

What makes for an effective team in science? Understanding Cross-disciplinary Collaboration for Research Centers

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Overview

Part I. SciTS Challenge 1

Defining Research Approaches

Part II. SciTS Challenge 2

Understanding the Science of Team Science

Part III. SciTS Challenge 3

Understanding Teamwork in "Team Science"



Part I. Science Teams - Challenge 1

Defining Research Approaches

ISSUE - *Dealing with Scholarly Structure*

Disciplines are distinguished partly for historical reasons and reasons of administrative convenience (such as the organization of teaching and of appointments)… But all this classification and distinction is a comparatively unimportant and superficial affair. **We are not students of some subject matter but students of problems. And problems may cut across the borders of any subject matter or discipline** (Popper, 1963).



ISSUE - *Dealing with University Structure*

What is critical to realize is that "**the way in which our universities have divided up the sciences does not reflect the way in which nature has divided up its problems**" (Salzinger, 2003, p. 3)

Science of Team Science purposely designed to surmount these challenges through cross-disciplinary research.

Part I. Science Teams - Challenge 1

Defining Research Approaches

SciTS CHALLENGE 1 - ***Understand what it means to do research across disciplines***

CROSS-disciplinary Research

Offer this as a general term to describe:

Research utilizing, in some way, varied concepts, methods, and theories from differing fields

Team members contribute disciplinary expertise and collectively contribute to production of new knowledge

The form of collaboration tailored to research needs

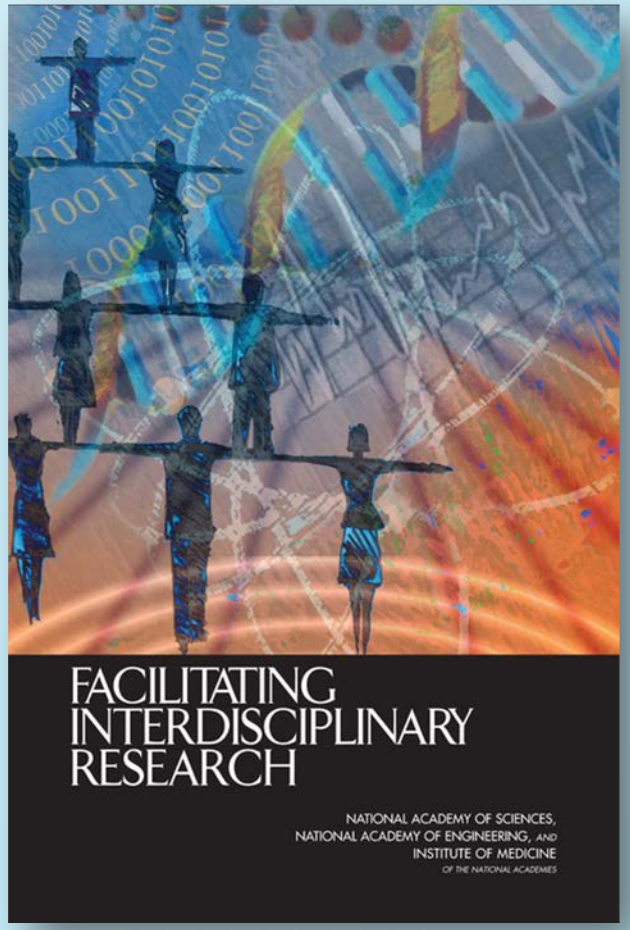
Multi-, Inter-, and Trans-disciplinary Research

Depends on nature of interdependencies

Depends on need for integrative outcomes

Depends on level(s) of analysis

Depends on composition of team (scientists, stakeholders)



Klein, J. T. (2010). A taxonomy of interdisciplinarity. In R. Frodeman, J. T. Klein, & C. Mitcham (Eds.), *The Oxford Handbook of Interdisciplinarity* (pp. 15-30). Oxford: Oxford University Press.
National Academies, Committee on Facilitating Interdisciplinary Research (2004). *Facilitating interdisciplinary research.* Washington, DC: National Academies Press.
Stokols, D., Hall, K.L, Taylor, B., Moser, R.P., (2008). The science of team science: Overview of the field and introduction to the supplement. *American Journal of Preventative Medicine, 35(2S),* S77-S89.

Part I. Science Teams - Challenge 1

Defining Research Approaches



Addressing SciTS Challenge 1

Determine your science team's **Mission**

To **advance** (inter/trans)disciplinary education, research, practice?

Determine your science team's Scientific **Goals**

To utilize **complementary** approaches or to **integrate** knowledge?

Determine role/Involvement of **Stakeholders**

To develop knowledge… to produce **problem-oriented scientists?**

Be **Planful** about Collaborations

Build collaborations that strengthen research that does (or will) transcend disciplinary boundaries and solves (or will solve) complex societal problem

SciTS MESSAGE 1a: ***Teams need to pursue form of cross-disciplinary research aligned with mission and goals***

RCCN MESSAGE 1b: ***When engaged in interdisciplinary research, scientists change how they view themselves -- no longer tied to a particular disciplinary identity***

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Part II. SciTS Challenge 2
Understanding Science of Team Science

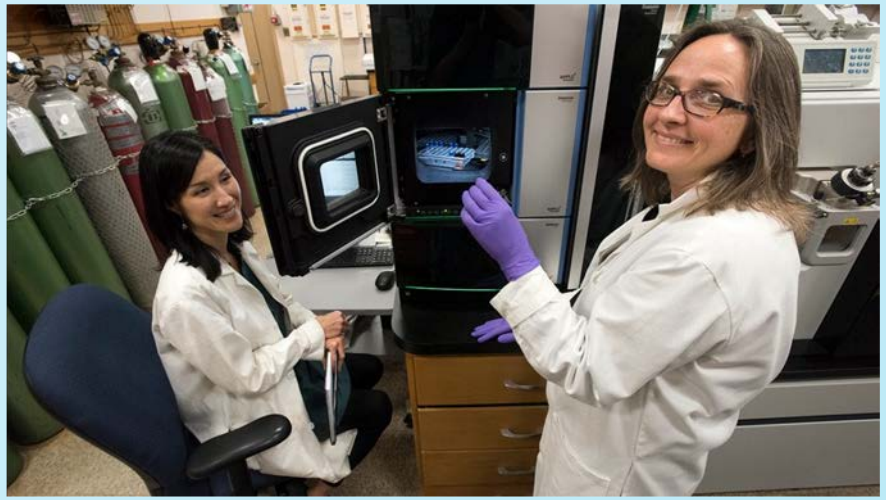
SciTS CHALLENGE 2 – *Understand what is the Science of Team Science*

What do we mean by teams

- Multiple information sources and intensive communication
- Task-relevant knowledge with meaningful task interdependencies
- Affective and attitudinal factors influence group dynamics
- Coordination among members with specialized roles

Reframing interdisciplinarity as a process of teamwork to be mastered (Fiore, 2008)

- Allows us to leverage science of teams
- Changes question to understanding team activities necessary for science
- Makes the achievement and measurement of interdisciplinarity more tractable



Fiore, S. M. (2008). Interdisciplinarity as teamwork: How the science of teams can inform team science. *Small Group Research, 39(3),* 251-277.

Part II. SciTS Challenge 2
Understanding Science of Team Science

A New Field - *Science of Team Science*

Commitment to **develop scholarly examination of teamwork in science** (Fiore, 2008)

Goal to understand and improve how scholars interact and integrate across disciplinary, professional, and institutional boundaries

"the inherent complexity of contemporary public health, environmental, political, and policy challenges… [leads to] realization that an integration of multiple disciplinary perspectives is required to better understand and ameliorate these problems" (Stokols et al., 2008).



Must understand how to make full use of **scientific capacity** of science teams (Salazar et al., 2012)

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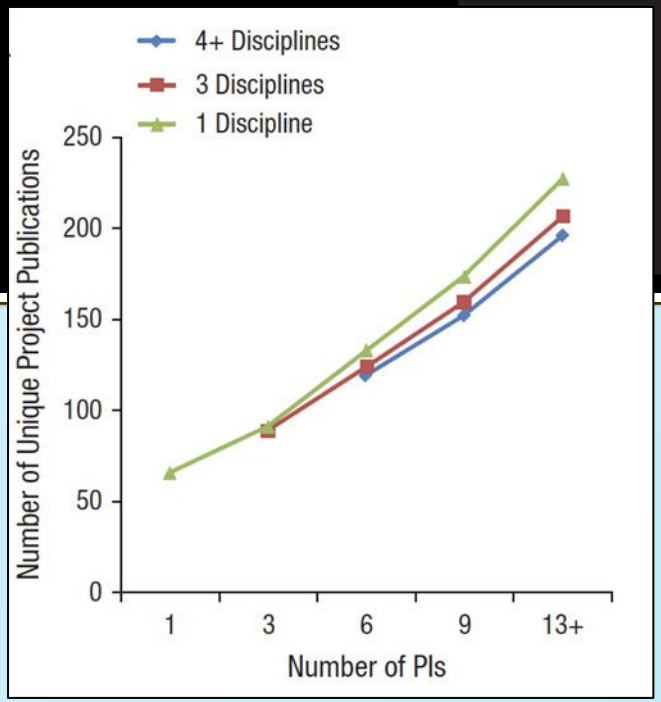
Salazar, M. R., Lant, T. K., Fiore, S. M., & Salas, E. (2012). Facilitating innovation in diverse science teams through integrative capacity. *Small Group Research, 43(5),* 527-558.

Stokols, D., Misra, S., Moser, R. P., Hall, K. L., & Taylor, B. K. (2008). The ecology of team science - Understanding contextual influences on transdisciplinary collaboration. *American Journal of Preventive Medicine, 35(2),* S96-S115.

Part II. SciTS Challenge 2
Understanding Science of Team Science

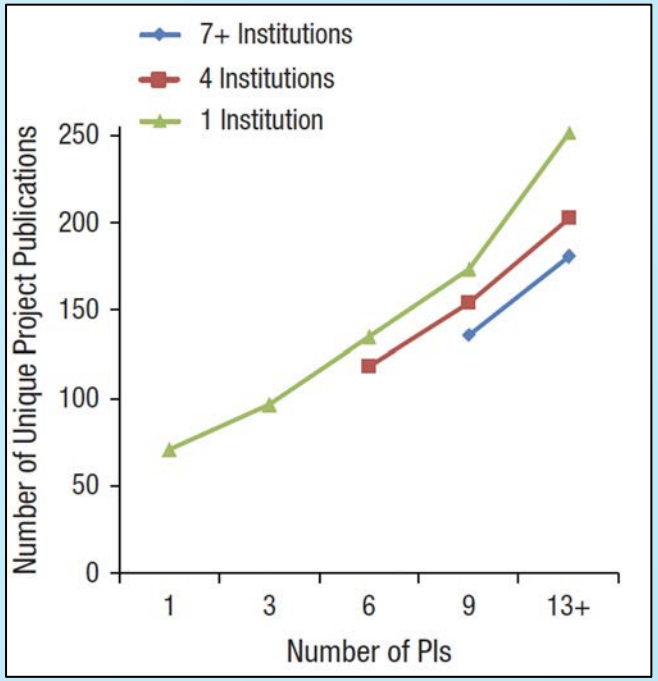
Predicted number of publications as a function of research group size and heterogeneity as measured by number of disciplines of the investigators

Key Finding: Greater numbers of disciplines result in less productivity



Predicted number of publications as a function of research group size and group heterogeneity as measured by number of institutions involved in the research

Key Finding: Greater numbers of institutions result in less productivity



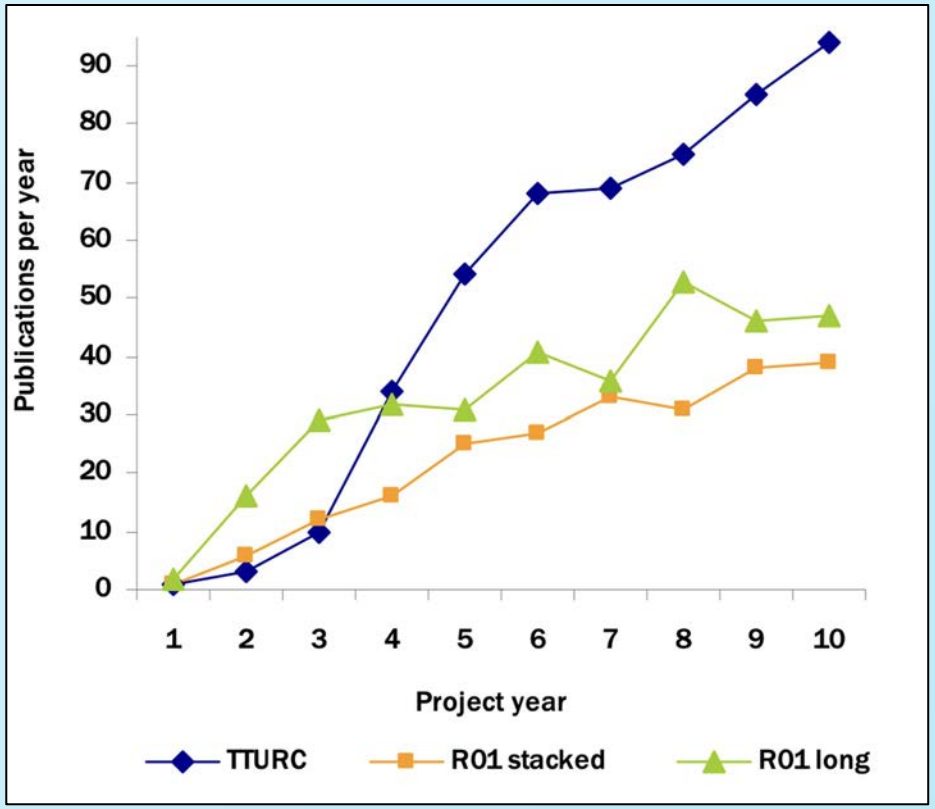
Cummings, J. N., Kiesler, S., Zadeh, R., & Balakrishnan, A. (2013). Group heterogeneity increases the risks of large group size: A longitudinal study of productivity in research groups. *Psychological Science, 24*(6), 880-890.

Part II. SciTS Challenge 2
Understanding Science of Team Science

Productivity of TD Center Grants and R01 Investigator-Initiated Grants

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

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



Hall, K.L., Stokols, D., Stipelman, B.A., Vogel, A.L., Feng, A., et al (2012). Assessing the Value of Team Science: A Study Comparing Center- and Investigator-Initiated Grants. *American Journal of Preventive Medicine 42*, 157-163.

Part II. SciTS Challenge 2
Understanding Science of Team Science

NSF versus NCI

NCI Approach: ***Develop strategies that support transdisciplinary collaborations*** *to produce science that contributes to reducing the cancer burden*

Examples of strategies include:

Funding – **provide incentives**; special reviews
Multiple linked projects/centers – facilitate **within/across center integration**
Cores/Coordination Center – provide some **"institutional"/administrative support**; maximize diverse collaboration; **bridging** mechanism
Developmental funds – address scientific readiness issues; **support "unanticipated" integrative ideas**; propel emerging areas of TD research
Semi-annual meetings – **foster new collaborations**
Training – address needed **TD competencies**

1

- **NCI** specifically created **"interventions"** to **reduce existing barriers** (at the team/institutional, coordination, review, funding, etc levels)
  - Helping to create an **incubator space** to conduct science across disciplines and universities - resulting in higher productivity.

2

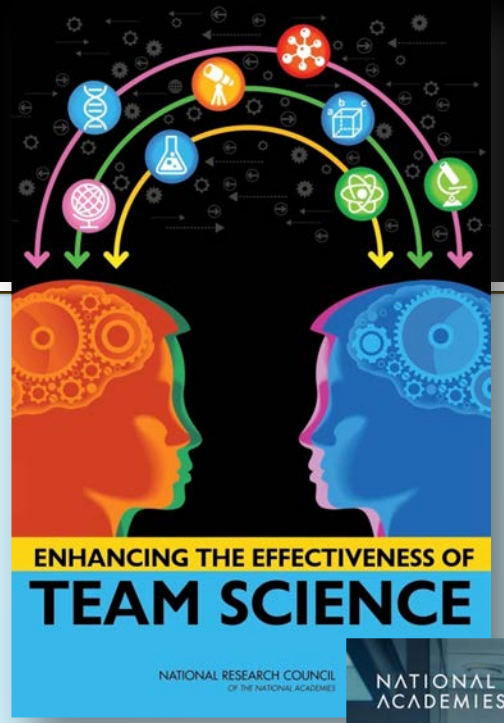
- Cummings et al. assessed projects **"in the wild"** that were subject to the broad context (potentially unsupportive of team science)
  - These findings may be an indicator of the challenges of doing this kind of work **in the existing context with existing strategies** (e.g., limited number of coordination activities).

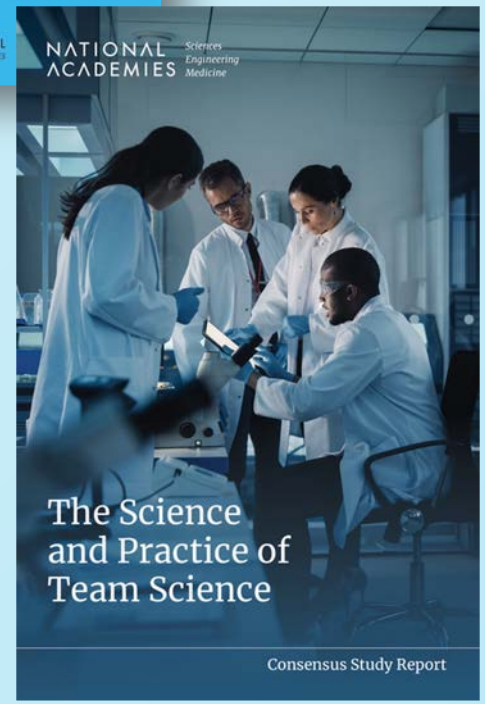
3

- This highlights an opportunity to better **understand the mechanisms** facilitating and hindering productivity and innovation
  - Offers an optimistic possibility that **interventions to reduce barriers** and increase strategies to facilitate team science can enable us to encourage scientists to **use approaches best suited to address complex** scientific problems (rather than moving toward a reductionist approach to science).

Hall, K.L. & Vogel, A.L. (2015) *Team Science: Strategies for Success*. Invited Presentation, Howard University, Washington, DC.

Part II. SciTS Challenge 2
Understanding Science of Team Science





2015 NASEM Study - Enhancing the Effectiveness of Team Science

- Assembling teams
- Group dynamics in teams
- Supporting leadership development opportunities
- Virtual collaborations
- Study and measurement of science teams
- Promotion & Tenure in science teams
- Credit for team-based work

2024-2025 NASEM Study - Research and Application in Team Science

(1) best practices, barriers, impacts, and the role of virtual and hybrid environments
(2) improve understanding of best practices in team science
(3) evaluate the growing role of virtual and hybrid teams
(4) identify gaps in resources and training for team science; and
(5) better understand how to measure the effectiveness of teams

Enhancing the Effectiveness of Team Science (2015) -- http://www.nap.edu/catalog/19007/enhancing-the-effectiveness-of-team-science
Research and Application in Team Science - https://www.nationalacademies.org/our-work/research-and-application-in-team-science

Part II. SciTS Challenge 2
Understanding Science of Team Science

UCF

Addressing SciTS Challenge 2

International Network for Science of Team Science (INSciTS)

- **Support understanding and improving scientific collaboration (https://www.inscits.org)**
- **Annual Science of Team Science (SciTS) Conference**

Global Alliance for Inter- and Transdisciplinarity

- **Strengthen global capacity for collaborative modes of boundary-crossing research (https://itd-alliance.org)**
- **Semi-Annual International Conference**

SciTS MESSAGE 2a: ***Understand that there is a rich and robust scholarly literature on team performance that can improve team science effectiveness***

RCCN MESSAGE 2b: ***Researchers need to develop expertise in varied forms of cross-disciplinarity being funded, and acquire the capabilities to pursue them***

INSciTS | Building the knowledge base for effective team science
International Network for the Science of Team Science

ITD Alliance | Global Alliance for Inter- and Transdisciplinarity

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Understanding Teamwork "in" Team Science

Guidance for Team Development

GOAL 1: Provide summary of subset of concepts necessary for team effectiveness

GOAL 2: Make explicit key areas of teamwork necessary for team learning and performance success

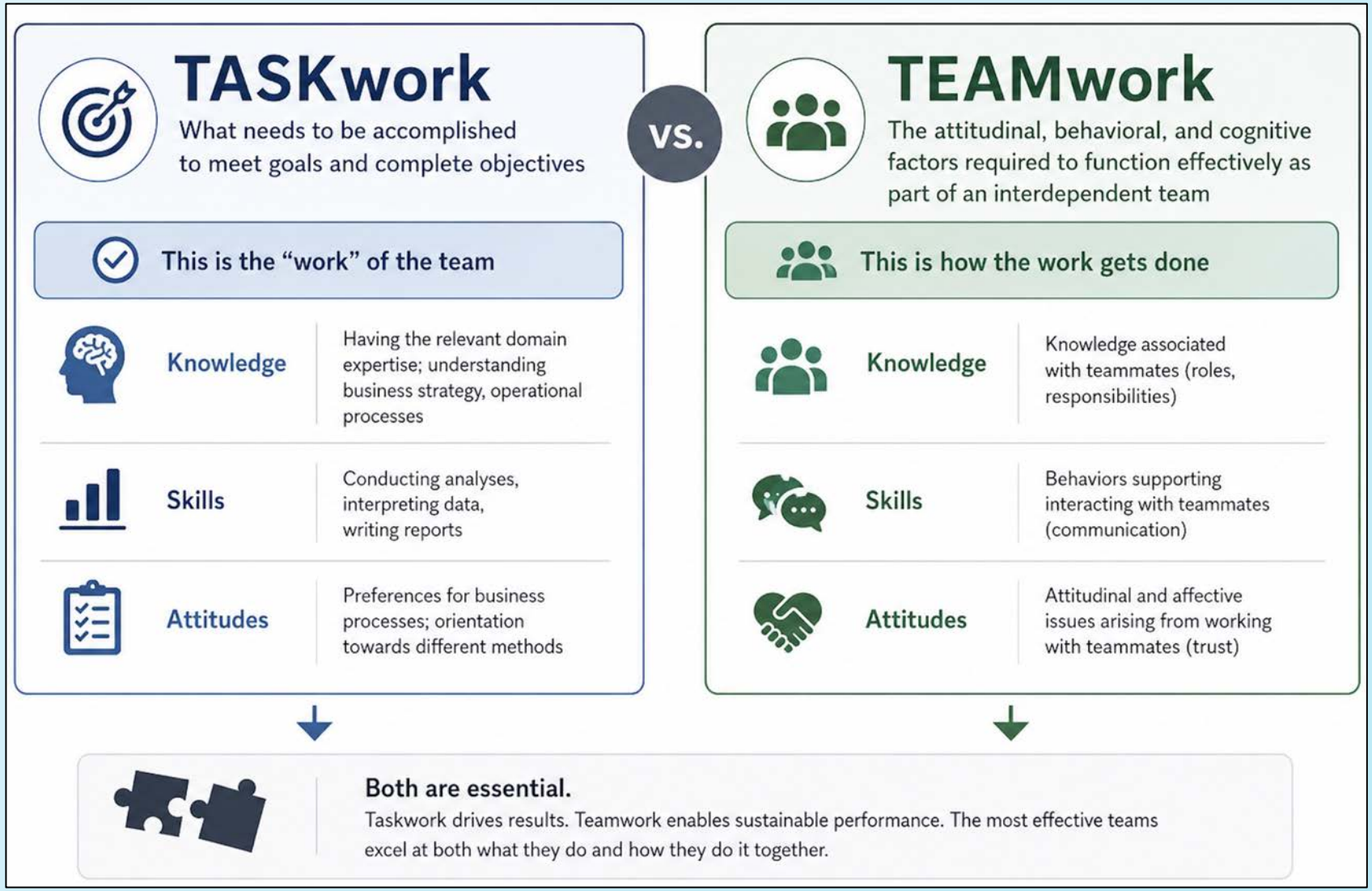
Good scientists already reflect on their scientific process (i.e., they reflect on research processes)

- … in which s/he is engaged
- … in which his/her colleagues and peers are engaged
- … in which his/her students are engaged

OUTCOME: Recognize that, to be a good 'team scientist' you also need to reflect on and learn from *team processes*

Part III. SciTS Challenge 3
Understanding Teamwork "in" Team Science

SciTS CHALLENGE 3 – ***Understand that science teams engage in both taskwork and teamwork as they work and learn from each other***
(Fiore et al., 2015; Fiore, 2008)

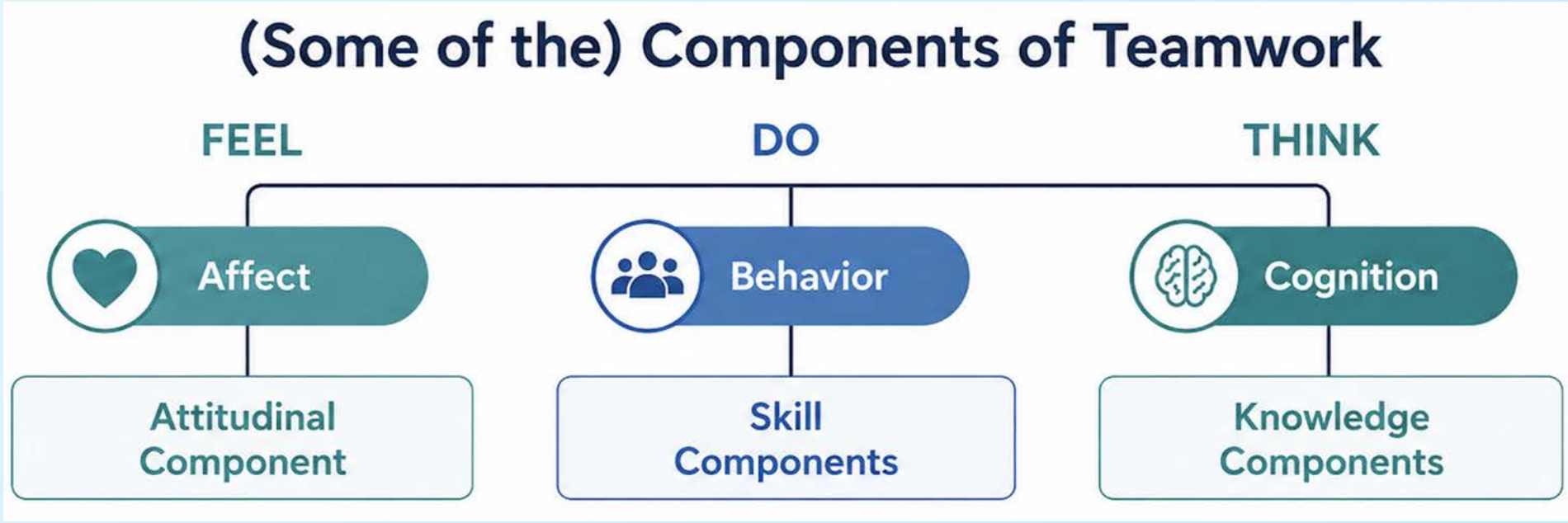


Fiore, S. M. (2008). Interdisciplinarity as Teamwork: How the Science of Teams can inform team science. *Small Group Research, 39(3),* 251-277.

Fiore, S.M., Carter, D.R., & Asencio, R. (2015). Conflict, Trust, and Cohesion: Examining Affective and Attitudinal Factors in Science Teams. In E. Salas, W.B. Vessey, & A.X. Estrada (Eds.), *Team Cohesion: Advances in Psychological Theory, Methods and Practice* (pp. 271-301). Emerald Group Publishing Limited.

Part III. SciTS Challenge 3

Understanding Teamwork "in" Team Science



Fiore, S.M., *Gabelica, C., *Wiltshire, T., & Stokols, D. (2019). Training to Be a (Team) Scientist. In K. Hall, R. Croyle, & A. Vogel (Eds.), *Handbook of Interdisciplinary Team-based Behavioral Research: New Evidence and Perspectives.* Basel, Switzerland: Springer International Publishing.

Part III. SciTS Challenge 3

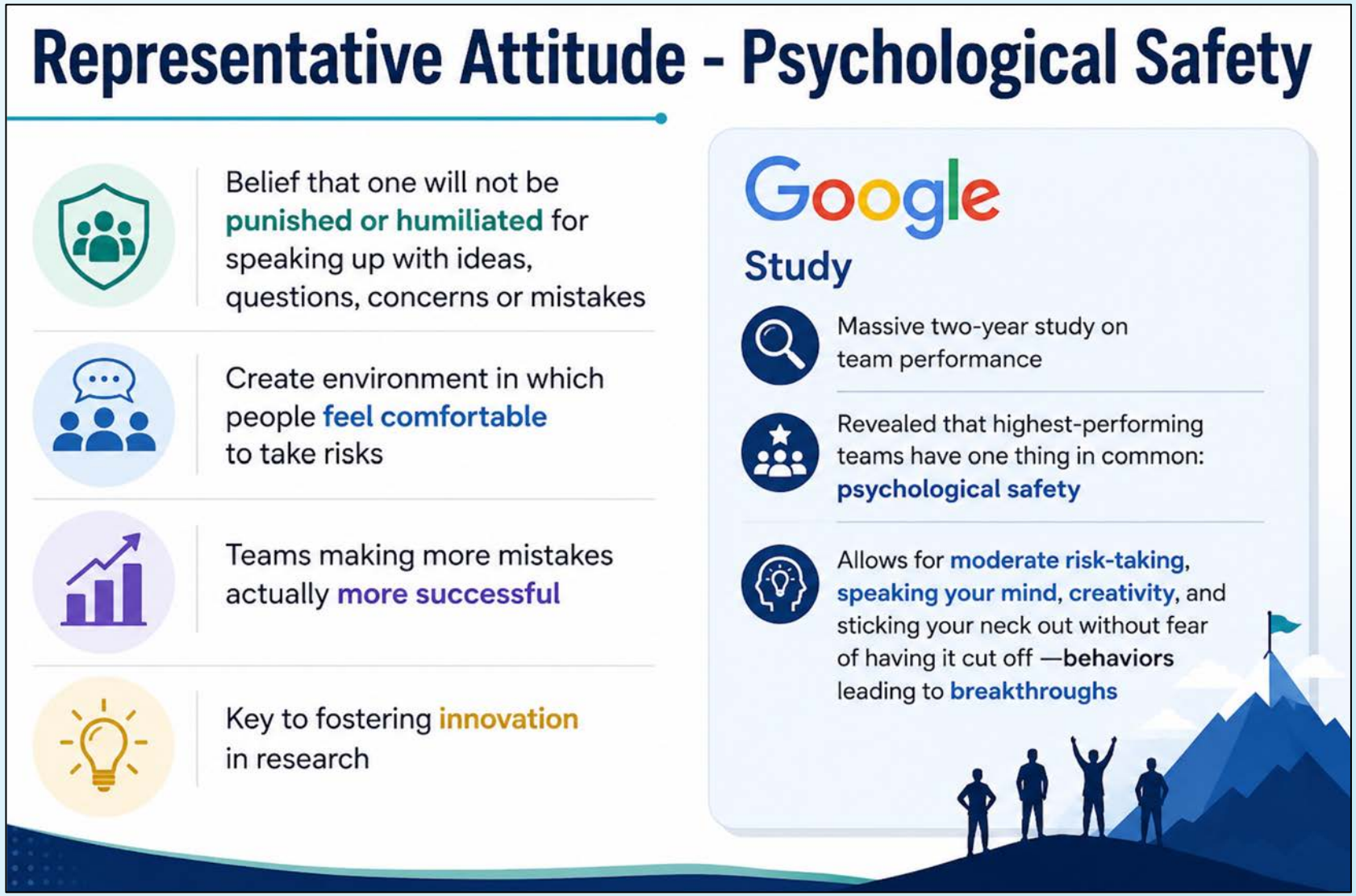
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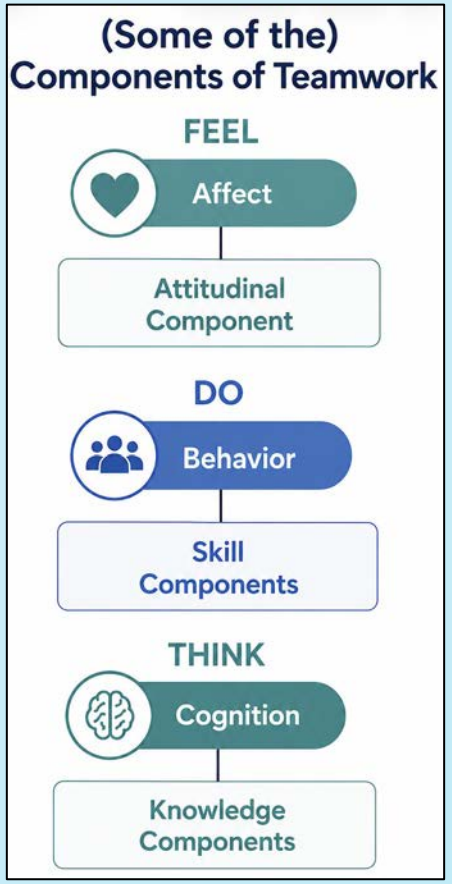
Representative Attitude - Psychological Safety

- Belief that one will not be **punished or humiliated** for speaking up with ideas, questions, concerns or mistakes
- Create environment in which people **feel comfortable** to take risks
- Teams making more mistakes actually **more successful**
- Key to fostering **innovation** in research

Google Study

- Massive two-year study on team performance
- Revealed that highest-performing teams have one thing in common: **psychological safety**
- Allows for **moderate risk-taking, speaking your mind, creativity**, and sticking your neck out without fear of having it cut off —**behaviors** leading to **breakthroughs**





Edmondson, A. (1999). Psychological safety and learning behavior in work teams. *Administrative Science Quarterly, 44(2)*, 350-383.

Graham, J. (2016). What Google Learned From Its Quest to Build the Perfect Team. *New York Times.* https://www.nytimes.com/2016/02/28/magazine/what-google-learned-from-its-quest-to-build-the-perfect-team.html

Part III. SciTS Challenge 3

Understanding Teamwork "in" Team Science

Representative Behaviors - Communication Competencies *(Fiore et al., 2019)*

Active Listening

- Carefully attending to what is said
- Asking other party to explain exactly what is meant
- Requesting that ambiguous ideas or statements are repeated

Competency targets "listening to learn and understand" and "listening to contribute and integrate to problem solving"

Super Tuning

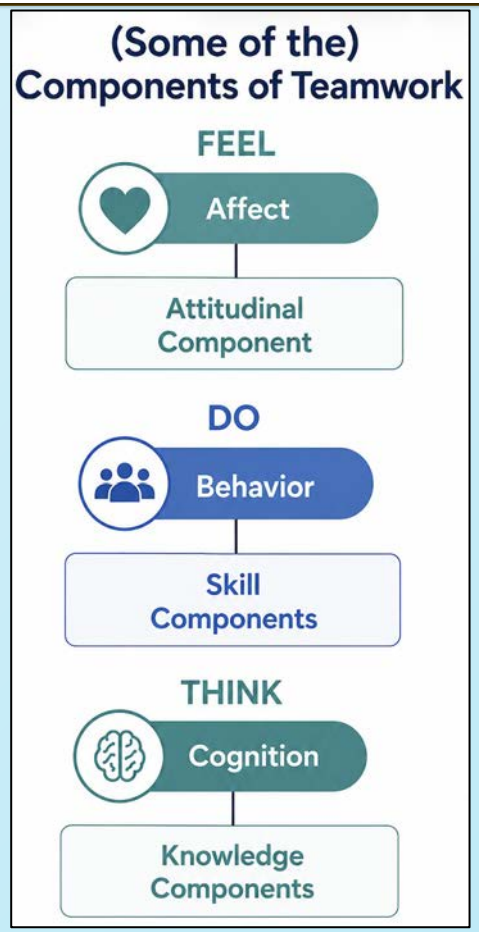
- Tailoring message for the receiver
- Drawing on understanding of audience level and form of knowledge
- Construct and convey message in appropriate ways

Competency helps team members learn from each other; targets the ability to "express yourself clearly to others outside one's discipline" (e.g., avoiding jargon) and "effectively conveying intended meaning of other disciplinary perspectives"

Assertive Communication

- Directly expressing one's ideas and opinions
- Addressing conflict purposely and openly
- Addressing differences without intimidation

Competency targets the ability to "propose ideas", to "defend one's disciplinary values/methods" and to "be directive and appropriately assert your needs and views"



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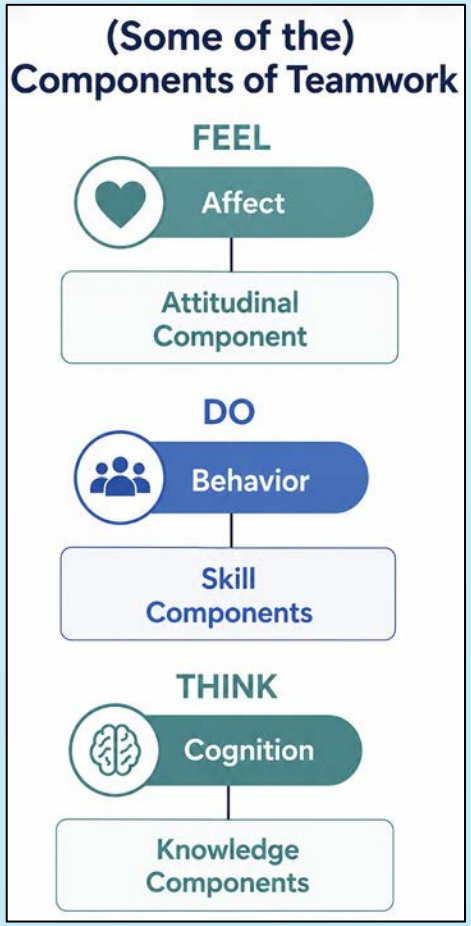
Part III. SciTS Challenge 3

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Representative Cognition – Transactive Memory Systems for Interdisciplinarity

- Memory structures related to teamwork in which members do not store all the knowledge relevant to their work *(Lewis, 2003)*
  - Team members store knowledge consisting of who knows what
  - *Team-related knowledge related to one's understanding of a teammate's capabilities and expertise*

- Utilizes expertise specialization and coordination
  - Groups specialize in different aspects of task
  - Groups delegate responsibility to coordinate their work efficiently based on knowledge of who knows what



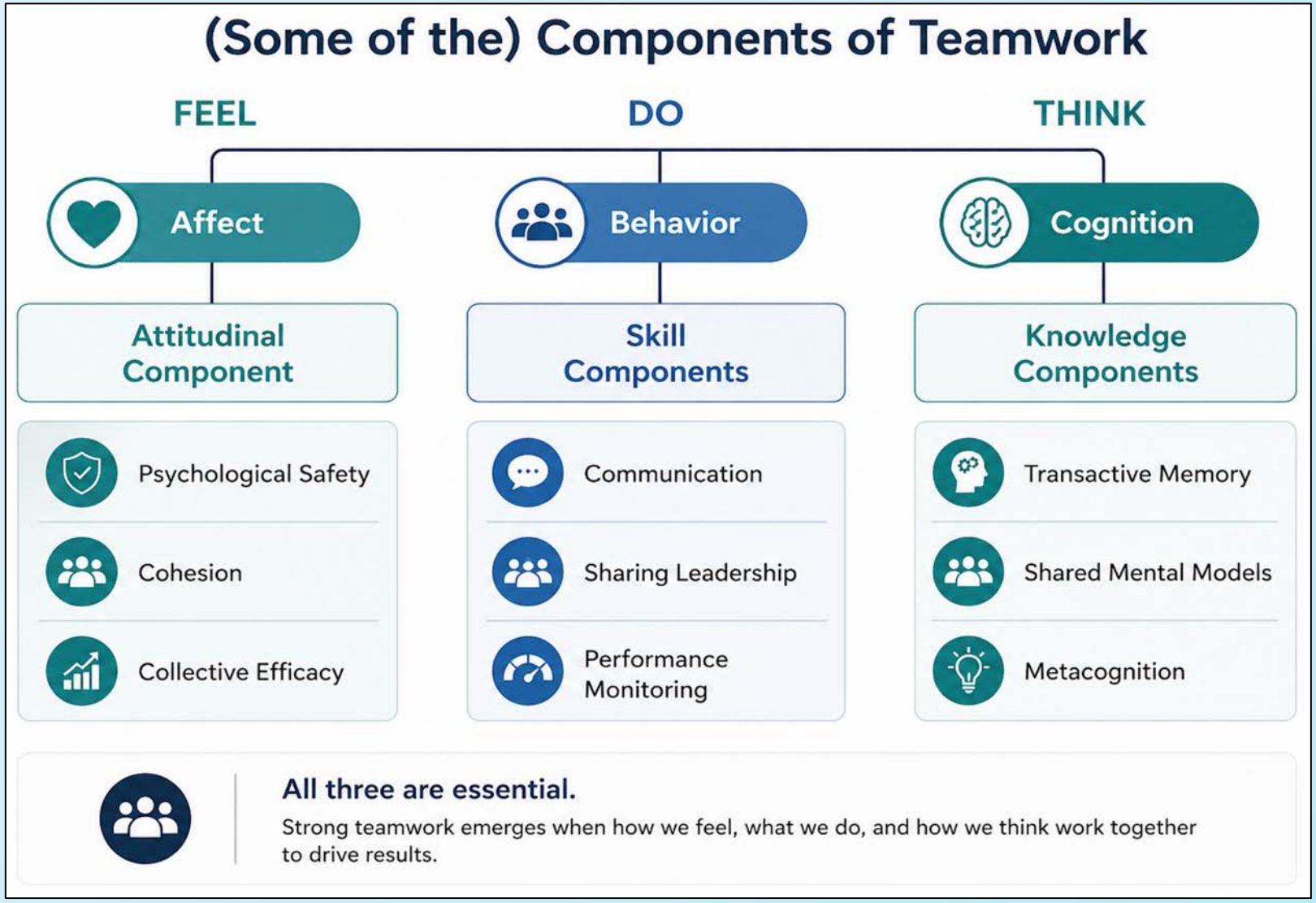
Lewis, K. (2003). Measuring transactive memory systems in the field: scale development and validation. *Journal of Applied Psychology, 88(4),* 587-604.

Part III. SciTS Challenge 3

Understanding Teamwork "in" Team Science

SciTS MESSAGE 3: ***Focusing on attitudinal, behavioral, and cognitive components of group dynamics can improve team science learning and performance.***

RCCN MESSAGE 3: ***Ensure that the university provides instruction on, practice, and feedback on ABCs of teamwork***



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- SciTS MESSAGE 1a: *Teams need to pursue form of cross-disciplinary research aligned with mission and goals*
- RCCN MESSAGE 1b: *When engaged in interdisciplinary research, scientists change how they view themselves -- no longer tied to a particular disciplinary identity*

Part II. SciTS Challenge 2 - Understanding the Science of Team Science

- SciTS MESSAGE 2a: *Understand that there is a rich and robust scholarly literature on team performance that can improve team science effectiveness*
- RCCN MESSAGE 2b: *Researchers need to develop expertise in conversing with those of different backgrounds (active learning and cognitive tuning competencies)*

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Thank You!

Questions or Comments?

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