Enhancing the Effectiveness of Team Science (2015 Report)

Briefing for NASEM Committee on ***Research and Application in Team Science***

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Board on Behavioral, Cognitive, and Sensory Sciences
Division of Behavioral and Social Sciences and Education
National Research Council

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Study Background

- **Rationale:** Clear need to provide research-based guidance to improve the processes and outcomes of team science
- **Sponsors:** NSF, Computer and Information Systems and Engineering Directorate, and Elsevier
- **Goal:** Enhance the effectiveness of collaborative research in science teams, research centers, and institutes.
- **Audiences:** NSF and other public and private research funders; the scientific community; the SciTS community; universities; research centers and institutes.

Committee Charge

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… Explore:

- How individual factors influence team dynamics, effectiveness and productivity
- Factors at the team, center, or institute level that influence effectiveness
- Different management approaches and leadership styles that influence effectiveness
- How tenure and promotion policies acknowledge academic researchers who join teams
- Organizational factors that influence the effectiveness of science teams (e.g., human resource policies, cyberinfrastructure)
- Organizational structures, policies and practices to promote effective teams

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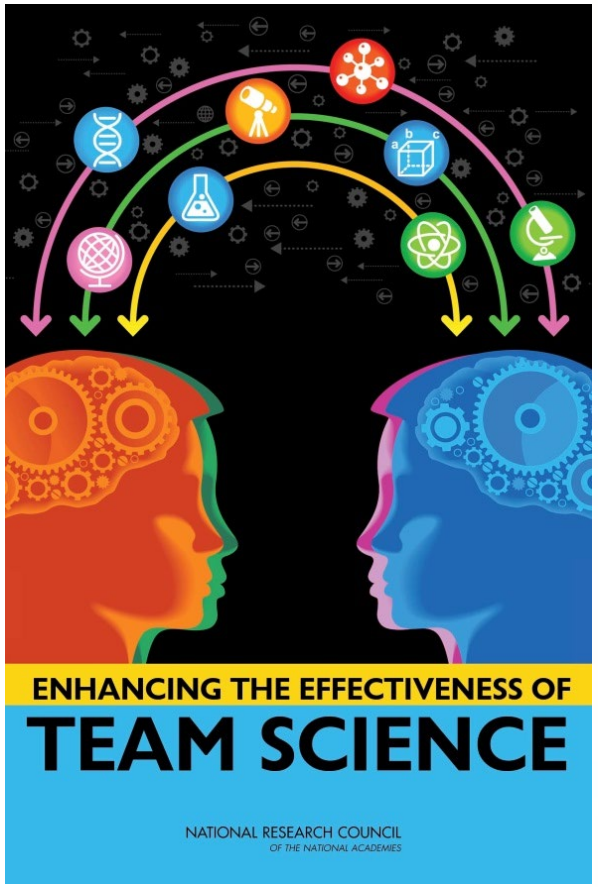


Why Team Science?

- Complex scientific societal problems often require a team
- Team Science:
  - is impactful (highly cited; Wuchty et al., 2007; Uzzi, et al. 2013)
  - is innovative (Uzzi et al. 2013)
  - is productive (Hall, et al., 2012)
  - has broad reach/uptake (Stipelman et al, 2014)

However…

- Not all science requires a team
- Team science is difficult

Defining Key Terms

- ***Team science*** - Collaborative, interdependent research by more than one individual
- ***Science team*** – Conducted by 2 to 10 individuals who conduct team science
- ***Larger group*** - More than 10 individuals who conduct team science
- ***Team effectiveness*** – A team's capacity to achieve its goals and objectives

Science Teams (2 to 10)

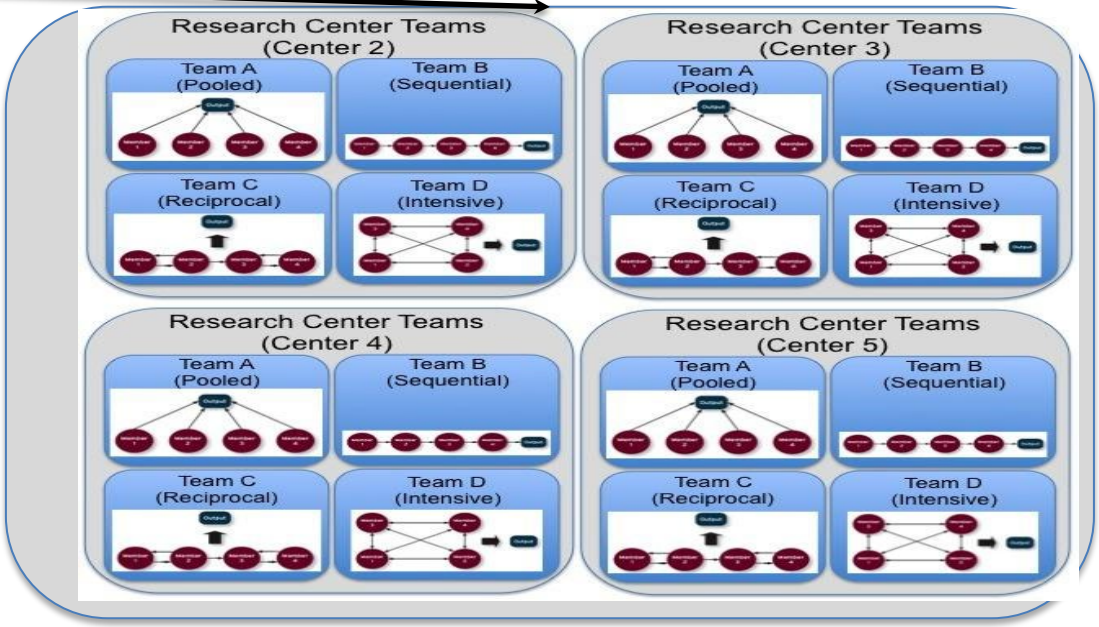
95 percent of all shared publications

Larger Groups (over 10)

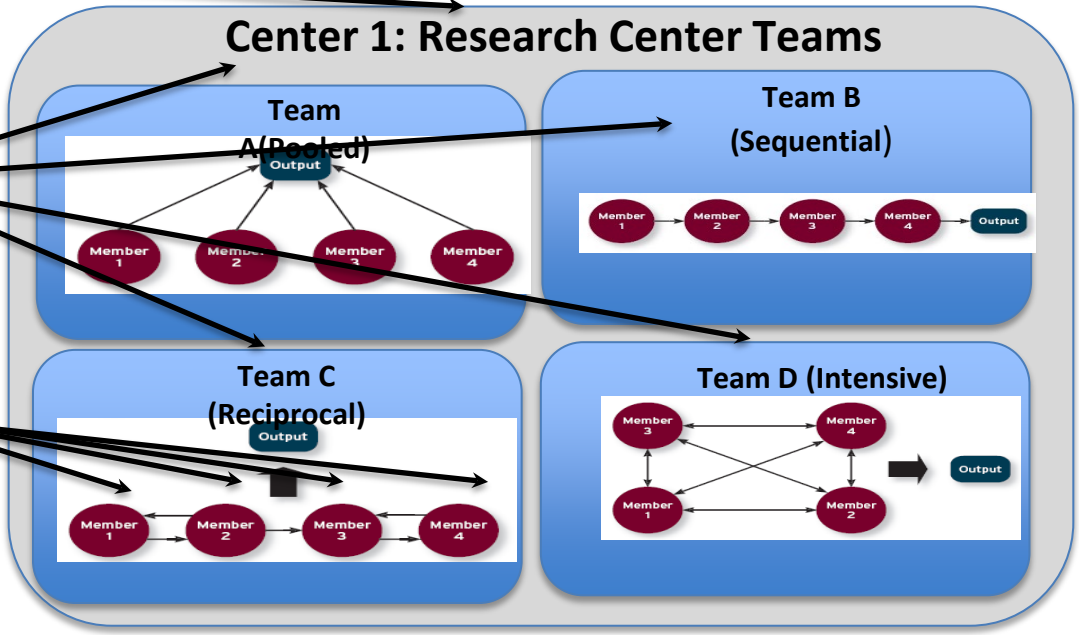
5% of publications by 11-100 and <1% by 100+

NSF Science of Learning Centers or NIH CTSA Program

Focus on Understanding Overall Center Program



Focus on Understanding Organization



Focus on Understanding Teams

Focus on Understanding Individuals

Key Features that Create Challenges for Team Science

- High diversity of membership
- Deep knowledge integration
- Large size
- Goal misalignment with other teams
- Permeable boundaries
- Geographic dispersion
- High task interdependence

Sources of Evidence

- Team level: Social science research on teams in other contexts
- Organizational level: Research and case studies on scientific and other organizations

- Ecosystem level: Science policy, research and practice in higher education
- Team Science: SciTS – Science of Team Science community

Improving Team Effectiveness

Conclusion: *A strong body of research conducted over several decades has demonstrated that team processes are related to team effectiveness. Interventions that foster positive team processes offer the most promising route to enhance team effectiveness.*

Interventions in 3 Areas:

- Team Composition
- Team Development
- Team Leadership

Composing the Team

- ***Conclusion:*** *Research in non-science contexts has found that team composition influences team effectiveness, and this relationship depends on the complexity of the task, the degree of interdependence among team members, and how long the team is together. Task-relevant diversity is critical and has a positive influence on team effectiveness.*

- ***Conclusion:*** *Task analytic methods developed in non-science contexts and research networking tools developed in science contexts allow practitioners to consider team composition systematically.*

Recommendation 1

Team science leaders and others involved in assembling science teams and larger groups should:

- Consider using task analytic methods and tools that help identify the knowledge, skills, and attitudes required effective performance of the project so that task-related diversity among team or group members can best match project needs
- Consider applying tools such as research networking systems designed to facilitate assembly of science teams
- Partner with researchers to evaluate and refine these tools and task analytic methods

Team Professional Development

Conclusion: *Research in contexts outside of science has demonstrated that several types of team professional development interventions improve team processes and outcomes.*

Recommendation 2

Team-training researchers, universities, and science team leaders should partner to translate, extend, and evaluate the promising training strategies, shown to improve the effectiveness of teams in other contexts, to create professional development opportunities for science teams.

Educating Team Scientists

- ***Conclusion:*** *Colleges and universities are developing cross-disciplinary programs designed to prepare students for team science*
- *Little empirical research is available on the extent to which participants learn the targeted competencies.*
- *Research to date has not shown whether the acquisition of the targeted competencies contributes to team science effectiveness.*

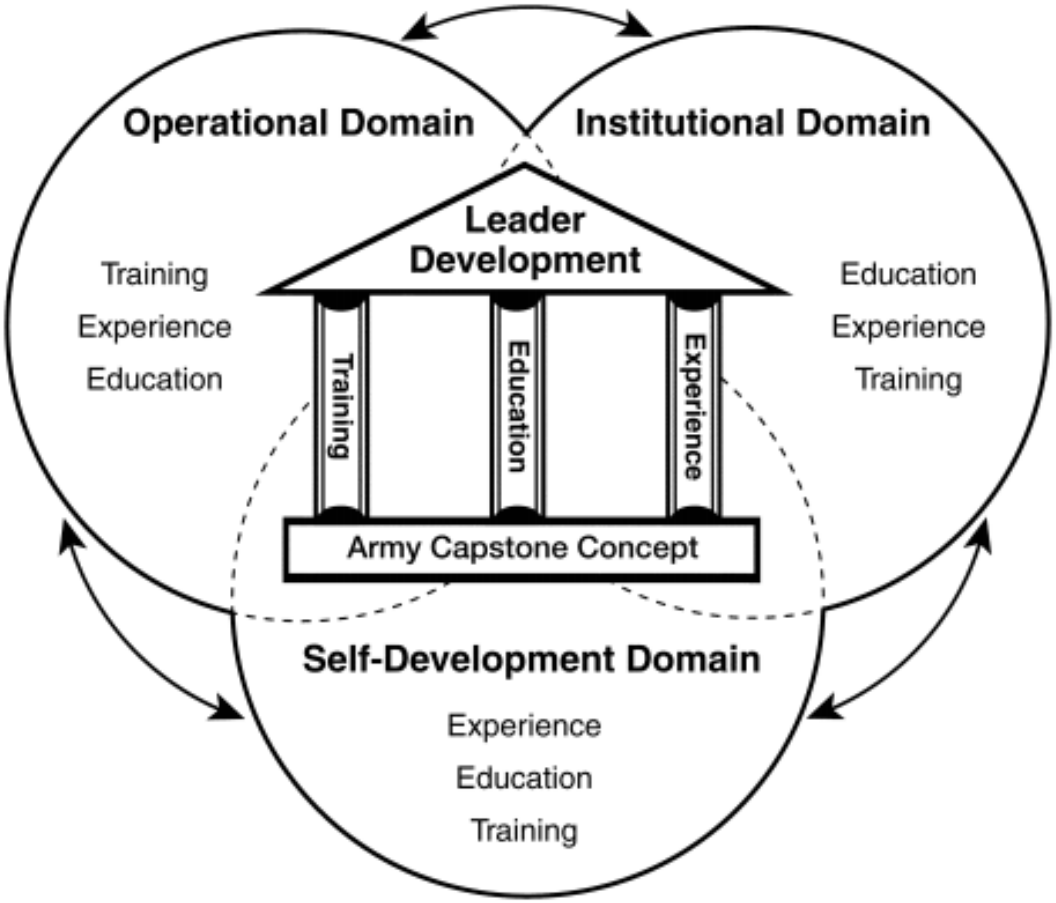
Leadership

Conclusion: *Decades of research on team and organizational leadership in contexts other than science provides a robust foundation of evidence to guide professional development for leaders of science teams and larger groups.*

Recommendation 3

Researchers, universities, and team science leaders should partner to translate and extend the leadership literature to create and evaluate science leadership development opportunities for team science leaders and funding agency program officers.

Example


Operational Domain
Institutional Domain
Leader Development
Training
Experience
Education
Education
Experience
Training
Training
Education
Experience
Army Capstone Concept
Self-Development Domain
Experience
Education
Training

The Challenges of Virtual Collaboration

- ***Conclusion**: Research on geographically dispersed science teams and groups has found that communicating and developing trust are more challenging relative to face-to-face teams and groups.*

- *These limitations of virtual collaboration may not be obvious to members and leaders of the team or group.*

Recommendation 4

Leaders of geographically dispersed science teams should:

- Provide activities shown by research to help all participants develop shared knowledge (e.g., a common vocabulary and work style).
- Consider assigning some tasks to semi-independent units at each location to reduce the burden of constant electronic communication.

Virtual Collaboration and Technology Challenges

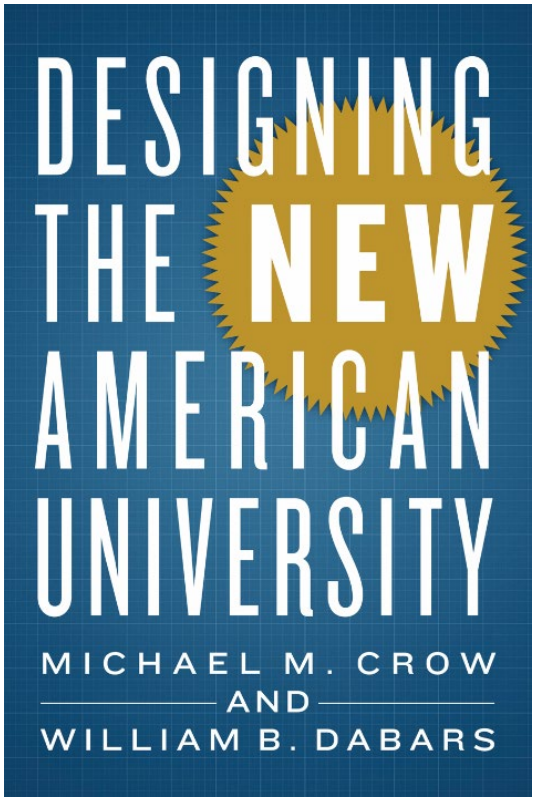
- ***Conclusion:*** *Technology for virtual collaboration often is designed without a true understanding of users' needs and limitations*
- *Even when a suite of appropriate technologies is available, users often do not recognize and use its full capabilities.*
- *These related problems may impede effective collaboration.*

Recommendation 5

- When selecting collaboration technologies, leaders should carefully evaluate project needs and participants' technology readiness.
- Organizations should promote human-centered collaboration technologies and provide ongoing training and technology support.

Research Universities

Conclusion: *Universities have launched new efforts to promote interdisciplinary team science (e.g., creating research centers and institutes), but the impact of these initiatives on the amount and quality of team science has not been systematically evaluated.*



Reward Structures of Research Universities

- ***Conclusion:*** *University promotion and tenure review policies typically do not provide comprehensive, clearly articulated criteria for evaluating individual contributions to team-based research.*
- *The extent to which researchers are rewarded for team-based research varies widely across and within universities.*
- *Where team-based research is not rewarded, young faculty may be discouraged from joining those projects.*

Recommendation 6

Universities and disciplinary associations should proactively develop and evaluate broad principles and more specific criteria for allocating credit for team-based work to assist promotion and tenure committees in reviewing candidates.

Funding Agencies

Conclusion: *Public and private funders are in the position to foster a culture within the scientific community that supports those who want to undertake team science, not only through funding, but also through white papers, training workshops, and other approaches.*

National Institutes of Health

Recommendation 7

Funders should work with the scientific community to:

- Encourage the development and implementation of new collaborative models (e.g., research networks, consortia)
- Develop incentives for team science (e.g., new P&T policies)
- Provide resources (e.g., information repositories, training modules).

Funding Agencies

- ***Conclusion:*** *Funding agencies are inconsistent in balancing focus on scientific merit with collaborative merit (i.e., consideration of how teams and larger groups are going to execute the work.*

- *Funding Opportunity Announcements soliciting team science proposals often include vague language about the type of collaboration and the level of knowledge integration they seek in proposed research.*

Recommendation 8

- Funders should require proposals for team-based research to present collaboration plans and provide guidance to scientists for the inclusion of these plans in their proposals, as well as guidance and criteria for reviewers' evaluation of these plans
- They should also require authors of proposals for interdisciplinary or trans-disciplinary research projects to specify how they will integrate disciplinary perspectives and methods throughout the life of the research project.

Advancing the Research

- ***Conclusion:*** *Targeted research is needed to evaluate and refine the tools, interventions, and policies recommended in this report, along with more basic research on team science to guide continued improvement in the effectiveness of team science.*

- *Few if any funding programs support research on the effectiveness of science teams and larger groups.*

Research Challenges

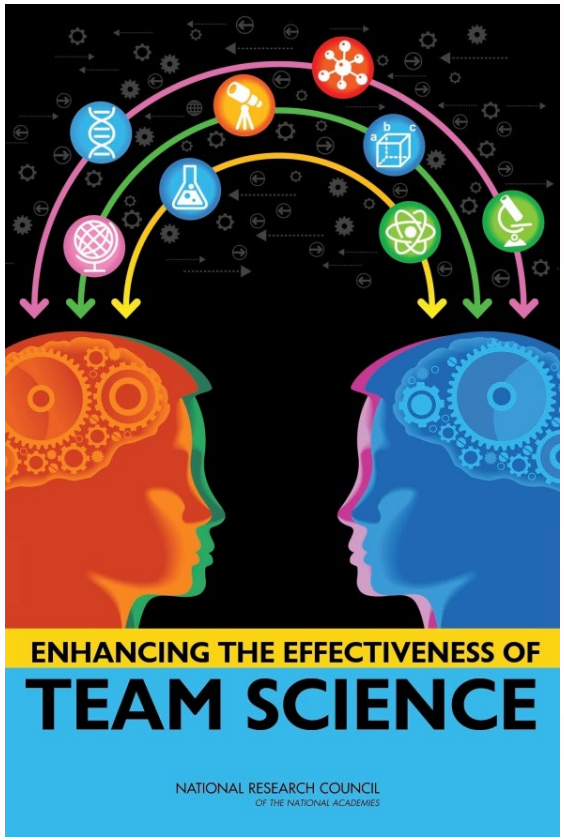
- Multiple goals of team science projects
- Multi-level perspective
- Dynamic processes - individual, team, and organizational
- Relationship of processes to goals and outcomes

Recommendation 9

- Public and private organizations should support research on team science effectiveness through funding.
- Support ongoing evaluation and refinement of the interventions and policies recommended above
- Support research on the role of scientific organizations (e.g., research centers, networks, consortia) in supporting science teams and larger groups.
- Collaborate with universities and the scientific community to facilitate researchers' access to key team science personnel and data sets

Conclusions

- Rich and robust science of teams that can be extended to improve team science effectiveness
- The science points to interventions through:
  - Assembling teams
  - Providing professional development and education opportunities and
  - Leadership development opportunities
- Other interventions can improve:
  - Virtual collaboration
  - Promotion and tenure credit for team-based work
  - Support from funding agencies for team science



Questions?