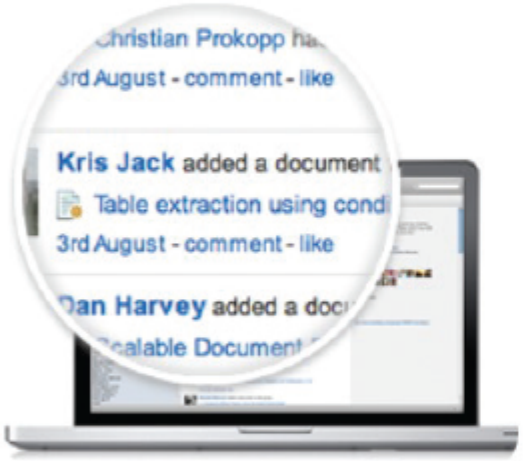
- **Identify** current and **discover** potential **collaborators**
- Provide data-driven analysis of **collaborative behavior** and impact
- Deliver insight into how institutions can facilitate **more powerful collaborations**

Mendeley



Share papers and collaborate

Whether you're a research team, lab, or university class - sharing papers can be a challenge. Simply create public or private groups and start sharing documents instantly.



Communication made easy

Group members can see papers and folders you add to the group on their newsfeed. Keep up-to-date with your collaborators and make working together a walk in the park.

- See when others add documents
- Comment and like to start discussion
- Watch projects progress over time

All your ideas in real-time

Reviewing an article with your colleagues? When a group member adds a note, highlight or summary to a group document, the edit is visible to all the members of the group.

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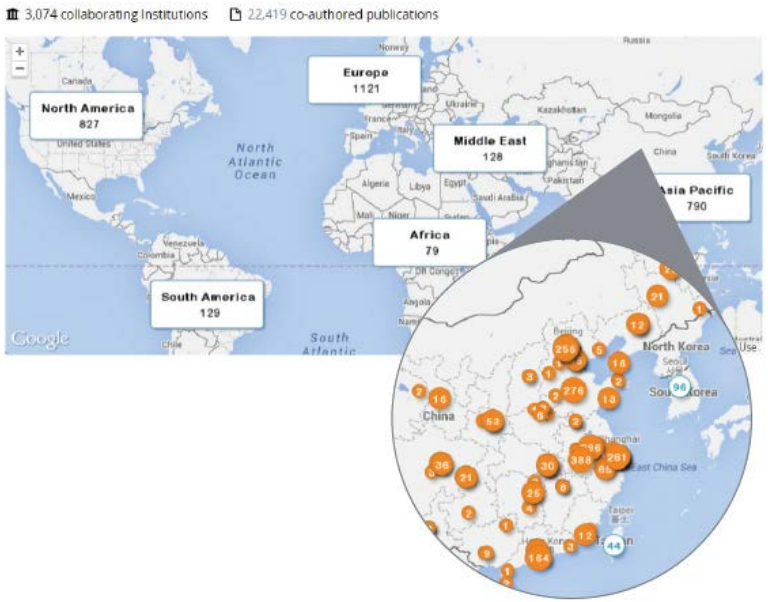
SciVal

Develop Collaborative Partnerships on a Global Scale

- Identify and analyze existing and potential collaboration opportunities based on publication output and citation impact;
- Explore rich visualizations of your institution's current and prospective research partnerships across sectors;

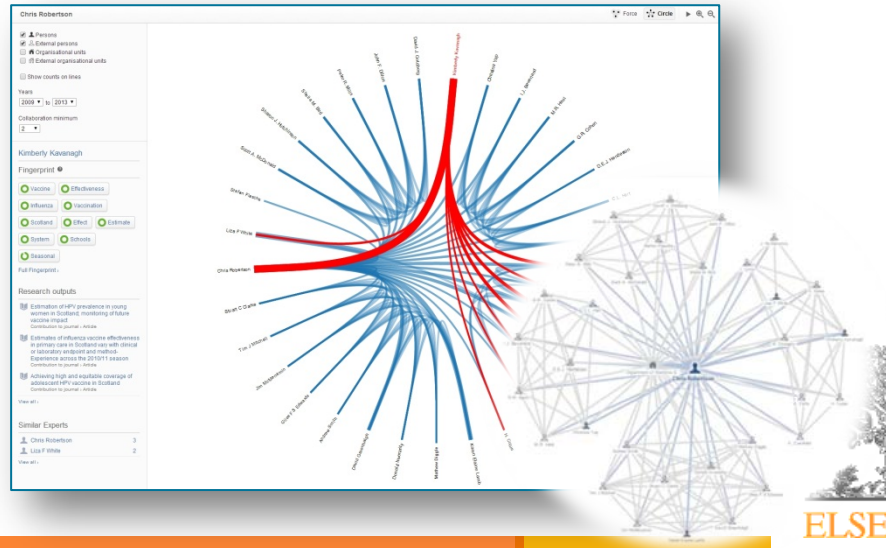
- Identify **top collaborative institutions**, geographic regions, countries and co-authorship;
- Gain insight into the key players in **emerging research fields** to find potential new collaborators



Research Networking Systems

Facilitate collaborations by exposing publishing connections and make researchers' accomplishments readily discoverable

- Demonstrate researchers' activities to the research community, government agencies, industry, media and the public
- Facilitate cross-institutional collaborations, economic development initiatives and other external partnerships through public portals
- Identify potential collaborators by accessing researchers with similar expertise via semantic profile mapping and via coauthor and institutional visualizations



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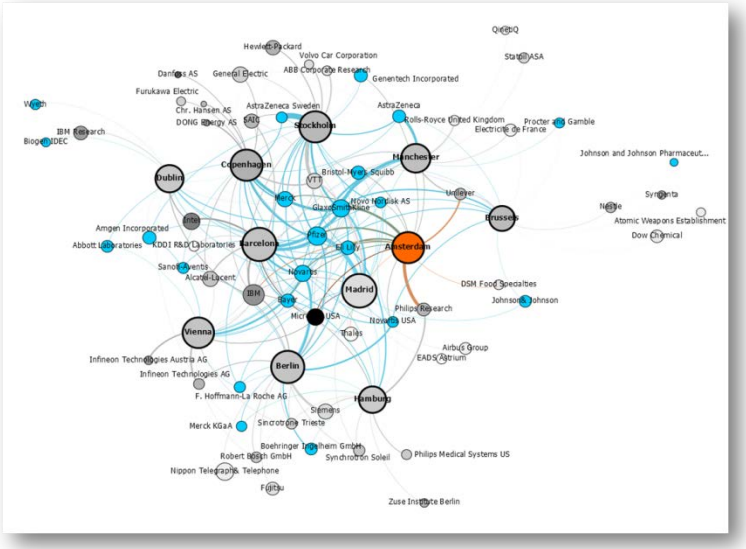
Analytical Services

Custom Analyses to Understand Institutional Research Performance Through Collaboration

- Intra- and inter-institutional collaboration;
- National and International collaboration;
- Cross-sector collaboration



International Collaboration
In what areas does our country or institution collaborate the most internationally?

Improving and building partnerships
Who are our most prolific collaboration partners according to the effect of the collaboration on both partners' citation impact?

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Connect with Me

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