Accelerating Cyberinfrastructure Adoption
Understanding the Strategies Behind Expediting Diffusion

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Introduction

The National Science Foundation (NSF) has been championing the development of cyberinfrastructure (CI) for more than a decade. CI, made up of interdependent technologies, remote instruments, big datasets, dispersed experts, and diverse institutions (Kee, 2015), provides a platform for researchers to keep up with computing demands of modern sciences, engineering, and big data. In spite of the NSF's promotion of e-science, contemporary approaches towards CI have not been prevalently utilized across all disciplines. Through the lens of the Diffusion of Innovations Theory (Rogers, 2003), this study examines how to promote and accelerate CI adoption and diffusion through capacity building strategies.

Literature Review

Everett Rogers' Diffusion of Innovations Theory (2003) revolutionized the methods behind understanding innovation adoption. The theory is the most cited communication theory to date (Kee, 2016; Rice, 2009). It describes a complex model of innovation attributes, adopter categories, diffusion networks, and opinion leadership, which enable the adoption and diffusion of innovations. This study specifically focuses on the capacity building strategies of opinion leadership, readiness and institutional support as they relate to accelerating the adoption and diffusion of cyberinfrastructure (CI).

Individuals who are perceived as credible, likeable, and trustworthy play key roles in promoting behavioral change (Rogers, 2003). Opinion leaders who embody these characteristics have the power to remove barriers to change and increase the rate of diffusion of innovations among peers (Valente & Davis, 2007). Current research on opinion leadership tends to suggest interventions at the stage of initial recruitment. With that in mind, it is clear that opinion leaders are key figures in informally expediting adoption and diffusion within organizations.

Opinion leaders cannot be solely relied upon, though, as organizations must also have attitudes that promote a readiness to change. Readiness is a positive state of mind about the need for an innovation and the capacity to undertake technology transfer (Backer, 1995). It is the first part of the natural cycle of change (Lewin, 1947). To enhance individual readiness means to decrease attitude barriers, which then allows for expedited innovation diffusion. It is done through persuasive communication, active participation and management of external sources of information (Backer, 1995).

Even with strong opinion leaders and individual readiness, organizations should additionally provide the resources and support to allow for new innovation. Organizations do so to add credibility, reduce risks, reinforce sustainability and ensure high quality efficiency when diffusing new innovation (Senegal, n.d.). Institutional support can be given in several forms: training, technical assistance, management consultancy and financial assistance (Senegal, n.d.).

Past research has emphasized the components of opinion leadership, readiness and institutional support. Certainly, the results achieved by these individual methods have been successful. Yet, there is little research that has placed a balanced emphasis on all aspects (Senegal, n.d.). In order to extend this body of literature, this study focuses specifically on amalgamating and expanding on these approaches to expedite the adoption of CI. Therefore, we ask the research question, *"What capacity building strategies can be developed and implemented to promote and accelerate cyberinfrastructure adoption and diffusion?"*

Methodology

This study employed the Grounded Theory Approach (Corbin & Strauss, 1990) and analyzed 30 interviews conducted with members in the e-science community, such as directors, domain scientists, and principal investigators. Participants were from a diverse range of institutions and states across the United States. Following a semi-structured protocol, interviews were conducted by telephone. Guided by the stated research question, the co-authors performed multiple iterations of data analysis and literature integration, yielding preliminary findings presented in this poster.

Findings

Teach-to-Fish

The Teach-to-Fish strategy highlights how opinion leaders facilitate and train others to adopt an innovation. Opinion leaders may also operate as facilitators, as facilitators may also be opinion leaders (Kitson et al., 1998). These advocates have experience with the use of the innovations and can help spread influence about the innovations as well (ACI-REF, 2016).

- "The ones that tend to do best are the ones that also invest in human resources to a company in CI. So, if you have a great cluster but you have nobody in person that can help when people get stuck...it's going to be much harder. You may not have a great resource but at least you have someone to get them through the hoop" (Facilitator, South Carolina, 4/06/16, 15:45).
- "Outreach is the recruitment end – that means we go out to conferences and we do campus visits that give them the initial first presentation and discussion about what XSEDE offers and national resources. Maybe we can tell them about local resources or regional sources, but that's the initial 'here is CI and this is what it can do for you' kind of talk. That is the recruitment where you get their attention, and they say, 'Maybe that applies to my research.' Also, you have to be persistent to create their persistence" (Administrator/Enabler, Washington D.C., 4/13/16, 25:30).

Readiness to Change

"Individual and organizational readiness for change is defined as involving people's beliefs, attitudes, and intentions regarding the extent to which changes are needed and their perception of individual and organizational capacity to successfully make those changes. Readiness is a state of mind about the need for an innovation and the capacity to undertake technology transfer" (Armenakis et al., 1993).

- "...there's just so much of the world that can benefit from advanced computing and that requires [a high] level of analysis. It's ever increasing and we need more folks who are literate in [CI], not only to address the tasks of today, but to train the workforce of tomorrow, both in scientific terms, in [readiness], and just in general. Increasing our literacy of these issues can really have a transformative affect across society" (Innovator, Texas, 5/13/16, 41:34).
- "We've [increased readiness] through having a global agreement on data principles. We're converging on open science, and what I've seen in the last three to five years is a convergence around the concept of open access, open source – what's starting to be melded into a broader concept of open science. I think we're moving towards an open science concept and a system of systems approach for cyberinfrastructure. As we get those pieces together, then you actually have something that can be [more rapidly] adopted" (Innovator, Arizona, 5/24/16, 42:54).

Institutional Support

"Institutional support for [CI] development is the availability of resources and the efficiency and effectiveness with which organizations deploy those resources to identify and pursue their [CI] development goals on a sustainable basis" (Otoo et al., 2009).

- "Institutional support is provided in several forms: training, the first priority; technical assistance; management consultancy; financial assistance, which decreases over time, to cover certain human resource, operational and capital expenditures" (Senegal, n.d.).
- "One thing that we're doing right now is to re-configure our training, so our training is more this century. It's not your cookie-cutter training that you just keep doing again and again. You need to be closer to the researchers and the faculty. You need to speak a different language. A lot of times, it needs to be customized. It needs to be scalable, too. So, sometimes you can spark a little bit of interest by inserting a model in a class. It doesn't need to be all or nothing" (Facilitator, South Carolina, 4/06/16, 43:16).

Conclusion

In answering the research question, *"What capacity building strategies can be developed and implemented to promote and accelerate cyberinfrastructure adoption and diffusion?"*, this study offers three capacity building approaches that organizations can implement to expedite adoption and diffusion of new innovations. They are opinion leadership, readiness, and institutional support. Collectively, these three approaches are interrelated and can be employed to accelerate diffusion within any given community. These various channels offer a variety of easy-to-employ strategies. First, an organization must have the basic framework built to support cyberinfrastructure adoption, primarily centered on having appropriate funding, training and technical assistance. Once this framework is in place, organizations should recruit opinion leaders and train them in the new innovations so that they can effectively diffuse the innovations to their peers. Once the peers have been persuaded, active participation will rise and organization members will be ready for change. If these strategies are implemented successfully and adjusted based on the organizational response, cyberinfrastructure adoption will accelerate dramatically in the research community.

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