Macrocognition in Teams: Understanding Cognition in Complex Collaborative Environments

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Macrocognition Theory Development

Theory Development - *Overarching Objective*

- Can we develop, validate, and refine a theory of macrocognition?
  - *Use CKI Program’s extant framework of collaborative problem solving (Warner et al., 2005) as initial point of departure*

- What constructs and mechanisms contribute to collaboration?
  - *Integrate literatures that both directly and indirectly bear on complex team problem solving activities*
Macrocognition Theory Development

Describing Collaborative Problem Solving
Figure represent measurable representation of how collaboration is happening

- **Individual and Team Knowledge Building**
- **Internalized and Externalized Knowledge**
- **Team Problem Solving Outcomes**

Theory development centered on:

1. *Conceptualizing* collaborative problem solving
2. *Describing* collaborative problem solving
3. *Predicting* collaborative problem solving
Macrocognition Theory Development

- **Historical Perspectives**
  - Cognition and Collaboration:
    - Distributed Cognition in Cognitive Science
    - Situated Cognition in Education Research
    - Team Cognition in Organizational Research
    - Group Cognition in CSCW Research

- **Now Macro cognition**
  - An interdisciplinary integration of varied theories and methods
  - Overarching Epistemological Issue:
    - How does the manifestation of high level cognition in problem solving contexts influence collaboration and performance?
### Macrocognition Theory – Internal Development Activities

**Current definition of macrocognition**

| Definition | • macrocognition is the process of transforming internalized team knowledge into externalized team knowledge through individual and team knowledge building processes;  
|            | • is collaboratively mediated occurring within and across individuals during team interaction;  
|            | • is influenced by artifacts in environment and/or created by team;  
|            | • is an emergent cognitive property; develops and changes over time |

| Unit of Analysis | both the individual team member and the whole team |

| Cognitive Process Focus | focus is on individual and team knowledge building; incorporates internalized and externalized cognitive processes |

| Empirically Studied | in the lab and in operational field settings given domain rich collaborative problem solving scenarios |
Macrocognition Theory – Conceptualizing Collaboration

Conceptual Representation of Collaborative Problem Solving

- Parallel, interdependent, and iterative nature of nested processes unfolding in the context of collaboration.
- Illustrates two, four person teams interacting to build knowledge and solve problem
  - Illustrates overall iterative nature of process – nested processes unfolding over individuals and teams, and across the stages of collaboration
  - How teams build knowledge in service of problem solving
**Defining Knowledge Building**

- Consists of:
  - synthesizing relationships among problem relevant content to create broader integrated understanding
  - involves – *integrating information, visualizing numbers via graphs, aggregating or organizing data using tables*

- Occurs at:
  - the individual and/or team level

- Results in:
  - *Something new – did not exist before*
  - Actionable knowledge within the particular problem solving context

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**SUMMIT Approach – Theoretical Issue**

- Knowledge Building and the Data, Information, Knowledge Transformation

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**Macrocnocognition Theory – Conceptualizing Collaboration**

**Context**

- Forming a Whole
- Grounding of Parts
- Receiving of Parts

**Understanding**

- Data → Information → Knowledge

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Macrocognition Model – Describing Collaboration

From This - Theoretical Drivers for our Research

- Driver 1. Examine the evolution of understanding within the team
  - Examine the interplay between the perceptual and conceptual in collaborative problem solving

- Driver 2. Understanding iterative nature of internalization and externalization of knowledge
  - Assess how interpretation and interaction within teams support comprehending task elements

- Driver 3. Understanding evolution from uncertainty reduction to determination of plausibility
  - Explore processes driving information interrogation and evaluation during collaboration
Describing Collaborative Problem Solving

Figure represent measurable representation of how collaboration is happening

- **Individual knowledge building**
  - Process which includes actions taken by individuals in order to build their own knowledge.
  - Can take place inside the head (e.g., reading, mentally rotating objects) or may involve overt actions (e.g., accessing a screenshot).

- **Team knowledge building**
  - Process which includes actions taken by teammates to disseminate information and to transform that information into actionable knowledge for team members.

- **Internalized team knowledge**
  - Refers to the collective knowledge held in the individual minds of team members.
Describing Collaborative Problem Solving

Figure represents a measurable representation of how collaboration is happening.

- **Externalized Team Knowledge**
  - Refers to facts, relationships, and concepts that have been explicitly agreed upon, or not openly challenged or disagreed upon, by factions of the team.

- **Team problem solving outcomes**
  - Team’s problem solutions or plan; quality dependent upon nature of collaboration
Macrocognition Theory – Describing and Predicting Collaboration

Summary

- Integrate extant research on problem solving and shared cognition
  - Moving from descriptive understanding of collaborative problem solving to predictive understanding
  - Understand how teams work with the environment and each other to build knowledge to solve problems

- Now discussion will be on how these factors are being examined and measured
  - Development of the appropriate metrics to measure dynamic cognitive processes
Thank You

Questions or Comments?