Assessing Complexity Leadership Theory (CLT) as a Change Model for Inculcating a Shared Vision and Fostering Transformation in an Engineering Department

Dr. Jennifer Harper Ogle, Clemson University

Dr. Jennifer Ogle is currently an Associate Professor in the Glenn Department of Civil Engineering at Clemson University. She specializes in transportation infrastructure design, safety, and management, and has been the faculty advisor for the Clemson Engineers for Developing Countries (CEDC) program since 2011. During this time, the CEDC program has tripled in growth and has been recognized by the Institute for International Education (IIE) with the Andrew Heiskell Award as a model program, and was also recognized by the State of South Carolina for the Service Learning Award in 2011. Dr. Ogle was also recognized in 2012 by President Obama as a Champion of Change for Women in STEM, and participates in a number of diversity-enhancement programs at the university including serving as the Deputy Chair of the Women's Commission and as a member of the ADA Task Force.

Russ Marion, Clemson University

Russ Marion, Emeritus Professor of Educational Leadership at Clemson University, has written research and theoretical articles on complexity leadership, one of which was honored as best paper of the year by The Leadership Quarterly and the Center for Creative Leadership in 2001 and another which was recognized as Best Paper of the Last Ten Years in 2017 (this paper has been cited over 1800 times according to Google Scholar). He served as a guest co-editor of a special issue of The Leadership Quarterly on leadership and complexity in 2007. Marion is author of the books, The Edge of Organization (1999), Leadership in Education (2002 and 2015), and Complexity Leadership (2007). h has conducted consultation evaluations in aeronautics, banking, research firms, hospitals, p-12 schools and in universities. He co-organized workshops on complexity leadership at the Center for Creative Leadership and at George Washington University. Marion has lectured on complexity leadership at the India Institute of Technology at Kanpur, the Institute for Management Development in Switzerland, and in workshops on destructing complex movements for a US Department of Defense contractor. Marion has guest taught for Kenya's Maasai Mara University, and at JUFE University and Nanchang Normal University in China. He is currently co-PI on NSF-NRT and NSF-RED grants in Engineering and is using Complexity Leadership Theory to provide guidance for, and to evaluate those programs.

Complexity Leadership Theory Driving Positive Change

Introduction

The formative evaluation of NSF-funded research in the Glenn Department of Civil Engineering at Clemson University is premised on complexity leadership theory (CLT). CLT proposes that social systems are inherently complex and that those in knowledge producing environments (such as higher education) are particularly complex. Complex systems exhibit non-equilibrium dynamics in which interacting, interdependent agents influence one another and consequently are perpetually changing. Intense interaction and consequent information flow define complex systems and their outcomes more than the individual characteristics and skills of individuals (as is traditionally assumed).

Complex systems of interacting, interdependent agents are most effectively led by formal leaders who can foster conditions that enable useful complex behaviors—useful referring to behaviors that promote change, creativity, adaptability, learning, information flow, and productivity in a system. They accomplish this by: organizing for interaction and interdependency (see physical structures at IDEO or Apple, for example); heterogeneity (as sources of interacting ideas); task related conflicts (conflict of ideas rather than personality); decentralized systems; psychologically safe environments; adaptive pressure (pressure to change or elaborate, for example); conflicting constraints (achievement of agent A's goals hampers the goals of agent B, thus creating pressure); cliques (a tightly connected group of three or more agents, in the meantime the group is also connected with other parts of the network, as opposed to siloes); constraints (that limit easy solution of problems); and a culture of change expectation.

The change dynamic itself is enhanced by informal leaders, or agents who engage in promoting, processing, sharing, enabling, elaborating, and incorporating information. Ample research evidence indicates that agents who act as informal leaders are more productive, creative, adaptive, and prone to change than those who don't.

The research vision of this formative evaluation is two-fold: To support the development of the NSF-funded research program to meet its summative goals, and to disseminate knowledge gained to a wider audience. The support vision is achieved by monitoring network dynamics and the activities of informal leaders and by providing guidance on how to achieve increased levels of engagement in information flow. These recommendations are guided by CLT principles.

Methods

Network Analysis of Faculty

Data was collected from 21 faculty members in the subject department using an interaction questionnaire (i.e., Who socializes with whom? Who has skills that you need? Who needs your skills? Who do you collaborate with?). Six types of faculty networks were analyzed: social, collaboration on grants, collaboration on publications, interdependency, access to knowledge, and access to resources. Results were converted to matrices and entered into

ORA, a network analysis program, which produced results on overall patterns of interaction, the network engagement of each participant (called agents), distribution of cliques, opinion leaders and the people they most influence, isolates (non-integrated individuals), and high/low engagement individuals.

Attitudinal Analysis of Faculty

In addition to interactions, the questionnaire also sought to gain information on the positivity or negativity of the respondent toward the NSF-funded research program. Analysis of the effects of faculty informal leadership on attitudes about the program was analyzed with principal components analysis, stepwise regression and multiple regression analysis. The dependent variable was faculty members' attitudes about the initiative (i.e., whether they are supportive of the initiative). There were five measures of positivity about the program, and principal components analysis indicated that these measures grouped into a single factor.

Results

The network analysis identified a rather large cadre of faculty who engage significantly in the information flow dynamics of the department in several ways (thus exhibiting high degrees of informal leadership). Some, for example, had high authority centrality because they interacted with "people in the know," others were at the nexus of information flow paths, and still others had high total centrality measures. While there were minimal numbers of isolates and low engagement individuals, there were no isolates or weakly engaged agents in the social network. This is positive as social relationships can constitute a foundation from which people learn about one another's skills and from which collaborations can emerge.

The regression analysis found positive attitudes toward the NSF-funded program are most influenced by faculty members who publish together, particularly with those who publish with colleagues with different skills than they, who have dense sets of direct knowledge, and who have dense sets of interdependencies. The following recommendations were generated to further develop such relationships:

- Focus on expanding publication collaborations among faculty.
- Reward heterogeneous publishing collaborations in end-of-year reviews and peer review.
- Establish a culture of expectation for departmental collaborations and cross-subject publications.
- Interestingly, the social network (Figure 1) was not important in analysis of positivity, but it is suspected that the social network is important for satisfaction, motivation, and building relationships that can turn into collaborations.

While there were few isolates and low engagement individuals, some specific strategies were suggested to help enhance engagement in the program, including:

- Create a culture of expectation of collaborative work, as noted above—perhaps with a vision statement, with end-of-year evaluation expectations, or by underscoring the importance of collaboration, particularly inter-disciplinary collaborations, to faculty.

- Create psychologically safe environments in which faculty can experiment with collaboration.
- Encourage faculty to actively seek ideas from outside sources that they can introduce to teams to which they may be assigned.
- Help faculty learn more about each other's skills, interests, etc.; that is, help them reduce the distance between themselves and access to information across the network.

A few faculty members were identified who expressed negative attitudes about the NSF-funded program and who have the ability to influence others. Strategies for addressing this have been generalized from the section on positivity; in addition, the following strategies were suggested:

- First and foremost, appreciate the fact that negative attitudes about the program are, themselves, a source of heterogeneous information and should be respected as such.
- By various means, provide greater transparency on what is happening and what is proposed in the NSF research program.
- Ensure that everyone is invited to comment on initiatives BEFORE decisions are made.

Finally, the program coordinators were encouraged to build network relationships for all faculty. The program coordinators need to continue to advance faculty engagement in teamwork, enhance heterogeneity of ideas, increase adaptive pressures (pressure to advance learning, creativity, productivity, etc.). Some specific tactics include:

- Establish a faculty on-boarding process that includes training on cross-disciplinary research.
- Organize a monthly virtual gathering around topics of interest for all faculty and students.
- Foster heterogeneous teams involving people with different skills, worldviews, dispositions, ethnicities, and information.
- Build group productivity that evolves from pressure to solve problems.
- Structure departmental meetings around problem solving.
- Create problem-solving networks in which the solution of issues for one person inhibits solution of issues for another.
- Generate pressure using task-related conflict. Pressure derives from complexity leaders but it also derives from the nature of interactions. People struggling over diverse preferences about how to solve problems, whose ideas conflict, or who pursue different visions of the project outcomes, will tend to elaborate their arguments/ideas and may stumble across new, unexpected ways to solve their common problem.

Figure 1. Social network with nodes color-coded for cliques. Four cliques emerge, shown as dark blue nodes, red nodes, teal nodes, and green nodes. The lines connecting each agent represent social connections. For instance, agent 3 has social connections with agents 14, 9, and 20, but not with 25 or 15.