



Cornell University

Science of Team Science

A Concept Mapping Project

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Presentation to First Annual Conference on the Science of Team Science
Northwestern University, Chicago, IL
Thursday, April 22, 2010

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Project Goals

- Develop a **“roadmap”** of a comprehensive research agenda for the science of team science
 - Help orient participants during the conference
 - Provide a framework that can help inform the field
- Use a **team science approach** to mapping team science
 - Structured concept mapping
 - Integrative mixed methods approach
 - Integrates group process with statistical analysis
 - Utilizes web technology for distributed participation
 - Provides a rigorous visually interpretable result

Define the Focus

Develop a focus



“One topic that should be part of a comprehensive research agenda for the science of team science is...”

Identify Participants

Develop a focus

Identify the participants

All conference invitees
were asked to Brainstorm
& Rate
- 63 Rated

15 steering
committee
members sorted



“One topic that should be part of a comprehensive research agenda for the science of team science is...”

Brainstorm Outcomes

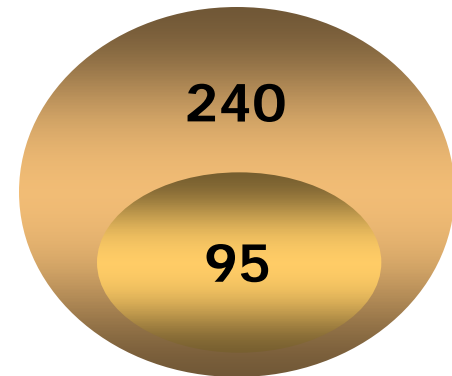
Develop a focus

Identify the participants

Generate Ideas



- 89 using publication and bibliometric data (e.g., citation rates, impact factors) to assess team science
- 69 importance of developing multi-method strategies to assess processes and outcomes of team science
- 2 how to evaluate success of team science-based research centers
- 65 measuring effectiveness of team science on multiple levels: individual team, impact of research, effectiveness of team science funding programs, etc.



Organize Outcomes

Develop a focus

Identify the participants

Generate Ideas

Structure Ideas



Sort the ideas



Rate the ideas

Importance

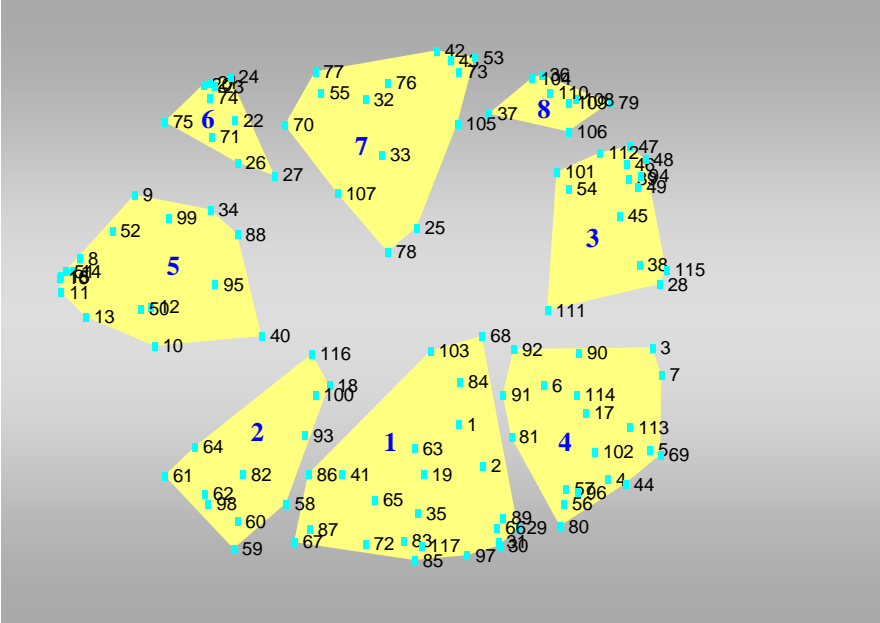
Compute Maps

Develop a focus

Identify the participants

Generate Ideas

Structure Ideas



Compute Maps

- Aggregate sorts
- Multidimensional scaling
- Hierarchical cluster analysis

Interpret Maps

Develop a focus

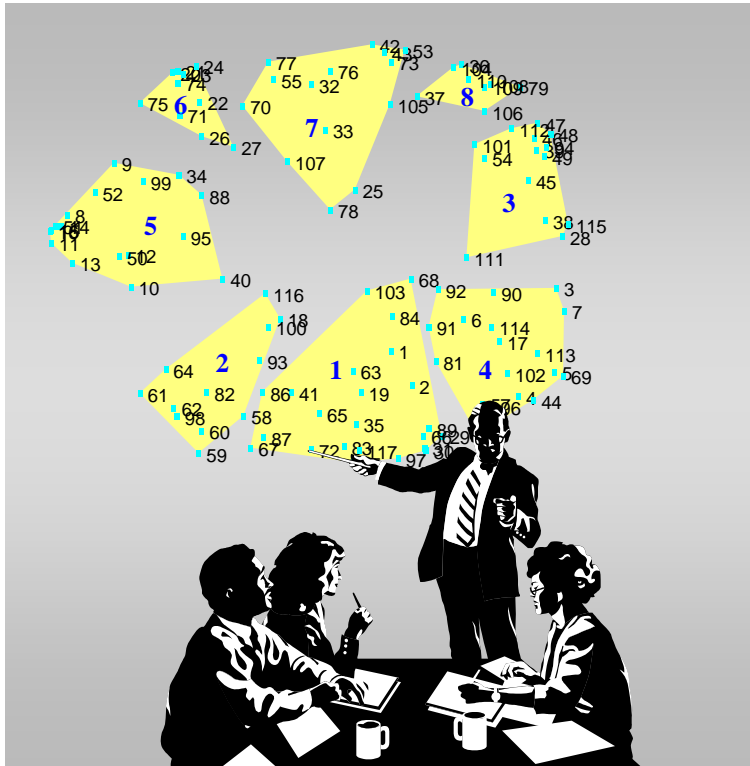
Identify the participants

Generate Ideas

Structure Ideas

Compute Maps

Interpret Maps



Use Maps

Develop a focus

Identify the participants

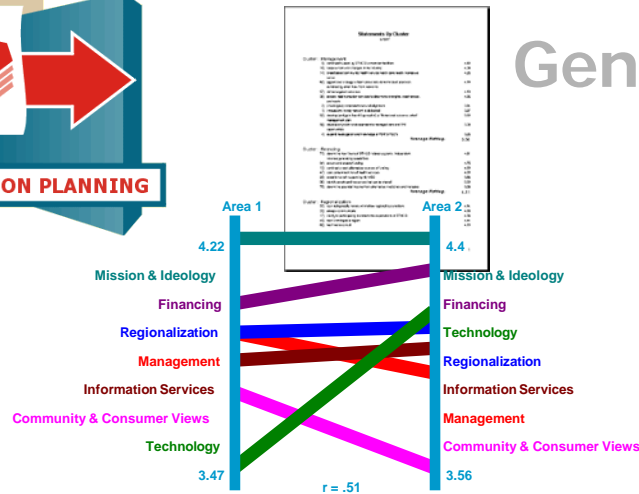
Generate Ideas

Structure Ideas

Compute Maps

Interpret Maps

Utilize Maps



Provide initial roadmap for conference and the field

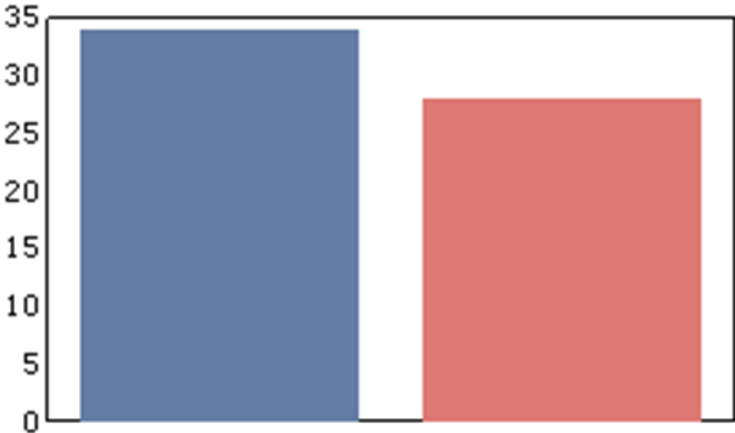
Who participated?

Gender

Questions Variable

Gender

1 Female
2 Male



Frequency

%

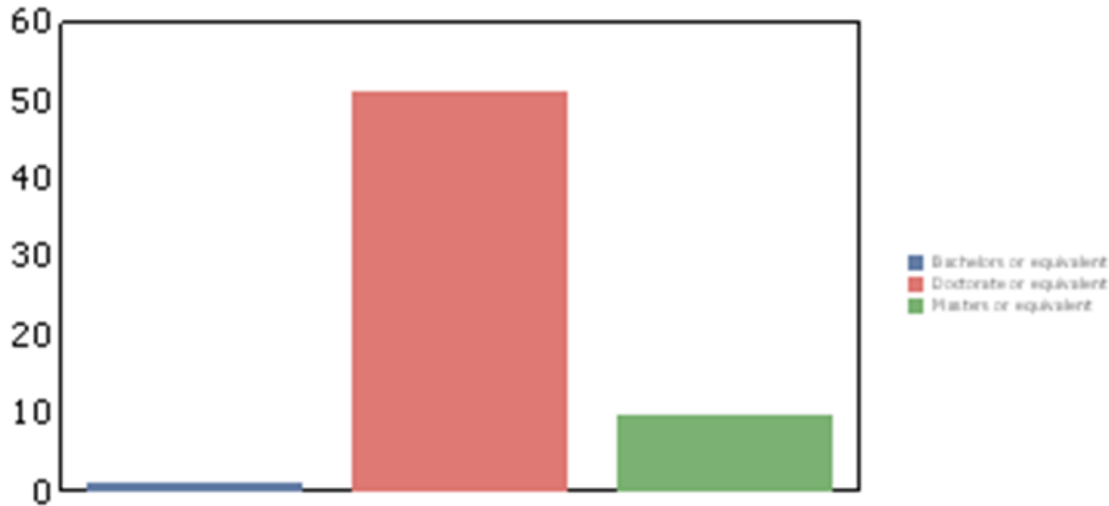
34	54.84%
28	45.16%
62	100%



Education

Education

- 1 Bachelors or equivalent
- 2 Doctorate or equivalent
- 3 Masters or equivalent



1	1.61%
51	82.26%
10	16.13%
62	100%



Academic Discipline

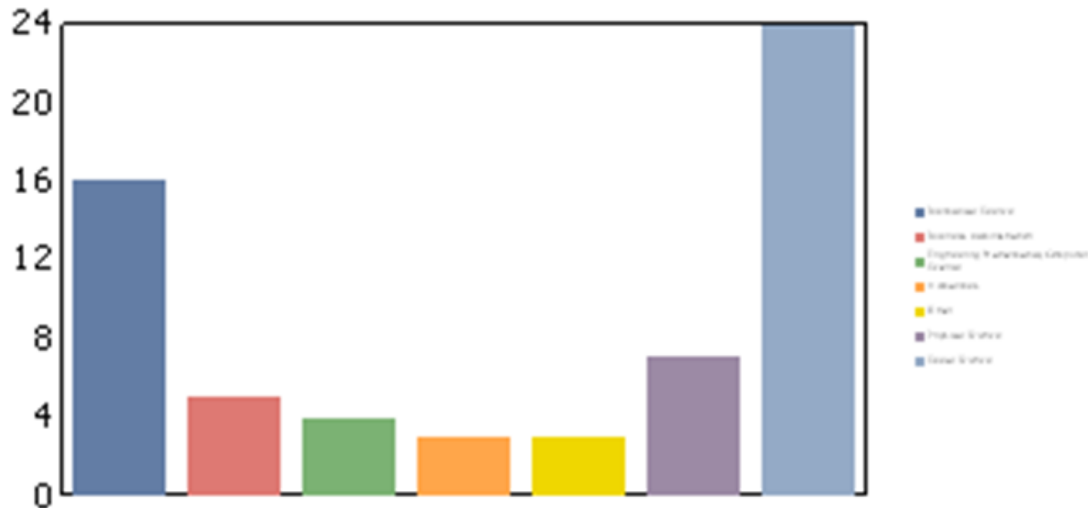
Questions Variable

Academic Discipline Area

- 1 Biomedical Science
- 2 Business Administration
- 3 Engineering/Mathematics/Computer Science
- 4 Humanities
- 5 Other
- 6 Physical Science
- 7 Social Science

Frequency %

16	25.81%
5	8.06%
4	6.45%
3	4.84%
3	4.84%
7	11.29%
24	38.71%
62	100%

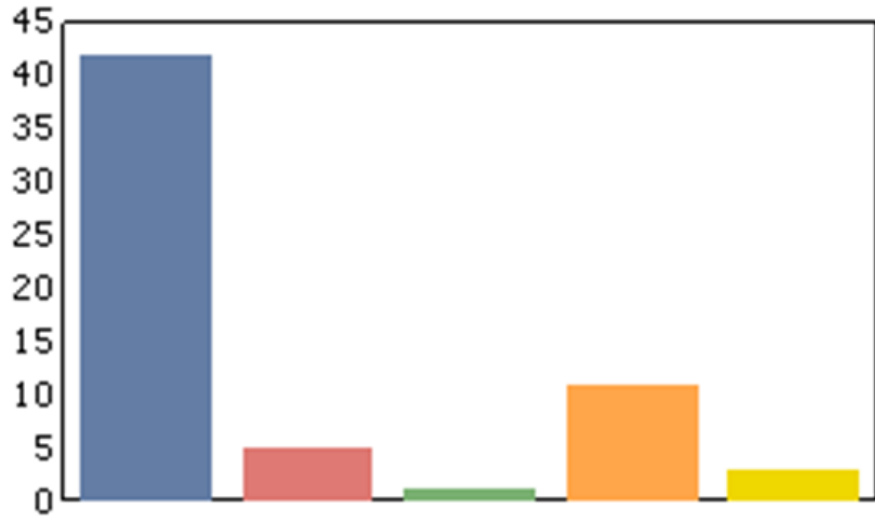


Employment

Employment Sector

- 1 Academics or Education
- 2 Business or Private Sector
- 3 Consulting
- 4 Government
- 5 Nonprofit Sector

42	67.74%
5	8.06%
1	1.61%
11	17.74%
3	4.84%
62	100%



■ Academics or Education
■ Business or Private Sector
■ Consulting
■ Government
■ Nonprofit Sector



Team Science Focus

Questions Variable

Team Science Focus

- 1 The practice of team science (e.g., creating better scientific teams)
- 2 The science of team science (e.g., studying the processes and

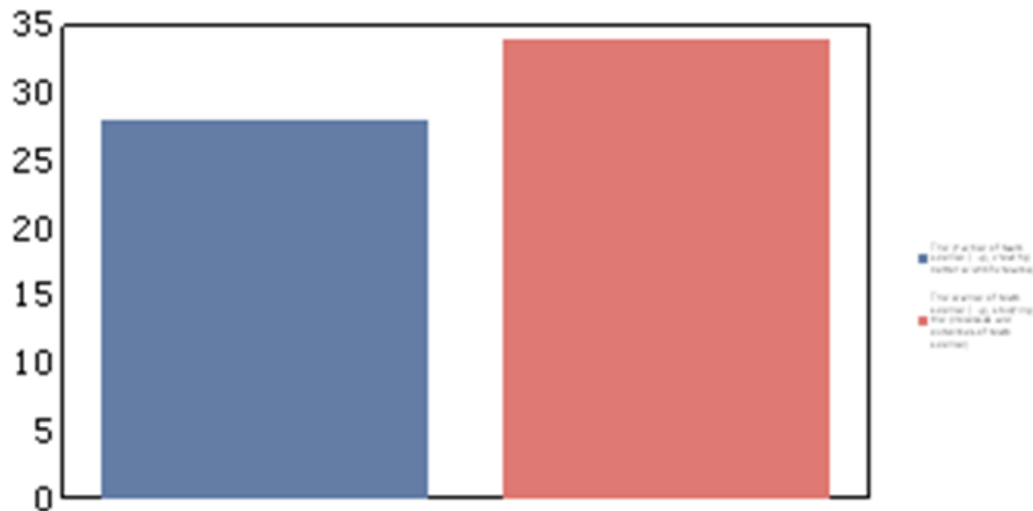
Frequency

%

28 45.16%

34 54.84%

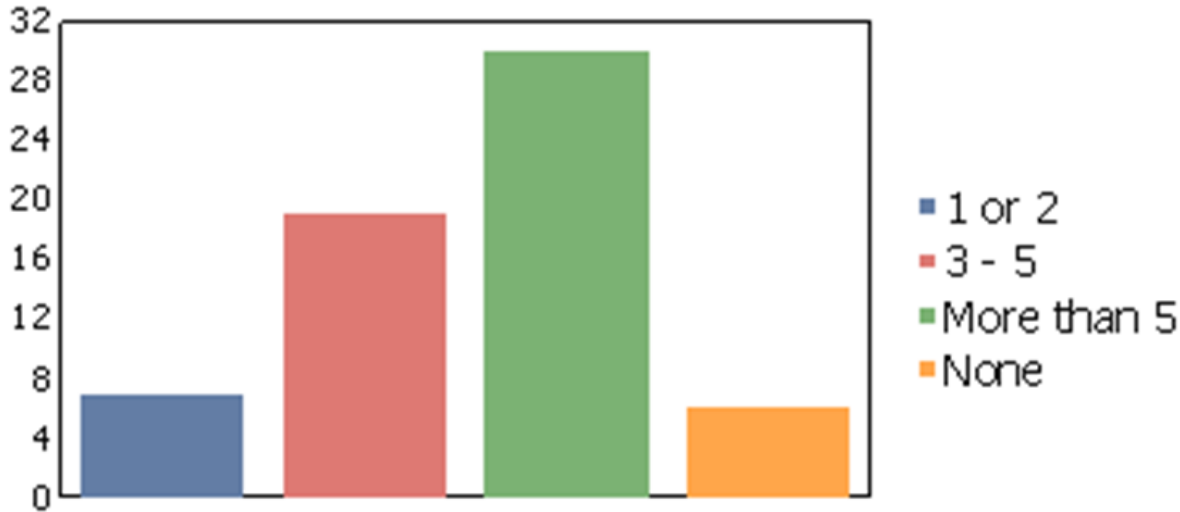
62 100%



Experience with Team Science

Experience with Team Science

- 1 1 or 2
- 2 3 - 5
- 3 More than 5
- 4 None



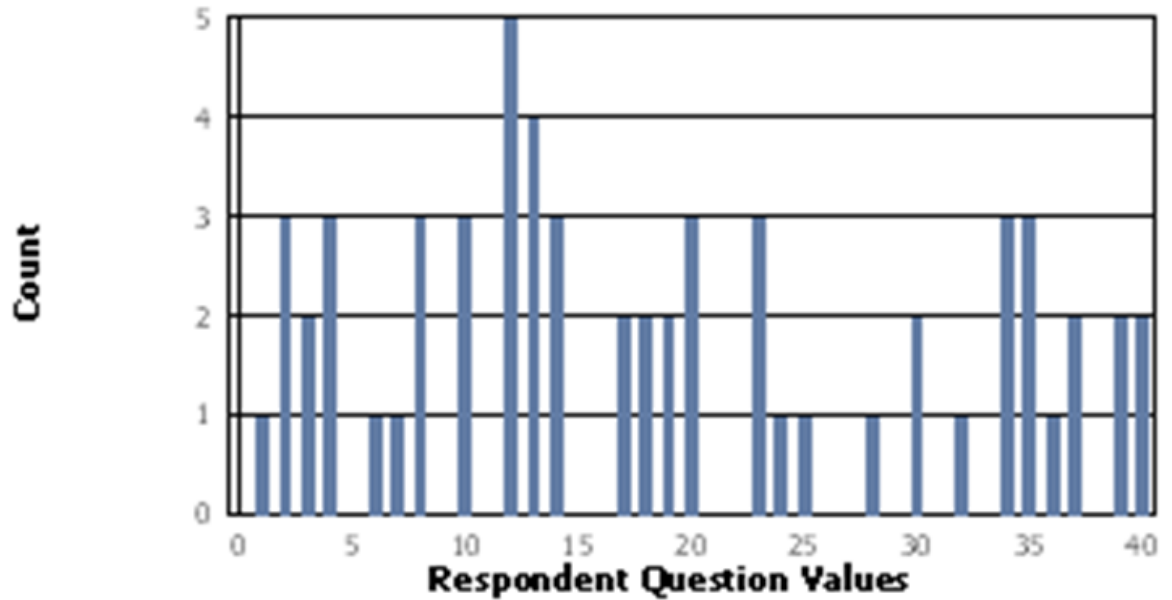
7	11.29%
19	30.65%
30	48.39%
6	9.68%
62	100%



Professional Experience

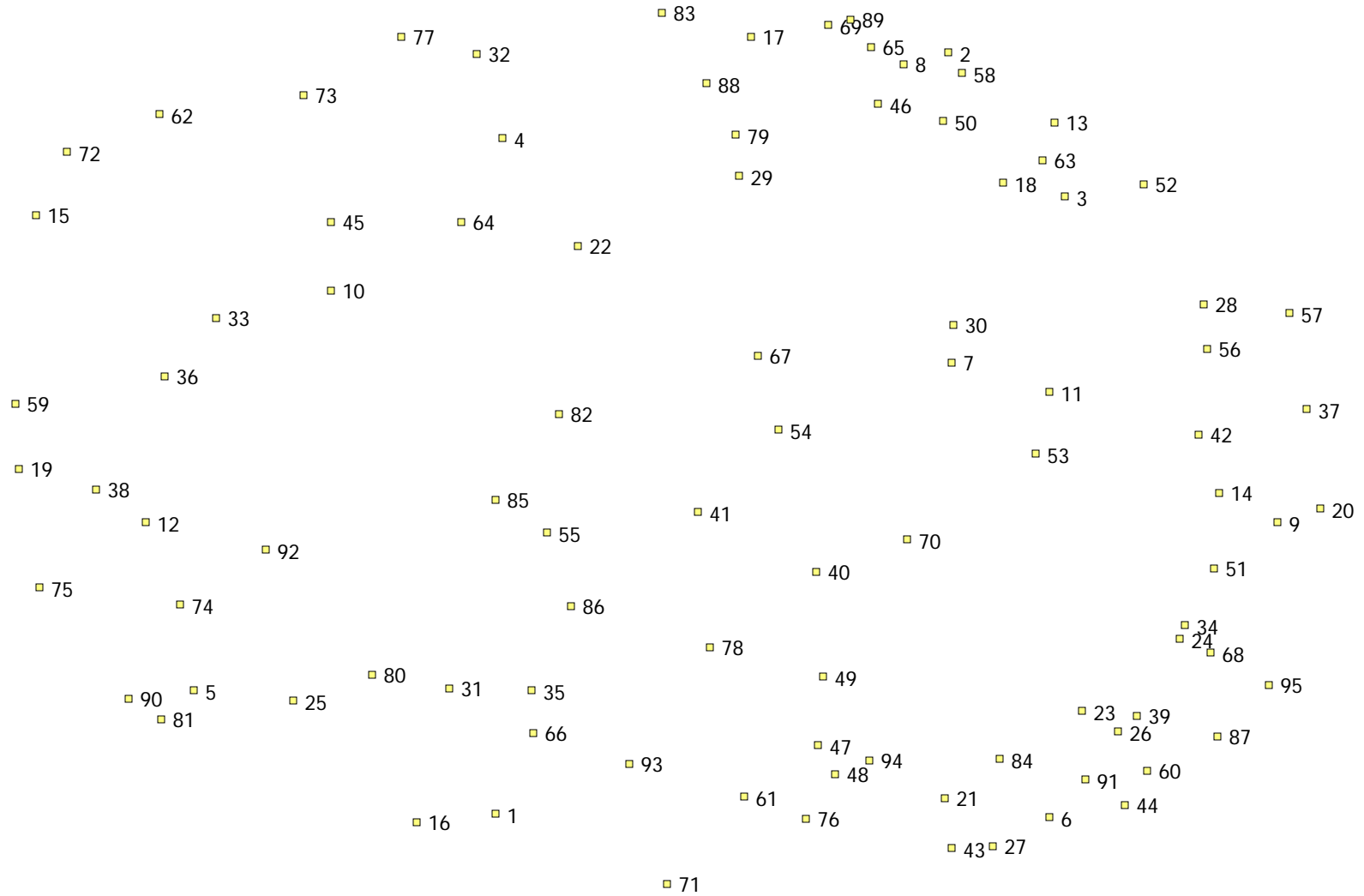
Professional Experience

Minimum: 0.00
Maximum: 90.00
Count: 60
Low: 1.00
High: 40.00
Median: 17.00
Mode: 12.00
Average: 18.78
Std. Dev.: 11.86
Variance: 140.57



**How did we obtain the
results?**

This initial map shows all the potential outcomes in relation to one another



Each point represents one of the brainstormed outcomes



6 heterogeneity of team membership

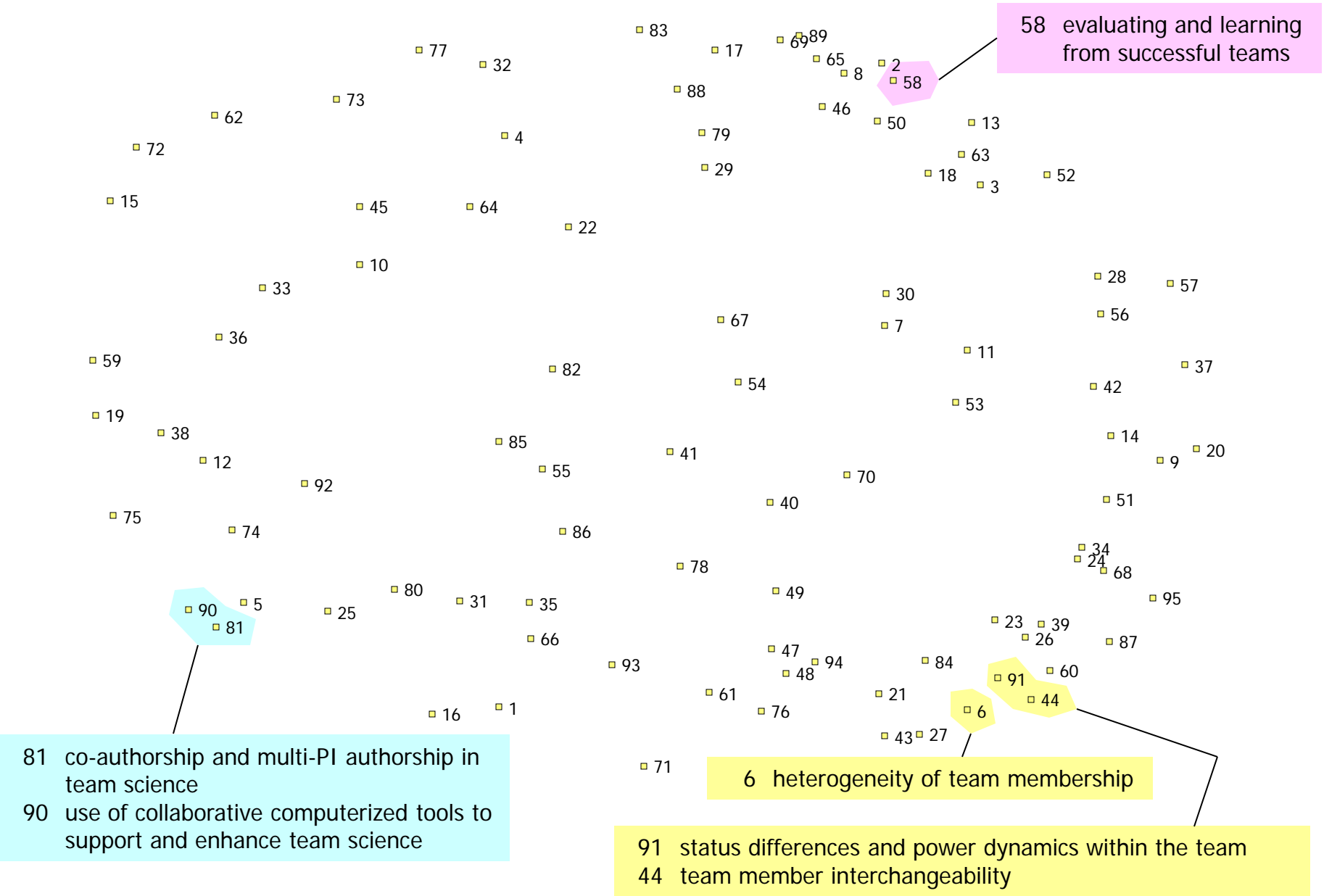
Conceptually similar outcomes are in close proximity



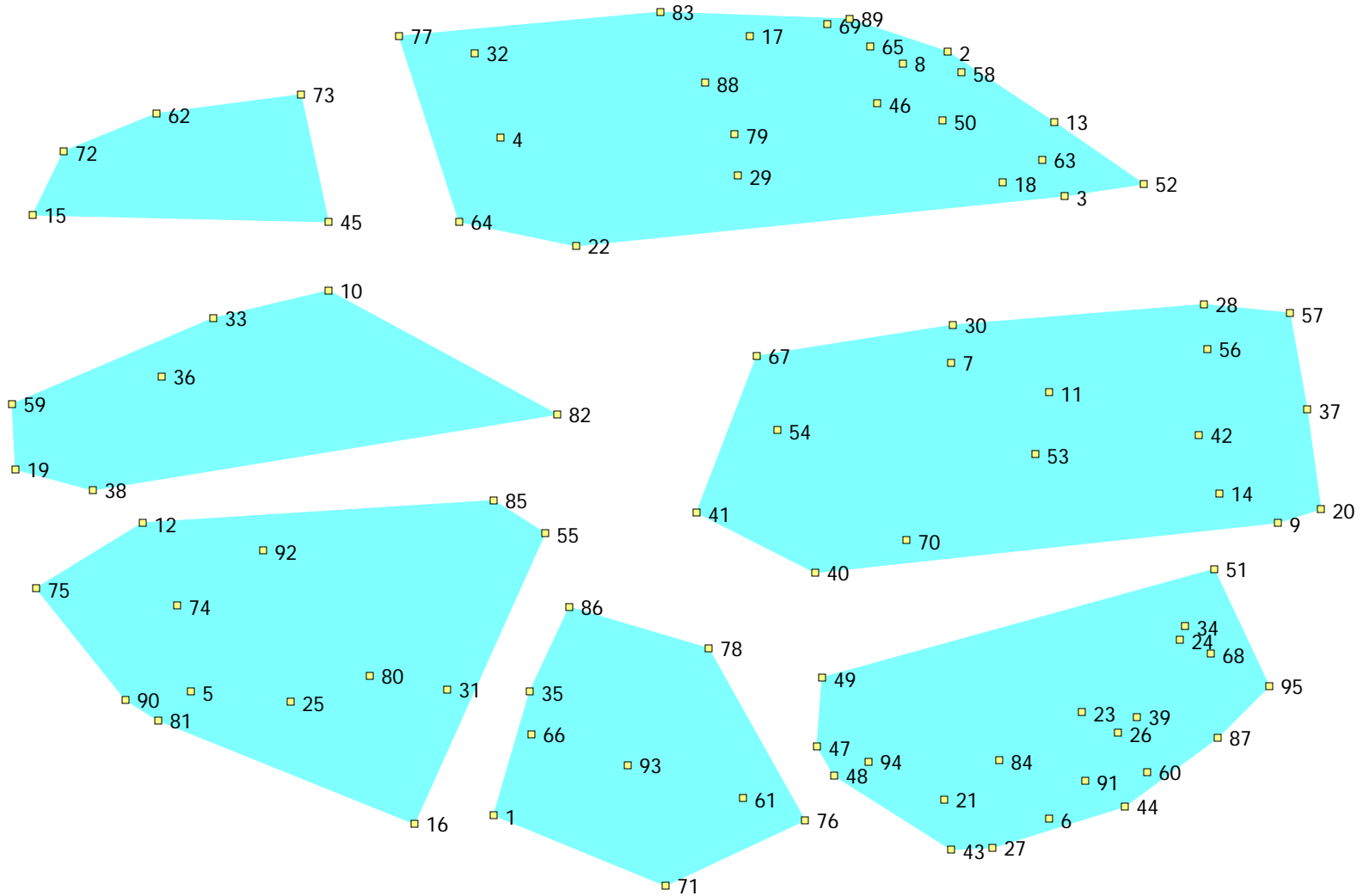
6 heterogeneity of team membership

91 status differences and power dynamics within the team
44 team member interchangeability

Conceptually different outcomes are further apart



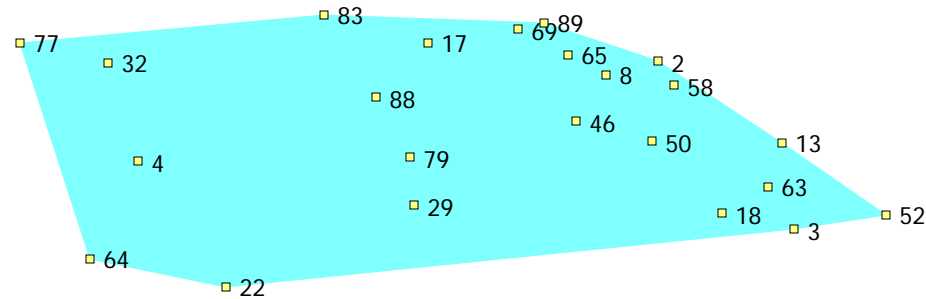
The outcomes are organized into clusters



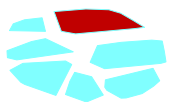
This map shows each of 95 statements grouped into seven clusters by hierarchical cluster analysis.

The Map Results

Measurement & Evaluation of Team Science

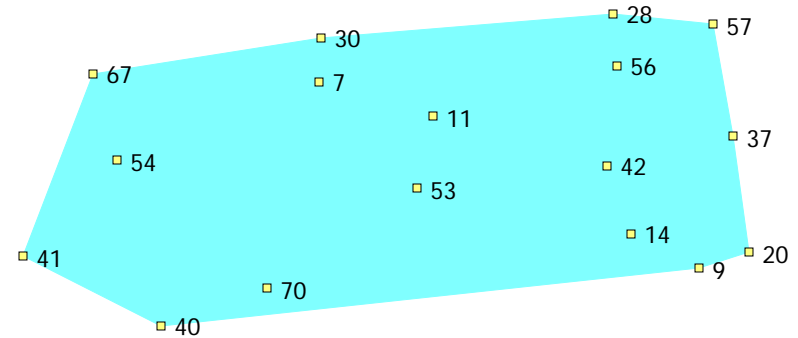


- 89 using publication and bibliometric data (e.g., citation rates, impact factors) to assess team science
- 69 importance of developing multi-method strategies to assess processes and outcomes of team science
- 2 how to evaluate success of team science-based research centers
- 65 measuring effectiveness of team science on multiple levels: individual team, impact of research, effectiveness of team science funding programs, etc.
- 8 measurement of key constructs (e.g., collaboration, disciplinarity, team effectiveness, personal/behavioral characteristics, team processes, readiness; synergy, productivity, shared knowledge)
- 46 best approach(es) to assessing scientific teams within an institution
- 17 research on methodology and measurement of team science
- 13 evaluation of team science and its impacts
- 58 evaluating and learning from successful teams
- 50 how to measure an increase in team science activity and collaboration at an institution, in comparison with other institutions
- 83 how to evaluate existing and new tools
- 63 how network information can provide insight into performance and evaluation of teams
- 88 key performance indicators to encourage team science evaluation into individual development and professional growth
- 3 comparing the effects of team science versus traditional science in advancing scientific knowledge
- 79 infrastructures to capture relevant data to better assess team science outcomes
- 52 to assess whether the findings produced by team science are more broadly disseminated, as compared to traditional science
- 18 social network analysis of scientific teams
- 77 strengthening the research methods for studying scientific teams (e.g., using quasi-experimental methods)
- 32 how to use team science approaches and methods in the investigation of team science
- 29 economic value created by team science
- 4 how to demonstrate an effective team in a grant proposal
- 64 the availability of organizational structure data as a data source
- 22 approaches for capturing the expertise of team science leaders

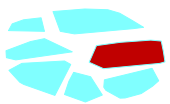


Structure & Context for Teams

- 41 whether collaborative spaces for team science encourage collaboration
- 54 use and impact of community-based organizations and community clinical practices in teams
- 70 what types of team organizations are best at facilitating team science
- 42 the impact of team size on process and outcomes in team science
- 11 the effects of the type and complexity of research question on team science
- 40 how research networking tools can enhance team science
- 9 the relationship between productivity and the composition of teams
- 67 the effect of research centers in promoting a team science approach
- 20 the relationships among creativity, innovation and the composition of teams
- 53 contextual/situational factors that influence the effectiveness of team collaboration

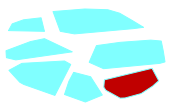
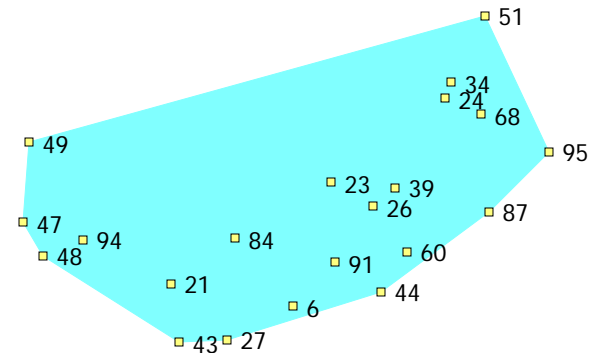


- 30 keys for success in team science
- 56 effects of sustained, hard team work
- 7 status of the team as it appears to external individuals and groups
- 28 a study of team science outcomes with junior versus senior PIs
- 14 how the changing ecology and structure of teams influence future scientific collaborations
- 37 the network characteristics of productive science team members and subgroups
- 57 how team dynamics can impact science



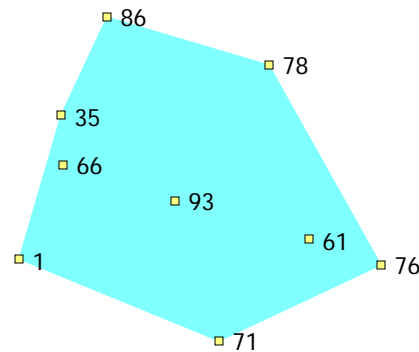
Characteristics & Dynamics of Teams

- 91 status differences and power dynamics within the team
- 44 team member interchangeability
- 21 how roles in teams are defined and communicated, and by whom
- 26 the influence of research team morale
- 60 personal and behavioral factors in team science collaborations
- 94 different types of conflicts that occur in scientific teams and how to address these effectively
- 23 communication styles in teams
- 84 leadership characteristics that drive effective team science
- 68 optimal team composition (e.g., specialists, generalists, boundary spanners) to enable use of diverse expertise.
- 87 social skills and competencies required for successful team science
- 27 the psychological and personality factors associated with being an effective team scientist
- 47 team member physical proximity (co-location)
- 24 ideal composition of scientific teams
 - 6 heterogeneity of team membership
- 39 how teams grow, shrink, expire over time
- 48 issues to consider when initiating or building a new team
- 43 collaborative readiness factors
- 49 finding potential/likely research collaborators
- 34 what factors contribute to the development of trust in different collaborations
- 95 why people join teams
- 51 gender differences in team contributions



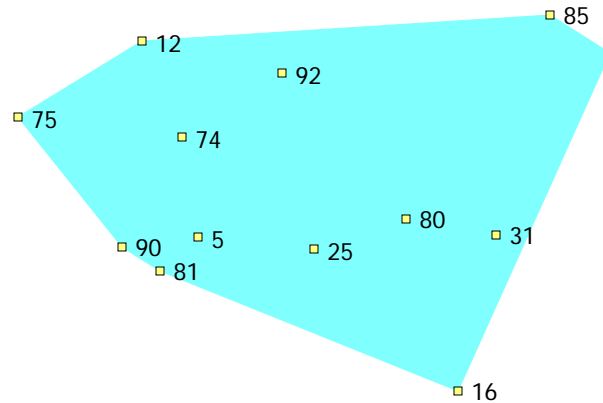
Management & Organization for Teams

- 76 value of rotating team leadership
- 93 the management of scientific teams
- 78 how to sustain scientific teams
- 61 membership in multiple, potentially overlapping, potentially conflicting teams
- 35 organizational policies that foster team science
- 66 virtual organizations and team science
- 86 formal vs. informal organizational structures of institutions
- 1 types of organizational structures of team science
- 71 disciplinary language barriers in team science



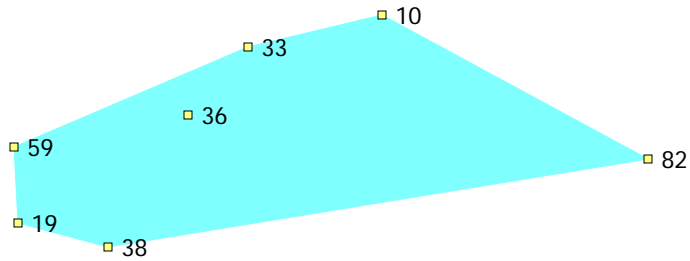
Institutional Support & Professional Development for Teams

- 31 incentives and incentive systems for team science
- 74 resources and infrastructure needed within and across institutions to promote collaboration and team science
- 25 how the university tenure and promotion system can be restructured to encourage team science
- 80 processes and methods that encourage and support teams (e.g., group activities, scientific conferences, grant opportunity distribution, systems-based approaches)
- 85 relationships between team science in the academy and industry
- 55 timing, with regards to investigator career stage, in team science
- 92 ethical issues in conducting team science (e.g. intellectual property ownership, defining collaborative relationships; attributing credit for work)
- 5 training and education issues in team science
- 75 funding to support the science of team science, research on team science
- 81 co-authorship and multi-PI authorship in team science
- 12 the effects of team science on the scientist's work and career
- 90 use of collaborative computerized tools to support and enhance team science
- 16 individual benefit/risk analysis to engaging in team science

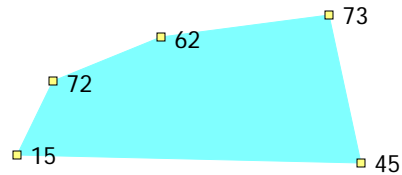


Disciplinary Dynamics & Team Science

- 82 variations in team science related to disciplinaryity
- 38 how to overcome disciplinary traditions to move toward interdisciplinary traditions
- 59 using team science and interdisciplinary research to support emerging areas of science
- 36 applying what is known about teams in different disciplines (e.g., management) and contexts (e.g., international)
- 33 relationships and connections between multi-, inter- and transdisciplinary research efforts and team science
- 19 how best to disseminate findings and best practices from the science of team science
- 10 understanding differences between intra- vs. interinstitutional scientific teams



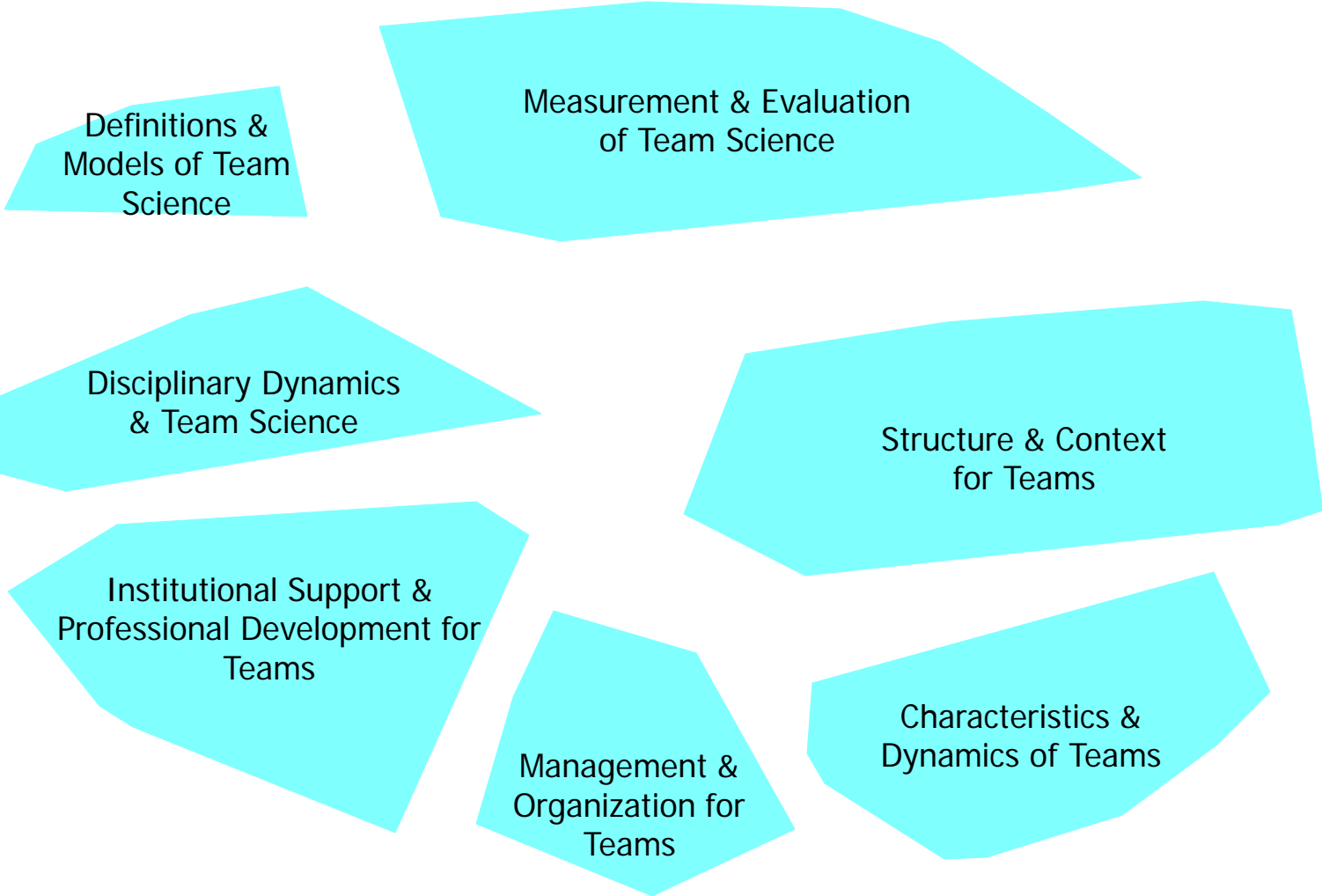
Definitions & Models of Team Science



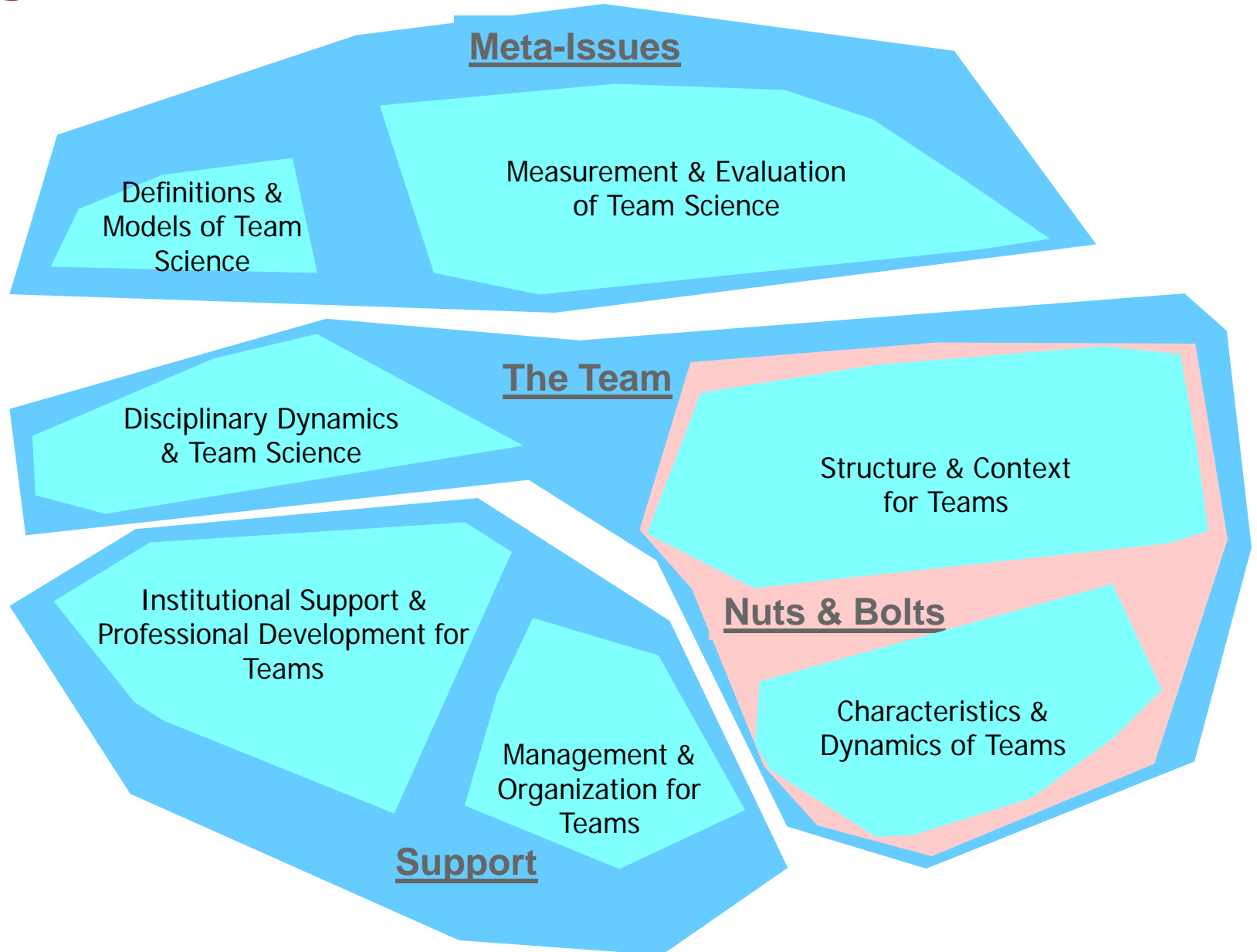
- 72 theories and models of team science
- 45 best practices of team science
- 73 developing testable hypotheses about team science
- 62 the definitions of team, scientific team, and team science
- 15 definition of different types of disciplinarity (interdisciplinary; multidisciplinarity; transdisciplinarity)



Cluster Map



Regional Interpretation



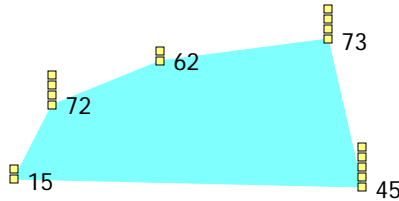
Ratings and Pattern Matches

Importance Point Rating Map

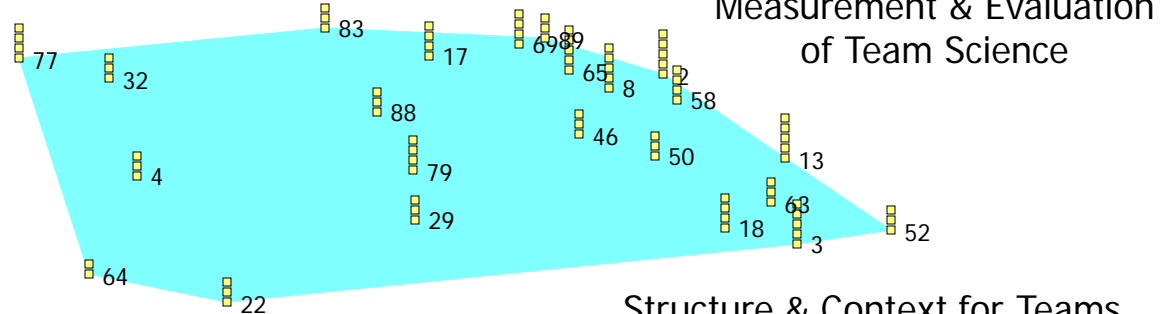
Point Legend

Layer	Value
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2	2.95 to 3.33
3	3.33 to 3.70
4	3.70 to 4.07
5	4.07 to 4.44

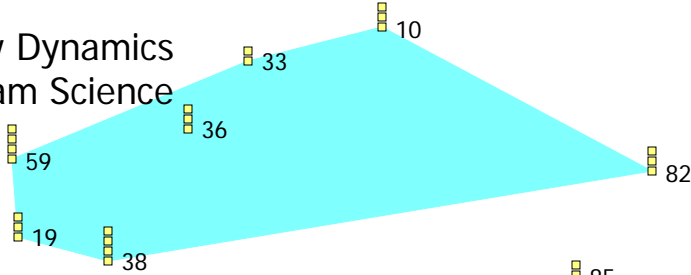
Definitions & Models of Team Science



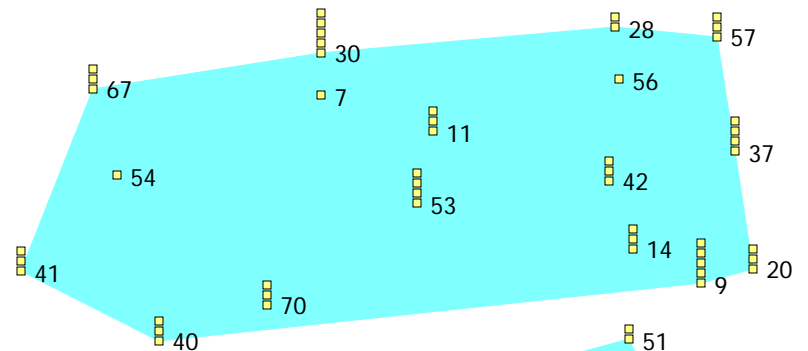
Measurement & Evaluation of Team Science



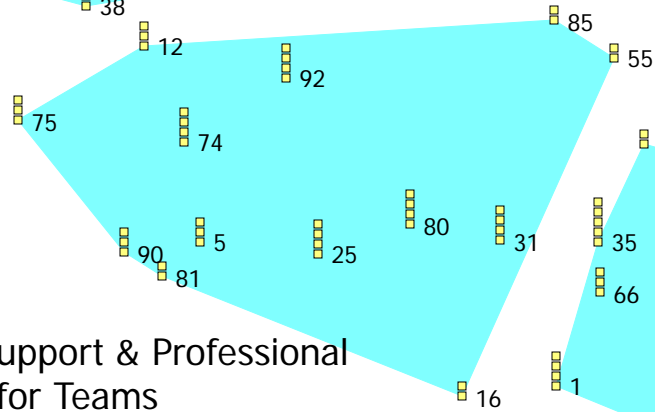
Disciplinary Dynamics & Team Science



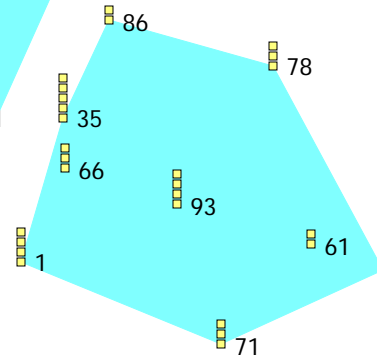
Structure & Context for Teams



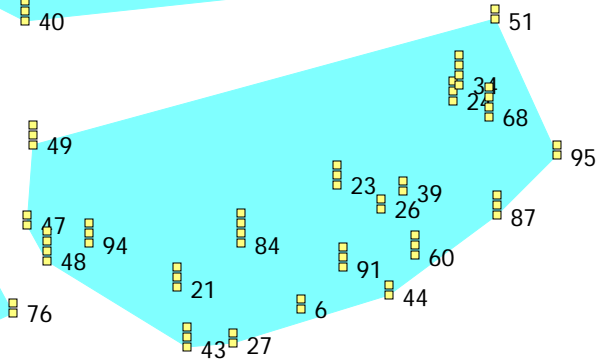
Institutional Support & Professional Development for Teams



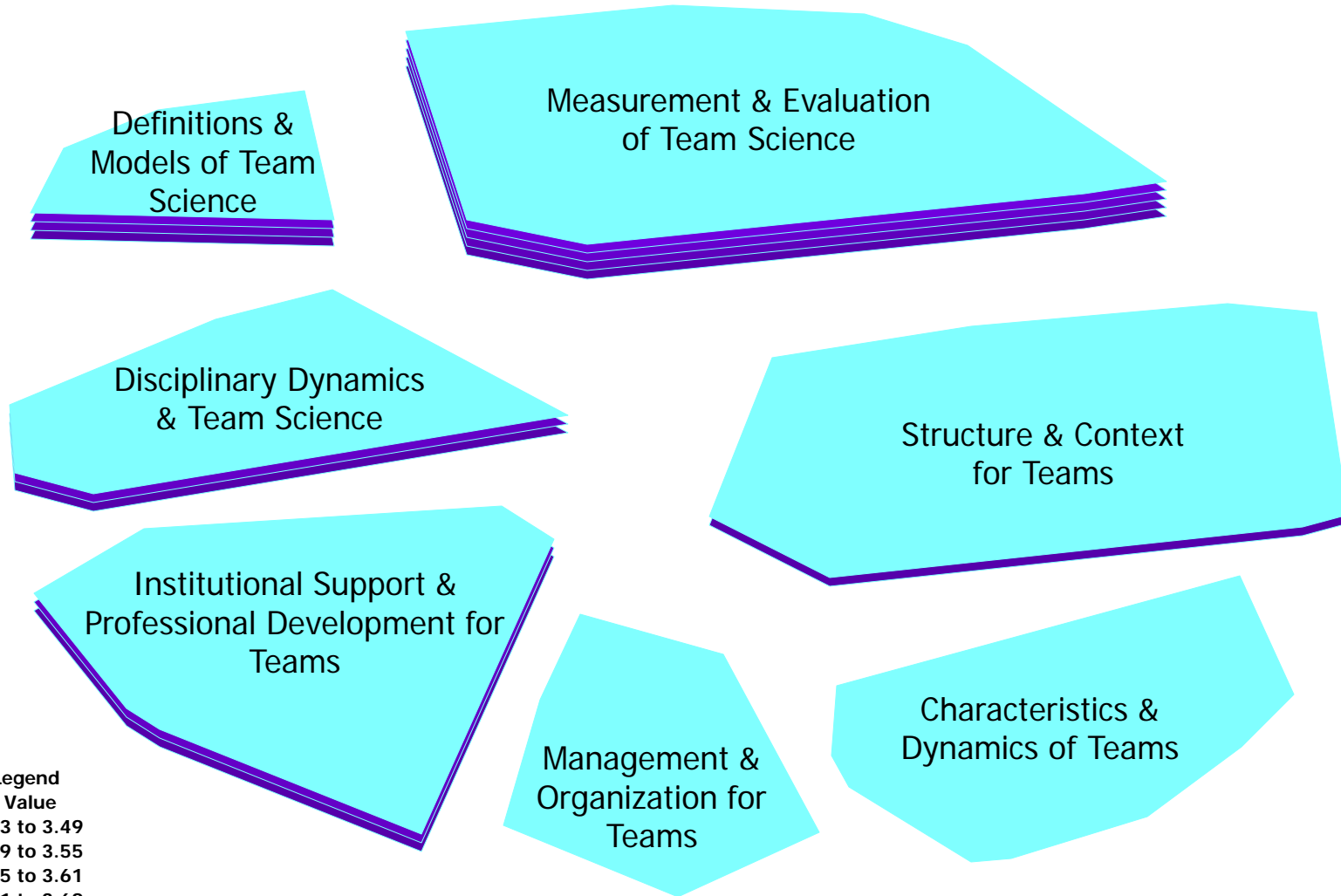
Management & Organization for Teams



Characteristics & Dynamics of Teams



Importance Cluster Rating Map



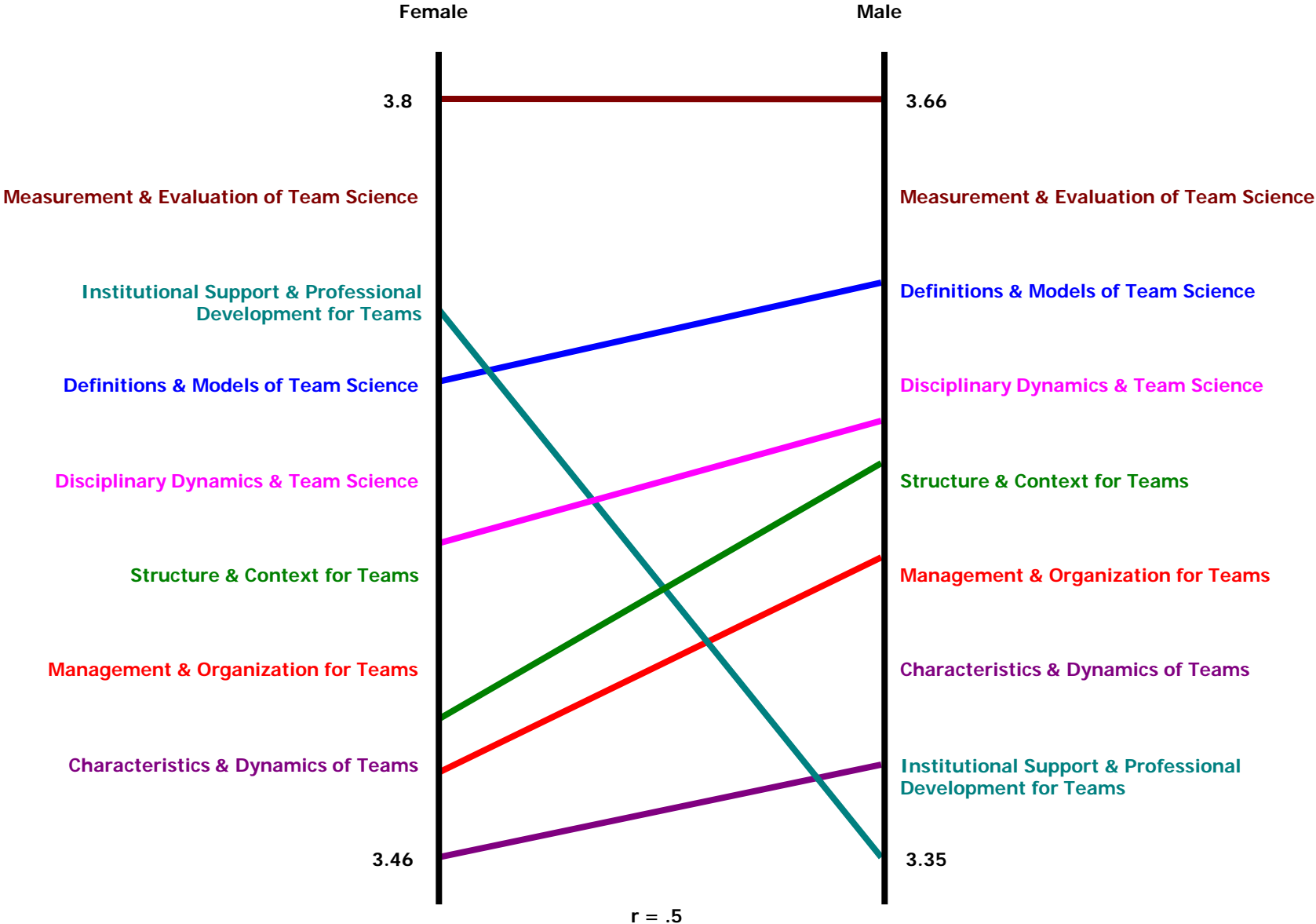
Cluster Legend

Layer	Value
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2	3.49 to 3.55
3	3.55 to 3.61
4	3.61 to 3.68
5	3.68 to 3.74

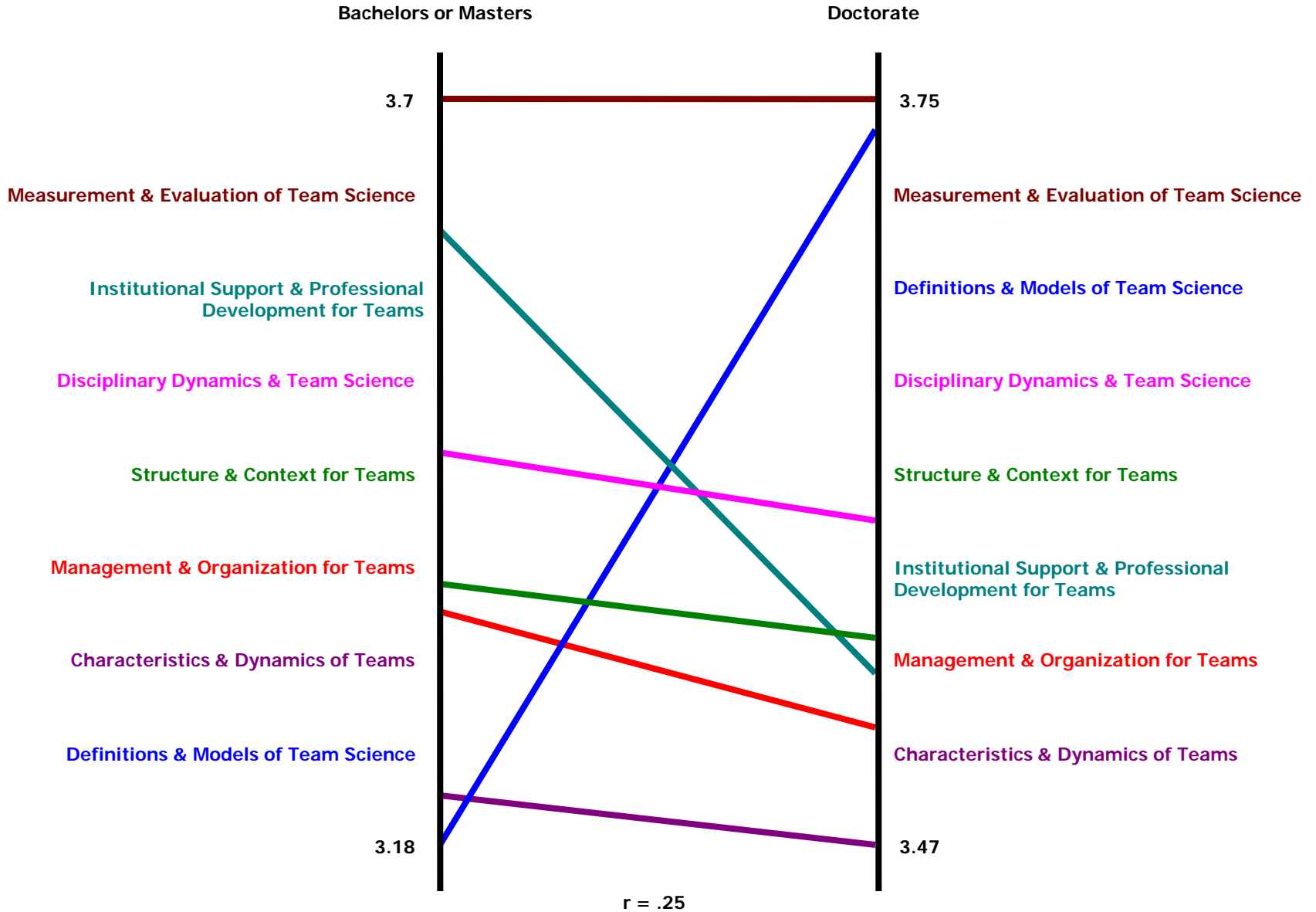
Top Ten Statements By Average Importance

- 8 measurement of key constructs (e.g., collaboration, disciplinarity, team effectiveness, personal/behavioral characteristics, team processes, readiness; synergy, productivity, shared knowledge) (4.44)
- 30 keys for success in team science (4.23)
- 13 evaluation of team science and its impacts (4.22)
- 45 best practices of team science (4.16)
- 65 measuring effectiveness of team science on multiple levels: individual team, impact of research, effectiveness of team science funding programs, etc. (4.16)
- 2 how to evaluate success of team science-based research centers (4.14)
- 35 organizational policies that foster team science (4.13)
- 9 the relationship between productivity and the composition of teams (4.11)
- 3 comparing the effects of team science versus traditional science in advancing scientific knowledge (4.08)
- 74 resources and infrastructure needed within and across institutions to promote collaboration and team science (4.03)

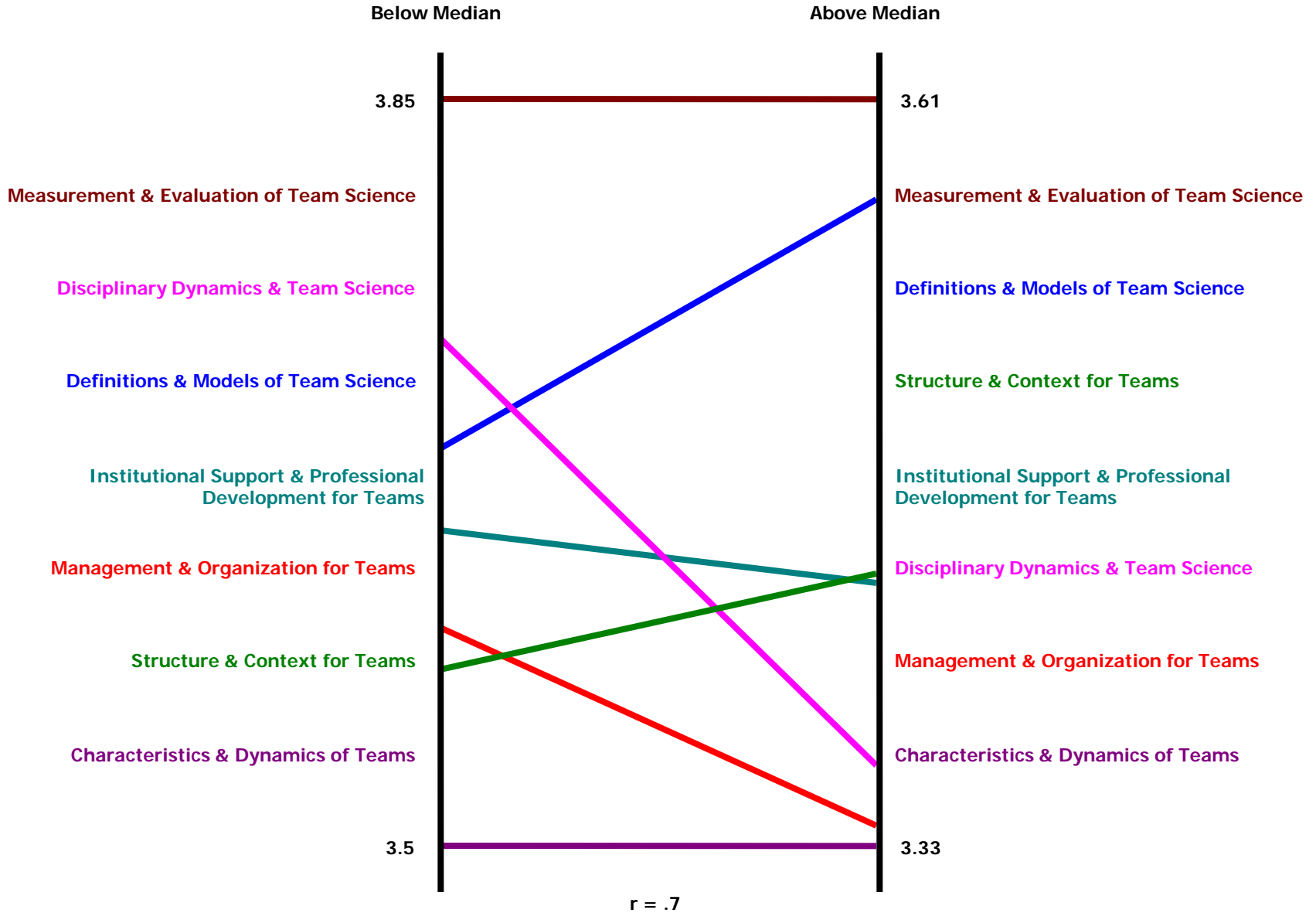
Gender



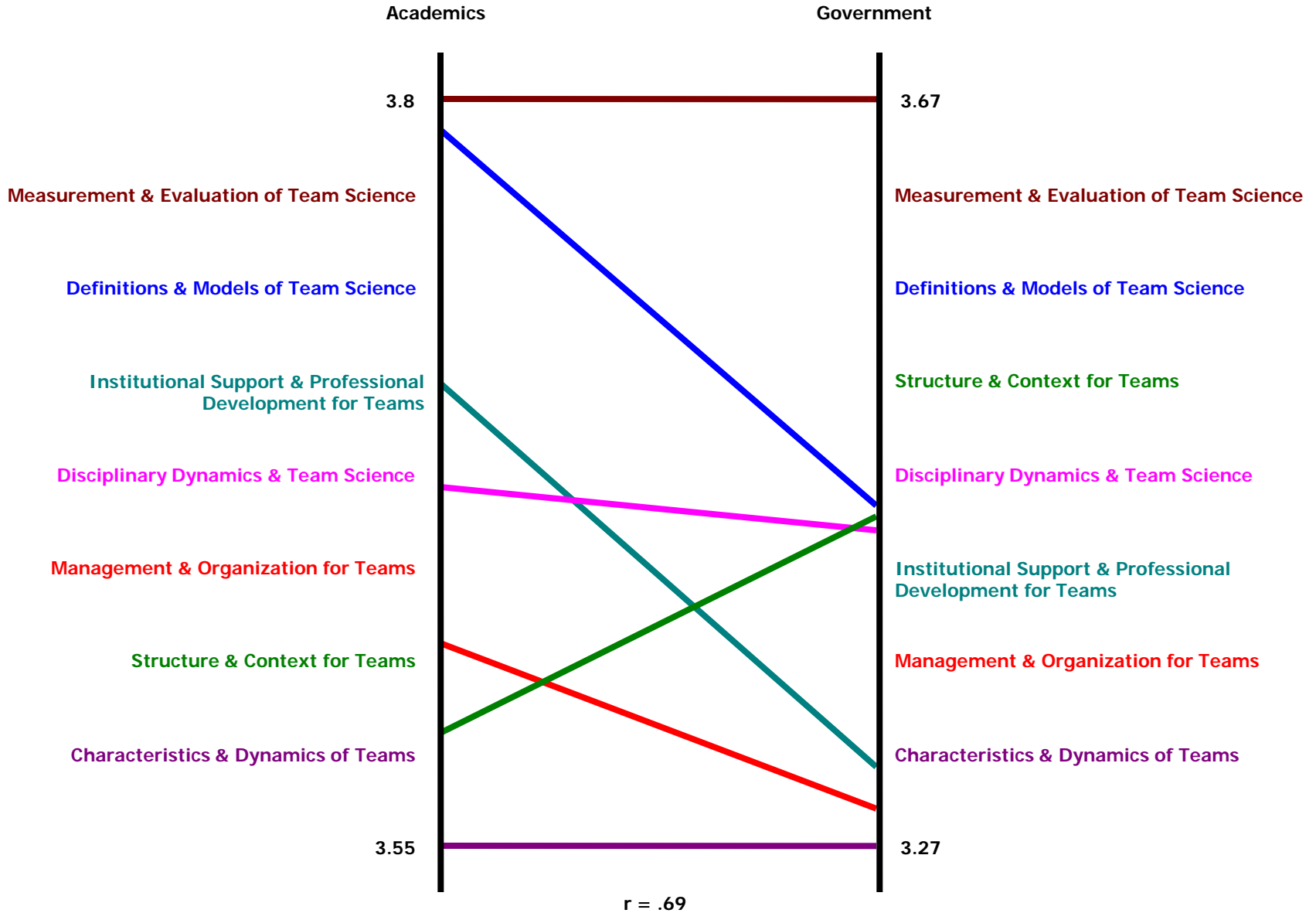
Education



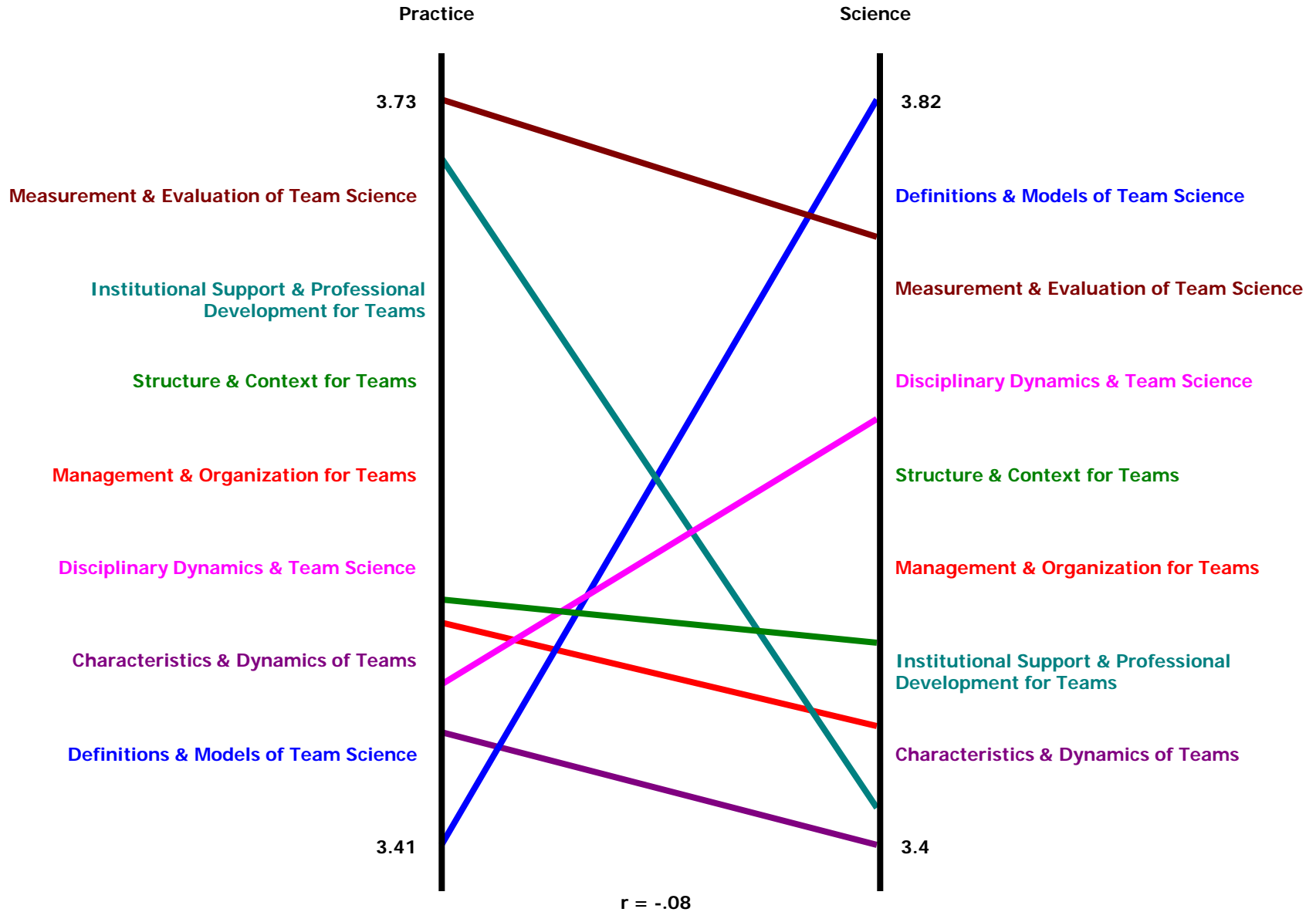
Professional Experience



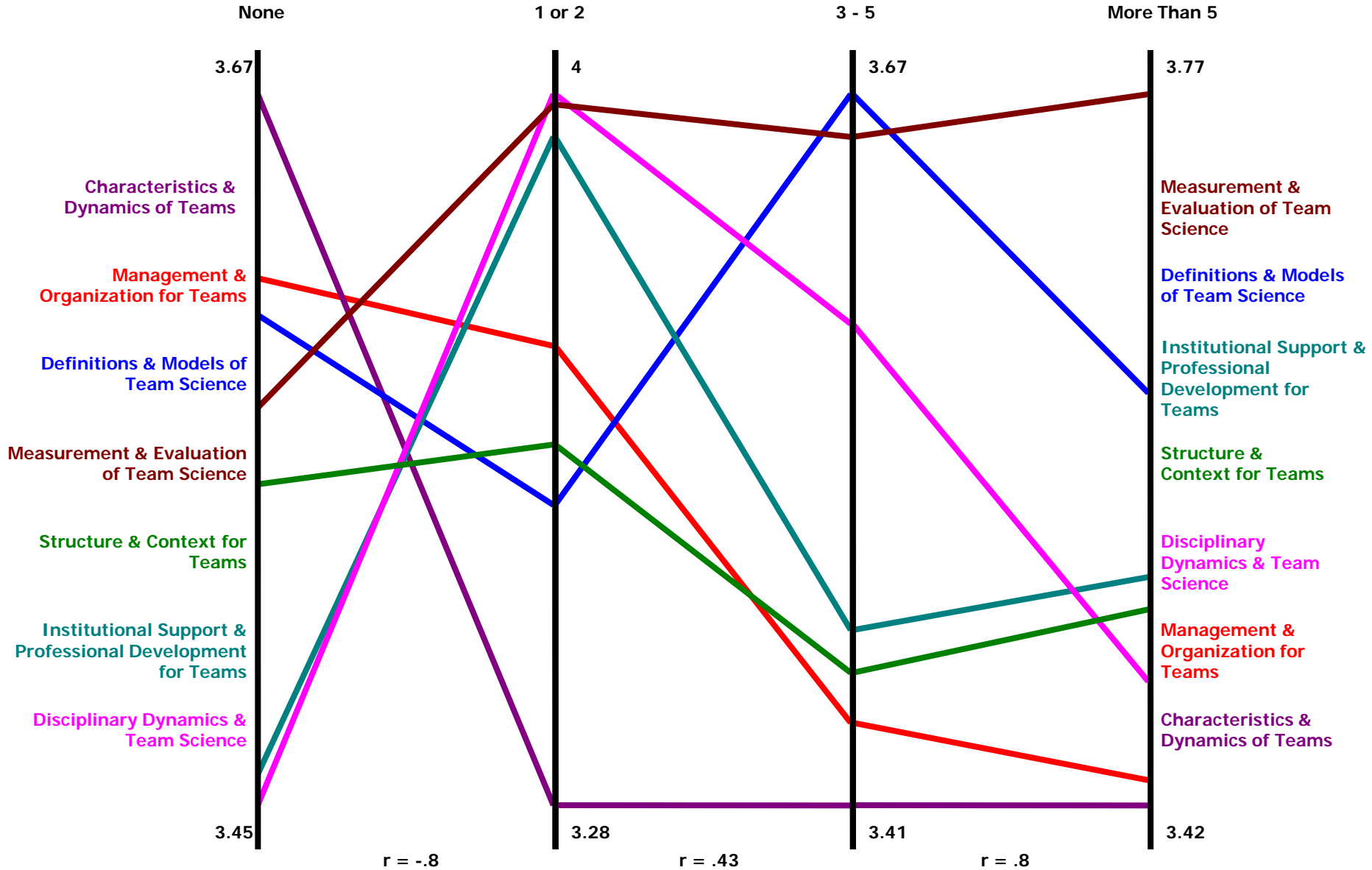
Employment Sector



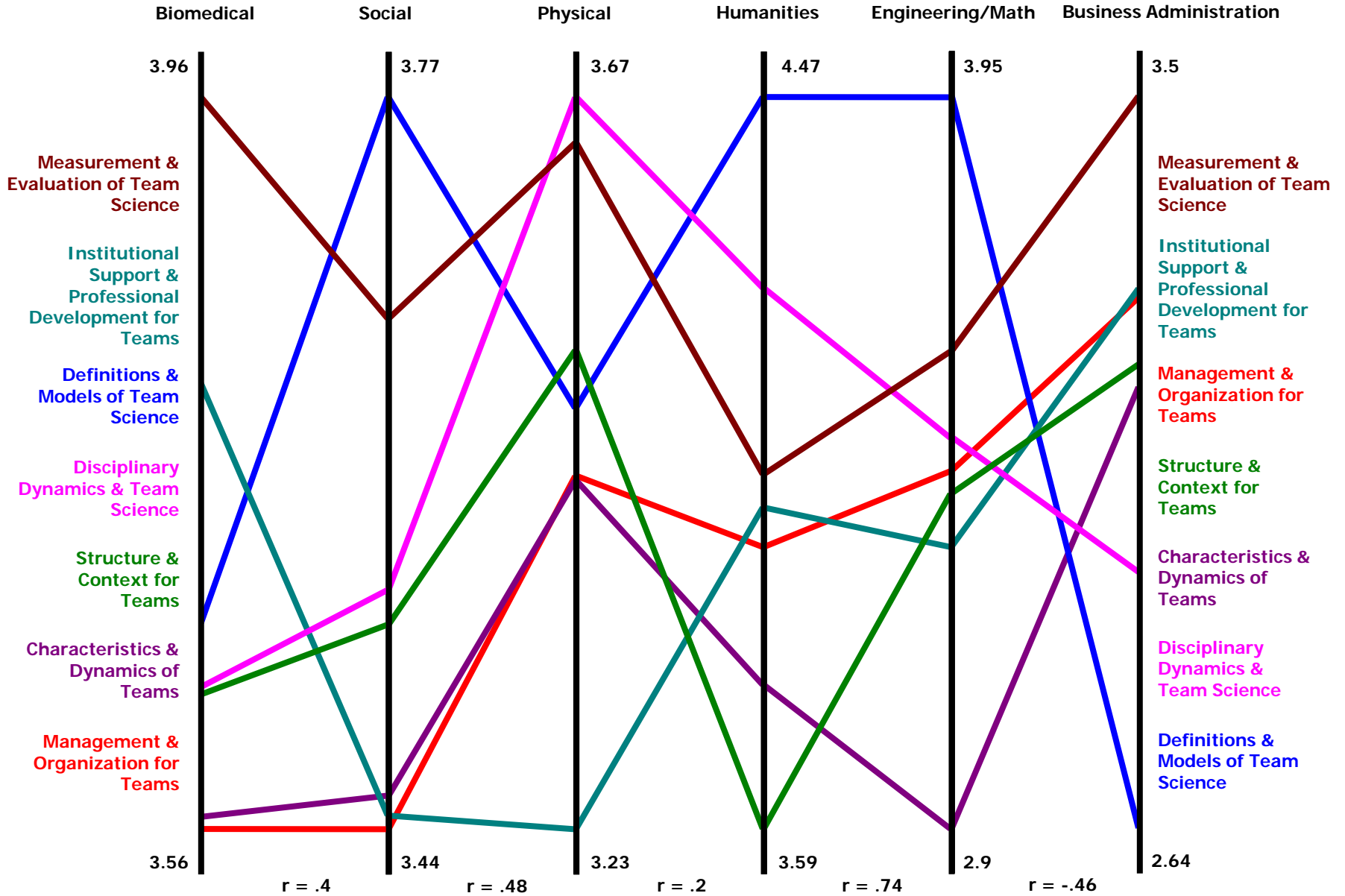
Team Science Focus



Experience with Teams

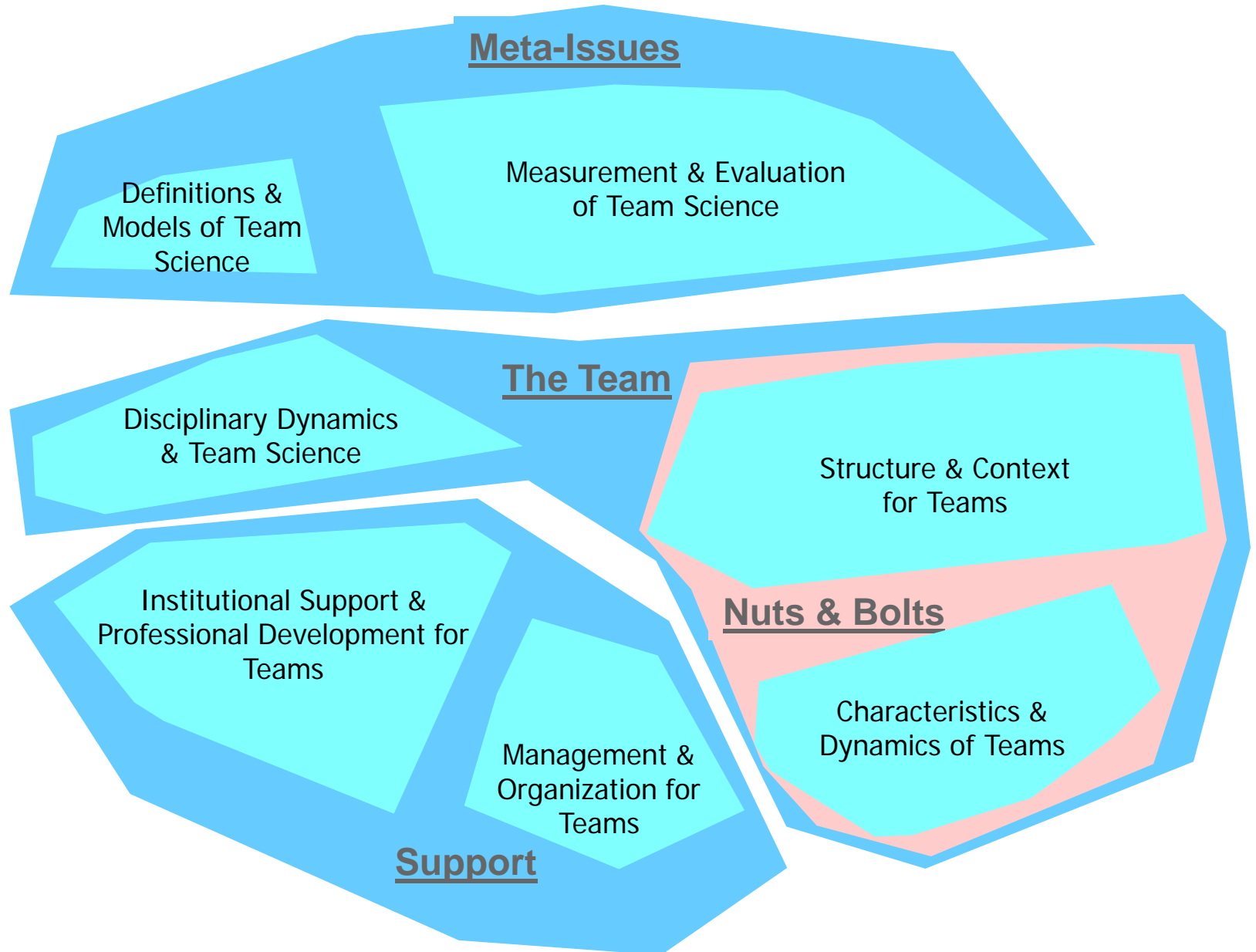


Academic Discipline

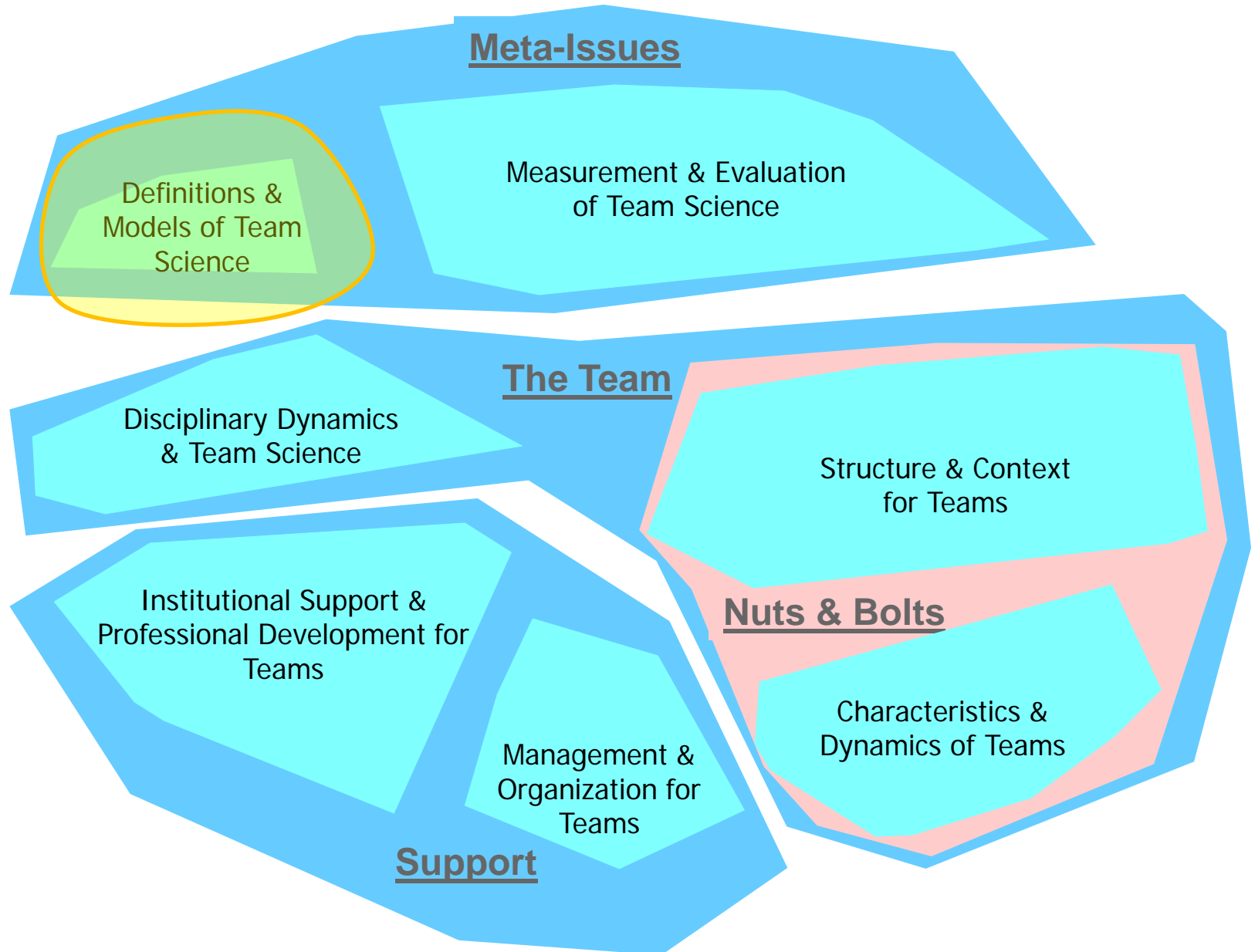


**Using the Maps:
The Science of Team Science
Conference Program**

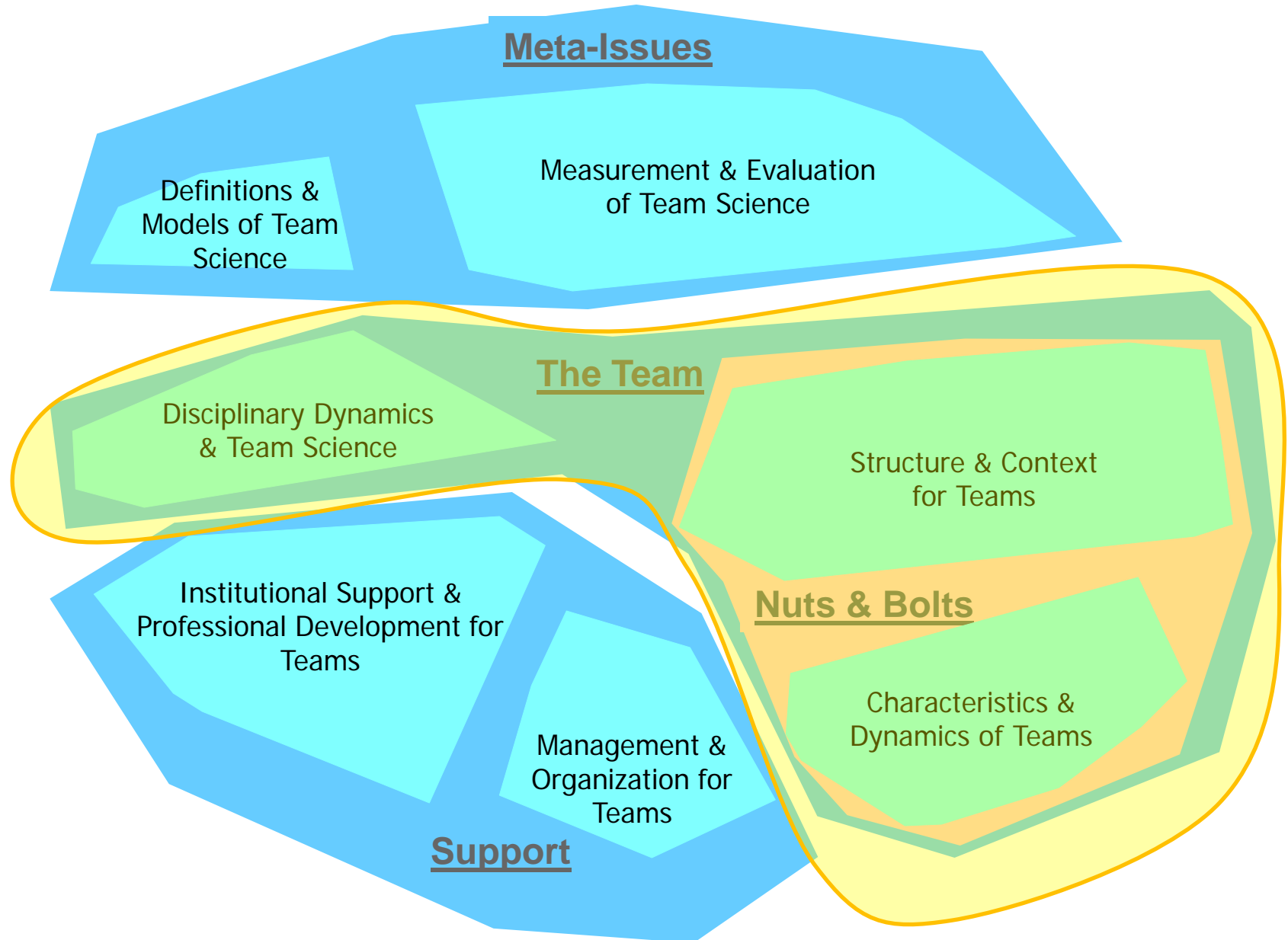
Regional Interpretation



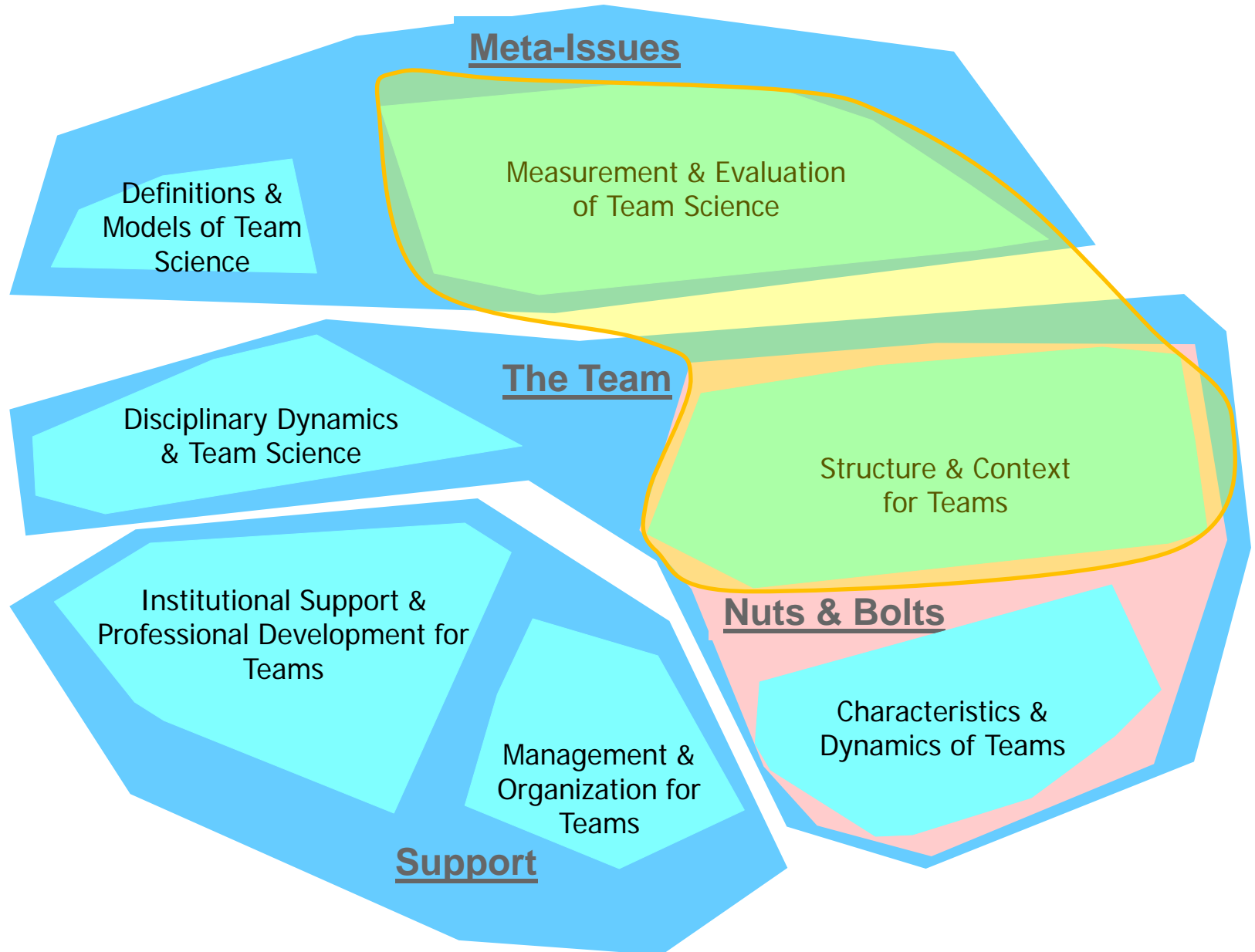
Regional Interpretation - Panel X1



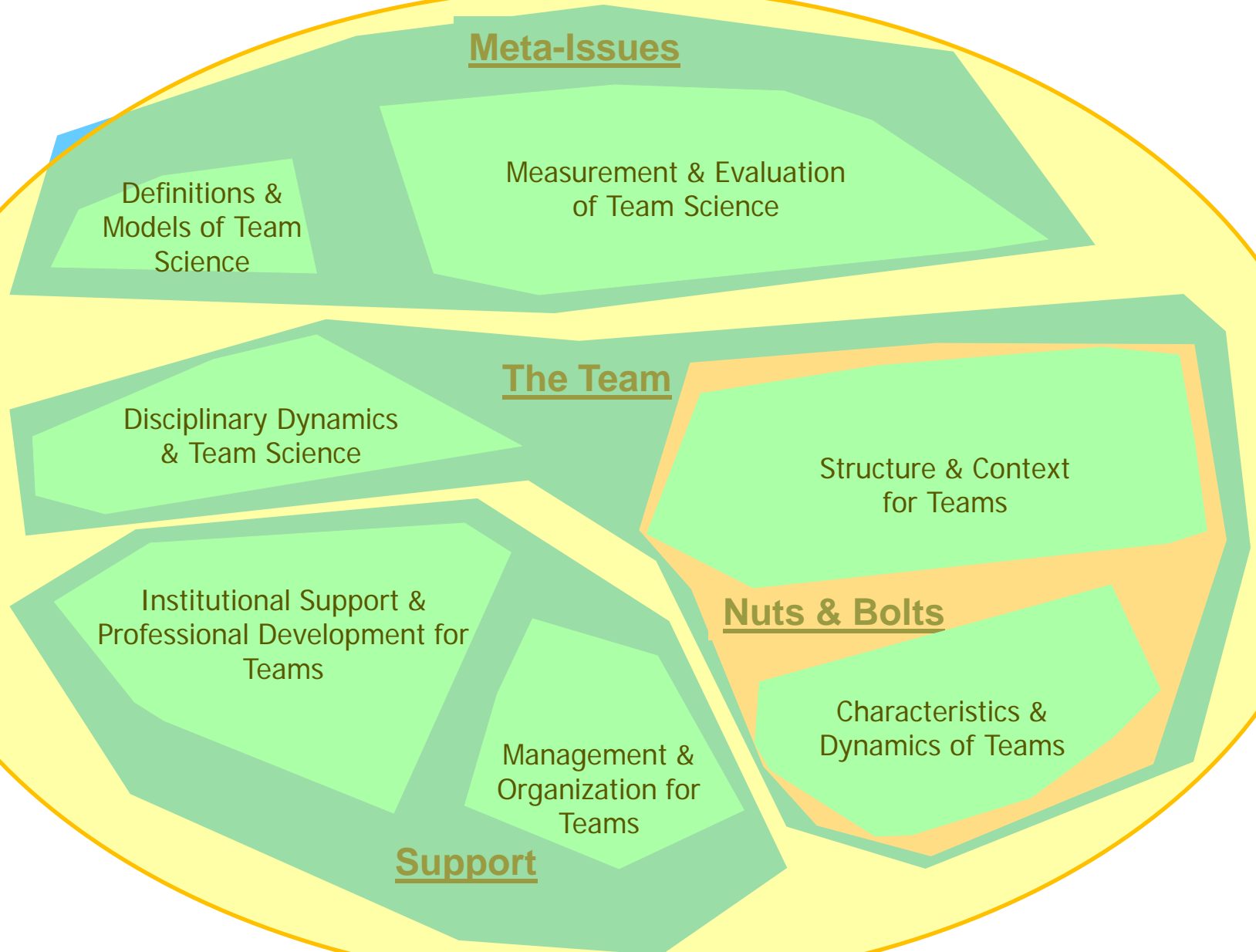
Regional Interpretation – Panel X2



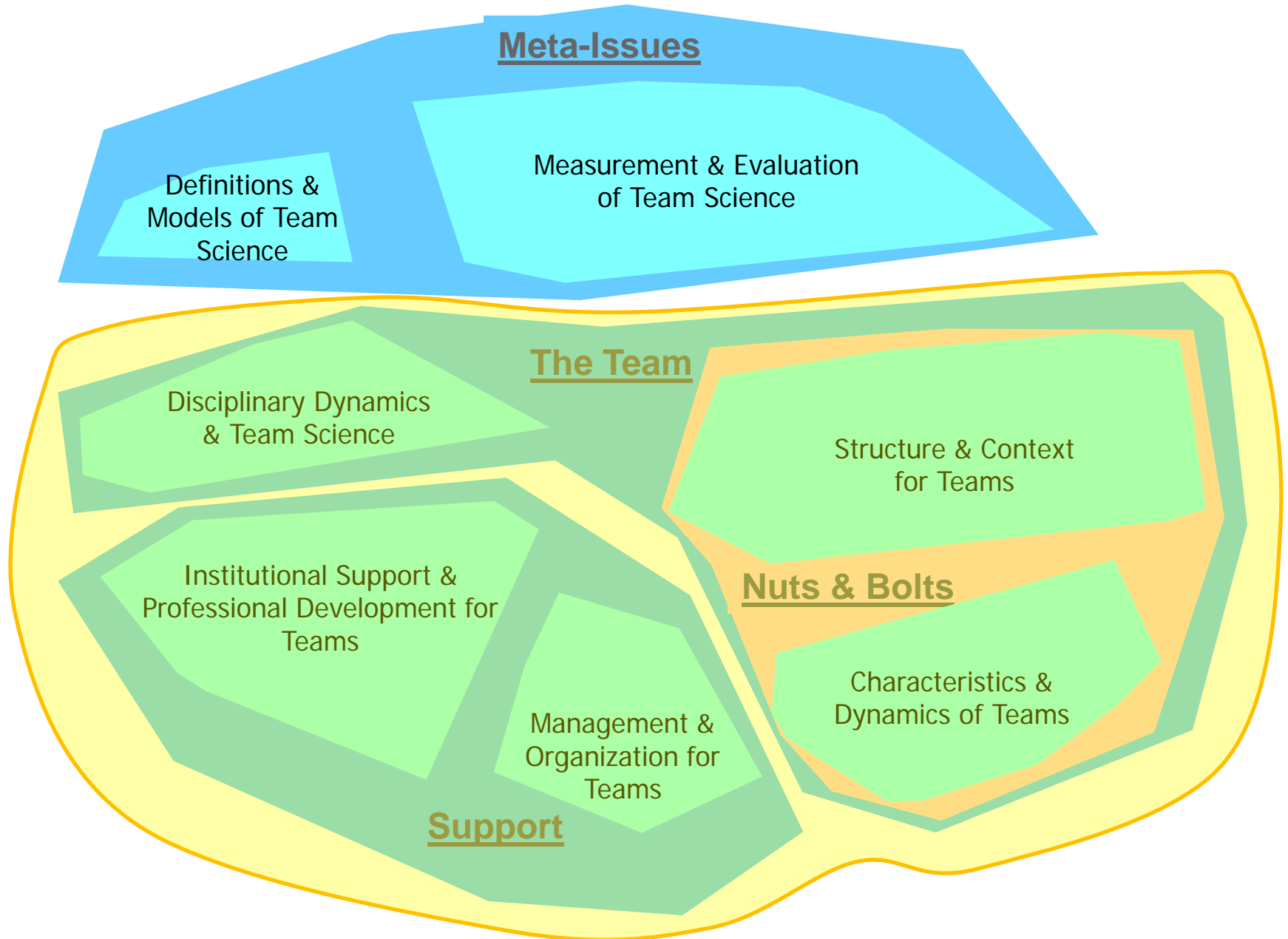
Regional Interpretation – Panel X3



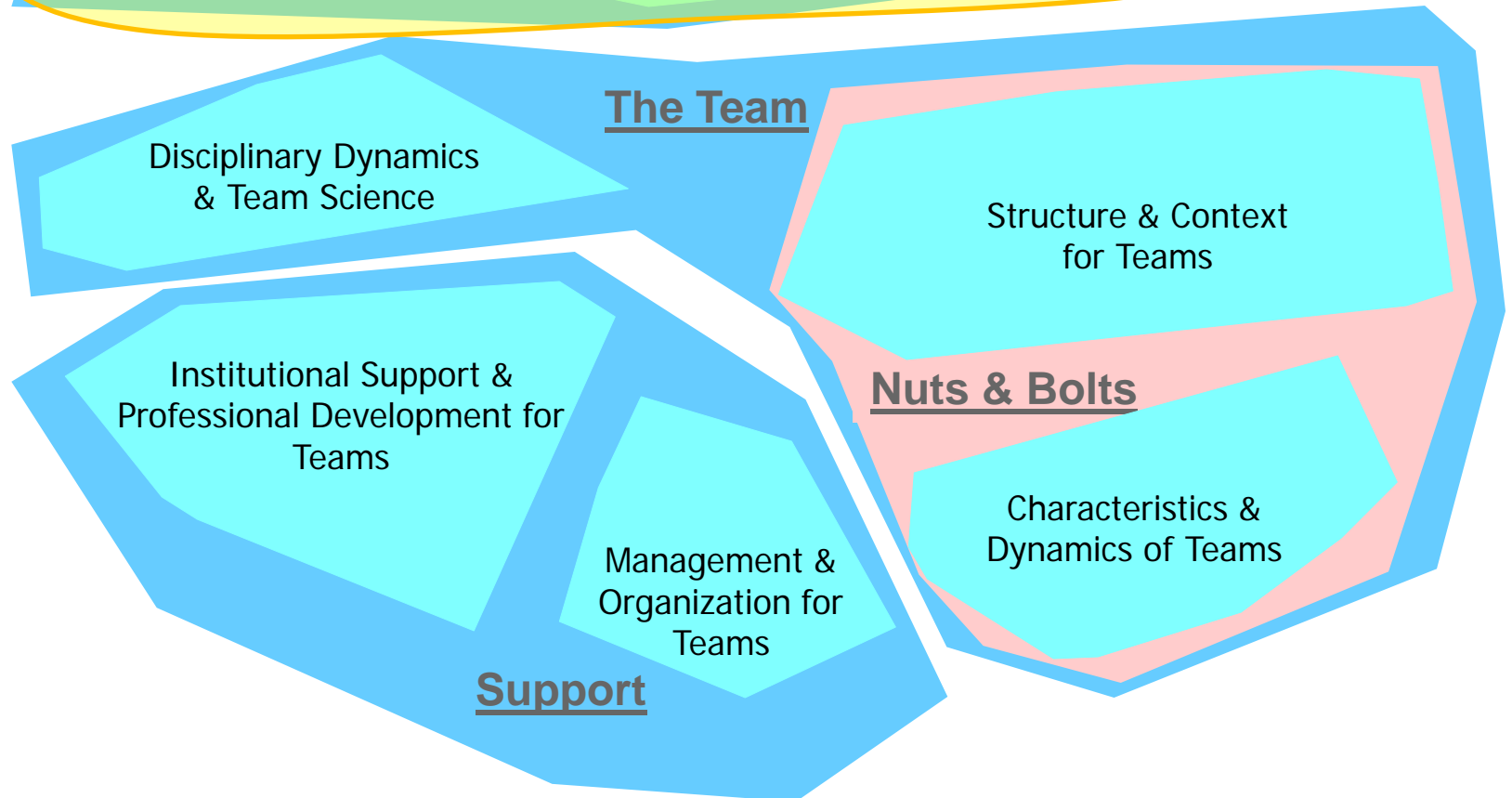
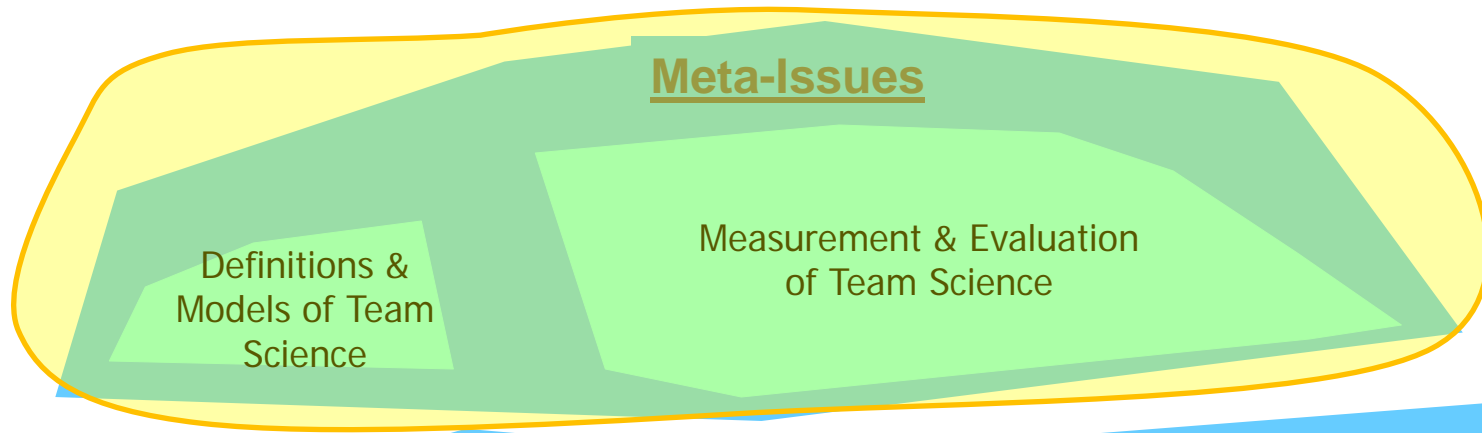
Regional Interpretation - Panel X4



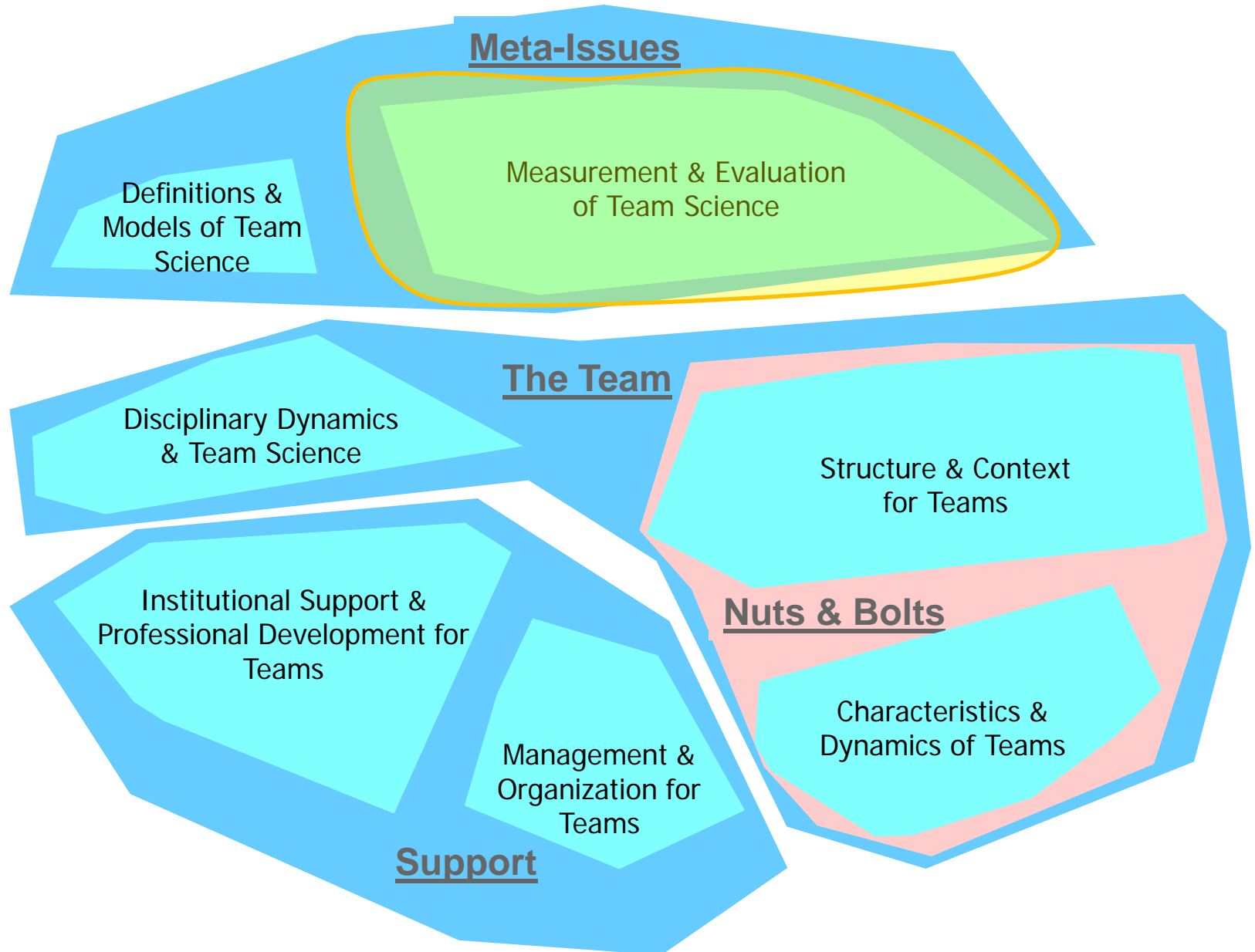
Regional Interpretation - Panel X5



Regional Interpretation - Panel X6



Regional Interpretation - Panel X7



Thanks

- The Concept Mapping Steering Committee
 - Cath Kane
 - Holly Falk-Krzesinski
 - Steve Fiore
 - Dan Stokols
 - Kara Hall
 - Bonnie Spring
 - Noshir Contractor
- For more information
 - www.conceptsystems.com
 - Bill Trochim: wmt1@cornell.edu