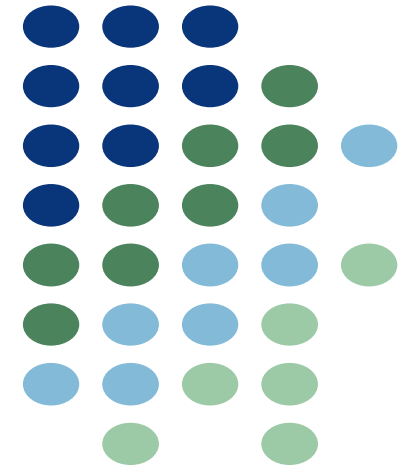


The Science of Team Science

A quick introduction

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Systems Science

GEORGE WARREN BROWN
SCHOOL OF SOCIAL WORK



Washington University
Institute of **C**linical and
Translational **S**ciences

Goals

- Provide overview of the new discipline called *Science of Team Science* (SciTS)
 - Scope
 - Models & methods
 - Importance for Washington University scholarly activity
- Present an example of how we are taking a SciTS approach in the evaluation of WU Institute of Clinical and Translational Sciences (ICTS)

Changing nature of scientific activity

- <http://www.nytimes.com/2012/09/10/health/research/for-a-lung-cancer-drug-treatment-may-be-within-reach.html?hpw>
- <https://www.nature.com/articles/nature11404>

Science becoming *Team Science*

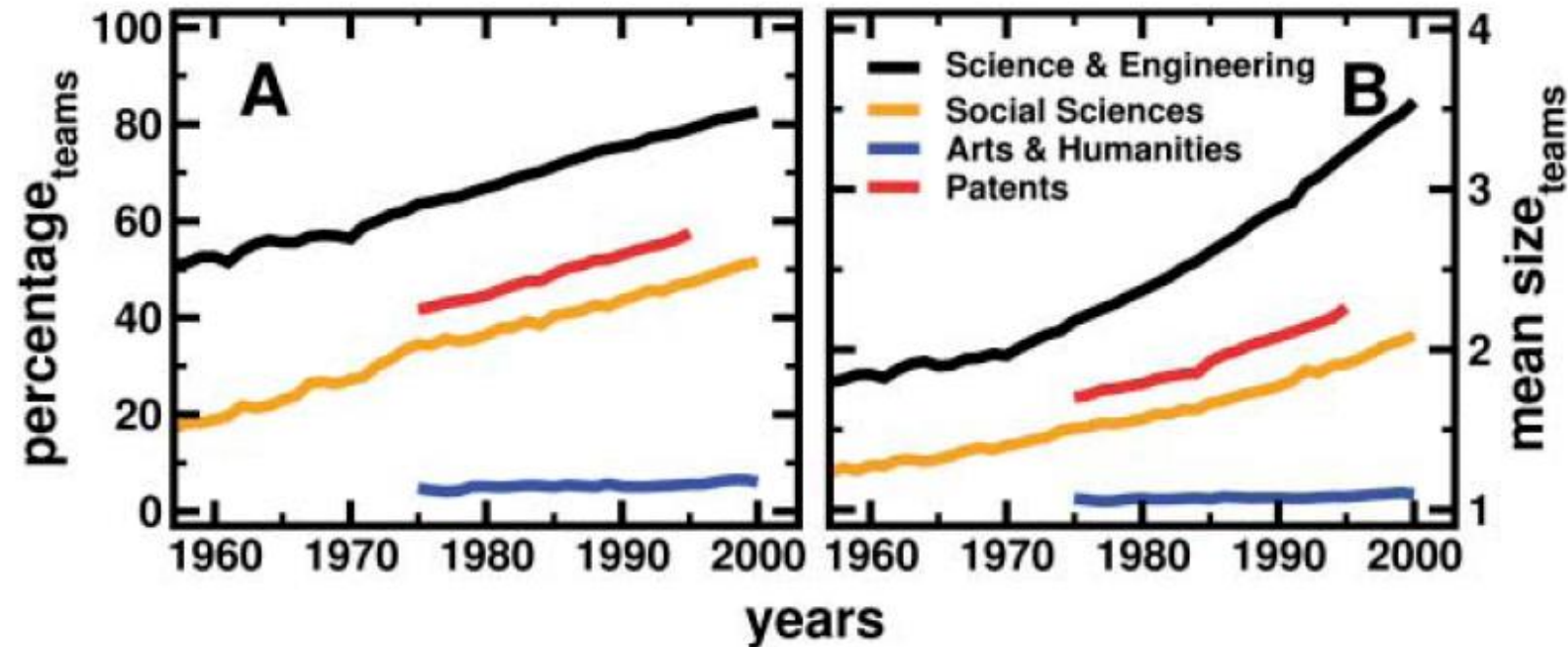
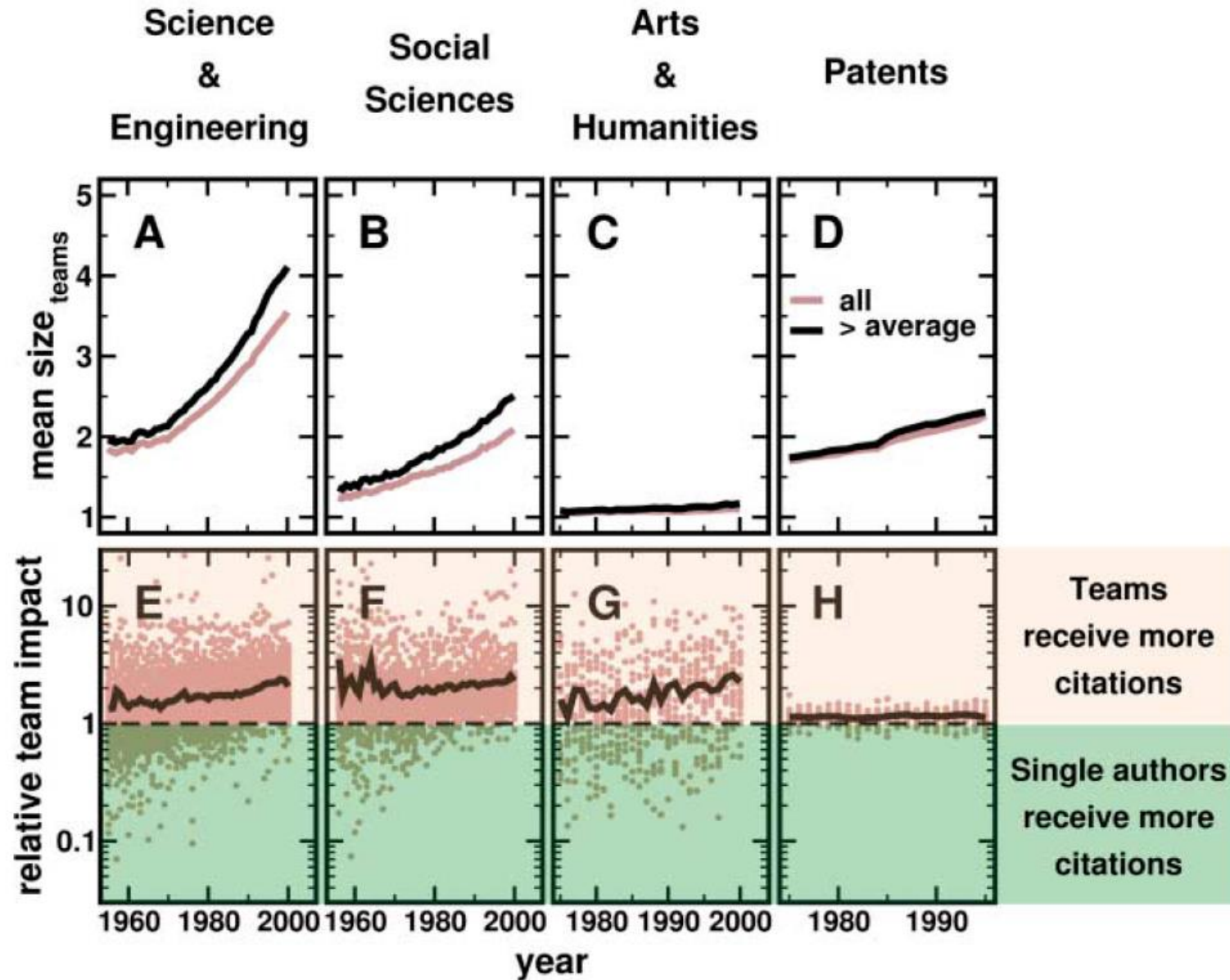


Fig. 1. The growth of teams. These plots present changes over time in the fraction of papers and patents written in teams (A) and in mean team size (B). Each line represents the arithmetic average taken over all subfields in each year.

(Wuchty, et al., 2007)

Teams have more impact



Teams as driver of science

...solo authors did produce the papers of singular distinction in science and engineering and social science in the 1950s, but the mantle of extraordinarily cited work has passed to teams by 2000.

(Wuchty, et al., 2007)

SciTS is:

...the examination of the processes by which scientific teams organize, communicate, and conduct research.

(Börner, et al., 2010)

Team Science Initiatives – Key Features

- Team science (TS) initiatives are the principal units of analysis in the *science of team science* (SciTS)
 - These include large research, training, and translational programs implemented by public agencies and non-public organizations
- Designed to promote collaborative and often cross-disciplinary approaches to analyzing complex research questions about particular phenomena
 - Intra-center (within) and cross-center (between) collaborations are critically important

(Okamoto, 2012)



Transdisciplinary Tobacco
Use Research Centers



CTSA Clinical & Translational[®]
Science Awards

Key question:

Do large cross-disciplinary initiatives lead to scientific breakthroughs and public health improvements that would not have occurred without those initiatives?

(Okamoto, 2012)

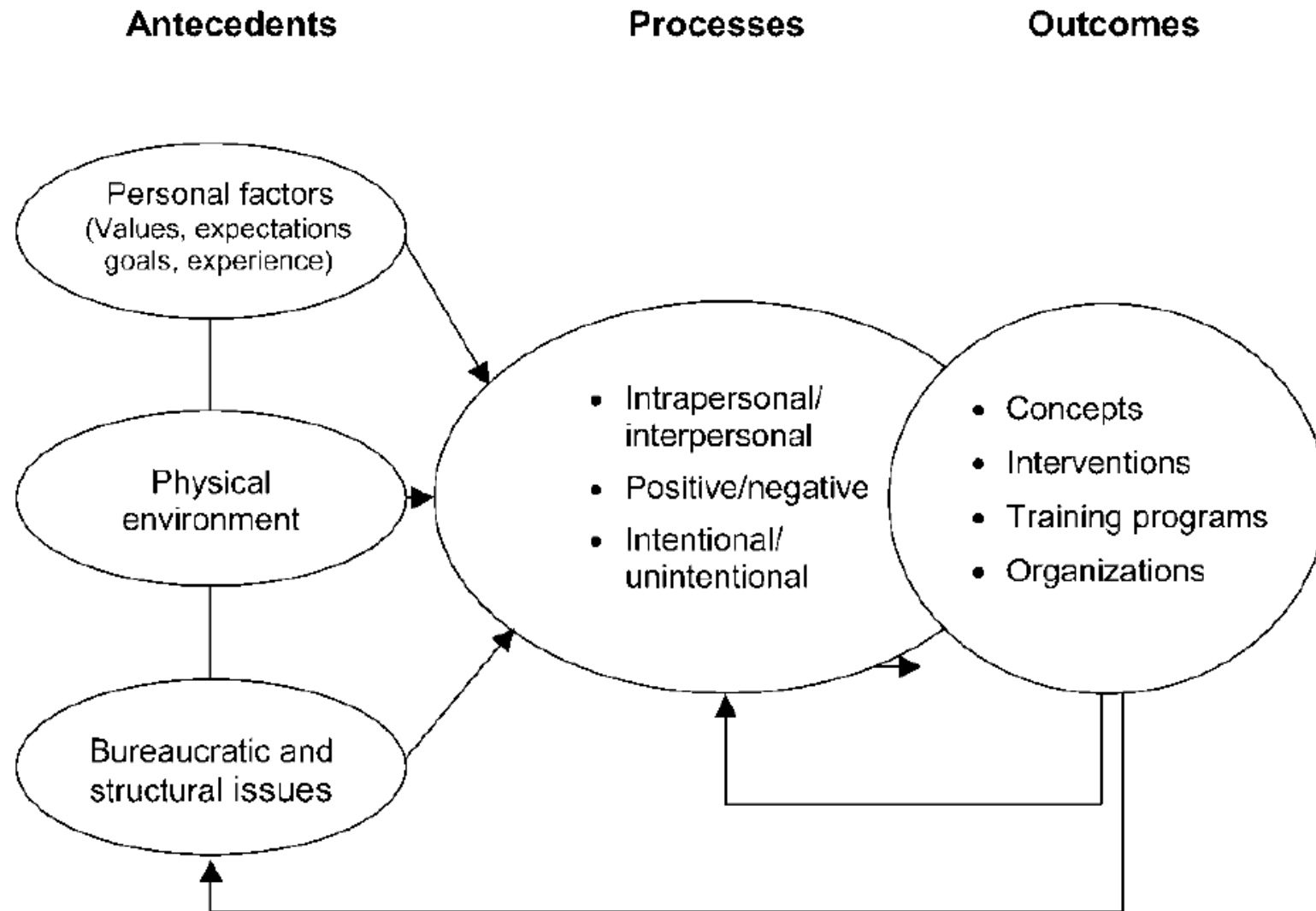


Figure 1. Working model of transdisciplinary scientific collaboration.

(Fuqua, et al., 2013)

Logic model for TTURC evaluation

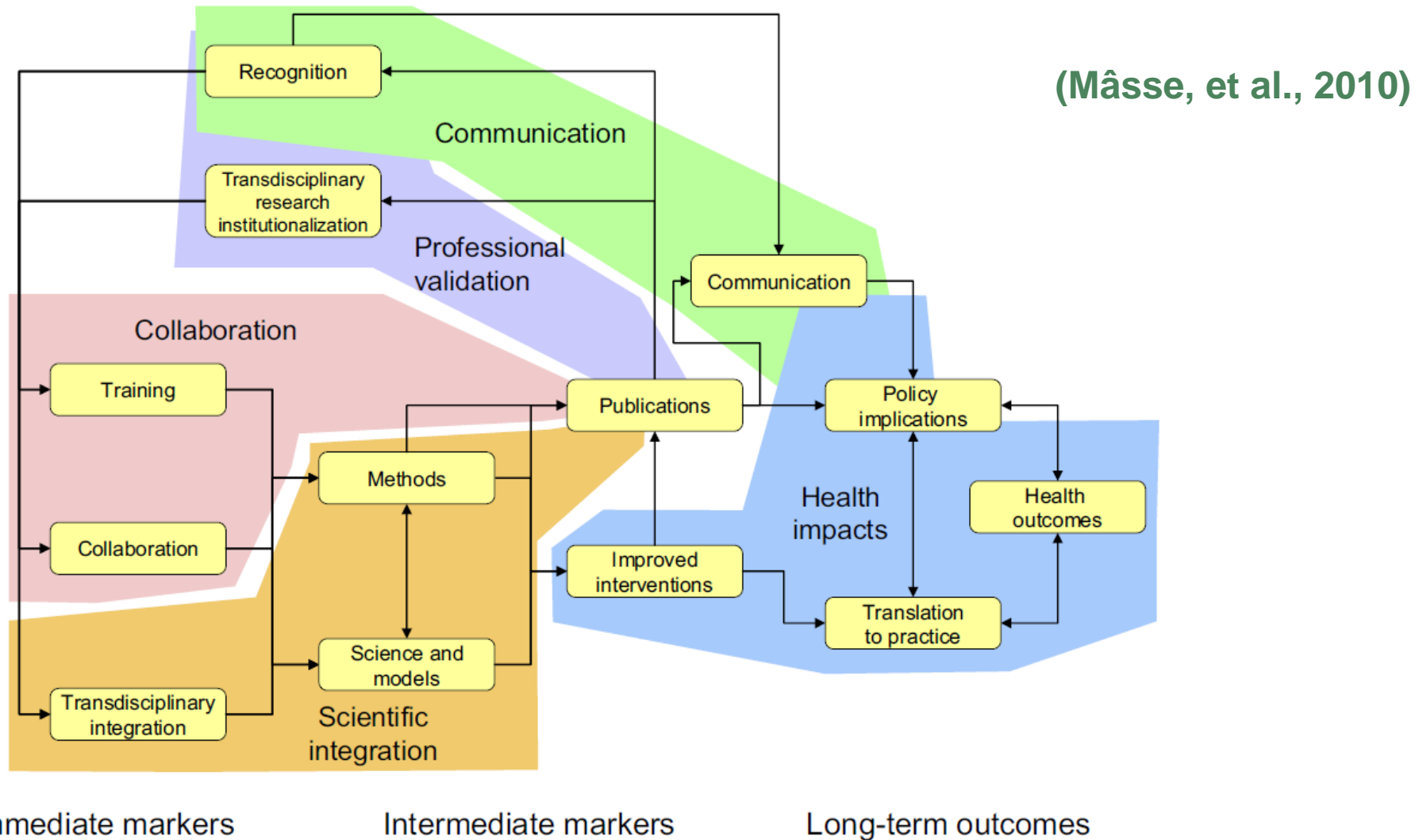
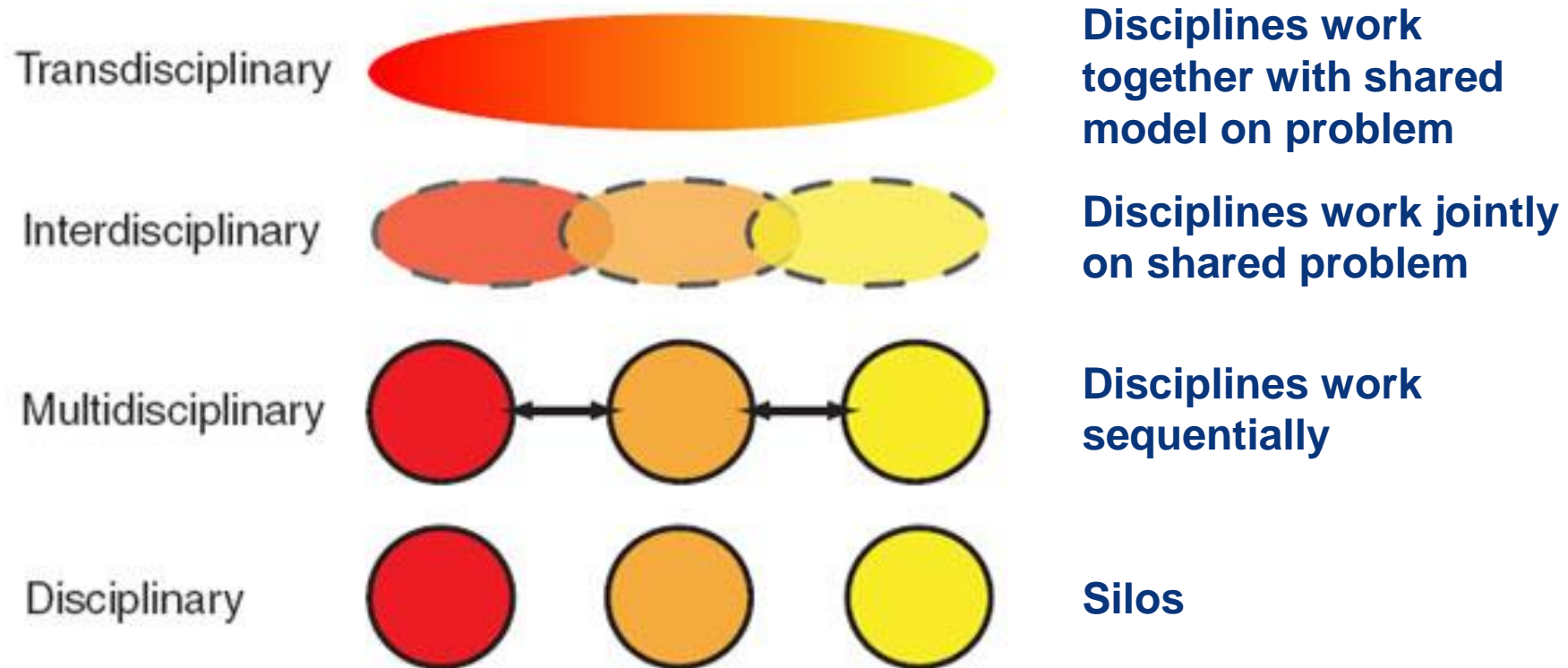


Figure 1. Logic model for the TTURC evaluation that guided the development of the researcher-survey items showing inter-relationships among constructs divided into expected temporal-outcome groups

Transdisciplinary framework



Participatory team science

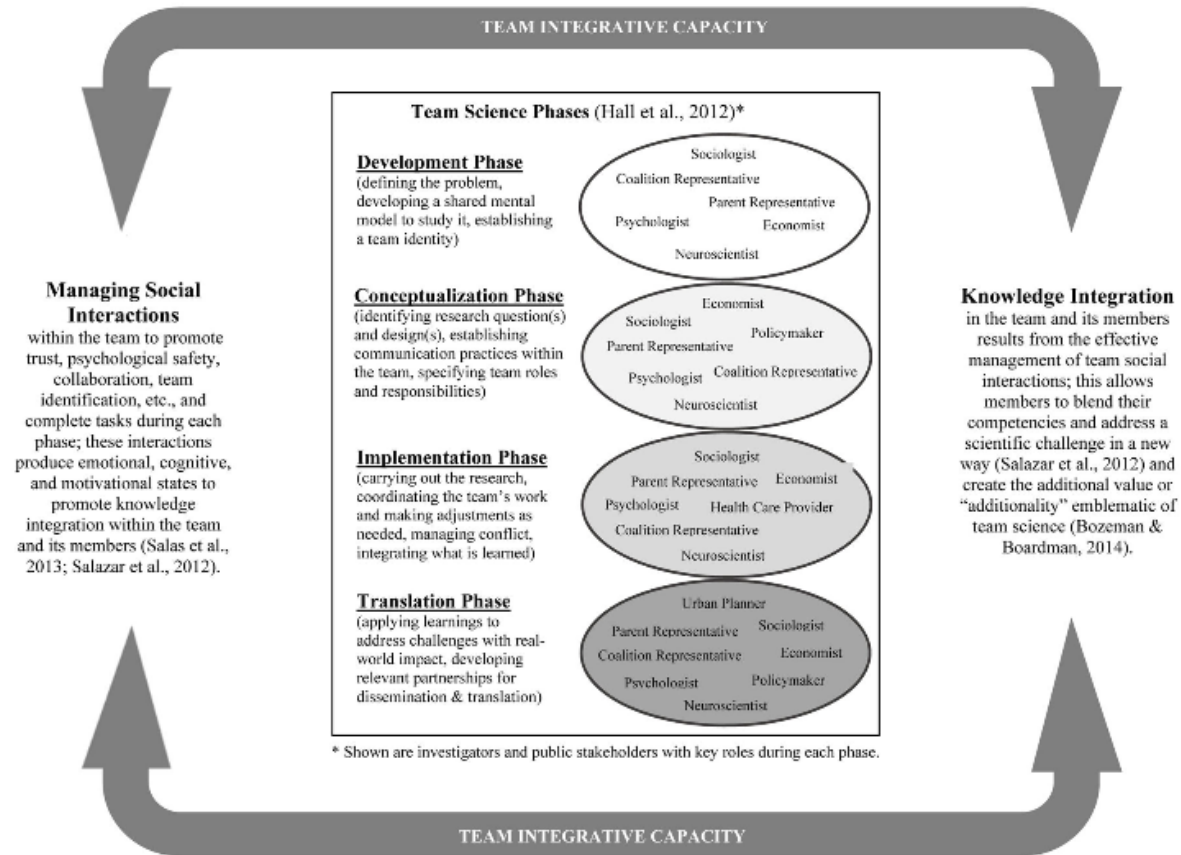
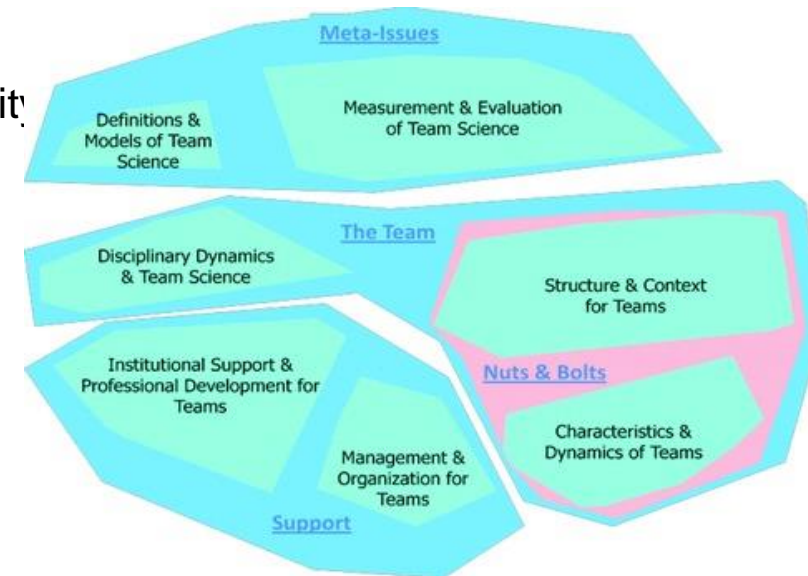


Figure 1. Team Integrative Capacity across Four Phases in Participatory Team Science. Shown is a Hypothetical Science Team Studying the Impact of Adverse Childhood Experiences (ACEs) and Neighborhood Disadvantage on the Health and Well-Being of Children and Families

(Tebes & Thai, *American Psychologist*, 2018)

SciTS types of questions (following Börner, 2010)

- Micro – role of scientist
 - Predictors of successful team scientist
 - Relationship between collaboration process and productivity
 - Professional risk issues
- Meso – role of team
 - Structure of successful scientific teams
 - Building successful scientific teams
- Macro – role of organization, society
 - Required organization infrastructure
 - Role of proximity
 - How to evaluate large-scale research initiatives



Does Collocation Inform the Impact of Collaboration?

Kyungjoon Lee¹, John S. Brownstein², Richard G. Mills³, Isaac S. Kohane^{1,2*}

1 Center for Biomedical Informatics, Harvard Medical School, Boston, Massachusetts, United States of America, **2** Children's Hospital Informatics Program at the Harvard-MIT Division of Health Sciences and Technology, Boston, Massachusetts, United States of America, **3** Operations and Business Affairs, Harvard Medical School, Boston, Massachusetts, United States of America

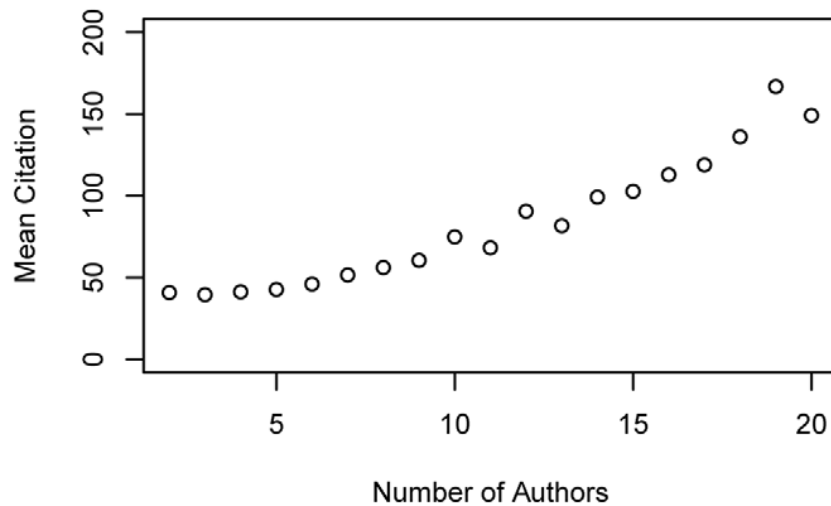


Figure 1. Number of coauthors and mean citations. Citation of an article has strong positive correlation with the number of coauthors. This trend becomes obvious for articles with more than 5 authors. Because of this, to see the relationship between author distance and citation, articles with different number of coauthors need to be analysed separately. We separated articles with 4 or less authors and 5 or more authors.

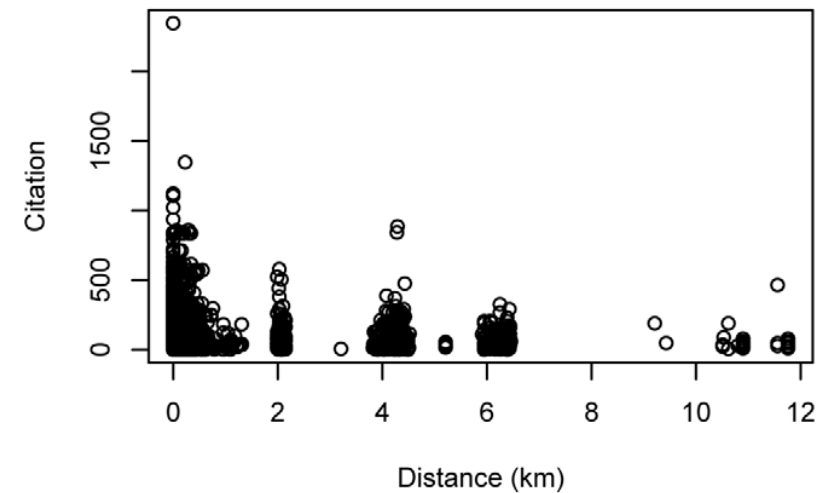


Figure 2. Scatter plot of distance between authors and citation for high resolution data. High resolution data is only available for Harvard affiliated authors. Harvard authors are in 4 major geographical locations: Longwood Medical Area, Massachusetts General Hospital (MGH) main campus, MGH Navy Yard campus, and McLean Hospital. Distances between authors are aggregated in discrete values because authors are not uniformly distributed but in one of those 4 locations. Maximum value (12 km) are for authors in MGH campuses and McLean Hospital.

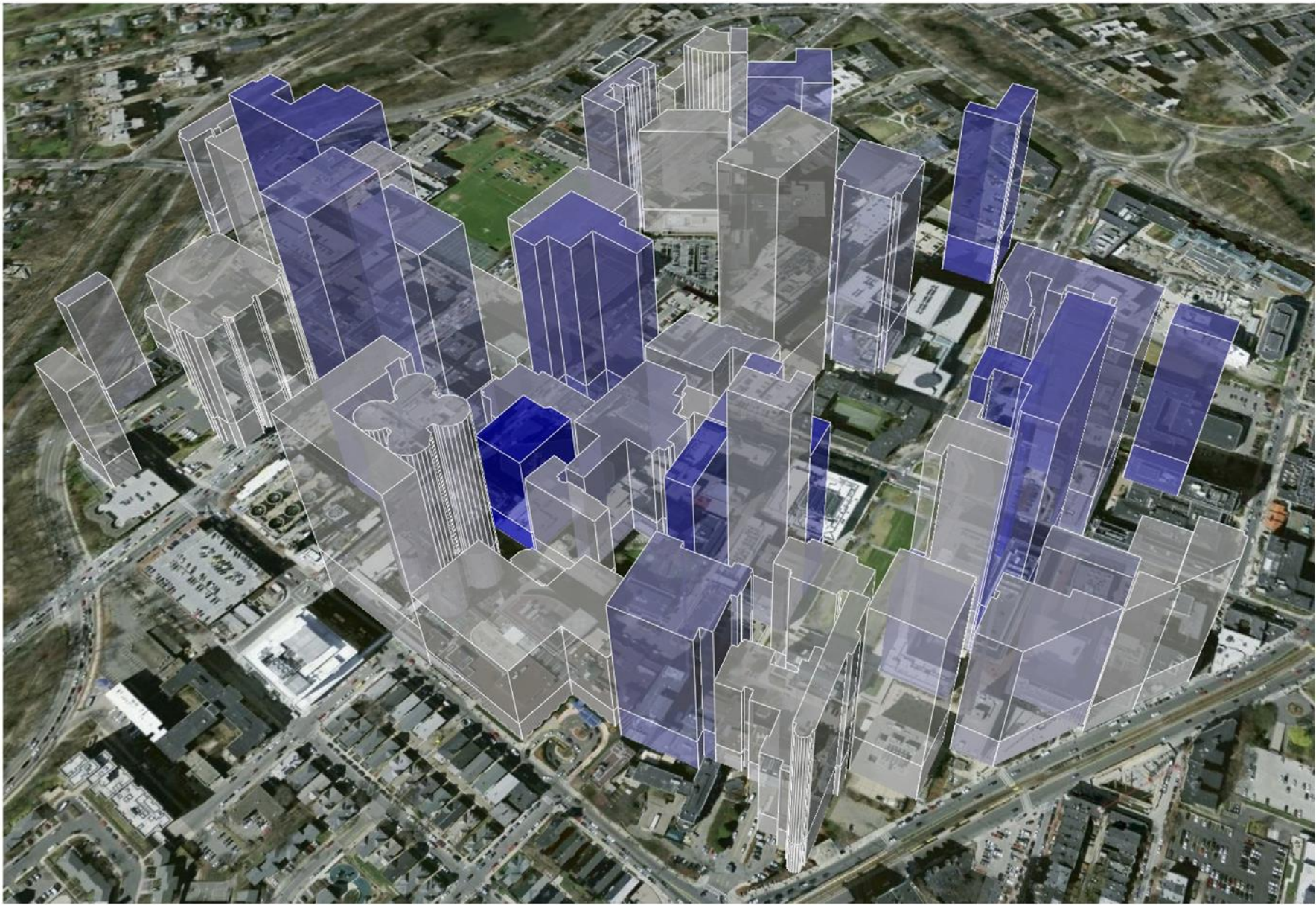



Figure 8. 3-D representation of the relationship between intra-building collaboration and mean citation impact on the Longwood campus of Harvard Medical School. The height of each building reflects the mean number of citations of publications originating in that building, and the color gradient reflects the proportion of publications originating from that building in which both first and last authors work in the building (from grey = low to blue = high). An interactive version of this map could be found at <http://collaboration.harvard.edu>.
doi:10.1371/journal.pone.0014279.g008

Example – ICTS Evaluation

- One of the goals of the national CTSA award program is to enhance scientific collaboration and support transdisciplinary research
- WU ICTS evaluation incorporates a SciTS approach
 - Looking for evidence that CTSA funding has increased scientific collaboration and moved teams towards a more transdisciplinary approach

Approach

- Model
 - Team collaboration over time:
 - Planning, working, disseminating
- Data
 - Grant submissions
 - New collaboration survey
 - Publications & authorship



2011

 Washington University
Institute of **C**linical and
Translational **S**ciences
Tracking & Evaluation Program

ICTS Research Collaboration
Survey Results

November 2011

Prepared by:
ICTS Tracking and Evaluation Program
Center for Tobacco Policy Research
Washington University in St. Louis

Strong support for collaboration

Figure 4. *In general, collaboration has improved your research productivity.*

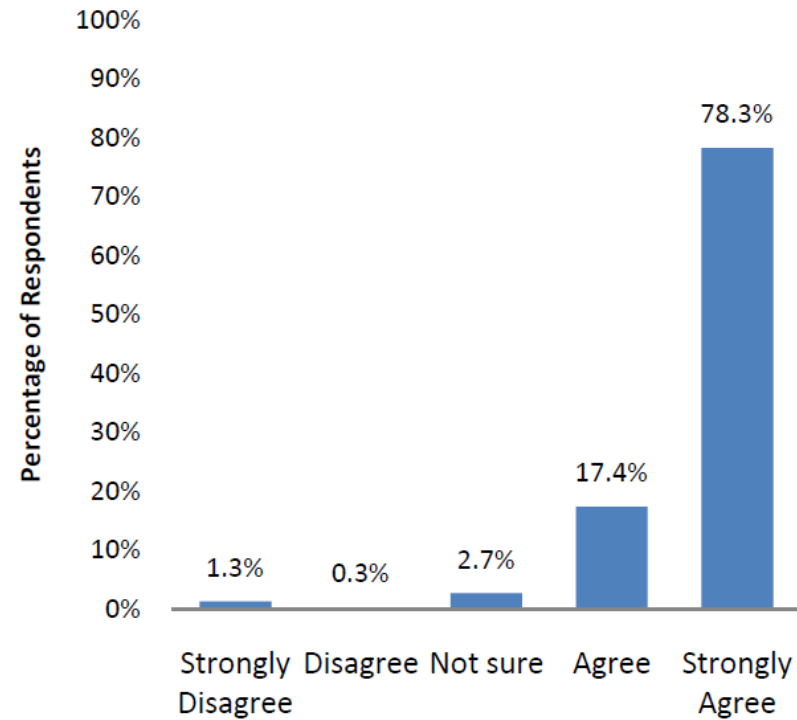
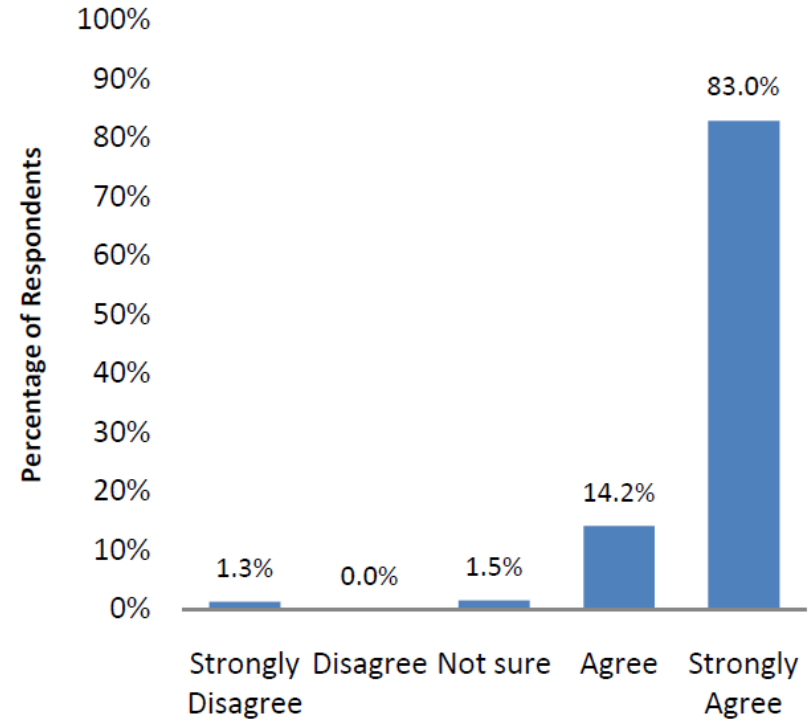


Figure 5. *In general, collaboration has improved the quality of your research.*



Attitudes toward transdisciplinary research

Figure 8. *In transdisciplinary research, it takes more time to produce a research article.*

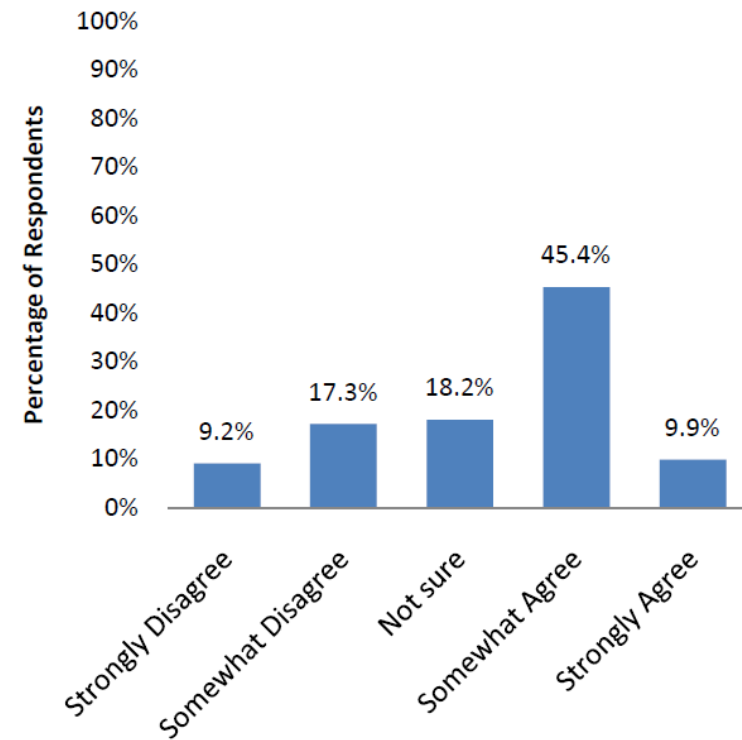
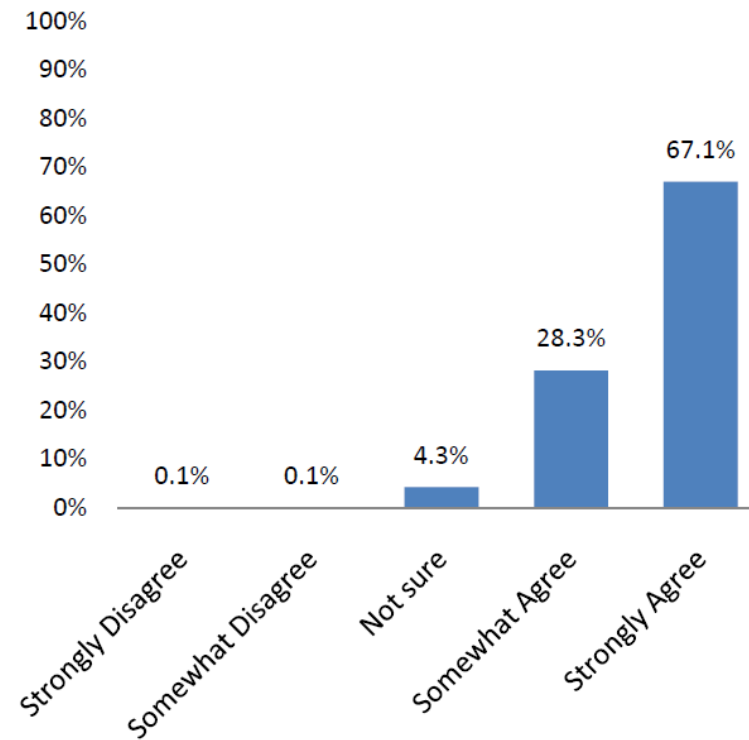
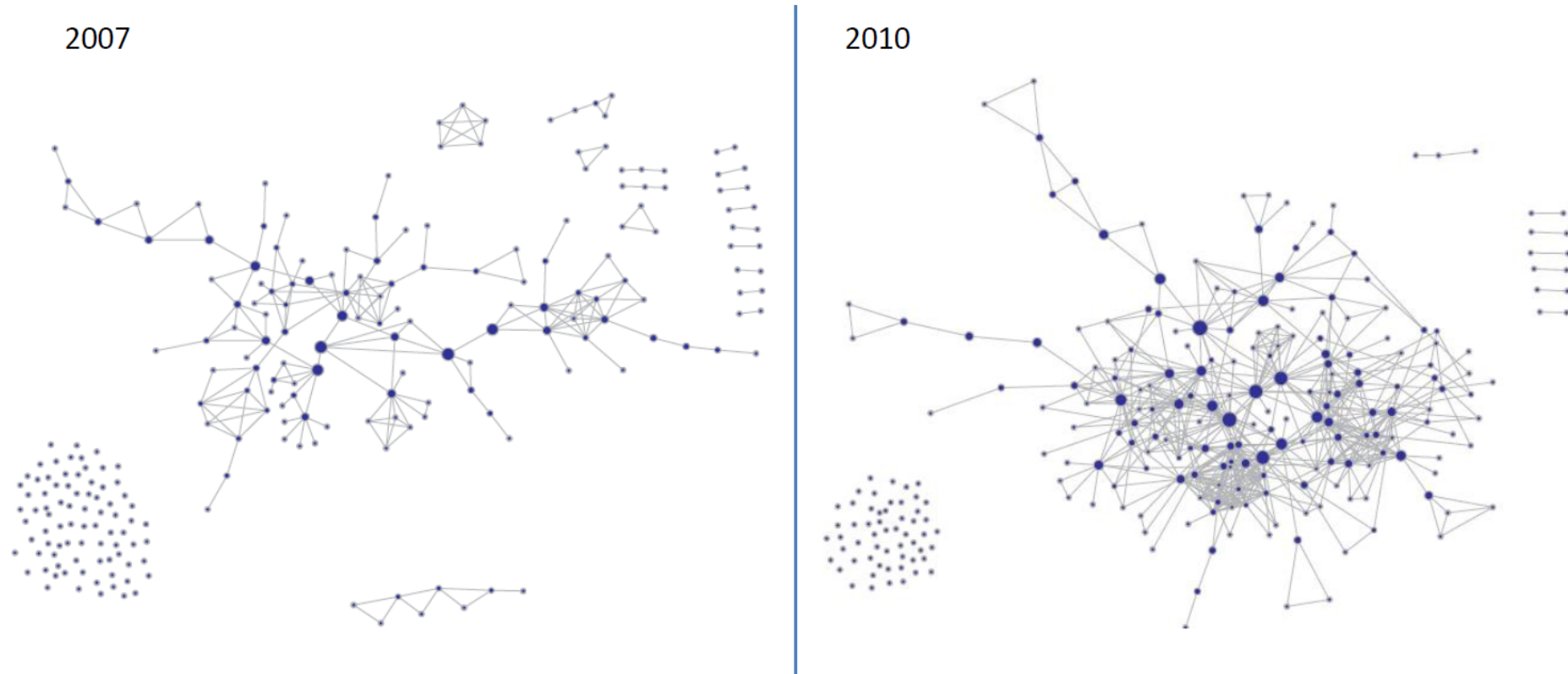


Figure 9. *Generally speaking, I believe that the benefits of transdisciplinary scientific research outweigh the costs of such work.*



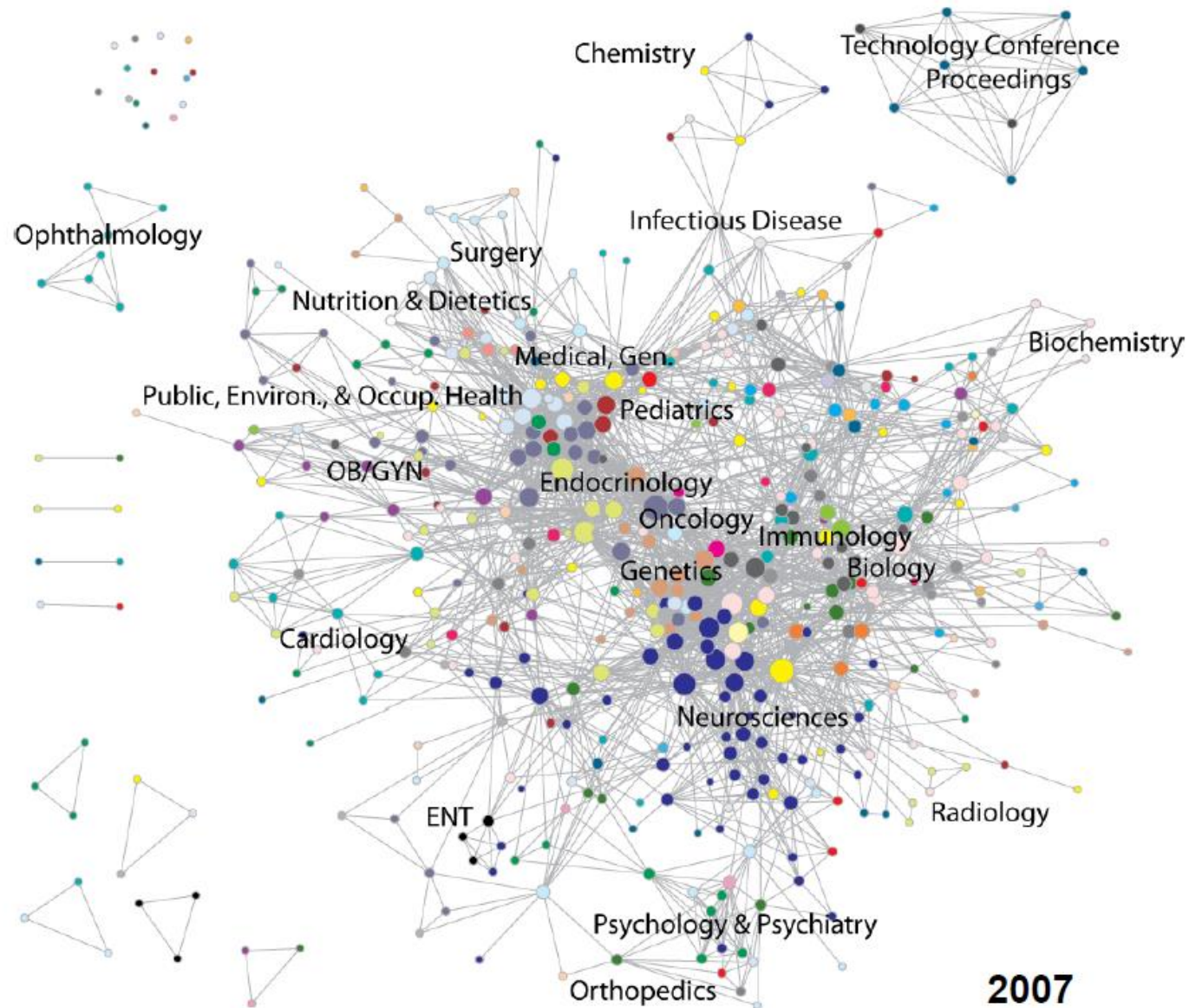
Increased collaboration over time

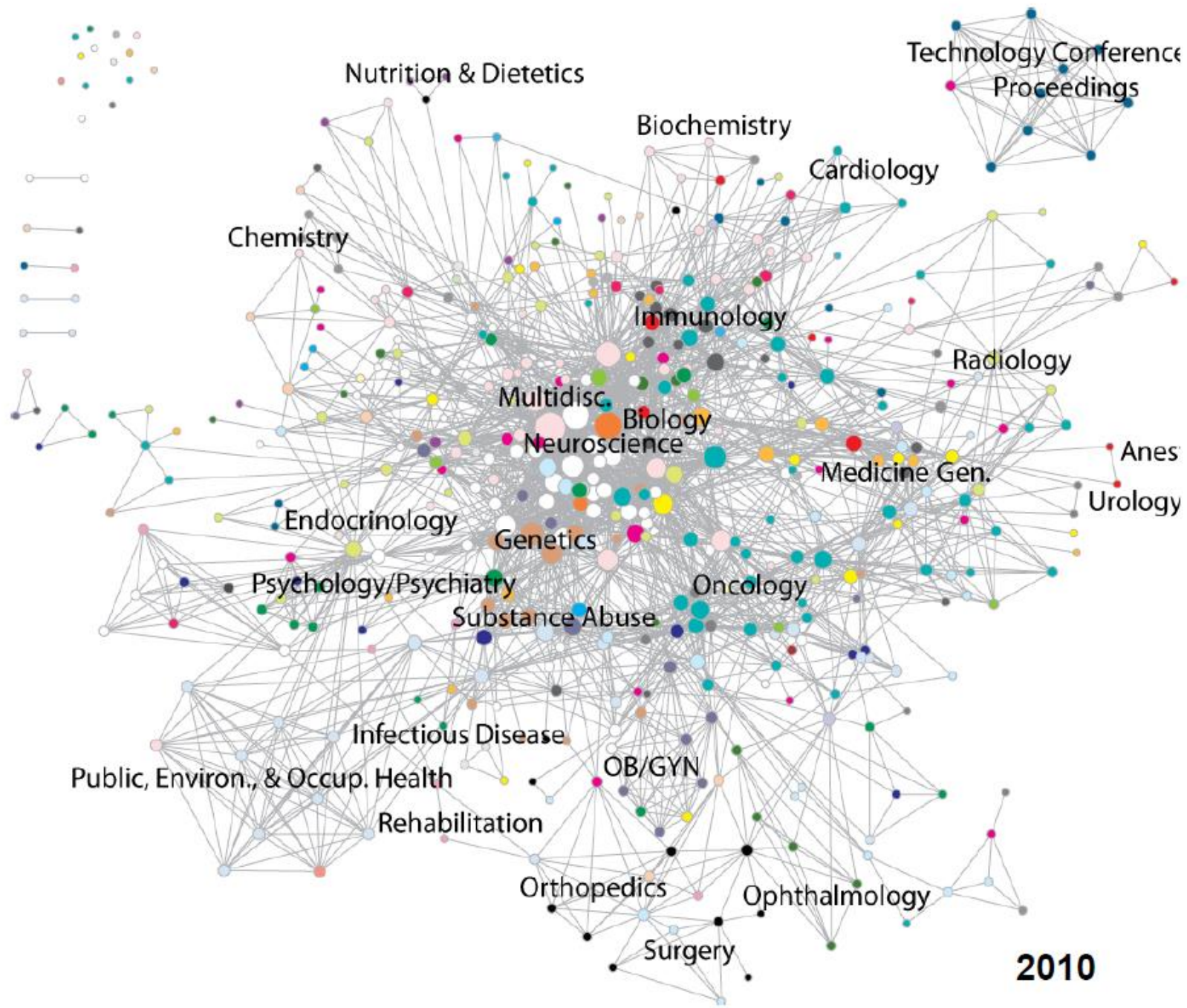
Figure 2: Grant Networks (cohorts 1 and 2)



Year	# of Nodes	Density	Average Degree	Size of Largest Component	Diameter	Ratio of Inter- to Intra-disciplinary Collaborations
2007	236	.008	1.92	76	16	.216
2010	257	.019	4.81	184	11	.436

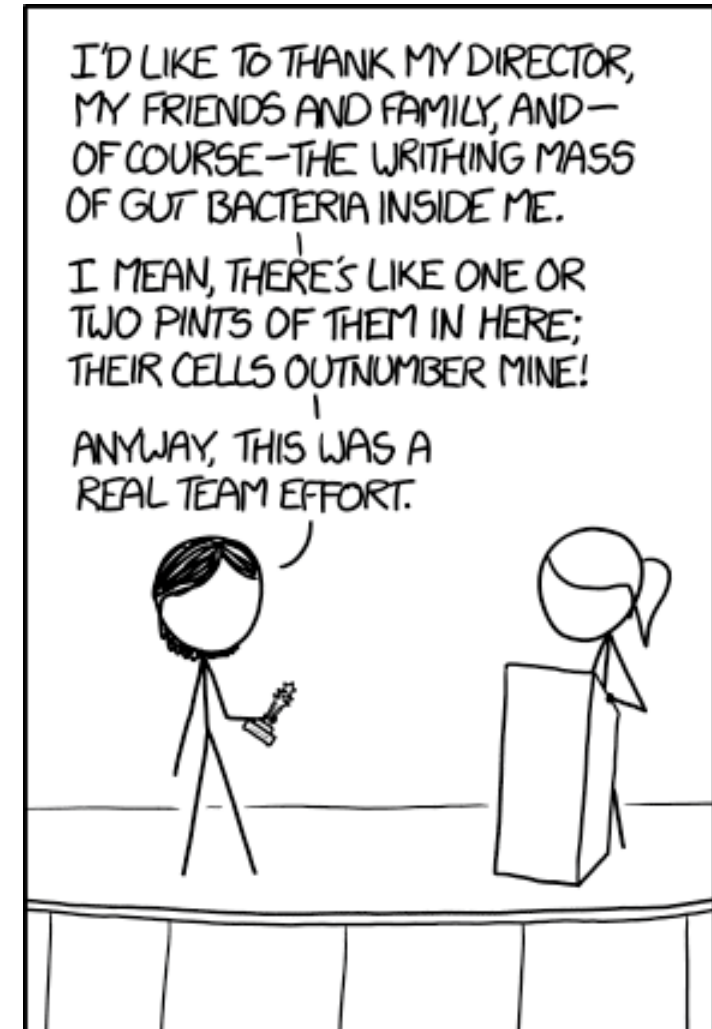
Figure 5. Comparison of intra & interdisciplinary science connections pre (2007) and post (2010) ICTS





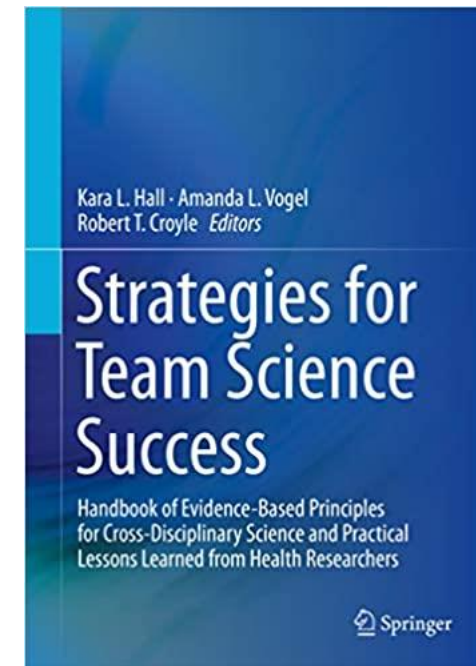
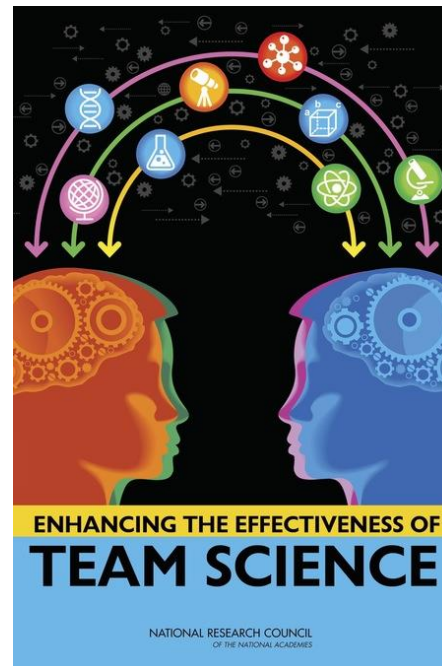
Teaming principles

- Forming
 - Establish team (top-down & bottom-up)
- Storming
 - Establish roles and responsibilities, communications, processes
- Norming
 - Working together effectively & efficiently
 - Members develop trust and comfort
- Performing
 - Work together efficiently
 - Focus on shared vision
 - Resolve issues
- Adjourning/Transforming
 - Natural end
 - New project or goals



Important resources

- Team Science Toolkit (www.teamsciencetoolkit.cancer.gov)
- Hall, et al. *Strategies for team science success*, 2019.
- Tebes, & Thai, Interdisciplinary team science and the public: Steps toward participatory team science. *American Psychologist*, 2018.
- National Academies, *Enhancing the effectiveness of team science*, 2015



Things to think about (and discuss)

Tips

- Distinguish between collaborations and teams
- When building teams, think of skills, knowledge, resources
- Understand the team science environment when looking at jobs
- The teams on paper may bear little resemblance to the actual team
- Develop and disseminate team policies/guidelines
- For papers and grants, think and talk through collaborations *early!*
- Think of your teams/collaborators as a resource (social capital)

Traps

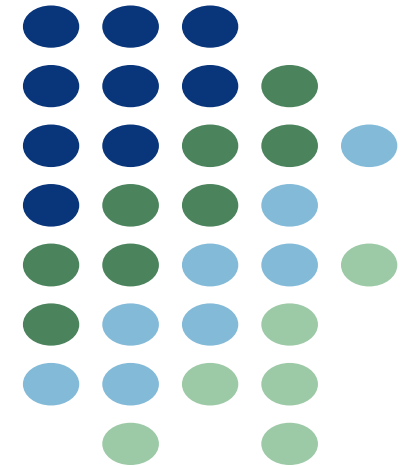
- Avoid the *usual suspects* approach to building teams
- Talk time does not equate to successful and healthy collaborations/teams
 - Don't equate meetings with teamwork
- Avoid the extremes of *all process vs. all products*
- Don't skip the early stages of teambuilding, especially with interdisciplinary teams

For more information:

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