Main Paper Introduction

*Harnessing Scientific Discovery for Societal Progress: A Multifaceted Approach to Wicked Problems*

Can scientific discovery pave the way for solving society's most complex challenges? In an era where complexities intertwine with every aspect of societal progress, understanding and addressing wicked problems becomes a necessity. A "wicked problem," as described by Rittel and Webber (1973), refers to complex social challenges characterized by their intricacy and resistance to straightforward solutions. These problems, such as those outlined in the United Nations’ Sustainable Development Goals (SDGs), are marked by their interconnectedness, and the repercussions ripple through various social systems. Social processes within these challenges are likened to networks, where each action creates a web of effects, underscoring the importance of considering the broad, interconnected systems (Rittel and Webber 1973). These problems necessitate a comprehensive approach that blends scientific inquiry with innovative policymaking.

This thesis explores how research collaboration can be aided to enable novel insights into these multifaceted issues. Collaborative research teams, especially those that span different disciplines at academic institutions and include community stakeholders, are recognized to produce the highest impact work and most groundbreaking innovations (e.g., Sonnenwald 2007; Disis and Slattery 2010; Hart 2000; Enns et al. 2023; Lieberknecht et al. 2023). Boise State University (Boise State), recognizing the urgency and complexity of local, regional, and national societal issues, is invested in the ambitious Grand Challenges (GCs) initiative. This initiative's multivariate approach, settled as the cornerstone of Boise State's strategic plan, is designed to foster a transdisciplinary culture of research and creative activity. The University's Center of Research and Creative Activity (CRCA) is pivotal in this endeavor, leading the charge by investing in an Interdisciplinary Research Accelerator (IRA) model (LaRosa 2023b).

Acknowledging the increasing emphasis in management and organizational studies on researching teams addressing grand societal challenges (Bednarek et al. 2023, citing George et al., 2016; Harley & Fleming, 2021, p.133), the CRCA has identified the need for comprehensive research evaluating the impact of their researcher support plan. This observation led to the formation of the Social Network Analysis Project (SNAP), asking, “How do the GCs investments change collaborations across campus?”

My thesis, set against this backdrop, aims to describe the structural and relational dynamics among Boise State faculty and staff, focusing on understanding the state of the collaborative environment before and during the GCs investments. By analyzing these dynamics, this research seeks to understand and elucidate how these investments have altered collaborative patterns across campus. This exploration will not only contribute to understanding the immediate effects of the GCs investments but also serve as a foundation for future studies to track ongoing collaboration changes. Additionally, this study aims to highlight areas requiring targeted interventions, thereby enhancing the efficacy of Boise State’s GCs' initiative addressing Idaho’s wicked problems, contributing to the global pursuit of SDGs.

**Thesis Statement**: This thesis posits that through a detailed analysis of the structural and relational dynamics within Boise State University's Grand Challenges initiative, significant insights can be gained into enhancing interdisciplinary collaboration. These insights are crucial for addressing complex societal challenges and contribute to advancing the field of social network analysis in academic settings, thereby informing strategies to optimize collaborative efforts for societal progress.

Background

*Advancing Idaho’s Societal Progress: Boise State University's Approach to Grand Challenges*

The inception of Boise State’s GCs initiative can be traced back to 2015 when Jana LaRosa, the Assistant Vice President for Research Advancement and Strategy (AVPR) in the Division of Research and Economic Development (DRED), inspired by institutions like the University of Texas Austin (UT Austin), began contemplating Boise State’s own GCs (J. LaRosa, personal communication, September 25, 2023). UT Austin’s Planet Texas 2050 (PT2050), as analyzed by Lieberknecht et al. (2023), exemplifies an innovative, collaborative, interdisciplinary ethos. This interdisciplinary ethos supports researchers in crafting their own thematic roadmaps and provides a useful comparative framework for understanding team dynamics within Boise State’s GCs.

In 2019, Boise State’s Interim Vice President of Research (VPR) Harold Blackman, Interim Provost Tony Roark, and President Marleen Tromp put out a call to campus asking faculty to send in 2–3-page proposals on what could be theme areas for the GCs (J. LaRosa, personal communication, September 25, 2023). They looked at the approximately 150 submissions and then put together five different thematic areas (J. LaRosa, personal communication, September 25, 2023) with two primary challenges: "Resource Nexus for Sustainability" and "Healthy Idaho" (The Center for Research and Creative Activity 2024). This process demonstrates the faculty’s active role in shaping the GCs, reflecting the relational dynamic and collaborative spirit central to my thesis.

*"Resource Nexus for Sustainability" and "Healthy Idaho": Addressing Global Challenges Regionally*

The "Resource Nexus for Sustainability" GC embodies SDG goals like access to clean water and sanitation, promoting affordable and clean energy, and fostering sustainable urban and community development (United Nations Department of Economic and Social Affairs 2024). This initiative integrates various scholarly disciplines and stakeholders, aiming to build resilient urban and rural systems through a collaborative nexus of scholars and practitioners. Similarly, "Healthy Idaho" GCs are rooted under a public health umbrella, which focuses on the interconnectedness of human, animal, and environmental health (J. LaRosa, personal communication, September 25, 2023).

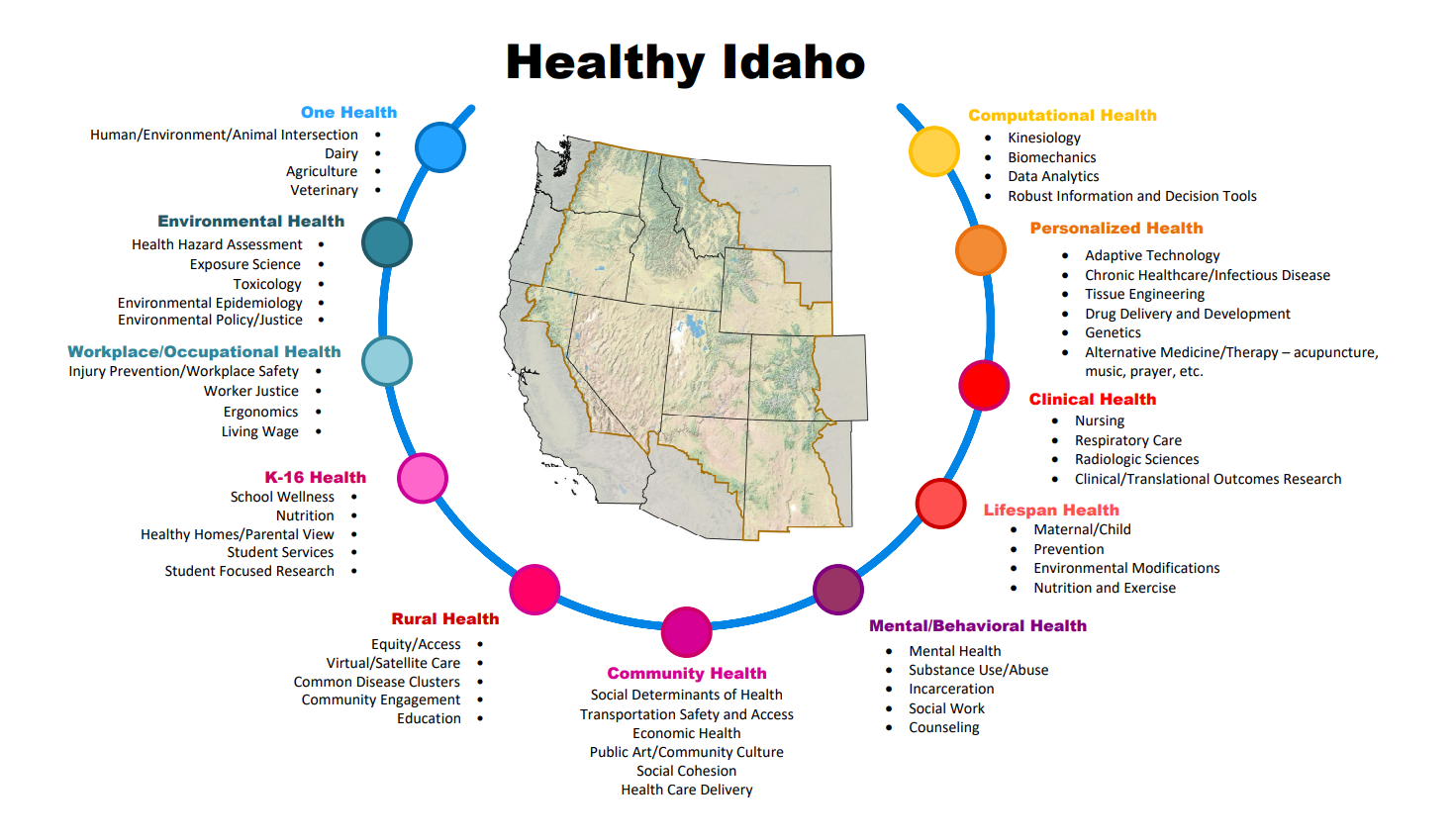


Figure 1. The "Healthy Idaho" GC, as depicted in the document provided by CRCA, outlines key areas for collaborative efforts to improve health outcomes across the state. These areas include Public Health, emphasizing the human-environment-animal intersection; Environmental and Workplace Health; K-16 Health, focusing on youth wellness and education; Rural Health, addressing equity and access; Community Health, underlining social determinants; and spans to Computational, Personalized, Clinical, Lifespan, and Mental/Behavioral Health. Research teams might explore innovative solutions across these dimensions to foster comprehensive well-being and address the multifaceted health challenges in Idaho's diverse communities.

*Integration into Boise State's Strategic Vision*

Boise State's strategic plan, "Blueprint for Success 2021-2026," outlines key goals encompassing educational access, research advancement, and community engagement. The GCs initiative, particularly aimed at advancing research and creative activity, intersects with all these goals, showcasing its multifaceted impact on the university's vision (Boise State University 2024). Notably, Goal 3 specifically highlights the GCs initiative as a pivotal strategy for research advancement (Boise State University 2024). However, the GCs initiative's influence extends beyond this single goal: it actively contributes to all five goals, embodying the diverse strategies outlined in the blueprint. Throughout this thesis, I will point out some of the ways the GCs initiative not only bolsters research but also synergistically supports the broader objectives of Boise State's, thereby playing a crucial role in realizing the university's vision for success. This backdrop of interdisciplinary and collaborative effort within Boise State’s strategic framework is pivotal to my thesis, as it underscores how the GCs initiative not only advances research but also supports broader institutional goals.

*Understanding Collaboration*

SNAP is a research team dedicated to understanding faculty collaboration at Boise State in the context of the impact of the GCs initiative. The team includes staff and faculty across campus, including Anthropology, Philosophy, Human-Environment Systems, the School of Public and Population Health, the Library, and DRED. Additionally, the team includes a graduate student: me. As a member of this project, I have access to this innovative learning experience, an example of the GCs initiative performing Boise State's’s blueprint goal to improve student success (Boise State University 2024).

Several research branches were formed to measure the impact of the GCs initiative’s investments. Phase 1 of SNAP moves to characterize research and creative activity at Boise State's before and at the start of the initiatives' programs. This thesis details three branches of SNAP: VAMPIRE, CUPID, and LOVE.

Vicken And Many Persons Interview Research Enterprise (VAMPIRE) is a cheeky name for describing the qualitative expertise of SNAP research branch lead Dr. Vicken Hillis. Tasked with conducting and analyzing informal faculty interviews about collaboration, VAMPIRE asks, “In what ways do faculty at Boise State's conceptualize collaboration beyond traditional metrics such as proposal applications and publications?” and “What diverse forms of collaboration are prevalent among Boise State's faculty, and how do these collaborations manifest in academic settings?” To help answer these questions, chapter three of this thesis thematically analyzes faculty responses from focus groups and semi-structured interviews. The chapter explores themes of academic culture, institutional structures, and interpersonal dynamics, offering insights into the multifaceted nature of collaboration in a university setting.

Collective Understanding of PI Data (CUPID) is a research branch of SNAP that uses social network analysis (SNA) on grant application data to answer three research questions. CUPID asks, "How have the dynamics of grant networks at Boise State's evolved, and what factors have influenced this change?" "To what extent have the Grand Challenges initiatives influenced these evolving grant proposal networks?" and "Is it possible to predict the formation and changes in collaborative ties between Principal Investigators (PIs) and Co-PIs within these networks?" Chapter four of this thesis contains a report on historical grant networks. I describe collaborative grant proposal networks between 2016 and 2020 using network visualizations, whole network metrics, and exponential random graph models (ERGMs) for a comprehensive analysis.

The fifth chapter of this thesis reports on research teams formed out of the GCs initiative. In this project branch, SNAP replicates the mid-point survey by Love et al. (2021) to investigate these characteristics in interdisciplinary scientific teams. Budding off VAMPIRE and deemed the LOVE branch, SNAP asks, “How do intensive research collaborations within the GCs initiative evolve and impact the nature of collaborative relationships over time?" It is anticipated that LOVE will survey the team several times over the course of the GCs investments. The LOVE chapter reports the initial survey results, visualizing and comparing various team networks, which provides a dynamic view of interdisciplinary collaboration within the GCs framework.

Through these diverse yet interconnected branches of SNAP, this thesis aims to paint a comprehensive picture of the dynamics of interdisciplinary collaboration at Boise State's. The insights gained are instrumental in understanding how such collaborations can be optimized to tackle the wicked problems of our time, aligning with global efforts like the SDGs. In the next chapter, I explore collaboration literature. I examine the literature that details the value of collaboration, defines its various forms in academia, and outlines teaming concerns.

Chapter Two: Literature Review

*The Power of Collaboration in Science: Paving the Way for Groundbreaking Discoveries and Solutions*

Collaboration is vital for solving complex scientific problems and furthering various political, economic, and social agendas, including thriving democracy, sustainable development, and cultural integration. Collaboration can extend the scope of research projects and foster innovation by providing additional expertise (Sonnenwald 2007). Disis and Slattery (2010) point out that multidisciplinary research teams possess a robust knowledge base and extended networks and are more prone to dynamic, connective thinking, leading to radical innovations. Collaboration also increases scientific reliability and success probability by involving multiple perspectives in verifying results (Sonnenwald 2007). This concept of increased scientific reliability through collaboration is a key consideration in the SNAP project. By examining the nature and outcomes of collaborative efforts at Boise State's, this research seeks to identify how collaborative dynamics influence the success and reliability of research projects under the GCs initiative. This rationale also underpins the promotion of collaboration at the university, as it not only advances research quality but also enhances a scientist’s credibility within the scientific community in line with Boise State's blueprint goal 4: fostering a thriving community (Boise State University 2024). The inclusion of community partners in GC research development also aids in the achieving of goal 4 and aligns with the idea that to effectively tackle society's wicked problems and achieve the United Nations' SDGs, academia must promote and support external community partnership (Rittel and Webber 1973).

Having established the crucial role of collaboration in advancing scientific discovery, it is pertinent to define what constitutes scientific collaboration. Scientific collaboration is defined as a behavior among scientists that involves sharing meaning and completing tasks toward a common, overarching goal, taking place within a social context (Sonnenwald 2007). Hart (2000) underscores the value of collaboration in enhancing the quality of academic work. In their study on collaborative publications by university librarians, Hart found that collaborative efforts often result in higher quality outputs than single-authored works (2000). This phenomenon is attributed to the diverse expertise, mentoring, and intellectual benefits brought together through collaborative efforts, indicating that multi-authored works tend to undergo more rigorous quality control (Hart 2000).

Intradisciplinary collaboration, or unidisciplinary (Okraku et al. 2017) or simply disciplinary, is a form of scientific cooperation where participants from the same field contribute and generate knowledge within their specific domain, as noted by Sonnenwald (2007). Moody (2004) describes research specialties within these collaborations as central clusters of scientists instrumental in generating innovative concepts and ideas. Dalton, Wolff, and Bekker (2021) further define a scientific discipline as a distinct field characterized by unique discourses and practices, akin to a specific language code. This “language”, encompassing methodologies, terminologies, and theoretical frameworks, remains largely exclusive to the discipline, providing its practitioners with a framework for focused scientific progress (Dalton, Wolff, and Bekker 2021).

Interdisciplinary collaborations play a crucial role in addressing global challenges by merging diverse expertise and perspectives, thus enabling a more comprehensive understanding of complex issues. While intradisciplinary collaboration significantly generates knowledge within specific domains, the shift towards interdisciplinary collaborations opens up new avenues for addressing more complex societal issues. Jana LaRosa, the Assistant Vice President for the DRED at Boise State's, emphasizes the importance of integrating disciplines (J. LaRosa, personal communication, September 25, 2023). She notes that while disciplinary work is valuable for its incremental contributions to specific fields, interdisciplinary work is essential for tackling broader, society-driven questions that single disciplines cannot address alone. This perspective aligns with the growing trend among federal agencies to prioritize interdisciplinary research in funding decisions (Huang et al. 2023; Lyall et al. 2013). LaRosa highlights that researchers at Boise State's must excel in team-based approaches to capitalize on funding opportunities that demand interdisciplinary efforts. She points out the need for authentic collaboration between STEM and social sciences, moving away from superficial integrations towards genuinely co-created and co-developed research questions that synergize both domains. This shift marks a departure from traditional practices where social science elements were often added as afterthoughts to STEM projects; instead, it calls for an equal and integrated partnership from the outset of research initiatives.

Measuring Interdisciplinary Collaboration

Increasing interdisciplinary and transdisciplinary collaborations is a core goal of the GCs investments. Scientific disciplines must work together to solve complex and large-scale societal challenges like Resource Nexus for Sustainability and Healthy Idaho. Collaborative research is often categorized into three distinct yet interconnected types: multi-, inter-, and transdisciplinary (e.g., Dalton, Wolff, and Bekker 2022; Sonnenwald 2007; Lieberknecht et al. 2023). Multidisciplinary research involves various disciplines working in parallel, each contributing their perspective without integrating their efforts (Dalton, Wolff, and Bekker 2021). In contrast, interdisciplinary research signifies a deeper level of collaboration where multiple disciplines converge their methodologies and viewpoints to tackle a common problem (Dalton, Wolff, and Bekker 2021). Transdisciplinary research transcends traditional academic boundaries by converging research design with external entities such as industry, government, and community stakeholders, thus offering a holistic approach to complex societal issues (Dalton, Wolff, and Bekker 2021). Understanding these diverse forms of collaboration is crucial for the SNAP project, as it seeks to examine how Boise State's GCs initiative navigates and fosters these varying levels of interdisciplinary cooperation.

Delving deeper into the classifications of collaborative research, Bolger (2021) zeros in on the degree of interdisciplinary research by categorizing discipline distances. Through a study of three established research centers, the study surveys faculty members on their motivations for joining the centers, their perceptions of interdisciplinary research, and the nature of their collaborative activities. Bolger introduces a novel classification based on the 'distance' between collaborating disciplines: 'within-discipline' collaborations (e.g., between biologists with different specializations), 'short distance' within the same super-discipline (e.g., an engineer collaborating with a biologist), and 'long distance' across distinct super-disciplines (e.g., an ecologist working with a social scientist) (Bolger 2021). This final categorization distinguishes collaborations spanning 'hard' sciences (natural and applied sciences) and 'soft' sciences (social sciences and humanities), offering a more granular understanding of interdisciplinary research dynamics (Bolger 2021).

Beyond academic boundaries, expanding our understanding to collaborations involving academia, business, and community groups is pivotal for addressing societal challenges. In this realm, participatory action, a collaborative approach between scientists and community members, values community members' knowledge, experiences, and values, aiming to integrate these into research projects (Sonnenwald 2007). Its goal is to generate knowledge that leads to effective social action and solves real-life problems, with the effectiveness of the action determined by participants (Sonnenwald 2007). To demonstrate the effectiveness of participatory action in bridging academic research with real-world application, I summarize two exemplary models: SPECTRUM and PT2050. These initiatives exemplify how collaborative efforts can address societal challenges by integrating diverse perspectives from academia, business, and community groups.

Enns et al. (2023) present a comprehensive study on the SPECTRUM project, showcasing a pioneering approach to tackling societal challenges in Canada. Initiated in 2018, the SPECTRUM Partnership addresses the fragmented nature of social services, which often suffer from a lack of coordination and evaluation, leading to suboptimal outcomes and resource wastage (Enns et al. 2023). This tripartite model, comprising community organizations, government, and academia, transcends traditional hierarchical frameworks, favoring a more egalitarian, knowledge-sharing approach (Enns et al. 2023). By integrating diverse perspectives and expertise, SPECTRUM effectively navigates the intricacies of public policy, social services, and systems (Enns et al. 2023). The partnership emphasizes community-driven research, leveraging existing data to fill knowledge gaps in social programs (Enns et al. 2023). Their findings are transformed into practical policy proposals, aligning with governmental priorities and offering tangible solutions to complex social issues (Enns et al. 2023). This collaborative model not only fosters holistic solutions but also ensures their relevance and effectiveness in addressing the real-world complexities of the problems at hand, demonstrating a viable path for optimizing public policy development in a collaborative, evidence-based manner (Enns et al. 2023).

Lieberknecht et al. (2023) present a comprehensive view of the transdisciplinary climate research PT2050, a model that equally values scientific and humanistic disciplines. PT2050's success in integrating diverse epistemologies and methodologies is credited to its focus on disciplinary equity and its inclusion of community partners in co-designing research, thereby avoiding technological solutionism (Lieberknecht et al. 2023). By fostering an environment where different disciplines and community stakeholders can collaborate as equals, PT2050 serves as an example of how GCs can transcend traditional academic silos to address wicked problems.

Transitioning from focusing on successful transdisciplinary projects like SPECTRUM and PT2050, it's important to address the inherent challenges of such collaborations. Merging various academic disciplines and community insights, transdisciplinary work often faces hurdles due to conflicts with entrenched discipline-based conventions, structures, and norms. Because of this, it is generally more difficult to co-create than aggregate research. This reality calls for understanding the intricate dynamics and challenges research teams encounter in interdisciplinary settings.

*Teaming Concerns: Academic Culture and Interpersonal Dynamics*

Interdisciplinary research often demands significant time, is prone to disagreements, necessitates blending different knowledge systems and methods, and calls for adaptability, thorough planning, and mutual trust within the team (Piqueiras, Stanley, and Laskey 2023). Piqueiras, Stanley, and Laskey conducted a detailed ethnographic study within a larger, federally funded, interdisciplinary scientific team, employing participant observation, semi-structured interviews, and a focus group over six months. They aimed to uncover and mitigate challenges in team science across institutional, cultural, and interpersonal levels. Their findings highlight that by understanding and addressing the three primary barriers of academic culture, institutional structures, and interpersonal dynamics, targeted team-building exercises and specialized training can be effectively employed to mitigate these concerns (Piqueiras, Stanley, and Laskey 2023). The SNAP project at Boise State, in embracing these insights, aims to explore how such challenges and proposed solutions manifest within the GCs initiative, thereby contributing to a more effective model of interdisciplinary collaboration.

Bednarek et al. (2023) research how grand challenge research teams achieve sustained research impact through time across multiple projects. There is an ebb-and-flow of activities and membership and this needs to be managed (Bednarek et al. 2023). They acknowledge the increasing demands for impactful research on grand societal challenges and identify several barriers, including institutional constraints, knowledge translation difficulties between researchers and practitioners, and the long timescales required for impactful outcomes (Bednarek et al. 2023). These challenges are compounded by the need for sustained engagement with stakeholders and the integration of diverse perspectives within research teams (Bednarek et al. 2023).

Crossing Disciplinary Boundaries

Interdisciplinary research, while crucial for addressing complex societal challenges, faces inherent difficulties due to varying academic cultures, methodologies, and terminologies. Dalton, Wolff, and Bekker (2022) emphasize that effective interdisciplinary collaboration, organized around a central principle like the GCs, is not without its limitations. Researchers often find it difficult to see beyond their disciplinary confines, a hurdle evident in Boise State's GC initiative “Healthy Idaho,” where early observations by LaRosa indicated struggles among researchers to envision their work within the broader societal framework (J. LaRosa, personal communication, September 25, 2023)

Similar issues were reported by Piqueiras, Stanley, and Laskey's study, which found that team members often reverted to thinking through their disciplinary lens, leading to conflicting ideologies and tensions in knowledge integration (Piqueiras, Stanley, and Laskey,2023). Differences emerged between trusting team members' expertise and trusting them as individuals, highlighting the necessity of actively creating a culture of trust (Piqueiras, Stanley, and Laskey 2023). Collaborating with various organizations, communities, and governing bodies brings additional trust challenges, such as differing research goals, ethical practices, and resource availability.

Collaboration failures have been blamed on epistemic and ontological incompatibilities, such as interpersonal or political problems and barriers related to language and terminology between disciplines (Dalton, Wolff, and Bekker 2021). In Belgian study, Duysburgh et al. (2012) found these types of barriers within multidisciplinary research groups focusing on information and communication technologies. Using ethnographic methods, including surveys, workshops, observations, and interviews, Duysburgh et al. explored the integration of diverse academic and community members. They found that the teams struggled to understand how other members would contribute to that larger, common goal, explaining various reasons why. STEM scientists struggle to understand how social scientists can contribute to a project or see their added value (Duysburgh et al. 2012). Additionally, rapid growth in team size led to increased specialization and differentiation among members, which posed a challenge to maintaining coordination and cohesion (Duysburgh et al. 2012). Competition between groups fostered further specialization, creating clusters within the teams and distancing the research groups from their university affiliations (Duysburgh et al. 2012). Teams were structured hierarchically with junior, senior, and head levels, alongside supportive roles like secretaries. However, this structure sometimes led to a sense of exclusion among junior researchers, who had limited involvement and access to information (Duysburgh et al. 2012). These factors lead to researchers not understanding the greater research agenda, which means that the result is an aggregation and not a co-creation of creative work.

In addressing interdisciplinary understanding, the perspective of critical realism, as advocated by Dalton, Wolff, and Bekker (2022), offers valuable insights. Critical realism, combining ontological absolutism (external structures) with epistemic relativism (the subjectivity of human understanding), provides a robust framework for understanding the structures and mechanisms in the real world and, by extension, within interdisciplinary teams (Dalton, Wolff, and Bekker 2022). This philosophical approach assists in unraveling the complexities of interdisciplinary interactions and identifying potential sources of conflict or misunderstanding among diverse team members.

Effective communication is vital for coordination, learning, research integration, and mitigating distrust perceptions. Trust, including cognitive (trust in the expertise of others) and affective trust (emotional bond among team members), is fundamental in collaborations (Sonnenwald 2007). Critical realism may help in building both cognitive trust and affective trust by acknowledging and valuing the contributions of different disciplines. By recognizing and accommodating different epistemological standpoints, critical realism fosters a constructive working environment where differences are not seen as barriers but as enriching elements of a shared objective reality. Critical realism can be instrumental in addressing STEM scientists' skepticism toward social scientists' contributions, as Duysburgh et al. reported. Implementing critical realism in practice could involve structured reflection sessions where team members discuss and acknowledge their disciplinary biases and work towards a shared understanding.

Learning, both explicit and tacit, is a critical component of collaborative research, particularly in interdisciplinary settings (Sonnenwald 2007). However, learning is often challenging and not typically included in research proposals (Sonnenwald 2007). Duysburgh et al. (2012) suggest that plenary project meetings, while bridging gaps between specialties, often missed opportunities for effective collaboration. A more frequent and focused meeting approach based on common research interests was recommended (Duysburgh et al. 2012).

Furthermore, critical realism’s emphasis on reflexive thinking encourages team members to be aware of and question their biases and assumptions, leading to more empathetic interactions and stronger affective trust. Critical realism encourages researchers, such as engineers, to appreciate social science’s qualitative, context-rich insights, complementing the quantitative, empirically focused approaches typical of STEM fields.

Scarcity of Time

In the GCs initiative, efficient time management and realistic goal setting are key strategies to mitigate the challenges of time scarcity identified by Piqueiras, Stanley, and Laskey (2023). Their study found that a constant perception of being behind and urgency affected project management and task division (Piqueiras, Stanley, and Laskey 2023). Additionally, a consistent issue was the regret and guilt expressed by team members regarding their inability to dedicate sufficient time to the project. This scarcity of time also affected the follow-through on tasks, depending on each member's availability and capacity (Piqueiras, Stanley, and Laskey 2023). Unrealistic timelines and conflicting responsibilities strained investigators and trainees (Piqueiras, Stanley, and Laskey 2023). The research team faced challenges with project management due to a lack of dedicated coordinators and unrealistic funding expectations (Piqueiras, Stanley, and Laskey 2023). This was exacerbated by funding institutions' requirements for principal investigators to propose ambitious project timelines, often beyond realistic scopes (e.g., a 10-year project within a 5-year timeframe) (Piqueiras, Stanley, and Laskey 2023).

Duysburgh et al. (2012) also recommend strong project management to solve the difficulties inherent in interdisciplinary work (Duysburgh et al. 2012). The lack of a unified software solution led to confusion, and project websites were viewed negatively (Duysburgh et al. 2012). Multiple funding sources, while providing stability, imposed greater administrative burdens, particularly on senior researchers and administrators (Duysburgh et al. 2012). The GCs investments include assisting researchers in project management to reduce administrative burdens.

Institutional Structures

Various institutional structures, including funding agencies, universities, IRBs, and bureaucratic partners, highlight how these structures shape collaborative research (Piqueiras, Stanley, and Laskey 2023).

Institutional Structures affect the attraction to research collaboration. As Okraku et al. (2017) emphasize, the predominance of unidisciplinary collaborations in scientific research is often a result of established organizational structures, training processes, and institutional reward systems. Such collaborations enable rapid consensus-building and efficient results production due to shared training and language (Okraku et al. 2017). Nonetheless, this emphasis on unidisciplinary work often leads to its prioritization in tenure and promotion processes, potentially fostering knowledge silos (Okraku et al. 2017). Lyall and Fletcher (2013) suggest that the preference for disciplinary over interdisciplinary research is often shaped by the funding frameworks of research institutions, which establish the guidelines and priorities governing the allocation of resources. Collaborative work can be marginalized or discounted within departments, especially if only one scientist is involved in a specific collaboration (Sonnenwald 2007), leading to the creation of knowledge silos and impeding the diffusion of knowledge across disciplines (Okraku et al. 2017). The GC initiative aims to allow individuals to work in an interdisciplinary way that serves their own disciplinary work (J. LaRosa, personal communication, September 25, 2023). This thesis will not evaluate institutional incentives and disincentives to collaborating at Boise State. It is beyond the scope of this project. Understanding these institutional influences is crucial for the SNAP project, as it navigates Boise State's structures to foster effective interdisciplinary collaboration within the GCs initiative.

Politics and Its Influence on Research Freedom

The broader political environment can influence the pursuit of innovative solutions within academic research, such as those endeavored by the GCs initiative. Political factors often shape research agendas, especially concerning wicked problems that intersect with public policy and societal issues. In navigating these political landscapes, research initiatives may face challenges that require cautious strategy, potentially influencing the scope and direction of their inquiry.

For instance, during the planning phase of the GCs, the selection of thematic areas for research was influenced by the prevailing political climate. Originally proposed topics, some of which delved into areas of equity and justice, were reassessed considering the time's broader political and social context (J. LaRosa, personal communication, September 25, 2023). Such decisions highlight the complex interplay between academic freedom and political considerations, underscoring the delicate balance research initiatives must maintain.

Furthermore, research projects that delve into areas of social and political sensitivity can encounter unique challenges. For example, certain research plans within the GCs initiative faced delays and adjustments due to their intersection with contentious issues. These incidents underscore the intricate balance required between academic exploration and political realities. Such experiences are not unique to any particular institution or state but reflect a common challenge faced by researchers globally: navigating the delicate interface between academic inquiry and the political landscape.

Interpersonal Relationships

Pre-existing collaboration histories among senior team members set implicit expectations for new members, complicating the team dynamics and contributing to feeling overwhelmed (Piqueiras, Stanley, and Laskey 2023). Sonnenwald (2007) also addresses concerns about unethical conduct, intellectual espionage, and skewed funding toward collaborative research at the expense of single investigators (Sonnenwald 2007). Duysburgh et al. (2012) noted that internal competition reserved team member collaboration efforts, resulting in some researchers and companies only using the initiative as a funding source. In the SNAP project, being cognizant of existing collaboration histories and their impact on team dynamics is vital to fostering a cohesive interdisciplinary research environment.

Leadership

Networks of scientific collaboration facilitate the spread of knowledge and innovation throughout various disciplines and institutions (Okraku et al., 2017). Disis and Slattery (2010) describe the connective thinking process through which an individual’s innovative idea moves through the team. After being fully evaluated, the idea becomes a sum of the team’s input (Disis and Slattery 2010). Moody (2004) cites theorists who argue that an individual’s ideas are a function of their position in a social setting, which is deeply structured by interaction patterns. The shape of the idea can be linked to the structure of a network, and in small groups, ideas and their movement depend on the authority structure (Moody 2004). Leadership, therefore, plays a pivotal role in the success of these teams, with transformational leaders being essential for motivating, moderating, and mentoring diverse groups (Disis and Slattery 2010).

Glied et al. (2007) describe sustainable leadership characteristics of center directors as charismatic, capable of negotiating with administrators, department chairs, and center members. A transformational leader is dedicated to mentoring and sacrifices self-interests to align projects and resources with the team's goals and priorities (Disis and Slattery 2010). Bland et al. (2005) describe research leaders as being regarded highly as a scholar and a sponsor, mentors, and peer models. When selecting interdisciplinary leaders, DRED considered faculty researchers seasoned in their careers, capable of “floating all boats within a thematic area” (J. LaRosa, personal communication, September 25, 2023).

Interdisciplinary leaders face challenges in publication and dissemination, including finding appropriate forums for interdisciplinary results, consensus on authorship, and different disciplinary expectations (Sonnenwald 2007). LaRosa gives an example from her personal experience assisting research collaboration.

“In some disciplines, writing papers has less value. They disseminate their work through conferences. That is all they need to get a promotion and tenure. The faculty in a different discipline might need to publish to get a promotion and tenure. This leaves one person stuck writing” (J. LaRosa, personal communication, September 25, 2023).

Addressing these issues at the onset of collaboration is critical for the success and recognition of research outcomes. Collaborations may face challenges due to varying informal traditions and norms among disciplines, especially regarding intellectual property sharing. For instance, experimental biologists often patent their ideas, while mathematicians are more open (Sonnenwald 2007). Model agreements provided by funding agencies can streamline the development of a shared understanding of IP and other legal issues (Sonnenwald 2007). Further research may consider investigating the personality characteristics of interdisciplinary team leaders to customize leadership training and extend the specific resources to fill the leader’s gaps.

New and Expanded Opportunities Across Campus

With the selection of seasoned faculty as leaders, there is a concern that the GCs investments may not benefit campus researchers. LaRosa articulated this by saying, “Any time an initiative holds resources for a specific venture, faculty may think that it is intended to empower the powerful and not extend to faculty as a whole” (personal communication, September 25, 2023). Additionally, the blueprint for Boise State’s success calls for the promotion of a fair, equitable, and accessible environment for all members of campus to make a difference (Boise State University 2024). Therefore, the SNAP project aims to assess if the GCs initiative is effectively broadening engagement opportunities across campus, ensuring that all interested faculty members have the chance to participate and contribute.

Disis and Slattery (2010) point out that loud and powerful researchers tend to receive resources. This could undermine the goals of the GCs investments as those with the most power perhaps could have found external resources where those without prestige continue to struggle to collaborate. Sonnenwald (2007, p 8) points out that collaborations “become powerful lobbying groups, influencing research policy and funding decisions in their favor.” This inequality underscores the importance of ensuring systemic biases in allocating resources and opportunities do not undermine Boise State’s GCs initiative. In chapter 5 of this thesis, I aim to examine whether individuals selected to participate in the GCs teams are positioned so that they can effectively promote new and expanded opportunities across campus.

*Methods Used to Evaluate Scientific Collaboration*

Team science collaborations are embedded in a dynamic system encompassing social relationships, cultural contexts, and institutional power structures. This web influences and shapes the nature and outcomes of scientific teamwork. It is essential to study this system to ensure the GCs initiative reaches its outcome goals and to tackle Idaho’s Grand Challenges.

Given these considerations, various methods have been employed to study collaboration. Sonnenwald (2007) highlights approaches like bibliometrics, interviews, observations, experiments, surveys, simulations, self-reflection, social network analysis, and document analysis. Each method offers unique insights, shedding light on different aspects of collaboration, from quantifiable data to nuanced interpersonal dynamics.

In this thesis, my approach is multifaceted, utilizing several methods to understand collaboration at Boise State comprehensively. The research includes faculty semi-structured interviews and focus groups, historical grant proposal data analyzed using SNA, and research team surveys analyzed through network comparisons. Much of this thesis work is descriptive. The social network analysis captures structural regularities through summary parameters for network concepts such as mean grant proposal counts. In other cases, the analysis is explicitly generative, positing a micro-level behavioral model that produces a population-level network structure, clustering.

The upcoming chapter, Chapter 3: "VAMPIRE," will examine the institutional, cultural, and interpersonal factors influencing collaboration at Boise State. The chapter aims to delve deeper into the dynamics at play within the GCs initiative using semi-structured interviews and focus group data. This will involve exploring the culture of collaboration before the introduction of the GCs investments.

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