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The more multidisciplinary the better? – The prevalence and interdisciplinarity of research collaborations in multidisciplinary institutions

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ABSTRACT

Scientific research is increasingly relying on collaborations to address complex real-world problems. Many researchers, policymakers, and administrators consider a multidisciplinary environment an important factor for fostering research collaborations, especially interdisciplinary ones that involve researchers from different disciplines. However, it remains unknown whether a higher level of multidisciplinarity within an academic institution is associated with internal collaborations that are more prevalent and more interdisciplinary. Analyzing 90,000 publications by 2500 faculty members in over 100 academic institutions from three multidisciplinary areas, information, public policy, and neuroscience, we investigated the connection between multidisciplinarity and research collaborations. Based on social network analysis and text mining, our analysis suggests that more multidisciplinary institutions are not necessarily more collaborative, although they do feature collaborations that are more interdisciplinary. Our findings provide implications for academic administrators and policymakers to promote research collaborations and interdisciplinarity in academic institutions.

1. Introduction

Knowledge creation in the scientific community depends heavily on collaborations (Dong, Ma, Shen, & Wang, 2017; Wuchty, Jones, & Uzzi, 2007). Scientific research as a whole has become more collaborative, as evidenced by increasing multi-authored papers (Adams, 2012; King, 2012; Regalado, 1995). Collaborative research not only becomes more prevalent, but also tends to produce papers with better quality with respect to citations (Bu et al., 2018; He, Geng, & Campbell-Hunt, 2009; Wuchty et al., 2007) and help researchers increase productivity as measured by number of publications (Bu et al., 2018; Lee & Bozeman, 2005; Petersen, 2015). As Popper (1962) pointed out, *"We are not students of disciplines but students of problems. And problem may cut across the borders of any subject matter or discipline."* Different from the conventional collaborations in which researchers work only with peers with similar educational backgrounds or expertise, scientists now often form diverse collaborative teams to investigate novel and difficult problems that need to be addressed with an interdisciplinary approach (Derrick, Falk-Krzesinski, Roberts, & Olson, 2012; Ledford, 2015; NSF, 2005). Indeed, research collaboration not

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only connects tangible entities such as researchers, organizations, and countries. Further, it contributes to the increasingly blurry conceptual borders between academic disciplines. The importance of interdisciplinary research in major scientific advances has been widely recognized (Derrick et al., 2012; NSF, 2005; Van Hartesveldt & Giordan, 2008). Interdisciplinarity occurred not only in emerging areas such as HIV study (Adams & Light, 2014), nanotechnology (Wang, Notten, & Surpatean, 2013), and astrobiology (Gowanlock & Gazan, 2013), but also in traditional fields, such as physics (Pan, Sinha, Kaski, & Saramäki, 2012; Sinatra, Wang, Deville, Song, & Barabási, 2016) and applied math (Xie, Duan, Ouyang, & Zhang, 2015). In fact, science, as a whole, has become more interdisciplinary (Porter & Rafols, 2009), and interdisciplinary research also has higher long-term impact measured by citation counts (Van Noorden, 2015).

Interdisciplinary research can be conducted by a sole investigator. However, typical interdisciplinary practice would involve people with disparate backgrounds (NSF, 2005). On one hand, collaboration of researchers with diverse expertise can facilitate integration of knowledge from different areas. On the other hand, interdisciplinary research invites and even demands collaboration to resolve the underlying complexity. Investigation on interdisciplinary collaboration, nonetheless, is still at an early stage that lacks in-depth analysis. Two common ways to report collaborations that are interdisciplinary are (i) co-authorship (Bordons, Zulueta, Romero, & Barrigón, 1999; Qiu, 1992; Schummer, 2004) (more interdisciplinary if authors come from different department); (ii) self-report survey (Cummings & Kiesler, 2005, 2008; van Rijnsoever & Hessels, 2011; Woolley, Sánchez-Barrioluengo, Turpin, & Marceau, 2015). However, the former suffers from arbitrary disciplinary classification, whereas the latter inevitably introduces individual biased understanding of what interdisciplinarity means.

In university systems, the smallest units of academic operation are at department, school, or college levels. Inspection on collaborative patterns as well as dynamics, however, is often made at the level of university, field, and beyond (Bu, Ding, Liang, & Murray, 2017; Dong et al., 2017; Jones, Wuchty, & Uzzi, 2008), belittling the importance of (interdisciplinary) collaborations between researchers within the same academic department. In fact, intra-organizational research collaborations within an academic institution are still very important. Cummings and Kiesler (2005) pointed out that distance not only yielded unwanted costs due to the need of researchers getting together, but lowered the productivity of interdisciplinary projects. From the perspective of gender equity and hiring, departments are the basic organizational units that allocate human resources and shape career prospects (Clauset, Arbesman, & Larremore, 2015; Su, Johnson, & Bozeman, 2015). Indeed, invincible assets such as consistency of reward and evaluation systems and convenience of in-person communications can hardly, if not impossible, be obtained when collaborating with people outside researchers' home institutions. On the other hand, the current formation of departments is no longer restricted to branches of science. Emerging areas such as information (Zuo, Zhao, & Eichmann, 2017) have pushed the movement of building multidisciplinary institutions that have similar functionality as traditional well-established departments (e.g., physics). These institutions gather people with diverse backgrounds and hence offer opportunities for colleagues to walk on the boundaries of disciplines, leading to interdisciplinary research, without needing to seek external collaborators. However, there is little study to show how these institutions perform in stimulating both the prevalence and interdisciplinarity of collaboration. A systematic examination of these new types of institutions' functionality contributes to a deeper understanding of their benefits and costs, and therefore providing empirical evidence for university departmental structures and future science policies.

There are many ways to promote more collaborations and interdisciplinary collaborations within an academic institution, such as organizational culture and promotion/tenure policies. One way our study is particularly interested in is to create a multidisciplinary environment with researchers from various domains, so that they have more opportunities to form research teams, especially interdisciplinary ones driven by complex problem-oriented research (Van Hartesveldt & Giordan, 2008). Multidisciplinarity, a concept closely related to and easily confused with interdisciplinarity, is about the co-existence of multiple disciplines, whereas interdisciplinarity focuses more on the integration of knowledge from several disciplines into research endeavors (Derrick et al., 2012; Wagner et al., 2011). An academic institution with faculty members from many different disciplines, for example, have a higher level of multidisciplinarity compared to others whose faculty members have very similar background. Interdisciplinarity, on the other hand, is achieved when people with different expertise actually collaborate with each other. In fact, diverse teams were found to be associated with high productivity (Stvilia et al., 2011). While research has argued that having a diverse group of researchers within the same organization may help enhance team performance (Salazar, Lant, Fiore, & Salas, 2012), it is unclear whether, at the very first place, collaborations will arise in a multidisciplinary institution. This can be challenging due to the heterogeneous nature of different disciplines (Jackson, Joshi, & Erhardt, 2003; van Knippenberg, van Ginkel, & Homan, 2013).

From a unique organizational perspective, this study examined the connection between multidisciplinarity of an institution and the prevalence, as well as the interdisciplinarity of collaborations within the institution, with datasets collected from three disparate disciplines – information, policy, and neuroscience[1] (Appendix A). Specifically, we utilized social network analysis and text mining techniques to address two research questions: First, *do more collaborations occur when an academic institution has a more multidisciplinary environment?* Second, *do collaborations that are more interdisciplinary emerge in a more multidisciplinary environment?* While it may seem intuitive to have an affirmative answer to the second research question, the heterogeneous disciplinary boundaries may also hinder such collaborations (Disis & Slattery, 2010; Yegros-Yegros, Rafols, & D'Este, 2015), due to coordination costs and team management. Specifically, it may take more time as well

[1] Faculty data used in this study is available at https://data.mendeley.com/datasets/6c2p7r6p6y/.