Overview
Complexity science focuses on understanding how change occurs in complex adaptive systems (i.e., systems that are made up of many interdependent, heterogeneous parts that interact in a nonlinear fashion). The system may be conceptualized as a unit within an organization, the organization, and/or the wider inter-organizational system of which the organization is a part.
Example Application to Implementation Science
Braithwaite, J., Churruca, K., Long, J. C., Ellis, L. A., & Herkes, J. (2018). When complexity science meets implementation science: a theoretical and empirical analysis of systems change. *BMC medicine, 16*(1), 63. Colón-Emeric, C. S., Corazzini, K., McConnell, E. S., Pan, W., Toles, M., Hall, R., . . . Anderson, A. L. (2017). Effect of promoting high-quality staff interactions on fall prevention in nursing homes: a cluster-randomized trial. *JAMA internal medicine, 177*(11), 1634-1641.

Construct	**Definition**
Self-organization	A process whereby local interactions give rise to patterns of organization
Uncertainty	The unpredictability of a system's behavior and its effects
Interdependence	The relationships, connections, and interactions among the parts of a complex system
Feedback loops	A phenomenon characterized by outputs of a system continuously becoming the inputs
Minimum specifications	A few, flexible, simple rules: 1. direction pointing (accounting for past phenomena in future iterations) 2. boundaries (delimitations of the system) 3. resources (means available) 4. permissions (latitude in decision-making; Pslek and Wilson, 2001)
Sense making	A social activity through which people assign meaning to experience

Propositions

1. Interdependencies contribute to sense making.
2. Interdependencies among people with diverse perspectives contribute to more effective sense making
3. "Interdependencies that are trusting, attentive to new ideas, and mindful of differences between ideas are more likely to result in effective sense making than interdependencies that lack these qualities." (Lanham et al., 2009 as cited in Lanham et al., 2013)
4. Interdependencies and sense making contribute to self-organization.
5. Feedback loops may amplify some effects and reduce others.
6. At times, small changes will lead to large scale differences in outcomes (i.e., "the butterfly effect") and vice versa.
7. Change that is guided by minimum specifications allows individuals to self-organize most effectively.
8. The whole system is greater than the sum of its parts.

Potential Relevance to Implementation Science

Implementation involves as sequence of events that occur within the normal, ongoing dynamics of the organization.

Complexity theory suggests the following **implementation strategies as a means of leveraging those ongoing dynamics**– all from Lanham et al (2013):

1. Leverage existing and foster new interdependencies.

a. Assess patterns of interaction (interdependencies).
b. Attend to existing and developing interdependencies in scale-up and spread (SUS) settings.
c. Acknowledge interdependencies as critical to SUS success.
d. Assess the quality and strength of interdependencies.
e. Reinforce existing relationships when effective.
f. Foster new relationships where needed.
g. Foster trust among those who are interacting.
h. Encourage interdependent experiences to foster collective sense making.
i. Conduct cyclical small studies to foster local patterns of self-organization.
j. Fortify existing interdependencies with increased communication and novel communication channels.

2. Acknowledge lack of predictability.
    a. Allow design to be tailored to local contexts.
    b. Emphasize discovery in each intervention setting.
    c. Design for multiple plausible futures.
    d. Encourage SUS stakeholders to conceptualize surprises as opportunities.
    e. Encourage SUS participants to collectively learn and adapt during implementation (Lanham et al, 2013).

3. Recognize self-organization.
    a. Develop "good enough" SUS designs with the expectation that the design will be modified as initial plans are implemented and experience is gained.
    b. Solicit input into intervention design.
    c. Encourage sensemaking.
    d. Engage individuals with diverse perspectives.
    e. Encourage focused experimentation.
    f. Encourage participants to ask questions, admit ignorance and cope with paradox.
    g. Seek out diverse points of view.
    h. Offer opportunities for reflection and conversation. (Lanham et al, 2013).

Criticisms and/or Bounds on the Theory

Cochran-Smith, M., Ell, F., Ludlow, L., Grudnoff, L., & Aitken, G. (2014). The challenge and promise of complexity theory for teacher education research. *Teachers College Record, 116*(5), 1-38.

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Type: Theory (grand, mid-range), perspective, model, etc.
• Grand theory

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