INTERDISCIPLINARITY NOW

"Optimally Ambiguous Exchanges" and Other Conditions for Productive Interdisciplinary Collaboration

When scholars collaborate across disciplines, what shapes their perceptions of that experience? Drawing from their recent research on a range of interdisciplinary networks, Lamont, Boix-Mansilla and Sato find that cognitive and intellectual payoffs tell only part of the story. Emotional and social dimensions to collaboration intertwine with the cognitive in complex ways, while the research environment established by funders creates a frame within which participants experience a sense of achievement across disciplinary divides.

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In the current climate of general enthusiasm for interdisciplinary research among researchers, university leaders, and funding agencies, everyone seems to have an opinion about what defines and what leads to successful interdisciplinary collaboration. We investigated just this question through an in-depth comparative study of nine interdisciplinary research networks created and supported by the MacArthur Foundation, the Santa Fe Institute, and the Canadian Institute for Advanced Research. These networks typically benefit from multi-year support and bring together scholars who are interested in researching problems that require combining analytical tools and perspectives from several disciplines. They focus on broad and ambitious topics such as "early experience and brain development," "urban growth and social dynamics," "successful societies," "geochemical origins of life," "genetic networks" and "complexity and the gene concept." We produced a voluminous report describing our findings, which are summarized in a paper [1] recently published in *Science, Technology, and Human Values*. Here we highlight some of our findings and what lessons can be learned from them.

We examined network members' experiences through ethnographic group observation, questionnaires, and semi-structured interviews concerning their involvement in the network. We asked respondents to describe their experience in detail, addressing their motivations, roles and contributions; their selection and integration of disciplinary specialties and the obstacles they confronted; and the interactions among group members and the role of leaders and foundations in supporting their work. We paid particular attention to how they defined or recognized a successful interdisciplinary collaboration and what they believed helped and hindered their group in achieving such success. We triangulated these data with the analysis of their publications and observations of their meetings. Our examination of experiences and views of success aimed to move beyond commonly used "objective metrics" of number of publications and citations. By comparing these nine networks, we were able to identify inductively key markers and conditions for success in interdisciplinary collaborations salient across cases.

The multidimensionality of interdisciplinary collaboration

Our analysis suggests that the success of interdisciplinary collaborations pivots on the coconstruction and sustenance of a shared collaborative space we call a cognitive-emotional-interactional platform, constituted at once by social, cognitive, and emotional dimensions in dynamic interaction. We identified the markers of, and factors for, successful interdisciplinarity put forth by our informants, which we view as embodying three dimensions of interdisciplinary work: the cognitive, concerned with intellectual substance, from the problem under study to disciplinary approaches and their integration and evaluative criteria for outputs; the emotional, concerned with feelings, such as excitement, annoyance, and boredom, and with how participants emotionally engage with a shared cognitive or disciplinary agenda and with team members; and the interactional, concerned with interactional rules, meaning-making, and group styles, including rituals, expectations, habits, and artifacts.

It is hardly surprising that our informants would point to cognitive markers in their description of what characterizes successful interdisciplinary collaboration. When asked to describe indicators of success, most mentioned a network's capacity to generate rich mutual learning, the generativity of emerging ideas, and the advancement of tools and analytical approaches able to provide common grounds for exchange. They also mentioned the excellence and relevance of the various disciplinary expertise each member brings in, the groups' capacity to advance knowledge by integrating different disciplinary perspectives, as well as, as expected, its output—the quantity, quality, and prestige of their publications. In their views, such success was propelled by cognitive factors such as their peers' intellectual caliber and open-minded dispositions, having a clear and shared intellectual mission, and a useful framing of the problem of study.

The salience of emotional markers in our interviews was less expected. Indeed, for many of the researchers we talked to, the success of an interdisciplinary collaboration becomes manifest in feelings of pleasure and excitement provoked by experiencing the "steep learning curve" that takes place when one is learning another discipline. Many pointed to "collective intellectual excitement" and the "joy of working together" as the result of a collective sense of mission, and considered these affective phenomena to be an indicator of success. These emotions not only signify working collaborations, but also serve as a powerful source of cognitive and interpersonal bonds. Perhaps it was not surprising that emotional markers were rarely mentioned in isolation given the social nature and explicit cognitive objectives of interdisciplinary collaborations. In fact, intellectual substance and social relations provided the context of emotions.

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Nonetheless, this salience of the emotional dimension is noteworthy given the limited attention emotions have received in the literature on collaboration (although Parker and Hackett's "Hot Spots and Hot Moments in Scientific Collaborations and Social Movements" [2] is a notable exception), including the literature on cross-occupational collaboration, in the sociology of higher education, and in the sociology of science. Typically, these approaches consider non-cognitive factors as "subjective" or as "corrupting" science (such as Robert K. Merton's *The Sociology of Science* [3]), that is, as orthogonal to rationality and the production of knowledge (see Michèle Lamont's *How Professors Think* [4], as well as Steven Shapin's *A Social History of Truth* [5]). What our study teaches us is that researchers are human too, that emotions matter… and so do interactions.

Indeed, interactional markers of successful collaborations were also frequently mentioned by our respondents. In their views, success is deemed evident in a group's growing competency for deliberation and learning from each other, as well as the development of meaningful social relations among group members. In turn, success is also made possible by the creation of a climate of conviviality, a group identity, and a shared working style, which are built in the blow-by-blow interactions of members in and outside official project meetings. Having productive styles of intellectual exchange was seen as essential for successfully calibrating different interpretations and gaining new insights (e.g., better explanations, more valid models, more nuanced accounts) through interdisciplinary integration.

Collaborators are inclined to undertake the efforts of interdisciplinary dialogue not only because they value its intellectual rewards, but also because they enjoy the sense of belonging and trust such groups engender. They appreciate the opportunity to work with peers whose stature, competency, and intellectual dispositions they respect. Their commitment goes beyond strategic, career-advancing objectives, or material interests, such as funding or professional networking. Many of them report the pleasures of working together on something "exciting and interesting" and building "meaningful and long-lasting relationships." Personal relationships greatly facilitate the intellectual work of the group. On the whole, success was viewed as made possible by the sociability and groups' co-constructed communicative styles, and the presence of effective enabling leaders.

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These interactional and emotional dimensions are typically not captured by standard indicators of research success, such as number of publication and citation rates. It is important to take them into consideration if we want to fully capture what generates new knowledge.

How do cognition, emotion, and interaction work together?

Our analysis of the nine networks showed that shared intellectual agendas are constructed over time through interactions between network members who sign up to develop a program of research together. Emotional experiences associated with collaborative success (and failure) fuel or constrain cognitive activity (e.g., love for ideas, the joy of discovery, "feeling right," or alternatively, the frustration of cognitive conflicts). Meaningful personal relations, in turn, are enabled by and build feelings of belonging, respect, trust, admiration, and self-validation, exemplifying the mutual dependence of the interactive and emotional dimensions.

The mutual dependence of cognitive, emotional, and interactive dimensions of interdisciplinary platforms were manifest, for example, in participants' iterative process of defining their collective intellectual agendas in shared but "optimally ambiguous" terms: open enough to invite and facilitate participation and multiple ownership of a problem, and circumscribed enough to empower meaningful exchange. This ambiguity is an important characteristic of shared cognitive-emotional-interactional platforms (or SCEI platforms), as it allows for forms of engagement

adapted to the needs and intellectual commitments of each participant, and facilitates alignment between their respective interests. It also encourages emotional and interactional engagement, by allowing each researcher to make connections between the collaborative project and their previous research agenda and intellectual identity.

The researchers we talked to frequently expressed intellectual excitement and group belonging, which we took to be evidence of the mutual constitution of cognitive, emotional and interactional dimensions of collaboration. They were excited by opportunities afforded by network participation—for example, to develop alternative perspectives, learn new and helpful methods, and discover neighboring fields. Conversely, negotiating differences in disciplinary expertise, managing the anxiety produced by intellectual disagreement, information overload, competition, or being intellectually overextended presented not merely cognitive, but also emotional, challenges. Meaningful personal relations, which are at once interactive and emotional, fuel the construction of a climate of conviviality, openness to new relationships, and the trust perceived as necessary for cognitively fertile collaborations. They enable individuals to "park their ego at the door" to "build trust and well-being at the interpersonal level," and to set safe conditions for participants to move beyond their comfort zones.

"Knowledge integration is significantly shaped by extra-cognitive factors."

Cognitive, emotional, and interactional dimensions are consistently present across networks, but these varied in terms of: the kinds of markers and factors they highlighted, the meaning assigned to particular markers, and the degree of intra-group agreement. For example, while some networks put a premium on the social and intellectual caliber of participants, others focused primarily on the sense of collective mission and problem framing. Furthermore, while integration across disciplines is pivotal to the success of interdisciplinary collaborations, networks vary in their preferred approach to making integration possible. Some networks allow more spontaneous and individual interpretations of the process of connection-making and borrowing. Other networks seek a tight and consensual integration. Similarly, we detected that while in some networks members converged around preferred markers and factors for success, preferences were more divergent in other networks. This suggests various degrees of network cohesion, where agendas and group norms can be more or less loosely defined.

Beyond serendipity: How institutions set conditions for success

Such differences were not random. We found that the priorities and styles of funding institutions create institutional conditions, within which cognitive, emotional, and interactional dimensions operate in conjunction. Such conditions encompass the rules and organizational context for collaboration (e.g., general intellectual objectives, output expectations, modes of funding and control, management styles) and material and organizational resources, as well as institutionalized expectations about collaborations that are communicated to researchers (e.g., risk-taking, deliverables).

While the MacArthur Foundation, the Santa Fe Institute, and CIFAR all emphasize the significance of interdisciplinarity and innovation across the research projects they fund, invoking intellectual risks, curiosity, and creativity, they differ in their missions and expectations. For example, CIFAR encourages the pursuit of big, exploratory questions to advance knowledge that enriches human life and improves understanding of the world in the long run. It matches its emphasis on big, open-ended questions with the room and intellectual freedom it gives its participants. The foundation plays an active role in identifying and coframing a new area of inquiry and selecting the program directors and the initial core members. Once a network is established, senior staff maintains a supportive ongoing presence at meetings, but has a hands-off management style. While it expects its program to develop frontier knowledge at the meeting point between various fields, it does not specify deliverables to the surprise (and delight) of participants.

For its part, the MacArthur Foundation also funds networks with the goal of increasing understanding of human and community development in novel, fundamental, and long-view terms, but places more emphasis on the practical implications and policy relevance of the work—immediately setting the stage for a more convergent problem framing and work styles. Here too, foundation staff plays an active role in the early phase of the creation of a network, co-developing the agenda, and selecting and vetting the network chair and core members, to ensure that its research is consistent with the foundation's visions. The foundation reviews its networks for funding decisions, but imposes no specific expectations on the network in terms of the outcome of its work other than its high quality and "visible impact on policy."

In sum, characteristics of a funder's mission, expectations, funding practices, and management styles crucially shape the construction of SCEI platforms. They do so by setting the conditions for particular forms of intellectual enterprises, group cultures, and working styles of interdisciplinary collaborations, which will in turn enable or inhibit success.

What conclusion should be drawn from our deep plunge in the world of interdisciplinary collaboration? Most importantly, there is a disconnect between traditional "objectivizing" methods for measuring academic success (number of publications, citation rates, etc.) and how researchers involved in such interdisciplinary enterprises describe and experience their own success. First, researchers take into consideration pleasure and feelings of belonging when describing what matters to them and what conditions lead them to fruitful intellectual interaction. Second,

knowledge integration is significantly shaped by extracognitive factors. From emotional engagement with collaborative processes to personality fit and group identity to modes of funding, factors other than intellectual substance also affect what kinds of expertise are incorporated and how. Put another way, what we may consider noncognitive is constitutive of knowledge production. Time spent on socializing and building up productive group culture, for instance, is essential to successful integration of different knowledges. Such crucial dimensions of the relative success of interdisciplinary collaborations are not captured by classical "output" measures of productivity and citation rates.

These findings should serve as a lesson to experts in the science of science: if necessity is the mother of invention, emotional synergy and interactions are the mother of cross-pollination and creativity. Researchers are humans after all…

Optimal ambiguity is a concept borrowed from our colleague David Perkins.

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