

Leadership, Motivation, and Teamwork Behaviors of Principal Investigator's in Interdisciplinary Teams: A Synthesis of Research

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Abstract

Increased demand, limited resources, knowledge gaps, and seemingly less time to produce results are the challenges facing researchers and others in higher education today. Working together across disciplines is almost a requirement to stay afloat in the competitive arena most principal investigators are finding

themselves in. This study sought to synthesize existing research on leadership behaviors of these investigators in the agricultural discipline. The sections specifically addressed include team science, discipline structure, boundary work, challenges of interdisciplinary research, the direction of research, and leadership in interdisciplinary teams. After analyzing 32 articles, researchers determined that research should continue to investigate the role of leadership behaviors in primary investigators to continue to improve effectiveness.

Introduction

Higher education is facing unique challenges today – increasing demand, limited resources, knowledge gaps, and the same amount of time to produce results (Bruce & Ricketts, 2008; Miller, Baird, Littlefield, Kofinas, Chapin, & Redman, 2008). Budget cuts have forced researchers to adapt their work to be more efficient in the division of resources and knowledge (Minarovic, 2000). Sources of funding are also requiring more comprehensive research, forcing disciplines such as those in agricultural sciences to work together to receive funding (Minarovic, 2000). Stedman (2011) stated that historically many teams granted funds for research reflect a unidisciplinary scope, providing only one perspective of the problem and its solution. Many researchers attest that many challenges associated with solving complex research problems are due to strict differences in approaches to research which restrict holistic perspectives (Miller et al., 2008; Minarovic, 2000). In response to these many challenges research is being conducted by interdisciplinary, multidisciplinary, and transdisciplinary groups.

Multidisciplinary researchers focus on a single problem from the perspective of their own discipline and later, research findings from each discipline are compiled (Miller et al., 2008). Interdisciplinary research involves a greater integration of disciplines, from identifying the problem to analysis and interpretation (Miller et al., 2008; Eigenbrode et al., 2007). Transdisciplinary research groups formulate unique problems that can only be viewed through a newly adopted epistemological perspective exclusive to the research problem (Eigenbrode et al., 2007). In addition, the structure of universities and departments are so deeply set that the process of cross-disciplinary research is challenged further (Fiore, 2008).

Although cross-disciplinary research seems to be the panacea approach to research, many complicated barriers arise when multiple disciplines join forces. Stedman (2011) stated that philosophically challenges leading teams which incorporate researchers from different disciplines exist, including within the social and bench sciences. In other words such issues arise when involving multiple social science disciplines. Every discipline comes forth with different epistemologies or foundations of knowledge for solving problems (Miller et al., 2008). Rhoades (1984) was one of the first researchers to emphasize the need for

social scientists in the agricultural sciences in his published book, *Breaking New Ground: Agricultural Anthropology*. Rhoades enabled the agricultural field to recognize the importance of interdisciplinary teams in order to contribute valuable research to solve complex problems. Furthermore, in order for cross-disciplinary research efforts to be worthwhile, researchers must recognize barriers and be proactive in finding solutions. Principal investigators (PIs), as leaders of cross-disciplinary research, play a pivotal role in the way multiple disciplines collaborate to solve complex research questions. One vantage point for assessing the research associated with the quality of interactions between transdisciplinary teams is through the teams' perception of leadership and teamwork (Stedman, 2011). As teambuilding efforts in cross-disciplinary research become more important, so does the need to access the leadership behaviors of principal investigators. The qualities and perceptions that research PIs have regarding leadership, teamwork, and motivation may give insight into how research teams function (Stedman, 2011).

The problem this study sought to describe is the need for more synthesis of existing literature. "A methodological review of past literature is a crucial endeavor for any academic research" (Webster & Watson, 2002, pp. 48-49). As the need for interdisciplinary research teams in food and agricultural systems has risen to solve complex problems, a holistic understanding of leadership behaviors that principal investigators bring to interdisciplinary teams warrants an investigation. Without an understanding of leadership behaviors of principal investigators, effective leadership approaches to interdisciplinary research cannot be determined.

Purpose and Objectives

The purpose of this study was to synthesize existing research in the agricultural discipline concerning leadership behaviors of principal investigators in interdisciplinary research teams. For this study research is defined as an endeavor scholars intentionally set out on to enhance the understanding of a phenomenon and as a result they expect to communicate what they discover to the at large scientific community (Leedy & Ormrod, 2005). The objectives of this research were to identify facets of interdisciplinary research that affect leadership, identify challenges facing interdisciplinary research, and examine existing findings pertaining to leadership in interdisciplinary research teams.

Methodology

A synthesis of research approach was used for this study. There were 32 articles used to gather data to meet the objectives of this study. The articles for this study were collected from the following journals – *Journal of Leadership Education*, *Journal of Extension*, *Small Group Research*, *Journal of Higher Education*, *BioScience*, *Ecology and Society*, *Agriculture Human Values*, *American Journal of Preventative Medicine*, and *the Association for International Agricultural and Extension Education Annual Meeting*. These journals were chosen based on a review of the research done in each journal and deemed relevant by researchers of the review. Studies appearing in these references were located through a library systems search using Library System, Google Scholar, and done through journal databases. The search terms used to locate these references included “leadership behaviors of principal investigators,” “principal investigators and leadership behaviors,” “leadership style of principal investigators in interdisciplinary research teams,” “leadership behavior in interdisciplinary research teams”. “PI Behaviors,” “teamwork,” “leadership style of lead researchers,” “principal investigator behaviors,” “problems with interdisciplinary teams,” “interdisciplinary research outcomes,” “collaboration in interdisciplinary work/research,” “PI’s as leaders,” and multiple variations of the statements provided. The sources used were published from 1984 to 2010.

Synthesis

To meet the objectives of this research, the following has been presented to synthesize existing literature surrounding the ultimate goal of understanding the role and implications of the leadership of PIs in interdisciplinary research.

Team Science

According to Bruce and Ricketts (2008), teamwork is extremely important among cross-disciplinary groups in order to produce effective and efficient work. Collaboration has been the focus of much research (Bruce & Ricketts, 2008; Grage, Place, & Ricketts, 2004) relating to the effectiveness of multiple disciplines coming together to produce mutually beneficial results. Collaboration is defined as the act or work with others for mutual benefit (Bruce & Ricketts, 2008). According to Whent (1994), in a study of agriculture teachers, when information sharing, team building, and assigned tasks were characteristic of groups then the amount of cooperation and resource sharing significantly increased. Fiore (2008) argues that interdisciplinary research is team research and this science of teams is a catalyst for change. Coordinating scientific teams is a process that does not naturally occur, but is learned. Fiore makes clear that researchers are often burdened by interdisciplinary research, because researchers

feel they must have a great understanding of each discipline. However, Fiore makes the argument that when teams outside of scientific research come together, they do so by bringing unique skills to the problem they are solving and in this way solve problems by connecting overlapping knowledge. Therefore, Fiore suggested that interdisciplinary research should be viewed through a teamwork lens, not as a product that emerges. The opportunities of team science in an interdisciplinary context help frame the concept of social intelligence, which is necessary in interdisciplinary teams. According to Fiore, this viewpoint could potentially make interdisciplinary research more amenable.

Discipline Structures

According to MacMynowski (2007), an important discussion on cross-disciplinary research involves the structure of each discipline coming together. Some disciplines are closed structures, intellectually self-sustaining and difficult to penetrate. Other disciplines are open structures, flexible, and nebulous. Researchers have explored how ideas flow between different social and intellectual structures, concluding that social science literature is more analytically informative and provides theoretical frameworks for discussion (Star & Griesemer, 1989). Star and Griesemer note that environmental researchers have been known to inform social scientists on interdisciplinary research through their experiences. Biophysical research has actually provided an ecological analytical framework for approaching one of many social issues. However, social researchers focus primarily on structural and process-oriented issues and how they develop (MacMynowski, 2007). Nevertheless, researchers have elementally different goals that create barriers when they try to work together. Social scientists approach problems with the means of interdisciplinary research in mind but without an end goal in sight. Biophysical scientists approach problems with an end in mind and do not necessarily consider the means it takes to get to the end. Therefore, MacMynowski has acknowledged that when multiple disciplines come together many struggles develop, such as that between power and knowledge.

In response, MacMynowski (2007) has identified four scenarios that researchers can experience and that lead to different types of research being conducted. The four scenarios, including conflict, tolerant ambivalence, cooperation and identification, and transformation. Interdisciplinary research should begin with mutual intentions and then researchers take separate paths, but conflict prevents mutual collaboration from beginning. Tolerant ambivalence is where researchers from different disciplines work on the same project, but analytical approaches remain separated. Cooperation and identification between researchers can occur when theories and analytical tools can be transformed into consistent models, concepts of theories and applications through collaborative communication. Finally, transformation occurs when a common problem has been recognized that

requires a unique approach from a conceptual, philosophical, and methodological perspective. Each scenario is multiscalar and transscalar and can emerge at many levels, such as between individual researchers, between multiple groups on research, and even between strictly disciplinary groups. According to MacMynowski, most interdisciplinary research, especially between social and biophysical science has been between tolerant ambivalence and cooperation and identification, although these scenarios apply to any combination of disciplines that have joined together.

Boundary Work

Boundary work is another concept inherent to interdisciplinary research (Hinrichs, 2008). According to Fisher (1989), boundary work is defined as “those acts and structures that create, maintain, and break down boundaries...and is the process whereby legitimacy and cognitive authority are attached to knowledge” (p. 162). Boundary work makes investing time into intellectual and personal interactions necessary (Hinrichs, 2008). According to Hinrichs, developing shared vocabularies among different disciplines builds trust and comfort in the research process. MacMynowski (2007) points out that in order for interdisciplinary researchers to negotiate assumptions and values, they must first understand how they are disciplinarily different, which requires a deep focus on boundaries. According to Hinrichs (2008), if the height and heft of boundaries remain unknown, boundaries will not be broken down or even reduced in any way. Furthermore, working on boundaries in interdisciplinary research makes each discipline stronger. However, interdisciplinary research, according to MacMynowski (2007) is not a linear progress, rather it is an iterative process where differentiation, clarification, and synthesizing repeat throughout the research process to resolve problems and draw conclusions.

Challenges of Interdisciplinary Research

Bruce and Ricketts (2008) conducted a qualitative study evaluating non-formal educators and classroom educators for the purpose of analyzing the current environment and cooperation between the two interdisciplinary groups in the agriculture sector. The findings identified several benefits and barriers facing interdisciplinary groups. Benefits included improvements to programmatic problems, time saved, an increase in available resources, and workload reduction. Barriers included time constraints, lack of awareness along with perceived programmatic differences, and lack of relationships and networks across disciplines. Bruce and Ricketts noted that competition among groups was present; therefore to encourage cooperation, incentives should be implemented in order to bring the interdisciplinary groups on a level playing field. In addition, one participant in Bruce and Ricketts’ study reported that there should be

encouragement from group administrators and managers that benefit the way groups work together. In addition, Ricketts and Bruce's (2009) study of extension and agricultural educators showed that educators perceived cooperation between disciplines as important. However, a lack of action behaviors, in regards to these perceptions about cooperation, creates a gap. Early research by Meier (1989) recommended rewarding the leaders of interdisciplinary teams that help foster a collaborative environment, but evidence of such reward has not been seen, thus contributing to the gap.

Furthermore, Bruce and Ricketts (2008) addressed the stigma of inequitable resources by stating that education was the key to solving this problem in order for the environment of interdisciplinary teams to turn from hostility and separation to one of harmony and civility. However, what remains absent from Bruce and Ricketts discussion is the role that a principal investigator plays in making productivity and harmony characteristics of the environment among interdisciplinary groups. The role of the principal investigator should be that of the administrator or manager as previously referred to in Bruce and Ricketts' 2008 study. However, principal investigator's leadership behaviors have failed to be an important topic discussed among researchers. The reason is unknown, but the benefits of knowing the role principal investigators play could alleviate or conquer some of the current challenges that interdisciplinary groups are facing (Bruce & Ricketts, 2008). Cropper & Merkowitz (1998) recognized that interdisciplinary teamwork allows for researchers to reduce replicated information and programming. This interdisciplinary teamwork increases support for members of the team.

Younglove-Webb, Gray, Abdalla, & Purvis Thurow (1999) identified five obstacles to multidisciplinary team success. According to Younglove-Webb et al. (1999), the list of obstacles include disciplinary chauvinism, different worldviews, status differences, organizational membership, geographic location, logistical problems, and gender differences. In the 1999 Younglove-Webb et al. study, two leaders of the interdisciplinary team had different leadership styles but members of the group found it to be a good balance. In reflection, the obstacles that the teams of faculty had the most difficulty with in this study were conflict resolution and emotion management. Faculty reported that team building activities would have been helpful. However, Younglove-Webb, et al. found after two years the team reflected positively on the experience and had better communication and conflict resolving skills between each other. In addition, Younglove-Webb et al. suggested that although multidisciplinary research teams contribute solutions to complex problems, they are challenged with barriers to succeed as a team in regards to their performance. There is an emphasis on multidisciplinary research teams that, since they are naturally diverse, the team must work even harder to overcome the obstacles of team dynamics. Ricketts & Bruce (2009) suggested that

leadership needs to continually encourage research teams and are responsible for removing barriers. Lastly, a barrier for teams in the land-grant institutions involves the lack of support for such teams. In regards to support for multidisciplinary teams from institutions, Boone (1990) suggested that all faculty and staff should be participating in team development and leadership facilitation activities. According to Boone, land-grant institution systems that compartmentalize disciplines are not providing an environment that encourages interdisciplinary teams.

Research Direction

The barriers and challenges associated with conducting cross-disciplinary research have been abundantly addressed. Not only has cross-disciplinary research emerged between social and environmental sciences, but healthcare has focused on transdisciplinary approaches involving cognitive neuroscience, psychology, education, health and policy (OECD, 2002). However, what researchers have failed to focus on have been the social interactions associated with conducting cross-disciplinary research. Lidstrom (2005) identified that leadership, trust, and communication are crucial to the success of team science. Stokols et al. (2008) followed by noting that strong leaders are necessary in team science for building collaboration through team building and managing conflict. According to Fiore (2008), when researchers have different viewpoints, they can often innovatively solve problems, but such differences can also have negative outcomes if not managed appropriately. In an editorial from *Nature* (2003) the importance of team leaders (PIs) in motivating and managing work environments from a cognitive and personality perspective were noted. In addition, health science researchers Aboelela et al. (2007) found in a review of literature on interdisciplinary research that 60% of the articles mentioned communication, leadership, and trust as being pivotal to interdisciplinary research. According to Porter et al. (2006), in order for interdisciplinary teams to succeed, the entire process must be properly managed from maintaining outside support, such as funding, to managing the problem under investigation, and the team of researchers. However, research on effective principal investigator leadership behaviors in cross-disciplinary research is minimal to non-existent in the agricultural sciences.

Ricketts & Bruce (2009) suggested that the leadership needs to continually encourage research teams and are responsible for removing barriers. Leading by example, as in showing a good interdisciplinary relationship, can influence others greatly. These relationships, in most cases, have benefits for all involved. A benefit that was discussed early in the literature was the funding and/or economic benefit for researchers to work together. Meier (1989) suggested many trends that the agricultural system was going towards. Historically, agriculture has been an

important issue, but Meier predicted that by the 1990s a decline in the interest of agriculture-based issues would occur. This factual prediction has made it significantly important for land-grant universities to integrate an attitude of “togetherness” to collectively gain support and funding for resolving issues. Boone (1990) suggested that land-grant institutions should assess the quality and reward the performance of their faculty’s performance with interdisciplinary teams. Boone recognized that faculty and staff will have discomfort about changing approaches, however as researchers the only way to improve is to practice these behaviors every day. Finally, Boone advises that individuals will not appreciate teamwork and crossing the interdisciplinary boundaries if they do not experience it and watch it themselves.

Leadership in Interdisciplinary Teams

More recently, scholars have been striving to understand how training can be implemented to improve the team aspects of cross-disciplinary research. According to Fiore (2008), many different types of training have been considered in order to improve the success of cross-disciplinary teams, such as team building, team dimensional training, cross training, and crew resource management. However, according to Fiore, several theoretical approaches to leadership have been identified and applied in a range of industries, such as politics and military. However, as Fiore notes, there lies a great opportunity for leadership to be assessed within cross-disciplinary research. In the agricultural context, Ricketts and Bruce (2009) and Meier (1989) argue that leaders of interdisciplinary teams are vital to the environment, collaboration, and communication of a team of researchers. Gray (2008) described leadership in cross-disciplinary research as a mental model, or mindset, that leaders impose and followers adhere. According to Huxham and Vangen (2000), leadership in multi-disciplinary teams provides “the mechanisms that lead a collaboration’s policy and activity agenda in one direction rather than another” (p. 1165).

Key themes in regards to what traits and actions team leader should possess and enact were prevalent in previous research. Stokols et al. (2008) recommended that supportive and empowering leaders employ considerable support for team members in an academic setting. Young (2000) noted that leaders need to be modest, benevolent, visionary, and strong. Young also identified a list of leadership tasks categorized as cognitive, structural, and processual when conducting research on leadership roles in transdisciplinary research. Cognitive tasks refer to leadership involving the management of meaning. Leaders provide meaning by providing a map of goals and pathways for achievement, and simultaneously encouraging creativity from members and instilling motivation. Structural tasks of the leader involve managing the need for coordination and information exchange directly inside and outside the team. Furthermore,

processual tasks involve the management. As outlined by Gray (2008) these tasks include designing meetings, determining ground rules, helping teams move toward objectives, building trust, making certain communication is effective, attaining buy-in, and managing conflict.

Key themes have also been identified in regards to the environment of interdisciplinary research – tendencies toward conflict, collaborative readiness, and preparation and practice (Stokols, Misra et al., 2008). These three themes have overlapped with previous studies and research previously mentioned, such as Boone's (1990) recommendation that practice is the sure way to become more effective in participating in multidisciplinary teams. Stokols et al. (2008) have extensively constructed the contextual factors that apply for leadership application for effectiveness in interdisciplinary teams. As the need for interdisciplinary teams increase, principal investigators must take a pensive view of themselves, investigating their behaviors and how these behaviors affect the success of interdisciplinary teams.

Analysis

According to Hinrichs (2008), principal investigators must realize that interdisciplinary research goes well beyond a task and budget focus that usual disciplinary research follows. Interdisciplinary research requires the principal investigator to build a new research culture that is committed to focusing on boundary work, while also multiplying reproductive capacities. A principal investigator must be dedicated to creating an innovative plan before bringing multiple disciplines together. As noted by Hinrichs, such plans must be focused on dedicating special resources to build a team-friendly environment. In addition, a focus must be placed on getting researchers to learn about shared research practices, such as accepting non-traditional research practices or outcomes. According to Hinrichs, structural context shapes how groups will design, sequence, evaluate and communicate research. Hinrichs suggests sufficient planning in this respect could help produce more efficient and effective interdisciplinary research. Research in the agricultural and environmental fields that has focused on the topic of interdisciplinary teams has been conducted by extension, international agricultural and environmental fields. Navarro (2007) stated that to provide adequate programs to build successful relationships with other researchers in an international and agricultural context, an interdisciplinary team is necessary. It should be recognized that researchers in international partnerships, especially in the agricultural, conservation and environmental fields, have almost exclusively worked in multidisciplinary teams. Guion (2010) provided guidelines to follow when working in an interdisciplinary team, for example recognize every team member's contributions, maximize every team member's expertise, and use a team approach, to name a few. However, Guion

never described who would be leading the team or how as well as whom makes sure the team is following the said guidelines? According to Stokols et al. (2008), skills and styles of team leaders immensely influence the quality of social interactions in cross-disciplinary research. Therefore, research should investigate the role of principal investigators in interdisciplinary research in an effort to improve effectiveness. Empirical data collection should be the next step in determining what types of leader behaviors are effective in interdisciplinary research teams.

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