FROM ENTHUSIASM TO PRAGMATISM: SHIFTING PERSPECTIVES OF SUCCESS IN INTERDISCIPLINARY RESEARCH

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SUMMARY

To formulate assessment criteria for interdisciplinary research (IDR) taking into account its specificity and cross-cutting nature on its own terms is a key and difficult issue. This paper reports results from a case study of an interdisciplinary, multi-institutional, multi-national research team convened to address a highly complex problem with societal relevance: to understand and model adaptive management of agricultural ecosystems in the Pampas of central-eastern Argentina in response to climate variability and other sources of risk and uncertainty. The analysis focuses on the shifting perspectives and metrics of "success" held by participants at three specific stages of the collaboration process: the project start, an intermediate stage (about two years into a three-year project) and the end. The case highlights a dynamics of knowledge production where an initial moderate level of understanding and accommodation of alternative standpoints may not be seen as sufficient in subsequent phases of interaction when criteria based on integrative standards are expected to emerge. Along IDR interaction obstacles and constraints reappear recurrently in subtle ways, making active participants gain a rising consciousness of the existence of new reachable aims and consequently, of novel shades of possible misunderstandings.

Interdisciplinary research to address complex societal problems with multiple dimensions, inclusion of stakeholders to reach social robustness, and reflexivity to monitor and intervene on the process of collective production of knowledge, all constitute hallmarks of contemporary scientific projects. It is increasingly accepted that addressing and modeling complex problems of global importance that have practical consequences, such as disease prevention, economic development, social inequality, and global climate change, can only be addressed by pulling together insights and methods from many disciplines (Nissani, 1997). As a consequence, interdisciplinary (ID) teams are becoming an emerging pattern for the organization of scientific and technological research (Boix Mansilla and Gardner, 1996, Rhoten, 2003; Luna and Velasco, 2006; Hidalgo *et al*., 2007). Integrative arrangements of scientific work are increasingly promoted by funding agencies as a means to avoid the dominant disciplinary fragmentation of the sciences.

Although there are multiple definitions of interdisciplinary research (IDR; Jeffrey, 2003), the Committee on Facilitating Interdisciplinary Research (NAS, 2004) offers the following one: "a mode of research by teams or individuals that integrates information, data, techniques, tools, perspectives, concepts, and/or theories from two or more disciplines or bodies of specialized knowledge to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline or area of research practice". As is apparent, the kind of interdisciplinarity that Sperber (2001) calls "cosmetic", where the actual scientific content merely involves the juxtaposition of disciplinary projects and results, probably is no longer acceptable.

Another emerging feature of the modern science enterprise is the widespread call for ''stakeholder'' involvement as a means for improving developmental decisions, particularly those involving complex technology, uncertain risks, and contending values (Kasperson, 2006). When social relevance is sought, the inclusion of stake-

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holders in scientific projects as full team members or peers in an extended community also becomes frequent, as a way to take into account diversity of knowledge and values, and to enhance interaction with a growing engaged population (Funtowicz and Ravetz, 1992, 1993; Funtowicz, 2002; Natenzon and Funtowicz, 2003). Unfortunately, in many cases stakeholder engagement has been limited, relatively *ad hoc* and unplanned, or conceived as a marginal add-on or an afterthought (Kasperson, 2006; Toth and Hiznsyik, 2008; Carney *et al*., 2009).

Significant difficulties remain in turning cooperation –working together for individual ends– into effective ID collaboration –working together towards a common end (Jeffrey, 2003). The obstacles that an ID team with stakeholder involvement must face are not just many but also diverse: achieving consensus on a common problem or topic for study, the "right" composition of the research team, language barriers, multi-sited research, understanding of operations applied to data series, tension between applied and theoretical outcomes, varied academic incentives, publication requirements, disciplinary biases, competition and the geopolitics of knowledge, institutional and personality issues.

Among these obstacles, one of the main impediments to effective ID collaboration is the lingering challenge of assessing ID work. The lack of consensus on common criteria for the assessment of results often is ranked as a major difficulty of doing ID research (Heintz and Origgi, 2006). A key issue is to assess whether IDR participants manage to rise above the boundaries of their disciplines or social standards to fulfill collective goals.

Given the relative novelty of IDR, the empirical and conceptual analysis of the challenges faced by interdisciplinary and collaborative production of knowledge with stakeholder involvement is an open issue. In this context, reflexivity on the process, needed to identify and intervene on factors that foster or impede the cooperative production of knowledge, becomes almost mandatory. Lemos and Morehouse (2005) claim that despite efforts to describe and characterize collaborative research by many scholars, conditions for success have yet to be identified and made explicit. They attribute this deficiency in part to the lack of extensive empirical work carried out on concrete cases.

This paper aims to contribute to fill the gap describing how an interdisciplinary, multi-institutional, multinational research team conceived assessment criteria during the process of knowledge production. A sequence of representations of "successful IDR" held by participants along three years of interaction is presented as a means to ground the definition of success in IDR settings on actual experiences during a case study. Although the limitations of studying a single case are recognized, it is argued that the participants' changing views may highlight some generic features of the dynamics of this type of knowledge production.

Current Assessment Criteria in IDR Settings

In previous work (Hidalgo *et al*., 2007, 2010) the general process of IDR collaboration has been documented, underlining that the issues that influence cooperative production of knowledge change during the project's life cycle. During project design, attention is placed on team composition, ensuring not only that the needed talents are included but also recruiting investigators open to interdisciplinary interaction. As the project begins, considerable effort must be dedicated to shared problem definition and development of a common language. Simple conceptual models and considerable redundancy in communication are helpful. As a project evolves, diverging institutional incentives, tensions between academic publication and outreach or policy-relevant outputs, disciplinary biases, and (inevitably!) personality issues play increasingly important roles. Finally, towards a project's end, the challenge arises of assessing interdisciplinary, integrative work.

In a research in some aspects similar to ours, Stokols *et al*. (2005) have characterized several processes (behavioral, affective, interpersonal and intellectual) observed along a cycle of what they call transdisciplinary (TD; we prefer ID) collaboration among members of a research program on tobacco use in USA. Crucial to these processes is the challenge to evaluate TD scientific "ventures" (Stokols, 2005). As outcomes emerge gradually and may not become evident for years, they seem to require a broad historical frame for their assessment. Near-term outcomes may emerge during initial phases of collaboration (i.e. a shared model -in their case a shared economic model to assess costs of smoking-, generation of TD research proposals, submission of renewal proposals, identification of new directions for TD collaboration across multiple research projects). Long-term outcomes may be more evasive and difficult to assess.

It is precisely this last issue concerning the evaluation of outcomes we will address. The four types of processes distinguished by Stokols *et al*. (2005) interweave in our analysis on the shifting perspectives on metrics of "success" held by members of an IDR team, analyzed in connection with the collaborative performance of individual participants or research units along the progress of the target project.

When applied to IDR settings, standard means for evaluating disciplinary research (i.e. number of publications, citations, successful research-grant proposals, teaching evaluations by students; benchmarking with other programs, awards received) may prove insufficient or irrelevant (NAS, 2005). Assessment criteria that evolved within each discipline or group of stakeholders are always available, but interdisciplinarity requires both understanding and accommodation of alternative intellectual attitudes. Research results that are important to some disciplines or groups may be not viewed as so significant by the others, or may not even be well understood by all audiences. Divergence of evaluation criteria can lead to confusions and even to serious misapprehensions, such as inappropriate evaluations or unwarranted charges of ignorance (Caruso and Rhoten, 2001).

The peer review system on which the evaluation of disciplinary research rests cannot be adopted without changes in the case of IDR. Heintz and Origgi (2006) argue that, because the results of IDR projects involve a new synthesis of expertise, their evaluation cannot rely on standard peer review system, simply because there are no such peers. They claim that there are not even procedures of combining peer competence that can overcome the problem. If IDR achievements are truly integrative, in principle nobody would be straightforwardly capable of judging the content of the research, making second order criteria (such as counting articles in high-impact journals) inadequate or insufficient. Although this perspective may appear somewhat extreme, it illustrates the need for broader IDR assessment criteria.

The broadening of quantitative and disciplinary biased criteria in IDR settings has been an explicit concern of science and technology policy and funding agencies. A report

meant to facilitate IDR in academia (NAS, 2005) asserts that IDR is expected to have measurable outcomes in multiple elements of technique, theory and application; new evaluation criteria that match its cross-cutting nature are required. The report distinguishes direct and indirect outcomes amenable to evaluation. Direct outcomes include new knowledge, creation of a new field or discipline, value added to many traditional fields of research, and development of new technologies or products. Indirect outcomes include creation of information-sharing networks, enrichment of the quality of undergraduate and graduate educational experience, enhancement of institutional reputation, and demonstration of the value of a major tool or instrumentation with multiple applications. At a close look, the cross-cutting nature of IDR does not seem to be taken into account by this inventory, because many of the listed outcomes concern also disciplinary research. Only two items may be considered exclusively relevant to IDR: creation of a new field or discipline, and value added to traditional fields of research. Nevertheless, the former is contested as a desideratum, as often it is not a shared aim of IDR teams to integrate knowledge in a single new perspective.

Taking into account these limitations, other researchers have formulated additional criteria. Boix-Mansilla and Gardner (2006) analysis of core epistemic criteria that underlie experts' evaluations of IDR results constitutes an advance. The IDR reviewers whom they studied attribute central importance to three main epistemic "symptoms" (perhaps better labelled "values") of quality of ID work: consistency with existing disciplinary criteria, balance among perspectives involved and woven together, and effectiveness with which intellectual products (a model, publications, theses, outreach, etc.) advance understanding and inquiry. It becomes apparent that current assessment criteria in IDR settings tend to add standards, those accepted for disciplinary research plus new ones.

The multiplicity of demands to fulfill in a short time-frame pressures IDR teams. The present case will show how the emphasis on some of them changes along the research process in connection to the enactment of collaboration.

TABLE I
TEAM'S DIVERSITY

Kind of institution	Institution[1]	Type	Country	Number of members
ACADEMIC	UNI 1	Private	USA	4
	UNI 2	Public	Argentina	5
	UNI 3	Public	Argentina	2
	UNI 4	Private	USA	2
	UNI 5	Public	Argentina	2
	UNI 6	Public	USA	2
	UNI 7	Private	USA	1
NGOs/GOs	NGO 1	Private	Argentina	4
	NGO 2	Private	Argentina	3
	GO 1	Public	Argentina	4
	GO 2	Public	USA	1
	GO 3	Public	USA	2

[1] UNI: university, NGO: non governmental organization, GO: governmental organization. Institutions called "UNI 2", "UNI 3"and"UNI 5" are schools of the same university.

Methodology

The case study

This analysis targets an IDR team convened to address a complex problem with societal relevance: to understand and model decision-making (including adaptation and learning) in agricultural production in the Pampas of central-eastern Argentina in the light of climate variability. An innovative design feature of the project was a built-in self-reflective analysis of the challenges posed by interdisciplinary, multi-institutional, multi-national collaboration with stakeholder involvement in integrative science. The process of IDR collaboration was monitored throughout the project's lifetime. Results are described elsewhere (Hidalgo 2006; Hidalgo *et al*., 2007, 2010). In particular, the research team acknowledged that measuring the success of their integrative work was of great relevance, as it could provide useful insights for the assessment of other integrative research projects.

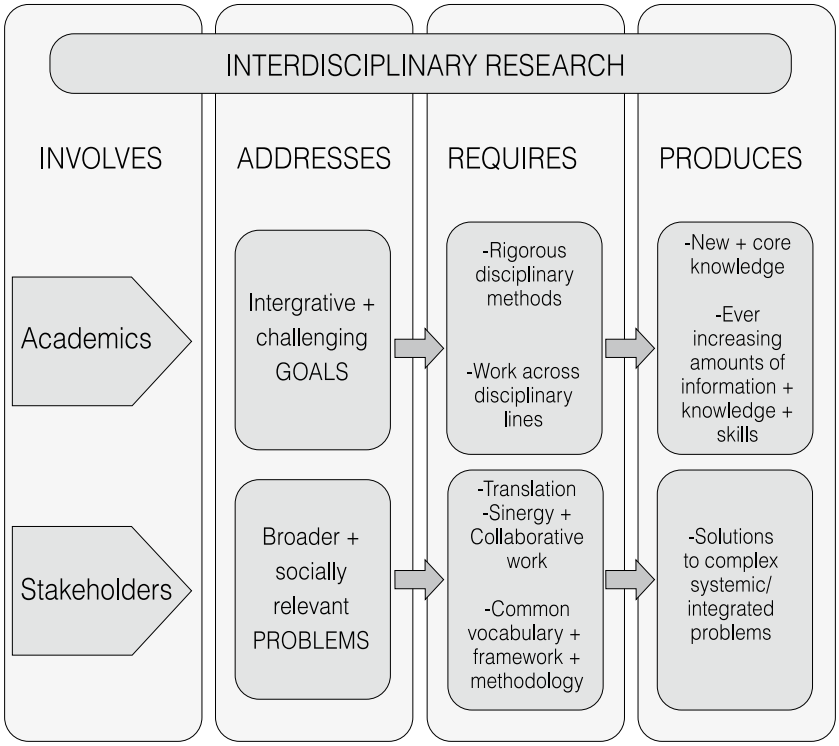
Successful and effective IDR collaboration ultimately requires not only the convergence of diverse disciplines, but also of talented and compatible individuals. The initial composition of the research team reflected the broad spectrum of disciplinary expertise necessary to address the project's ambitious objectives. The team of ~30 participants included statisticians, physicists, climatologists, biologists, psychologists, economists, geographers, anthropologists, sociologists, and agronomists (many of them heavily involved in extension and outreach) who contributed diverse and complementary theoretical abilities and practical skills. Based on a previous cooperation experience around less demanding problems, the large heterogeneity of the group was conceived as a significant potentiality. The team was remarkably diverse yet balanced on gender, career stage, and nationality dimensions. One third of the researchers were at the junior level, while two thirds were seniors; 60% were male and 30% female. Twelve institutions were involved: five universities (seven schools, three of them from the same university), three governmental and two non-governmental organizations; six institutions were from Argentina and six from the USA; seven were public and five private (Table I). A hallmark of the team was the participation of non-academic stakeholders (technical staff and members of a non-profit farmers' organization) as full peers. The leadership of a coordinator heavily committed with the design of the project, acquainted with the institutions involved and the intellectual skills of all participants, was crucial for the development of the interactions.

Approach

Most studies of IDR teams rely on retrospective (i.e. *ex post facto*) interviews and focus groups, and archival analysis (Jeffrey, 2003; Boix Mansilla and Gardner, 2006; Luna and Velasco, 2006). The first two methods, however, rely on memories and personal reconstructions of the process, and thus tend to be biased and distorted. Although they have great value, as often they represent the only access to the study of scientific groups, these approaches are not entirely suitable to investigate the dynamics of IDR knowledge production. To overcome the limitations of *ex post facto* reconstructions, this study involved direct and continuous study of the processes of collective adjustment and creation of emergent criteria of IDR success. The collective process of IDR and participatory modeling within this diverse team of investigators, stakeholders and outreach specialists was monitored and recorded along three years, the project's lifetime. For other illustrations of this still infrequent type of approach, see Stokols *et al*. (2005). The main elements of the methodological approach were: a) a diachronic design involving participant observation, individual interviews and a follow-up protocol; and b) the analysis of project working documents, draft and published papers to map patterns of interaction as networks evolving during the whole pro-

cess of IDR collaboration. Participant observation and focused interviews were facilitated by the interest of the team in self-reflection. Archival analysis focused on different kinds of preliminary and completed project outputs (peer-reviewed papers, book chapters and one-time publications, meeting abstracts and presentations, theses and outreach materials). Network computer tools were used to portray the evolution of knowledge exchange and network formation among members and subgroups within the team (Hidalgo *et al*., 2010).

TABLE II
COLLECTIVE SYNTHESIS OF DEFINITIONS OF IR (FEBRUARY 2005)



Design: Carolina Favre.

Results from Three Stages of the Project

This section presents shifting perspectives and metrics of "success" held by participants at three specific stages of the collaboration process: the project start, an intermediate stage (~2 years into the three-year project), and the end. The analysis highlights the dynamics of team collaboration and interaction in the process of knowledge production.

The project start

At the start of the project, successful IDR is a synonym of fulfillment of eligibility conditions of competitive scientific calls for funding. The assessment of IDR connects the concerns of practitioners and stakeholders involved in integrative projects to those of funding agencies and academic institutions. Their assessment criteria seem to coincide. Indeed, the first characterization of what would be considered a successful research team could be elicited from the wording of the request for proposals issued by the program that funded the project, the Dynamics of Coupled Natural and Human Systems initiative called by NSF in 2003.

The project solicitation called for the formation of new communities of investigators that could develop new methodologies and expertise, reaching beyond the borders of the USA for partners in inquiry. The program would support teams that could "provide a more complete understanding of natural processes, of human behaviors and decisions in the natural world, and of ways to use new technology effectively to observe the environment and sustain the diversity of life on Earth." Competitive projects would be those with a high degree of interdisciplinarity and a focus on complex environmental natural and human systems. An integrated, quantitative, systems-level method of inquiry and the production of advanced conceptual models were considered essential. Education experiences had to be integrated with all research to contribute to the development of a new generation of researchers. The adoption of a global perspective was encouraged, urging investigators to identify international research partners and to consider larger scale collaborative efforts. To enhance theoretical understanding of the dynamics of integrated human and natural systems at diverse spatial, temporal, and organizational scales, the IDR team had to articulate natural, social, and mathematical sciences, engineering, and education in a coordinated work.

The requirements of the call functioned both as conditions deemed necessary for success (namely those concerning the composition of the team) and as general aims (e.g. to contribute to the development of a new generation of researchers) or even values (e.g. to enhance theoretical understanding). Being able to fulfill these requirements could properly be conceived as a first level of success.

Once the grant was awarded, confirming in a sense the successful understanding of the call, a definition of success now based on actual IDR interaction started to be made explicit. When the available set of perspectives is so varied, diversity and plurality surely are considered of value, but they have to be collectively managed and channeled. The structure of interactions planned or already in progress delineated an initial network that seemed to assume the most stringent collaborative tasks as feasible. Participants believed they could overcome almost all difficulties and obstacles. The only remarkable axis of differentiation was between stakeholders and members of service-oriented governmental organizations heavily focused on outreach, and academic researchers mainly interested in modeling and publications.

A set of planned activities resulted from the composition of the selected team: a) linked modeling approaches for generation of climate and technology scenarios and assessment of decision outcomes; b) experiments on decision-making and behavior, including explicit consideration of adaptation and learning; and c) participatory research that drew on contextual knowledge and stakeholders' experiences and preferences. Given the strong focus on understanding the dynamics of human behavior and decisions, particularly with respect to the twin problems of choice and uncertainty in the context of a real-world complex natural/human system, special attention was paid to the active involvement of farmers and operational producers of climate information from governmental organizations.

Table II shows a collective synthesis of definitions of IDR drawn together during the project's first plenary session. The list is eloquent about the enthusiasm and optimism shared at the beginning of the project, when all impediments were minimized.

At the start, everything seemed possible. Participants´ representations of success/failure were conceived in an abstract and romantic way. They said they would achieve publications, an integrated model, policy prescriptions, a change in farmers' behavior, outreach products, new knowledge. They felt so enthusiastic and humorous that they even mentioned that IDR could achieve friendship, global harmony, and make them earn "frequent flyer miles and more money."

At this stage, the structure of interactions within the team, described as a network, showed the search for equilibrium among planned collaborations, analogous to the "balance in the weaving of perspectives into a whole" identified by Boix-Mansilla and Gardner (2006) as a core epistemic symptom of quality IDR work. An important first collective task addressed in plenary sessions centered on the design of a conceptual model that could synthesize the disparate knowledge of participants and enhance current modeling (i.e. through the inclusion of realistic estimates of uncertainty or fine-grained information about climate, agriculture and society). An underlying idea permeated the discourse: all participants would interact in an equitable way. They viewed themselves as equals and explicitly stated their willingness to participate in multiple project objectives. Even the coordinator spoke of himself only as a *primus inter pares*, merely in charge of the facilitation of activities.

A network was built that described the anticipated flows of data and information among participating institutions. Two features were apparent. First, the exchanges envisioned represented about a third of all possible links. Second, centrality metrics showed higher values for incoming links than for outgoing links. That is, most institutions expected to provide more information than they would receive. This is to be expected at the outset of a project, when institutions begin to work together.

Halfway along the project

Halfway through the project, the rapidly approaching end of funding introduced growing pressures and induced shifts in assessment criteria. Successful IDR started to be synonym of integrative, relevant and tangible outputs. Although at the start of the project the diverse and balanced composition of the team seemed sufficient to produce relevant collaborative knowledge, soon it became apparent that it was not. An enthusiastic and diverse team does not necessarily assure success of ID collaboration at the level of outputs and results. Participants still agreed that successful achievement had to be the consequence of interaction, but increasingly they accepted that such collaboration need not involve the team as a homogeneous whole, or that a single standard was needed to frame and solve research problems.

It is discursively recognized by funding agencies that useful outcomes of interdisciplinarity, as those of disciplinary basic research, cannot be measured directly on short terms (e.g. an annual basis) given their inherent unpredictability (NAS, 2005). In practice, however, short project durations and frequent reporting deadlines conspire against team-wide collaboration that tends to develop slowly. It takes time to generate mutual understanding and trust through deliberative horizontality. Furthermore, time-consuming redundancy becomes indispensable in IDR settings. A participant expressed this point with eloquence: "We have to repeat things several times, be they conceptual, procedural or organizational, until we can be sure that they are understood and accepted." The lack of time became a recurrent preoccupation of researchers. A combination of pressures related to project duration and a differential collaborative performance of individual participants or research units may have contributed to reducing the expectation of a generalized integration.

At a meeting of Argentine researchers held midway through the project, participants addressed the issue of the progress in their collaborative work. A collective synthesis of the ideas prevalent at the moment made clear that some participants had interaction problems: they were worried about the time required to consolidate data bases, to write a collective paper, to discuss issues that in their views could be closed without much deliberation, or to attend frequent meetings. The priority for stakeholders was the development or improvement of products and services, and did not share the academics' worries about publications. The stakeholders' interventions, at all times relevant, prevented scientists from forgetting the search for social robustness or from concentrating exclusively on scholarly problems. Their demands triggered innovative initiatives but also operated as a constant pressure.

Obstacles were now recognized as concrete and specific (i.e. different expectations about the timing of tasks, or different notions about how much simplification or realistic complexity should be introduced in models). In interviews and informal conversations held with participants, value conflicts, personality issues, compromises and negotiations were not stated explicitly or openly. Nevertheless, these issues started to emerge disguised as diverging perspectives of successful outcomes. Assessment criteria tied to tangible IDR outputs were accepted by the more active participants, who had acquired a rising consciousness of what a researcher referred as "the new avenues opened" by IDR interaction. Intangible, or to a great extent disciplinary results were mentioned as perceived outputs by less active researchers. Romanticism was over.

Although there were no apparent groupings of project participants along a single dimension (discipline, institution, or career stage), two coexisting groups of participants became apparent during this stage. The first group included researchers who formed highly-productive cliques with frequent and intensive interactions, whereas the second involved individual researchers or units that organized themselves around the project coordinator. The reasons behind the dual structure are not entirely clear, but may have responded, to a large extent, to a tight project schedule, the pressure to obtain useful and tangible results in a short timeframe, and the need to produce high-impact publications.

The two groups that developed had different ideas about the desirable intensity of actual ID collaboration, as well as different concepts of success. Researchers with frequent and intensive interactions elevated their stakes in the project, and continued to aim for higher standards of integration and effectiveness. They equated IDR success with a direct contribution to knowledge (NAS, 2005), which they called tangible results. For these participants, success meant research, educational and outreach efforts that ought to be objectively assessed through four important metrics: i) number and quality of project outputs, preferentially co-authored by participants from more than one discipline or institution; ii) number and quality of outputs involving both senior and junior members; iii) number and quality of services, materials and/or not strictly academic products, reflecting fluid communication with stakeholders and governmental organizations; and finally, iv) number of theses defended as a metric of successful teaching through research.

In contrast, researchers who organized themselves around the project coordinator or worked in isolation continued planning new fieldwork or near-future collaboration, attached to representations of success already redefined by other groups. Their work focused on products that in a strict sense were tied to a previous related project; their contributions to the present project played around initiatives proposed by the coordinator. This group stressed intangible outcomes or indirect contributions of interdisciplinarity to knowledge (NAS, 2005), such as the constitution of information-sharing networks, reciprocal learning, and a renewed understanding of their disciplinary problems. Their low interaction charged the coordinator with a double burden: cognitive, making him the only one in mastery of the general intellectual strategy, and managerial, compelling him to take a proactive leadership role in cases where cooperation had not emerged spontaneously.

It is important to note that the intermediate stage of a project is generally when teams explore their continuity in future projects. That is why, in this case, after designing arrangements to deepen integrative production of knowledge, a process begun in which participants who were less willing to pursue integration were not included in subsequent research proposals or applications for new funding to continue research.

The end of the project

At the final stage, successful IDR research is synonym of integrative outcomes. By the end of the project the collaborative structure of the team consolidated the interaction of a set of productive cliques. The centrality of the coordination, most apparent during the middle stage, faded somewhat. The cumulative intensity of interactions, quantified as the number of pairwise authorship in all project publications (506 from co-authored publications), exhibits high efforts of the team directed to produce integrated and relevant knowledge, not just a collection of disperse, separate or unusable findings.

Units that had worked in isolation or connected mainly with agents or institutions external to the team ended their work without open conflict, and simply did not pursue follow-up projects by the group. When asked, for a third time, about their criteria of success in IDR contexts, less integrated participants accommodated their representations to their actual situation. They lowered their own initial, self-defined standards of successful IDR interaction, emphasizing the value of indirect outcomes such as the establishment and consolidation of channels of communication among groups. Their epistemic measures of the acceptability of the results of IDR interaction equated successful outcomes to intangible intellectual goods that made them feel satisfied with their experience in the project.

In contrast, members of collaborative cliques were eager to develop IDR further. They were excited about having started new areas of research, created data bases, developed models, graduated students, and formed enduring partnerships of academics, governmental and non-governmental organizations and other stakeholders. These participants, together with a few new researchers, had developed, submitted and received a new grant that allowed them to continue working together, and in the new project they expected more interaction, collective work, and integrative results. Paradoxically, they did not feel as satisfied as the less integrated participants. They thought collaboration could be deepened and, consequently, their new project objectives posed more challenging standards of acceptability of IDR results. Now, their definition of success added new epistemic requirements to the quantitative and qualitative measures accepted at the middle stage. These exigencies were tied explicitly to what Boix-Mansilla and Gardner (2006) call the effectiveness with which outcomes advance understanding and inquiry. It was at this stage they felt ready to produce outcomes that would mark a significant difference with existing knowledge and services.

Conclusions

An assessment of IDR that seriously takes into account its cross-cutting nature is an open issue. Funders, managers and participants of the growing number of IDR teams with stakeholder involvement are interested in the formulation of reasonable assessment criteria for this type of knowledge production. Iterative learning and self-reflective processes are directed towards this formulation.

Although science is often recognized as an ongoing process both cognitive and social, an understanding of the dynamics of contemporary production of knowledge is often absent in its analysis. A static treatment of the subject has been avoided, and the need of a procedural consideration of what may be called cycles, short and long, of participation, collaboration and collective production of knowledge has been considered. It may be argued that the common features or patterns of processes of IDR collaboration that are characterized are also present in disciplinary settings. It is claimed, however, that they only occur in disciplinary teams, institutes or centers that have reached a high level of consolidation of a line of research. Indeed, also DR suffers multiple and additive pressures, but what is new in IDR is that they are experienced by teams since the very beginnings to the moment when, at least formally, projects are thought to end.

The common features are: 1) Processes usually involve teams able to consolidate a line of work and may not occur in those unable to follow studies further. The process of collaboration among participants involved in IRD exceeds the planned timetable (three years average), implying re-composition of IDR teams in successive projects. In the long run active researchers and stakeholders move up their expectations. 2) Results of past projects, commitment with present objectives and tasks, and prospective programming for the continuity of work live together in IDR. 3) At different stages of the interaction, the protagonist role of the project direction/coordination rises and decays, making its action a key element.

This process is long, involving regular phases:

Periods of team assembly/reassembly that include development and submission of research proposals, enthusiasm and commitment to general common goals and values, a willingness to interact with and learn from many different groups, and the perception that all obstacles are surmountable.

Intermediate phases when actual interactions and specific conceptual, and practical integration, become crucial. This is a phase of potential conflict that may break the overall collaborative structure into two types of participants: active cliques that integrate their contribution and individuals or groups unable to properly join collective work. Although contested feelings about the value of IDR ventures may emerge among participants, in our case conflict did not relate to the overall satisfaction or commitment of participants, or to incompatibility between the logics of disciplinary and interdisciplinary work, but to participants' different capabilities of col-

laboration, constraints emerging from schedules and the need to trespass a minimum level of general agreement on objectives, scientific terminology and strateg

Final stages often become "between projects" phases when IDR has been successful. This is a phase when integrative outcomes become crucial.

The present case shows that criteria of IDR success change along the process of interaction and collective knowledge production in relation to a) the stage of the process of collaboration, and b) the performance of participants as concerns actual interaction and productivity.

Teams tend to emphasize equal status and consensus at initial stages when assessment criteria point to conditions of success, general aims and values that, although being selective and stringent, they satisfy. Teams can plan a balanced allocation of tasks and responsibilities, but this does not necessarily imply that generalized interaction and consensus on integrative results will occur.

Those conditions for success must be distinguished from successful outcomes, be they direct or indirect contributions to knowledge and action, required in intermediate and final phases. When the focus is placed on outcomes (i.e. results and products) definitions of success tend to include not only the quantitative and qualitative criteria typical of disciplinary settings (i.e. number and impact of publications) but also the epistemic values specific of IDR, namely consistency with previous disciplinary knowledge and effectiveness in the advancement of understanding of complex problems. This combination, added to the requirement of social relevance stressed by stakeholders, places an enormous pressure on participants and a heavy burden on the coordinator. In this case, those who interacted more, worked on and reached tangible outcomes, increasing their expectations about relevant collective results. Those who could not properly work with others lowered their expectations to fit just with intangible outcomes such as achieving cognitive influences, mutual learning, understanding and communication. The multiplicity of outcomes of IDR, tangible and intangible, direct and indirect, short and long term, allowed all participants gain a positive view of their experience, although only those productive stood in a position to develop IDR further in successive funded projects.

Stakeholder involvement in the whole research process, from project definition to outcome validation, had multiple advantages. Indeed, stakeholders and participants from GOs were those most prone to collaborate and intervene in collective activities, always fostering learning and pointing to usable knowledge. What prevailed as a source of a veiled conflict had to do with the disparate priorities, expectations, capabilities for collaborative work and timing of scholars, not those of stakeholders. Academics made efforts to produce novel work and to avoid working in isolation, but papers and grants remained extremely important to them. To obtain grants that allowed the team to continue working on objectives increasingly ambitious constituted for them a privileged objective metric of success. At the same time, this aim tended to conspire against generalized collaboration, and ended in the segregation of less integrated participants.

An additional point to stress concerns what Cummings and Kiesler (2007) have treated as coordination costs. Indeed, despite the advantages of shared resources and expertise, collaborative research involving multiple institutions impose high burdens on coordination. In the present case, dissimilar organizational structures and epistemic differences had to be worked out and negotiated by participants through explicit self reflection. Group communication and consensus-making charged the coordinator with both administrative and cognitive responsibilities that had to be addressed so they would not become barriers to research continuity in successive projects.

The complex nature and social relevance of the problems scientists are called to address allow anticipating that IDR with stakeholders' commitment will grow and expand as a pattern of organization of knowledge production. In such a context, reaching reasonable criteria for the assessment of IDR results constitutes a priority. The study of an illustrative case, highlighting the challenges faced by a team and the dynamics of recurrent redefinitions of criteria that its members managed to conceive, is meant to contribute to the formulation of realistic criteria, not *a priori* ones, suited for the improvement of contemporary science.

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DEL ENTUSIASMO AL PRAGMATISMO: CAMBIOS EN LAS PERSPECTIVAS DE ÉXITO EN LA INVESTIGACIÓN INTERDISCIPLINARIA

Cecilia Hidalgo, Claudia E. Natenzon y Guillermo Podestá

RESUMEN

Formular criterios de evaluación para la investigación interdisciplinaria (IID) que tomen en cuenta su especificidad y transversalidad es un asunto difícil pero clave. Se presentan los resultados del estudio de un equipo de investigación interdisciplinario, multi-institucional y multinacional, convocado para abordar un problema altamente complejo con relevancia social: comprender y modelar la gestión adaptativa de ecosistemas agrícolas en la Pampa del centro-este argentino, en respuesta a la variabilidad climática y otras fuentes de riesgo e incertidumbre. El análisis se focaliza en las cambiantes perspectivas y mediciones del "éxito", sostenidas por los participantes en tres etapas específicas del proceso de colaboración: el inicio, un momento intermedio (a los dos años de un proyecto de tres) y el final. El caso ilumina una dinámica de producción de conocimiento en la cual un moderado nivel inicial de comprensión y acuerdo sobre puntos de vista alternativos puede no ser considerado suficiente en posteriores fases de la cooperación, cuando se espera que surjan criterios basados en estándares integrativos. A lo largo de la interacción de la IID, obstáculos y restricciones reaparecen recurrentemente en forma sutil, haciendo que los participantes activos adquieran conciencia creciente de la posibilidad de alcanzar metas más exigentes y, en consecuencia, del surgimiento de nuevos malentendidos.

DO ENTUSIASMO AO PRAGMATISMO: MUDANDO AS PERSPECTIVAS DE SUCESSO NA PESQUISA INTERDISCIPLINAR

Cecilia Hidalgo, Claudia E. Natenzon e Guillermo Podestá

RESUMO

A formulação de um critério de avaliação da pesquisa interdisciplinar (PII) dentro dos seus próprios termos, se põpoe como uma questão central e problemática. Este artigo relatará os resultados obtidos de um estudo de caso realizado por um grupo de pesquisa interdisciplinar, multi-institucional e multinacional, reunidos com o objetivo de abarcar uma questão social tão relevante quanto complexa: a compreensão e representação através de um modelo, da administração dos ecossistemas agrícolas situados na Pampa da região centro-leste da Argentina, como respostas adaptativas às variações climáticas e outras fontes de risco e incerteza. A análise focaliza-se sobre as perspetivas alternantes e medidas de "sucesso" sustentadas pelos participantes em três fases específicas do processo de colaboração: inicio, estágio intermédio (cerca de dois anos para um projeto previsto de três) e final. O caso ilustra uma dinâmica específica de produção do conhecimento, na qual o moderado nível inicial de compreensão e arranjo de posicionamentos alternativos, podem ser considerados como insuficientes nas fases de interação subseqüentes, dentro das quais prevê-se o estabelecimento de critérios baseados em parâmetros de integração. Ao longo da PII vê-se reemergir de forma sutil, porém recorrente, necessidades e obstáculos resultantes das interações, fazendo com que seus participantes ativos desenvolvam um estado de consciência crescente, no que se refere o reconhecimento da existência de novos objetivos alcançáveis e do surgimento de possíveis malentendidos e incompreensões resultantes deste processo.