PSYCHOLOGY OF COMMUNICATION AND INTERACTION IN SCIENTIFIC TEAMS

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SCITS

The science of team science encompasses an amalgam of conceptual and methodologic strategies aimed at understanding and enhancing the outcomes of large-scale collaborative research and training programs. This field has emerged rapidly in recent years, largely in response to growing concerns about the cost effectiveness of public- and private-sector investments in team-based science and training initiatives. The distinctive boundaries and substantive concerns of this field, however, have remained difficult to discern. An important challenge for the field is to characterize the science of team science more clearly in terms of its major theoretical, methodologic, and translational concerns.

The Science of Team Science: Overview of the Field and Introduction of the Supplement, page 1

Efforts to integrate knowledge in the SciTS field face considerable challenges, owing to the highly disparate units of analysis found in the earlier studies of scientific teams. Research teams, for example, may consist of investigators drawn from either the same or different fields (i.e., unidisciplinary versus cross-disciplinary teams). These teams vary not only in terms of their disciplinary composition but also in terms of their size, organizational complexity, and geographic scope, ranging from a few participants working at the same site to scores of investigators dispersed across multiple geographic and organizational venues. Furthermore, the goals of team science initiatives are quite diverse (e.g., spanning scientific discovery; training; and clinical, translational, public health, and policy-related goals), and both the quality and level of intellectual integration intended and achieved among disciplines varies from one program to the next (i.e., along a continuum ranging from unidisciplinary to multidisciplinary, interdisciplinary, and transdisciplinary integration, as described more fully below).

Table 1. Definitions and examples of scientific orientations[60]

Scientific orientation	Definition	Example
Unidisciplinarity	**Unidisciplinarity** is a process in which researchers from a **single discipline** work together to address a common research problem.	A team of pharmacologists collaborate on a laboratory study of the relationships between nicotine consumption and insulin metabolism.
Multidisciplinarity	**Multidisciplinarity** is a **sequential** process whereby researchers in different disciplines work **independently**, each from his or her own discipline-specific perspective, with a goal of eventually combining efforts to address a common research problem.	A pharmacologist, health psychologist, and neuroscientist each contribute sections to a multi-authored manuscript that reviews research in their respective fields pertaining to the links between nicotine consumption, changes in brain chemistry and caloric intake induced by nicotine, and physical activity levels.
Interdisciplinarity	**Interdisciplinarity** is an **interactive** process in which researchers work **jointly**, each drawing from his or her own discipline-specific perspective, to address a common research problem.	A pharmacologist, health psychologist, and neuroscientist conduct a collaborative study to examine the interrelations among patterns of nicotine consumption, brain chemistry, caloric intake, and physical activity levels. Their research design incorporates conceptual and methodologic approaches drawn from each of their respective fields.
Transdisciplinarity	**Transdisciplinarity** is an **integrative** process in which researchers work jointly to develop and use a shared conceptual framework that **synthesizes** and **extends** discipline-specific theories, concepts, methods, or all three to create **new** models and language to address a common research problem.	A pharmacologist, health psychologist, and neuroscientist conduct a collaborative study to examine the interrelations among nicotine consumption, brain chemistry, caloric intake, and physical activity levels. Based on their findings, they develop a neurobehavioral model of the links among tobacco consumption, brain chemistry, insulin metabolism, physical activity, and obesity that integrates and extends the concepts and methods drawn from their respective fields.

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SCIENCE OF TEAM SCIENCE CONCEPT MAPPING PROJECT

The conceptual maps derived from the concept mapping study, incorporating both qualitative and quantitative methods by integrating an online brainstorming exercise with multivariate analysis, provided a programmatic foundation for future research in this field. A visual map of the SciTS field and its directions include: Definitions and Models of Team Science; Measurement and Evaluation of Team Science; Disciplinary Dynamics and Team Science; Structure and Context for Teams; Institutional Support and Professional Development for Teams; Management and Organization for Teams; and Characteristics and Dynamics of Teams.

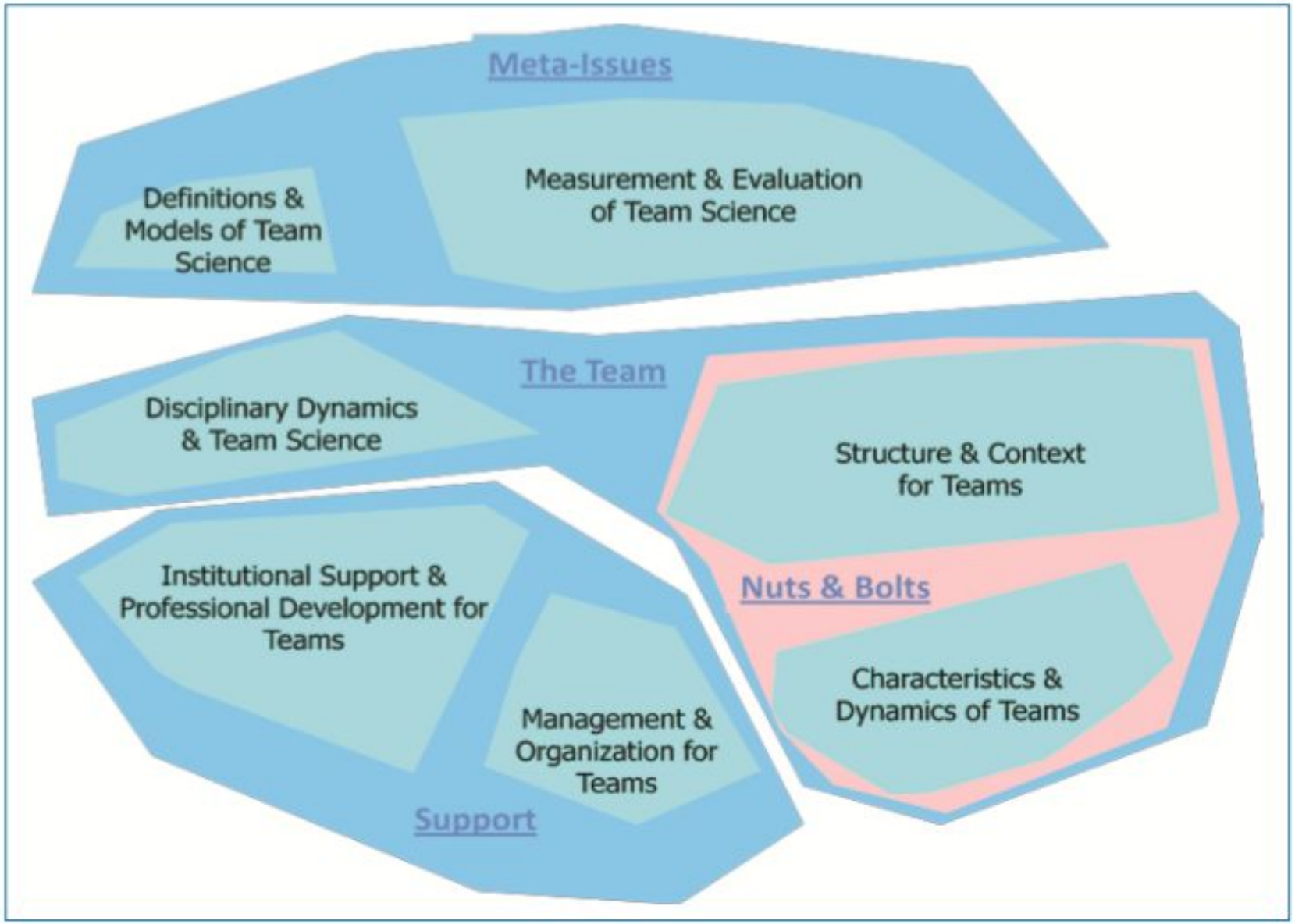


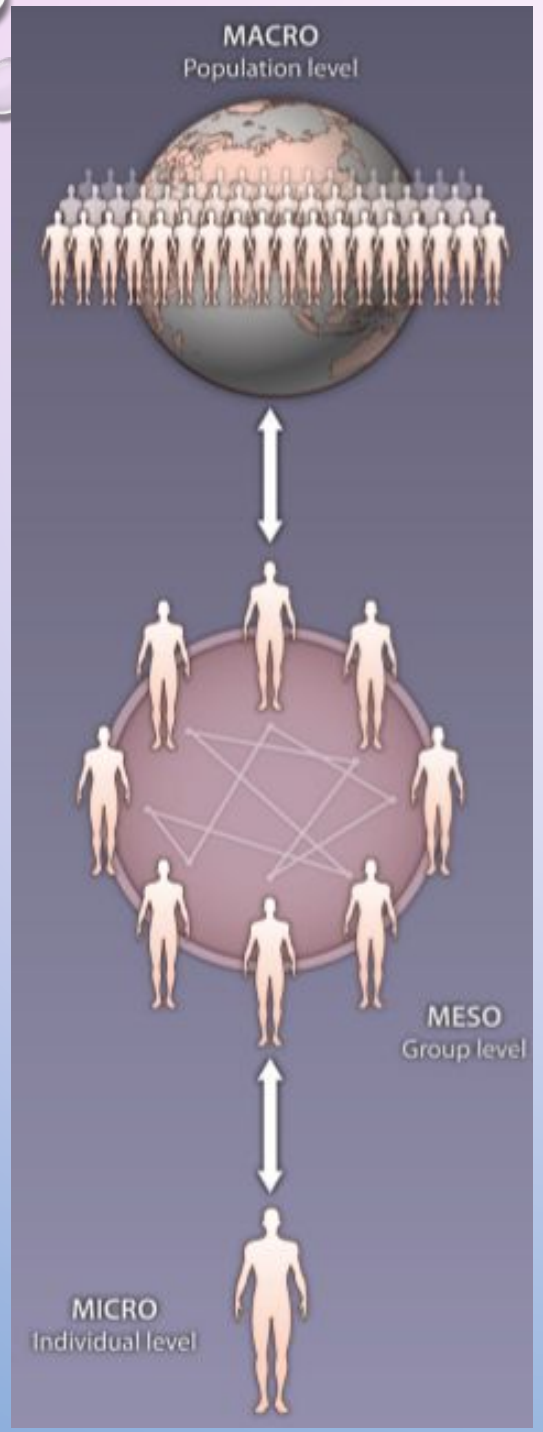
Figure 1. Science of Team Science Concept Map. This final interpreted map summarizes clusters and regions of topics identified as important parts of a comprehensive research agenda for the SciTS.

CONVERGENT VALIDATION OF EVALUATION DATA

Regardless of the research designs used to assess program effectiveness, the convergent validation of empirical data is an important benchmark of strategic evaluation. When evaluations of team science initiatives are conducted, the survey and interview assessments of program outcomes offered by participating scientists, trainees, and staff members should be supplemented with peer appraisals provided by external reviewers and consultants.

DEVELOPING CYBER-INFRASTRUCTURES TO SUPPORT SCIENTIFIC COLLABORATION

Interpersonal processes (e.g., communication networks, conflict-resolution strategies, leadership styles) are contextual factors that directly influence a team's readiness for collaboration at the outset of a project and their capacity to work together effectively over extended periods. Additional determinants of collaborative capacity and long-term success are the technologic resources (e.g., intranet and Internet connectivity, grid computing infrastructures, data-mining strategies) that enable team members to communicate and integrate diverse sets of data effectively over the course of a team science project. These facets of technologic infrastructure and expertise and their influence on scientific collaboration have received attention in the fields of information science and organizational behavior, but warrant further investigation in the context of team science research and training programs. The ways in which cyber-infrastructures can support successful scientific collaboration spanning multiple disciplines and research sites, and an agenda of related questions for future science-of-team-science studies.



Researchers working at different levels study different facets of the team science ecology, contribute different theories and techniques, and generate diverse findings. Each level might analyze different data; use multiple approaches, techniques, and visual representations; and provide different insights. The combination of insights from all levels is considerably larger than their sum.

A Multi-Level Systems Perspective for the Science of Team Science, page 7

Representative challenges for the SciTS.

Macro-level challenges	SciTS must address broad philosophical issues concerning the ways of pursuing (and encouraging) differing forms of scientific progress. For example, organizational change is needed at the university level, so that researchers practicing collaboration and interdisciplinarity are rewarded and not punished for their team-based versus individually pursued projects.
	From a policy standpoint, SciTS needs to understand how to develop and support a programmatic line of inquiry into team science. relevant studies should encompass professional and organizational culture and identity.
	Research on leadership is required to identify and leverage the factors that influence the management and effectiveness of interdisciplinary research (8).
Meso-level challenges	Research in SciTS can explore how to develop improved recommender systems that enable the assembly of optimal teams, taking into account the social incentives that are necessary for the team to function effectively.
	SciTS must help us understand how we can adapt and apply methods from the study of teams to team science. Such research could use systematic techniques to, for example, identify whether needs such as leadership or communication training should be implemented (8).
	SciTS can identify the particular coordination requirements that a team may need and the outcomes arising from these varied interdependencies.
Micro-level challenges	Research in SciTS can compare educational approaches that focus on training within a particular discipline versus those that foster exposure to multiple mentors across two or more disciplines, incorporating ideas drawn from other areas.
	SciTS can study the appropriate blend of educational approaches, teamwork skills, and training modalities required to support those trained in varied disciplines (37).
	SciTS can increase our understanding of the social and behavioral factors that affect who chooses to engage in team science.

TEAM EFFECTIVENESS IN COMMUNITY COALITIONS

Community coalitions between scientists and practitioners translate scientific findings into interventions and programs that promote public health and social justice. These collaborations are usually inter-organizational in scope. The scale and complexity of transdisciplinary collaboration among researchers and practitioners increase further as the goals become broader-gauged with the design, implementation, and evaluation of health programs and policies spanning local, regional, national, and international levels. Such broad-gauged collaborations are intersectoral in scope. Community coalitions are prone to the difficulties inherent in teamwork (such as conflict and social fragmentation) because of the complexity of their goals and environmental contexts as well as the diversity of participants' world views and educational backgrounds. Factors that can facilitate or constrain the effectiveness of community coalitions are noted below.

COMMUNITY COALITIONS AMONG SCIENTISTS AND PRACTITIONERS

Facilitating factors

- Supportive, democratic, and empowering leaders
- Members' readiness for collaboration
  - Cooperative orientation and commitment to collaboration
  - Interpersonal communication skills and training
- Presence of suitable electronic communication systems
- Strong incentives to participate and remain involved
- Sustained support by funding agencies

COMMUNITY COALITIONS AMONG SCIENTISTS AND PRACTITIONERS

Constraining factors

- Disagreement and conflicts due to divergent understandings of the coalition's goals and timelines among community practitioners and academic researchers
- Conflicts arising from different scientific worldviews, disciplinary perspectives, and decision-making styles
- Inequitable distribution of decision-making power, information, time, resources, and control
- Perception of status differences between scientists and community practitioners
- Lack of trust arising from negative experiences in prior collaborative projects
- Leaders who encourage secrecy, in-group exclusiveness, and interpersonal competition and confrontation
- Absence of adequate and regular communication among members
- Decline in participation of members in coalition activities
- Uncertainties about and absence of sustained funding to support the coalition's long-term goals and activities

SUMMARY

The preceding discussion offers an overview of the science-of-team-science field in terms of its major conceptual, methodologic, and translational concerns. This field encompasses a wide array of research projects and strategies aimed at better understanding, evaluating, and managing circumstances that influence the effectiveness of large-scale team science initiatives. Common themes are beginning to emerge in the literature, but several gaps in the science-of-team-science knowledge base remain to be addressed in future studies. The 2006 NCI conference on the science of team science and the present supplement were organized for the purposes of identifying and analyzing several cutting-edge issues that had received little or no attention in prior science-of-team-science meetings and publications. It is hoped that the articles included in this supplement will help to establish the foundation for achieving greater clarity and integration in science-of-team-science research and for advancing the field's scientific, training, and translational goals.