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Discovering collaborators online: Assembling interdisciplinary teams online at an Argentinian University

Descubriendo colaboradores online: Formando equipos interdisciplinarios en una universidad argentina

Descobrindo colaboradores on-line: reunindo equipes interdisciplinares on-line em uma universidade argentina

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ABSTRACT

This study explores how and why scholars find collaborators using team formation systems. Based on theories of teams and human and social capital, we describe how scholars' traits and social networks influence their team formation processes. We conducted a field study in Argentina in which 43 scholars used an online platform and assembled into eight interdisciplinary teams. Our results show that scholars initially tended to invite prior contacts, but, eventually, they assembled cohesive interdisciplinary teams with members they did not know before. We conclude by reflecting on how team formation platforms can enable individuals to expand their social capital.

Keywords: team assembly; platforms; online relationships; human capital; social capital.

RESUMEN

Este estudio explora cómo y por qué las personas encuentran colaboradores usando sistemas para la formación de equipos. Basados en teorías sobre equipos y capital humano y social, describimos cómo los rasgos de los individuos y sus redes sociales influyen en los procesos de formación de equipos. Realizamos un estudio en Argentina en el que 43 profesores utilizaron una plataforma en línea y formaron ocho equipos interdisciplinarios. Nuestros resultados muestran que, inicialmente, los profesores tendían a invitar a contactos anteriores, pero finalmente formaron equipos interdisciplinarios y cohesivos con personas desconocidas. Concluimos reflexionando sobre cómo estas plataformas pueden permitir a las personas ampliar su capital social.

Palabras clave: *formación de equipos; plataformas; relaciones en línea; capital humano; capital social.*

RESUMO

Este estudo explora como e porquê as pessoas encontram colaboradores usando plataformas de média social. Com base nas teorias de equipes e capital humano e social, descrevemos como os traços e as redes sociais dos indivíduos influenciam seus processos de formação de equipe. Realizamos um estudo de campo na Argentina em que 43 participantes utilizaram uma plataforma online e reuniram-se em oito equipes interdisciplinares. Nossos resultados mostram que os participantes inicialmente tinham a tendência de convidar contatos anteriores, mas, no final, reuniram equipes interdisciplinares coesas com membros que não conheciam antes. Concluímos refletindo sobre como as plataformas de formação de equipes podem permitir que os usuários expandam seu capital social.

Palavras-chave: montagem de equipes; plataformas de formação de equipes; relacionamentos online; capital humano e social.

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INTRODUCTION

As complexity and specialization of knowledge are rising in academic projects, scholars have been assembling interdisciplinary teams to bring together different ideas, skills, social connections, and resources (Jones, Wuchty, & Uzzi, 2008; Uzzi, Mukherjee, Stringer, & Jones, 2013; Wuchty, Jones, & Uzzi, 2007). This rise in interdisciplinary collaboration has been driven by a variety of factors, such as the combination of knowledge from different fields, the employment of a variety of research methods, the incorporation of shared information technologies, growing specialization among scholars, and the division of work (van Rijnsoever & Hessels, 2011; Wang & Hicks, 2015). By bringing in insights from small groups research, information, and communication technologies, as well as literature on team formation, researchers have made significant progress in understanding the emergence of interdisciplinary scientific teams (Falk-Krzesinski et al., 2010; McCorcle, 1982; Walsh & Maloney, 2007). Studies have explored the size, structure, composition, connections, resources, communications, and members' characteristics of these teams to understand the effects on their performance, collaboration, innovation, and creativity (Cummings, Kiesler, Bosagh Zadeh, & Balakrishnan, 2013; Guimerà, Uzzi, Spiro, & Amaral, 2005; Heck, 2013; Horn, Finholt, Birnholtz, Motwani, & Jayaraman, 2004; Lee, Walsh, & Wang, 2015; Lungeanu, Huang, & Contractor, 2014; Wu, Wang, & Evans, 2019).

Despite the growing recognition of the importance of interdisciplinary teams in academic contexts, little attention has been paid to exactly how information technologies are being used by scholars to search for, discover, choose, and work with collaborators. Specifically, how do scholars interact with these technologies to decide who to connect with? Although these questions have been answered in other collaborative domains, such as crowdsourcing, startups, hackathons, peer-production, and software companies (Agrawal, Golshan, & Terzi, 2014; Freeman & Wohn, 2017; Hoch & Dulebohn, 2017; Jarczyk, Gruszka, Jaroszewicz, Bukowski, & Wierzbicki, 2014; Lee & Edmondson, 2017; Trainer, Kalyanasundaram, Chaihirunkarn, & Herbsleb, 2016; Wen, Maki, Dow, Herbsleb, & Rose, 2017), less is known about how academic scholars have been using information technologies to assemble interdisciplinary teams. Moreover, connecting with new collaborators through online platforms is accompanied by challenges: meeting and working with strangers can create uncertainty about others and complicate their team's success, outcomes, cohesion, and efficiency (Woolley, Aggarwal, & Malone, 2015; Woolley, Chabris, Pentland, Hashmi, & Malone, 2010). Understanding these team assembly mechanisms can lead to rethinking technological features of these online team formation platforms to enable scholars to find appropriate collaborators that they would not otherwise have known. Therefore, we explore to what extent these information technologies can facilitate the discovery of new collaborators by scholars.

In this study, we examine how scholars find new collaborators using a team formation platform and their experiences after working with their respective teammates. To do so, we conducted an observational field study in an academic workshop held at an Argentinean university. A major goal of the workshop was to assemble interdisciplinary teams with scholars from different schools. Using survey data, we measured scholars' skills, traits, and social networks to study how those features affected their searches, choices, and final decisions using server data from the team formation platform. We studied the extent to which teammates met each other using the team formation platform and the extent to which the resulting teams were functionally diverse (i.e., interdisciplinary). Our observational study contributes to research on collaborations enabled by online platforms, theoretical conceptualizations of how online platforms may enable new collaborations, and provides a quantitative analysis that articulates scholars' searches, choices, team composition, and teamwork experiences. Moreover, we provide a novel observational study conducted in Latin America, where most studies focused on organizational contexts do not consider the role of online platforms on scholars' relationship formation (D'aguillo, 2012; Duran, Orellano, Eduardo, Virviescas Peña, & García, 2017).

This paper is structured as follows. In Section 2, we situate our work and research questions in the context of prior studies of interdisciplinary academic teams, team formation platforms, human and social capital, functional diversity, and team processes. In Section 3, we provide details of the study conducted, including its participants, procedures, and methodological processes. We also provide details of the techniques and statistical analyses used to study scholars' interactions and teamwork experiences. In Section 4, we present our results of scholars' choices, teams, and perceptions of this experience. Our discussion in Section 5 covers

the implications of our results for assembling teams online as well as a summary of scholars' experiences. Finally, the conclusions in Section 6 summarize the takeaways of this experience of enabling the formation of interdisciplinary teams and provides suggestions for future research directions.

LITERATURE REVIEW

In this section, we review theories and research on interdisciplinary academic teams, team formation systems, human and social capital, functional diversity, and team processes to understand how the assembly of interdisciplinary teams impacts their processes and outcomes.

INTERDISCIPLINARY ACADEMIC TEAMS

The topic of interdisciplinary academic teams has been examined in multiple adjacent literatures. Most academic teams are self-assembled, wherein their members have at least some measure of autonomy to choose who to invite and whose invitation to accept (Wang & Hicks, 2015). Prior studies have uncovered four sets of fundamental characteristics that predict future collaboration between any given pair of scholars: individual attributes, prior collaboration between them, having collaborators in common, and characteristics associated with the broader structure in which the scholars are embedded (Lungeanu, Carter, DeChurch, & Contractor, 2018; Newman, 2001). Interdisciplinary collaboration is likely to occur when scholars have complementary skills (Lee & Bozeman, 2005), are geographically proximate (Cummings & Kiesler, 2007), have longer tenure (Lungeanu et al., 2014), have been exposed to many disciplinary backgrounds (Lynch, 2006), and have prior experience in firms or governmental organizations (van Rijnsoever & Hessels, 2011). Research has also demonstrated that working with prior collaborators reduces uncertainty about starting a new endeavor (Gómez-Zará et al., 2019; Hinds, Carley, Krackhardt, & Wholey, 2000). Despite the fact that interdisciplinary academic teams have drawn attention over the last three decades, little is known about how their formation is enabled by information technologies.

TEAM FORMATION PLATFORMS

In light of the dominant use of social network platforms –such as Facebook, Twitter, Instagram, or LinkedIn– people have been exposed to novel ways of establishing new social relationships online (Ellison, Steinfield, & Lampe, 2007, 2011). Social media users have several options and paths to establish new social connections using information technologies, which have allowed them to change their routines, activities, and ways to meet new people (Walther, 2017). Through the use of recommender systems and shared virtual spaces (Chen, Geyer, Dugan, Muller, & Guy, 2009), people can engage with others in romantic relationships using online dating platforms (Courtois & Timmermans, 2018), select similar peers in online communities (Centola & van de Rijt, 2015), or hire potential employees by using enterprise social media platforms (Brewer, 2018). In order to initiate, maintain, or dissolve social ties through these systems, users look to manage impressions and facilitate desired relationships (Walther, 2007), to self-disclose personal information about themselves in online spaces (Tsay-Vogel, Shanahan, & Signorielli, 2016), to have frequent and intense social interactions with others through these digital technologies (Kim, Kim, Park, & Rice, 2007), and to perform several actions to gain more visibility in these platforms (Leonardi, 2014).

Despite the considerable attention given by communication scholars to personal relationships online, relatively less attention has been paid to finding work collaborators and to assembling teams online. Previous studies have analyzed the extent to which users can exercise their agency in searching for and choosing collaborators. These studies range from having freedom to choose with whom they want to work (Jahanbakhsh, Fu, Karahalios, Marinov, & Bailey, 2017; Lykourentzou, Wang, Kraut, & Dow, 2016), to having teams assembled by algorithms (Alkan, Daly, & Vejsbjerg, 2018; Retelny et al., 2014). Other studies have analyzed the impact of working in virtual teams on individuals' communication, trust, and leadership (Gilson, Maynard, Jones Young, Vartiainen, & Hakonen, 2014). While research has identified the positive impact of giving users agency or freedom in assembling teams online, little is known about a) how scholars' searches and teammate choices are influenced by online platforms, b) the consequences of these decisions on their teams' composition, and c) their subsequent experiences working with collaborators assembled online.

HUMAN AND SOCIAL CAPITAL

Compared to looking for collaborators offline, online systems have the ability to provide scholars with access

to a greater range of structured data about their potential collaboration options. The options that individuals consider when seeking collaborators online can be classified into two broad categories: human capital or social capital. Human capital refers to the individual attributes of the potential collaborators and encompasses their knowledge, skills, abilities, and experiences. Theorists classify these individual attributes into two dimensions: *competence* and *warmth* (Fiske, Cuddy, & Glick, 2007). The competence dimension characterizes individuals in terms of how capable, skillful, intelligent, and confident they are. The warmth dimension characterizes individuals in terms of how good-natured, trustworthy, tolerant, friendly, and sincere they are. Given their universality, competence and warmth provide a useful way to understand the two underlying dimensions that scholars attend to in evaluating the human capital of prospective collaborators.

However, scholars consider potential collaborators for reasons other than their individual characteristics. Being well connected, or located in an advantageous social network position, may also be important in choosing who to work with. The value of this second category of factors, also known as social capital, is not based on individuals' characteristics but comes from their relationships with others. For individuals, social capital allows them to draw on resources from other members of the networks to which they belong (Ellison et al., 2007, p. 1145) and to infer individuals' characteristics based on their social connections (Dong et al., 2015; Luo, Morone, Sarraute, Travizano, & Makse, 2017). Social capital in teams is accrued through two distinct mechanisms: *bonding capital* and *bridging capital* (Yuan & Gay, 2006). Bonding capital characterizes the quality of a connection between two people, such as strong and weak ties (Granovetter, 1977). Prior work examining teammate choices identifies the strength of ties with others as an important aspect of social capital in team formation. For examples, Hinds and her colleagues (2000) argued that individuals seek to collaborate with their prior collaborators because doing so helps them to avoid uncertainty. The second form, bridging capital, occurs when individuals connect with others who are not connected to one another (Williams, 2006). This means that they occupy an advantaged position in a social network by being uniquely positioned to combine ideas and resources from disparate sources (Burt, 2000). This quality might make them attractive as a team member to others. More generally, a scholar might offer valuable bridging capital by virtue of being popular, maintaining relationships with diverse sets of scholars, sustaining deep, trusting relationships over time, and operating as intermediaries between otherwise unconnected scholars (Uzzi & Dunlap, 2005).

Taken together, the search for human and social capital provides a useful conceptual lens through which to understand the characteristics that are more or less of a factor in considering potential collaborators online. Furthermore, these four dimensions offer insights into the differences among scholars in what matters most in a potential collaborator. To assess the relative importance of human and social capital theories, our first research question is:

- **RQ1**: What are the factors that best explain scholars' choices when they are looking for collaborators online?

FUNCTIONAL DIVERSITY

Research on teams typically studies interdisciplinary teams under the rubric of *functional diversity* (Bunderson, 2003; Yong, Sauer, & Mannix, 2014). Functional diversity is the degree to which team members differ in terms of their experiences or backgrounds (Bunderson & Sutcliffe, 2002; Cheung, Gong, Wang, Zhou, & Shi, 2016). Having high functional diversity in a team can lead to an atypical combination of knowledge that prompts novelty and scientific breakthroughs, as compared to homogenous teams (Uzzi et al., 2013). Despite the benefits of functional diversity, research on teams has found that team members struggle when searching, bridging, codifying, and integrating ideas from unfamiliar domains (Ancona & Caldwell, 1992). In other words, individuals' choices at the team formation stage have consequences on teams' functional diversity. This may lead individuals to avoid forming teams with diverse and unfamiliar individuals (Hinds et al., 2000). In the context of finding collaborators online, the balance between similarity and diversity of potential teammates depends on how individuals search for potential collaborators, the level of exposure that they have in these systems, and how search results are presented on the system (Hogan, 2010).

Third parties (e.g., managers, instructors, systems, etc.) can by fiat staff teams whose members are, for instance, functionally diverse and/or who know (or don't know) each other previously. However, when scholars exercise their agency to self-assemble online, the final composition of the team is more emergent and less

easily defined a priori. Very diverse team combinations can emerge when scholars are engaging in *laissez-faire* assembly strategies by freely searching for, choosing, inviting and accepting potential collaborators to be part of a team. The emergent teams' composition depends on the cumulative decision-making processes that scholars exercise online. How would the autonomous decisions made by scholars explain the emergent composition of teams formed using online platforms? Based on these theoretical considerations, we ask the following research question:

- **RQ2**: How is teams' functional diversity affected when scholars search for and choose collaborators online?

TEAM PROCESSES

Our final research question addresses the processes and dynamics experienced by scholars when they work on teams assembled online. Before starting work on a specific team, team members may develop certain attitudes, expectations, and perceptions that influence their feelings toward the team. These may or may not align with the expectations they had when they first found them online (De la Torre-Ruiz, Ferrón-Vílchez, & Ortiz-de-Mandojana, 2014). The literature on teams has elaborated several constructs to understand members' intra-personal experiences while they are working with others (Marks, Mathieu, & Zaccaro, 2001). Satisfaction within the team, cohesion, and trust are relevant processes that foster team effectiveness (Powell, Piccoli, & Ives, 2004; Staples & Zhao, 2006). First, *satisfaction within the team* is an affective concept that indicates the degree to which team members are satisfied with the team experience (Santos, Uitdewilligen, & Passos, 2015). Second, *team cohesion* is the tendency for a team to stick together and remain united in the pursuit of its instrumental objectives and for the satisfaction of members' affective needs (Carron & Brawley, 2000). Third, *trust* has been referred to as the union that propels a team towards the successful completion of its project and supports their social well-being (Altschuller & Benbunan-Fich, 2010). Based on these constructs, we explore which of these dimensions scholars valued when working on teams self-assembled online. Our final research question is:

- **RQ3**: What features of team processes did scholars value most after working with teams assembled online?

METHODOLOGY

PARTICIPANTS

We conducted this study during a five-week teaching practicum workshop hosted by a local research center at a public university in Buenos Aires, Argentina. Participants who enrolled in the workshop were scholars of this university who learned about it from the university's website and course catalog. The local research center granted a Certificate of Attendance to all the participants who completed the program as an incentive to finish all the required activities for this study. In total, 60 scholars enrolled in the workshop (34 were women) and 43 of them assembled into teams. Scholars came from 23 schools (or disciplines) within that university.

PROCEDURE

Once the workshop started, scholars had to assemble into teams ranging in size from 4 to 5 members. To facilitate this process, we provided them with a team formation platform called *My Dream Team*[1] that enabled them to search for potential collaborators and assemble teams. In the workshop's first session, the research team explained the syllabus to all scholars and showed them how to use this team formation platform. We provided scholars with user accounts, manuals, help instructions, and a video tutorial. We also explained to them that using this system was voluntary and we asked for their consent to use the collected data for research purposes.

The *My Dream Team* platform comprised three stages: a) collecting information about scholars by having them respond to psychological and network surveys, b) enabling scholars to make personalized searches for potential collaborators, and c) providing scholars with the ability to interact (invite, accept and/or reject) with others to assemble their teams. We describe each stage in the following subsections.

Initial survey

The first task for scholars was to complete a survey assessing their public profiles, as well as their human and social capital. Scholars logged into *My Dream Team* using their university email addresses, identified themselves using their real names, and completed public profiles by replying to a set of open questions related to their backgrounds, skills, favorite things to do, and motivation to take the workshop. This information was included in each scholar's public profile and was made available to other scholars.

To assess human capital and social capital, scholars responded to a confidential initial survey that included 72 questions relating to their demographic information (i.e., age, gender, and school), creativity (Tierney & Farmer, 2002), leadership experience (Mumford, Baughman, Threlfall, Uhlman, & Costanza, 1993), psychological collectivism (Jackson, Colquitt, Wesson, & Zapata-Phelan, 2006), social skills (Ferris et al., 2005), personality (Donnellan, Oswald, Baird, & Lucas, 2006), and project skills (Osterman, 1995). Additionally, we included questions about their previous network relationships with other scholars (Contractor, 2013): who they knew (i.e., *Contact* network), with whom they had previously worked (i.e., *Collaboration* network), and with whom they enjoyed socializing (i.e., *Friendship* network). We consolidated each scholar's responses by assigning a relationship between two scholars if at least one involved participant reported a connection to the other. Scholars were given two weeks to complete this initial survey.

Search for teammates

Once all scholars had completed the initial survey, they were able to use *My Dream Team* to search for other scholars and invite them to assemble into a team. *My Dream Team* enabled them to run advanced search queries on the responses provide by the scholars on their initial surveys. A *search query* consisted of a set of search preferences made by a user, making explicit which set of weighted factors the scholar was looking for in potential teammates. The search preferences were based on the initial survey's domains: looking for scholars with similar or different attributes (i.e., demographics, personality), who were the most skilled individuals in certain domains (i.e., creativity, leadership experience, social skills, project skills, technical skills, and soft skills), and who had previous relationships or who occupied central positions in their social networks, such as popular individuals or brokers. A combination of these search preferences constituted a query in which scholars selected the criteria and rated their importance using a 6-point scale, ranging from "Not important at all" (-3), to "Don't care" (0), and "Yes, for sure." (+3). By default, all the criteria were set to zero and the user had to select the criteria's importance to make a query. In order to trigger search queries, scholars had to select at least two search preferences for each query.

When a scholar completed a search query, *My Dream Team* rank-ordered all of the workshop's scholars based on how well they matched the specific search query (i.e., the first search response was the best match of the search). For each potential collaborator, *My Dream Team* displayed their picture, the percentage of how well they matched the user's query, a link to their full public profile, and an invite button. An invitation represents a request by the scholar to another scholar to join them on a team. Scholars' public profiles contained information provided by them in the initial survey phase described in the prior section. In addition, scholars could search for other people directly by typing their names into a text box and potentially send them an invitation. Here again, *My Dream Team* provided potential teammates' pictures, a brief description, a button that linked to their full public profile, and an invite button.

Team assembly

Scholars looked for and invited others to assemble teams throughout this search process. When a scholar sends an individual an invitation to form a team, a pre-populated message pop-up window opens, and they can either send the message as is or add personalized text to the invitation. Each invitation contained the sender's profile, the sender's current teammates, and an invitation message. The scholar who received the invitation could accept, reject, or ignore it. If the recipient scholar accepts the invitation and both scholars are not in a team, the system creates a new team including them. If one or both of the scholars are on two pre-existing teams, acceptance of the invitation will merge the pre-existing teams into a new team if the team size is less than or equal to the maximum team size allowed. The system does not identify a leader for a team; as a result, any person on the team has the ability to invite new members or merge teams, and any member on another team who has been invited may choose to accept the invite and merge the teams. Scholars also have the option to leave their teams.

Once the team assembly deadline was reached, the team formation was finalized, and the team project started. Then, scholars began working on their five-week projects.

ANALYSIS APPROACH

We conducted separate analyses to address the three RQs –factors that explain who scholars invited, the functional diversity of teams that emerged from this process, and factors of team processes that scholars most valued after using this team formation platform.

Participants searching for collaborators

RQ1 sought to identify factors that best explain scholars' choices when looking for collaborators online. We used Exponential Random Graph Models (ERGM) to identify the individual or dyadic variables that best explain the motivations behind scholars' invitations. ERGM are a type of stochastic model that provide an appropriate analytic methodology to test multi-theoretical multilevel (MTML) network hypotheses (Contractor, Wasserman, & Faust, 2006; Robins, Pattison, Kalish, & Lusher, 2007; Wasserman & Pattison, 1996). This statistical model estimates the likelihood of the observed network structures emerging out of all possible network configurations generated based on certain hypothesized self-organizing principles. The purpose of using ERGMs is to model the invitation network as a function of individual-level variables, dyadic variables, and endogenous network structures as a whole. In this ERGM, the dependent variable is the whole invitation network established by the scholars as one observation, and the independent variables are the scholars' traits, the scholars' networks' characteristics, and the team assembly's interactions. Similar to logistic regressions, ERGM uses Maximum Likelihood Criterion (MLE) to estimate the network statistics' coefficients. Positive and significant coefficients indicate that the corresponding independent variable is more likely to influence invitations being extended than by random chance, and negative and significant coefficients indicate that the independent variable is less likely to result in an invitation being extended than by chance alone. We defined an ERGM model that explained the likelihood of sending and receiving an invitation based on the four dimensions of human and social capital by considering scholars' traits and social networks respectively. The network statistics and definitions are presented in table 1 and they are based on the framework outlined by Robins, Snijders, Wang, Handcock, and Pattison (2007). We included demographic attributes and the likelihood of inviting a scholar of the same gender (i.e., gender homophily) as control variables.

To estimate the network configurations estimates, we use the Markov Chain Monte Carlo (MCMC) method to simulate thousands of networks from the model. This allows the ERGM to find the estimates without calculating all the possible network's edges permutations. Once the ERGM and its coefficients are estimated, we test if these simulated networks fit within the observed network. If the sampled networks provide a good fit for the observed network, then the ERGM model can explain the most relevant relationships between the observed network and the independent variables at the individual, dyadic, and endogenous levels.

Teams' functional diversity

RQ2 explores the impact of scholars' online search for, and choice of, collaborators on their teams' functional diversity. We consider two properties to measure functional diversity: the variety of schools and gender distribution (Harrison & Klein, 2007). First, we measure the extent to which different schools were represented on each team. We calculated the Blau index (1977), which measures the proportion of K schools represented on a team. It uses the formula $1-\sum p_k^2$, where p is the proportion of team members in k^{th} school. Blau index values range from zero to $(K-1/K)$. Since teams can have no more than six members and there are more than six schools, it is not possible for the theoretical maximum to occur. Therefore, we standardized the Blau index by dividing it by the number of total members in the team. With this transformation, the maximum occurs when the schools of team's members are spread equally (i.e., 1), whereas the minimum occurs when team's members all work at the same school (i.e., 0). Similarly, we calculated the Blau index to measure the gender distribution.

Evaluating team processes

After scholars finished and submitted their team projects, we conducted a final survey to understand scholars' perceptions of the various team processes as a result of their teams assembled online (RQ3). The purpose of this survey was to analyze scholars' teamwork experience as well as to perform the evaluation of their final work. Based on the taxonomy of team processes by Marks et al. (2001), we measured ten team process dimensions that are nested within three superordinate categories: (1) transition phase processes, (2) action phase processes, and (3) interpersonal processes. Each of the ten process dimensions refers to a general type of activity that can be performed from "very well" to "very poorly" (Marks et al., 2001, p. 362). In order to include human capital and social capital dimensions in this survey, we adapted this instrument and included expertise coordination (Faraj & Sproull, 2000), team trust (McAllister, 1995), team validity (Bayazit & Mannix, 2003), and satisfaction with the team (Peeters, Rutte, van Tuijl, & Reymen, 2006). Participants responded to this survey online voluntarily (table 2).

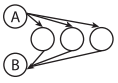
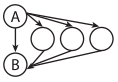
Parameter		Meaning	Visual representation
Control	**Edges**	Baseline likelihood of an invitation sent from one to another scholar	
	Age	Likelihood of inviting older people to the team.	
	Gender	Likelihood of inviting a woman to the team.	
	Same gender	Likelihood of inviting people of the same gender.	
Competence	**Project skills**	Likelihood of inviting a scholar with higher project overall expertise.	
Warmth	**Leadership**	Likelihood of inviting a scholar who reported high leadership experience.	
	Personality	Likelihood of inviting a scholar with a similar personality.	
	Social Skills	Likelihood of inviting a scholar who reported high social skills.	
	Creativity	Likelihood of inviting a scholar who reported high creativity skills.	
Bridging capital	**Popularity**	Likelihood that some scholar will receive a disproportionate number of invitations compared to others.	
	Activity	Likelihood that some scholar will send out a disproportionate number of invitations compared to others.	
	Two paths	Likelihood of scholar A to invite others who have invited scholar B.	
	Triadic closure	Likelihood of scholar A to invite others who have invited scholar B when A invited B.	
Bonding capital	**Contacts**	Likelihood that scholars will invite a contact.	
	Previous collaboration	Likelihood that scholars will invite a prior collaborator.	
	Friendship	Likelihood that scholars will invite a friend.	

Table 1. ERGM network statistics based on human and social capital dimensions

Source: Authors.

Citation	Dimension	Sub-dimension
Bayazit & Mannix (2003)	Team Viability	-
Faraj & Sproull (2010)	Expertise coordination	-
Marks et al. 2001	Action processes	Coordination
		Team monitoring and backup
		Monitoring progress toward goals
	Interpersonal processes	Motivating & Confidence building
		Conflict management
		Affect Management
	Transition processes	Mission Analysis
		Goal specification
		Strategy formulation & planning
Own elaboration	Cohesion	-
McAllister, D. J. (1995)	Team Trust	-
Peeters et al. (2006)	Satisfaction with Team	-

Table 2. Evaluation of team processes

Source: Authors.

RESULTS

RQ1: PREVIOUS COLLABORATIONS EXPLAINED MOSTLY PARTICIPANTS' TEAM CHOICES

At the end of the initial survey stage, 60 scholars extended a total of 80 invitations (figure 1). We found that less than one-third of the participants sent invitations to others: 18 scholars sent an average of 4.44 invitations (SD=3.32). In contrast, 51 of them received an average of 1.56 invitations (SD=0.90). 37 invitations were accepted, 24 invitations were declined, and 19 invitations were ignored.

Table 3 presents the ERGM results predicting the likelihood of a collaboration invitation among participants. We begin by examining scholars' human capital dimensions. First, we examine which individual attributes explained why scholars were more likely to send an invitation (sender's attributes). Scholars who rated themselves low on project skills (β=-0.31, $p<0.05$) were more likely to invite other participants. Despite being marginally significant, scholars who rated themselves highly creative (β=0.32, $p<0.10$) and high on leadership experience (β=0.20, $p<0.10$) were also more likely to extend invitations. Next, we examined which individual attributes explained why scholars were more likely to receive an invitation (receiver's attributes). Scholars who reported themselves as being high on leadership experience (β=0.65, $p<0.05$) were more likely to receive an invitation.

Next, we turned to the bonding capital effects on the invitation network. Scholars were more likely to extend an invitation to contacts (β=0.58, $p < 0.001$) and prior collaborators (β=0.54, $p > 0.10$). Finally, we examined the bridging capital effects of the invitation network. The positive and significant parameter for the (negative measure of variability in) scholars' popularity indicates that collaboration invitations were homogenously distributed among scholars (β=2.92, $p<0.001$) with no evidence that a few scholars received a disproportionate number of invitations. However, the negative and significant parameter for the (negative measure of variability in) scholars' activity shows that most invitations were extended by a small number of

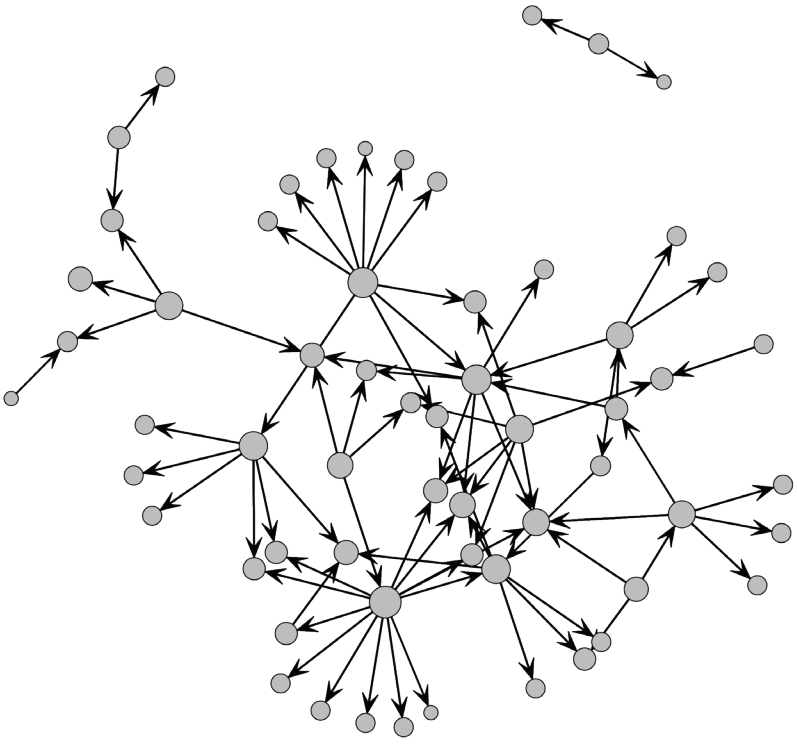


Figure 1. Invitation network. Participants invited each other to form a team. The arrows show who received an invitation

Source: Authors.

scholars (β=-3.58, $p<0.001$). Indeed, only ten scholars extended more than five invitations to others, becoming largely responsible for shaping the composition of project teams. Finally, we did not find evidence of brokers in the invitation network: the parameters for two paths and triadic closure were not significant.

To test how well the ERGM model fit the observed data, we used simulation-based model goodness of fit (GOF) tests. We simulated 10 million iterations, sampling every thousandth network, and then counted the number of various structural configurations for the simulated sample networks in order to create distributions of network statistics. A good fit would be reflected if the observed network had network statistics that were very likely to be found in the distribution from the simulated networks. We first calculated the *t*-statistics for the relevant observed graph statistic based on the mean and standard deviation from the simulated distributions (Stephens, Chen, & Butler, 2016). Our results show that the absolute values of the *t*-statistics for all the estimated statistics in the ERGM were less than 0.5, indicating that the network statistics fitted the data appropriately. Finally, we tested other global statistics, such as the geodesic distance distribution, degree distributions, and the model itself. The observed networks' statistics were also well explained by the model, lying within 95% of the confidence interval (figure 2).

RQ2: FUNCTIONAL DIVERSE TEAMS WERE ASSEMBLED USING A TEAM FORMATION PLATFORM

At the end of the team assembly, 43 scholars formed eight teams: six teams with 6 members, one team with 5 members, and one team with 2 members. Of these participants, 24 were women and 19 were men. 17 of the initial 60 scholars decided to leave and did not assemble into teams.

Given that the likelihood of scholars sending invitations to prior contacts was high, we tested whether scholars forged teams with new collaborations through the platform once the teams were assembled. Despite the high likelihood of sending invitations to previous contacts, most scholars did not know many others in their respective teams: 21 of the 43 participants

Network statistic	Estimate (S.E.)	Odd-ratio
Edges	-2.76 (2.62)	0.06
Control attributes		
Sender's Age	0.01 (0.01)	1.01
Sender's Gender (Male)	-0.01 (0.47)	0.99
Recipient's Age	-0.04 (0.02)†	0.96
Recipient's Gender (Male)	-0.22 (0.40)	0.80
Same gender	-0.12 (0.26)	0.89
Competence		
Sender's Project Skills (mean)	-0.31 (0.15)*	0.73
Recipient's Project Skills (mean)	0.24 (0.41)	1.28
Warmth		
Sender's Leadership	0.20 (0.12)†	1.23
Sender's Psychological Collectivism	-0.19 (0.24)	0.83
Sender's Personality	0.12 (0.28)	1.13
Sender's Social Skills	-0.23 (0.23)	0.80
Sender's Creativity	0.32 (0.17)†	1.37
Recipient's Leadership	0.65 (0.29)*	1.92
Recipient's Psychological Collectivism	-0.37 (0.51)	0.69
Recipient's Personality	-0.48 (0.71)	0.62
Recipient's Social Skills	0.59 (0.56)	1.80
Recipient's Creativity	-0.33 (0.49)	0.72
Bonding capital		
Contacts	0.58 (0.27)***	1.79
Previous collaborations	0.54 (1.00)	1.71
Friendship	0.13 (0.10)	1.14
Bridging capital		
Popularity (negative measure)	2.92 (1.09)***	18.56
Activity	-3.58 (0.38)***	0.03
Two paths	-0.12 (0.09)	0.88
Triadic closure	-0.56 (0.57)	0.57
Akaike information criterion	619.7	
Bayesian information criterion	774.0	

Table 3. Invitation ERGM results

*Note: ***p < 0.001; **p < 0.01; *p < 0.05; † p < 0.1; MCMC Iterations: 3 out of 50.*

Source: Authors.

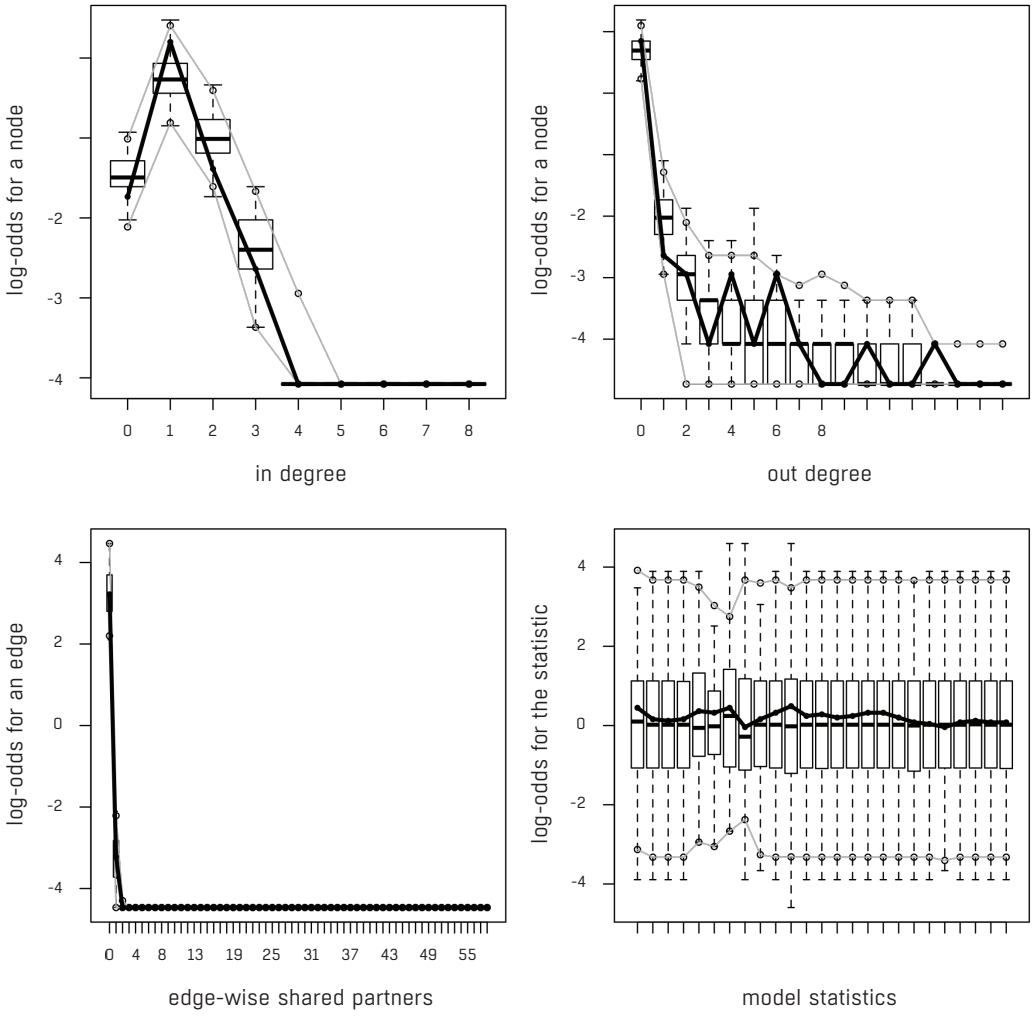


Figure 2. Goodness-of-fit diagnostics. Black dots and lines represent the observed network's statistics; White dots and lines denote simulated networks' statistics.
When the model is a good fit, the black line falls between or close enough to the grey lines

Source: Authors.

reported not knowing anybody in the workshop, 34 had not worked with any participants, and 29 did not report socializing with other participants. From those scholars who had prior connections with others, 21 of the 43 knew at least one person and the average number of their contacts was 4.19 (SD=3.4). Only 8 scholars had worked (i.e., had a previous collaboration network tie) with another participant: each of those 8 had previously collaborated with two others. Regarding their friendship networks, 13 of the 43 scholars reported previously socializing with other participants who assembled teams, having on average 2.15 connections (SD=0.54).

Our results indicate that scholars were able to self-assemble into functional diverse teams without any kind of intervention from the workshop administrators. Schools were well represented among all teams, where six teams had four or more schools and one group of five included five different schools. Among these teams, the average standardized Blau index of teammates' schools was 0.90 (SD=0.07), confirming that these self-assembled teams included scholars from several schools. However, this diverse distribution was not reflected in gender. Even though the ERGM model did not find any significant effect of sending invitations to scholars with the same gender, some teams were

Construct	Example question	Number of items	M	SD	α
Satisfaction with Team	*Taken as a whole, I enjoy working with my team.*	3	4.71	0.51	0.86
Cohesion	*Our team likes working together.*	2	4.27	0.91	0.48
Mission Analysis	*The team actively work to identify our main tasks.*	3	4.16	1.15	0.82
Motivating & Confidence building	*The team actively work to take pride in our accomplishments.*	3	4.16	0.77	0.72
Team Trust	*Our team has a sharing relationship. We can freely share our ideas, feelings, and hopes.*	3	4.12	0.87	0.87
Conflict management	*The team actively works to maintain group harmony.*	3	4.07	1.23	0.82
Coordination	*The team actively works to communicate well with each other.*	3	4.04	0.82	0.72
Team Viability	*I really enjoyed being part of this team.*	3	4.00	1.10	0.80
Goal specification	*The team actively works to ensure that everyone on our team clearly understands our goals.*	3	3.84	0.74	0.73
Expertise coordination	*Team members know what task-related skills and knowledge they each possess.*	10	3.80	1.12	0.81
Affect Management	*The team actively works to share a sense of togetherness and cohesion.*	3	3.71	1.20	0.89
Strategy formulation & planning	*The team actively works to develop an overall strategy to guide our team activities.*	3	3.47	1.12	0.84
Team monitoring & backup	*The team actively works to assist each other when help is needed.*	3	3.40	1.18	0.92
Monitoring progress toward goals	*The team actively works to regularly monitor how well we are meeting our team goals.*	3	3.38	1.13	0.86

Table 4. Team Processes Survey

Note: N=15. All questions followed a 5-Likert scale, where 1 means "Strongly disagree" and 5 means "Strongly agree".

Source: Authors.

composed of a high proportion of women: More than 60% in 4 of the 8 teams. We confirmed this unequal distribution by calculating the average Blau index for teammates' gender, which was only 0.5 (SD=0.16).

RQ3: SATISFACTION AND COHESION WERE THE FEATURES OF TEAM PROCESSES THAT INDIVIDUALS MOST VALUED AFTER WORKING WITH TEAMS ASSEMBLED ONLINE

From the team processes survey, we sorted the aggregated scholars' answers from the highest to the lowest (table 4). Fifteen scholars responded to this last survey (39.5% response rate). Overall, responders evaluated their team experiences positively. On a five-point Likert scale, these scholars reported high levels of satisfaction with their teams (M=4.71, SD=0.51), high cohesion (M=4.27, SD=0.91, confidence in their team (M=4.16, SD=0.77), and high trust in their team (M=4.12, SD=0.87). In contrast, interpersonal processes obtained lower scores, slightly higher than the neutral Likert option: monitoring progress toward goals (M=3.38, SD=1.13), team monitoring and backup (M=3.40, SD=1.18), and formulation of strategies (M=3.47, SD=1.12) registered low scores among scholars.

DISCUSSION

Our results indicate the relevance of human capital and social capital at the moment of assembling teams online. Scholars' bonding capital and warmth were influential factors for sending invitations: participants were more likely to send invitations to those who they already knew and those who had higher scores on leadership experience (RQ1). These results are consistent with previous literature, which also found the influence of prior connections on assembling teams

(Hahn, Moon, & Zhang, 2008). In terms of competence, most invitations came from scholars with lower scores on expertise. Previous literature shows that competent users are more likely to receive invitations (Hinds et al., 2000), but our results provide more insights into the sender's perspective. We extend the literature by demonstrating that these social proclivities are also likely to occur in online environments, an aspect that had not been fully explored in the past.

Regarding the emergence composition of teams, scholars were able to effectively find collaborators and self-assemble functional diverse teams online (RQ2). Regardless of the relevance of scholars' bonding capital during the team formation process, scholars exercised their agency and achieved the formation of teams with members of different schools, precluding the need for the workshop's administrators to intervene and assign workshop's participants to teams. Since exercising agency leads scholars to have a more productive and meaningful experience in teams than in staffed teams (Wang & Hicks, 2015; Zhu, Huang, & Contractor, 2013), it was important that the workshops' scholars were able to assemble functional diversity and exercise their agency at the same time. The achieved functional diversity reflected the scholars' ability to be conscious of their need for teammates with diverse backgrounds and social capital. However, gender diversity did not achieve high levels. Despite the balanced gender distribution of the final participants (in total, 54% were women), most teams were composed of a high number of scholars of the same gender. Previous studies show that increasing gender diversity brings different attitudes, perspectives, and values to the tasks conducted by a team, and ultimately, a positive and significant predictor of team's productivity (Apesteguia, Azmat, & Iriberri, 2011; Rogelberg & Rumery, 1996; Vasilescu et al., 2015). Regardless of the research evidence about the advantages resulting from gender diversity, scholars were not inclined to assemble into teams with people of the opposite gender. In contrast, this gender imbalance reflects how individuals' agency can sometimes lead to suboptimal team formation strategies, where homophily affects team composition (Ruef, Aldrich, & Carter, 2003).

Our study demonstrates that team satisfaction was the feature that scholars valued most after working with their teams assembled online (RQ3). Meeting people online may not have been a comfortable social situation, considering that working with strangers can be associated with multiple risks for the final team's success. However, meeting face-to-face was a logistically challenging option for these scholars given that they worked in more than 20 disciplines, spread across six campuses within a 15-kilometer range, and across the traffic congested city of Buenos Aires. Despite these challenges and the fact that most scholars who worked in these teams had not previously met, they reported high levels of satisfaction with their teams and high levels of team cohesion. Overall, using this team formation system provided scholars with a new space to connect with people that they would not have otherwise met. These results provide more evidence of how online team formation platforms offer a unique space for finding new collaborators, augmenting scholars' ability to assemble teams beyond ad hoc face-to-face approaches.

Finally, our findings reveal scholars' passivity in these virtual spaces (Romero, Galuba, Asur, & Huberman, 2011): less than 33% of the scholars sent invitations to others. While scholars were free to send invitations during the team formation stage, few of them took the lead and proactively worked on the team formation process. We know of no offline studies with which we can compare this skewed distribution. That said, this skewness in participation has repercussions for team composition, especially considering that most team invitations came from non-experts. In order to involve greater participation, team formation platforms' design must consider incorporating more inclusive participation mechanisms and promote community efforts among their users (Butler, Sproull, Kiesler, & Kraut, 2002; Preece & Shneiderman, 2009). As a reference, "team dating" encourages all participants to interact with others to evaluate potential teammates (Lykourentzou, Kraut, & Dow, 2017).

LIMITATIONS

Our study did not investigate whether or not self-assembled teams would outperform those assembled using other strategies (such as random assignment, ad-hoc assignment, etc.). Future experimental designs that compare self-assembled teams and those assembled in traditional settings, and that compare different search preferences, would allow us to better infer causality. Because performance is a relevant aspect of teams' success (Bell, 2007; Woolley et al., 2015), future studies should incorporate collective tasks and tests to evaluate if scholars' searches and invitations lead to better or worse performance outcomes. The connection between scholars' choices and teams' performance will better illuminate our understanding of the factors that

determine teams' successes along different dimensions. Since this study was conducted in an academic workshop in Buenos Aires, more studies in other contexts are needed to assess whether the scholars' behaviors observed here vary or are generalizable across different organizational, cultural, and linguistic contexts. Another limitation of this study was the participants' self-reports of their human capital. These assessments may not be accurate. In the future, peer-evaluations can be used to confirm others' human capital (Treem & Leonardi, 2017). Additionally, we acknowledge that specific features of the team formation platform may affect scholars' searches and team formation processes. The system likely induced certain search preferences and decisions and precluded scholars from looking for alternatives that might have been considered in platforms designed differently (e.g., the search options available). Finally, some scholars might have agreed to assemble into teams offline and simply used the team formation platform to indicate their decision. It was not possible to measure if this was the case.

CONCLUSION

Grounded in theory and research on human and social capital, functional diversity, and team processes, this study sought to understand the phenomenon of searching for and choosing teammates on an online team formation platform. By conducting a study of team formation at an academic interdisciplinary workshop at an university in Buenos Aires, we analyzed scholars' searches and choices, team compositions, and teamwork experiences with these self-assembled teams online. We studied the impact of those decisions on the composition of the team and process within the team after it was assembled. Our results show that team formation efforts were driven by a small number of scholars –who mostly reported high levels of leadership experience and low levels of expertise– and that bonding capital was a determinant for sending an invitation. Further, we found that teams were able to self-assemble into functionally diverse teams and that the most valued team processes features were the satisfaction with their teams and team cohesion.

We discussed the social cognitive mechanisms by which scholars discover and seek new collaboration connections using an online platform. Our work examined how these connections can be enabled by information technologies and explored how scholars can overcome the challenge of working with strangers when provided the opportunity to review structured information about their human and social capital.

NOTES

1. See more details at https://v2mdt.soc.northwestern.edu/

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