

Conducting Interdisciplinary Research in Higher Education: Epistemological Styles, Evaluative Cultures and Institutional Obstacles

Sabine Hoidn

University of St. Gallen, Switzerland

Abstract: Complex problems cross the boundaries of traditional disciplines and thus, require researchers and research groups in higher education to engage in interdisciplinary inquiry and collaboration to generate knowledge that is more than the sum of its parts. This article explores interdisciplinary research in higher education and the different views scholars in the social sciences (e.g., education, sociology, economics) hold in terms of how knowledge is produced, integrated and evaluated. Hindering institutional factors of interdisciplinary research that linger within the existing departmentalized framework at many higher education institutions are discussed. Finally, conclusions and implications are drawn to facilitate interdisciplinary research likely to advance fundamental understanding and lead to relevant, applicable and socially valuable results.

Keywords: Interdisciplinarity; Interdisciplinary research; Epistemic cultures; Evaluative cultures; Institutional obstacles; Social sciences; Higher education.

I. INTRODUCTION

Interdisciplinarity, understood as the general phenomenon of combining or integrating disciplinary perspectives, is a major approach in the new academy of the 21st century because complex real-world issues necessarily cross the boundaries of traditional disciplines. More and more researchers continue to recognize the limitations of their disciplinary lenses in that “a single discipline alone cannot cope with the challenges of complex societies, competitive knowledge-based economies or pluralistic democracies” (Božić & Pohoryles, 2009, p. 144; Choi & Pak, 2006; Klein, 2010). Contemporary issues and challenges facing society demand the collaboration of multiple disciplines with different cultures, standards and languages (Bergmann et al., 2012; Boix Mansilla, Lamont & Sato, 2016; Klein, 2013; Weingart, 2010).

Against this backdrop, interdisciplinary studies refer to “a process of answering a question, solving a problem, or addressing a topic that is too broad or complex to be dealt with adequately by a single discipline, and draws on the disciplines with the goal of integrating their insights to construct a more comprehensive understanding” (Repko & Szostak, 2017, p. 16). Thereby, the concept of interdisciplinarity is complementary to and corrective of the disciplines since the former draws on disciplinary perspectives. Thus, understanding the role of disciplines in interdisciplinary studies is central to a full understanding of interdisciplinarity (Klein & Newell, 1998).

In recent decades, interdisciplinary research (IDR) and the creation of interdisciplinary programs, research groups, centers and institutes have become integral features of academia. Federal US funding agencies such as the National Institutes of Health (NIH) and the National Science Foundation (NSF), for example, have begun to offer support for research that is explicitly “cross-cutting” or “bridging” between and among disciplines in order to push fields forward and accelerate scholarly discovery (e.g., IDR in neuroscience and nanotechnology). Although academic training and specialized research in the disciplines remain crucial in scientific research, IDR promises to play an increasingly vital role in the coming decades.

This article uses the term IDR since it focuses on the advancement of knowledge in ways not possible through traditional disciplinary research (Lyll, Bruce, Tait & Meagher, 2011). First, IDR is defined and its main characteristics are outlined. Second, the different views scholars in the social sciences (e.g., education, sociology, economics) hold in terms of how knowledge is produced, integrated and evaluated are explored. Third, hindering institutional factors of IDR that linger within the existing departmentalized framework at many higher education institutions are discussed. Finally, some conclusions and implications are drawn to facilitate interdisciplinary higher education research.

II. INTERDISCIPLINARY RESEARCH IN HIGHER EDUCATION

According to Tight (2004, p. 410) higher education research needs to be recognized “as an interdisciplinary field of research in which multiple communities of practice operate.” The implications are twofold: researchers need to engage with different disciplinary perspectives and the field of higher education research needs to find more effective means of bringing researchers with different disciplinary perspectives together (Davies, Devlin & Tight, 2010). According to MacKinnon, Hine and Barnard (2013) IDR processes are characterized by interdisciplinary activities that are a natural progression in the scientific quest to both solve problems and built upon the success of disciplinary science. Researchers tend to engage in interdisciplinary activities when it becomes obvious to them that moving beyond their field is necessary for extending scientific knowledge. The US National Academies (2005) defines IDR as 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. (p. 188)

The definition highlights four important characteristics of IDR: The mode of research (teams or individuals), the centrality of integration, the embeddedness of disciplines as knowledge sources and the aim of advancing theoretical and practical understanding (see also Hoidn, 2010).

- Fiore (2008, p. 256) suggests that, “by reframing interdisciplinarity as a process of teamwork to be mastered, that is, as an understanding of the teamwork activities necessary for success, and not primarily as a product that emerges, we may be able to make the achievement of interdisciplinarity more tractable” (see also Repko & Szostak, 2017). IDR is often “team science”; consequently, difficulties can arise from both the interaction of knowledge experts and the content itself.
- IDR places a distinctive emphasis on the integration of disciplinary theories, concepts, methods and tools from different disciplines such as political science, philosophy, sociology, education, economics, law or medicine to advance a particular purpose. Similar to a painter mixing one or more of the basic colors to make a new color, IDR continues to require concepts and methods developed through disciplinary research. The integration of disciplinary knowledge creates new connections between disciplines and new explanations of complex phenomena (Cheng, Henisz, Roth & Swaminathan, 2009).
- The problem-driven nature of IDR strives to leverage cognitive resources in order to achieve cognitive integration and strongly depends on situational factors and circumstances (e.g. institutional structure, funding) largely determining success or failure (Hollaender, Loibl & Wilts, 2008).
- Finally, compared to disciplinary research, IDR tackles more broadly defined goals with an explicit reference to practical relevance and societal value in addition to advancing fundamental understanding. Thus, IDR creates an additional complexity as it transgresses boundaries between academic disciplines and between science and practice.

III. MOVING BEYOND DISCIPLINARY LENSES

High-quality IDR depends on the presence of experts with strong backgrounds in their respective disciplines. Thereby, academic disciplines provide some general patterns or paradigms for analysis, which are applied to the phenomenon under study (Krishnan, 2009). Yet, while a strong background in a discipline is important for investigating complex issues, interdisciplinary researchers also require a ‘synthesizing mind’ (Gardner, 2006). Solving complex problems affords investigators who can engage in interdisciplinary translation and synthesis, as part of multidisciplinary teams or individually, in order to develop more complete pictures than would be possible from any one disciplinary perspective. To create knowledge that no single discipline can create on its own, researchers from different disciplines need to learn how to access, understand, employ, and synthesize the expertise from various disciplines (Golding, 2009; Lyall et al., 2011).

The IDR process as necessary and beneficial it might be is a challenging one because higher education brings together disciplines that are remarkably different in their intellectual traditions, evaluative cultures and professional languages. Different disciplines such as education, sociology or economics have distinct cultures, diverging research worldviews and standards, and different ways of doing science. Most of today's scholars have been educated and worked in largely disciplinary cultures (e.g. O'Rourke & Crowley, 2013). They absorb a variety of beliefs and perceptions about disciplinary cultures, especially each field's approach to producing and evaluating knowledge. They become familiar with these differences through intellectual activities such as graduate training, mentoring or reading within and outside their fields, as well as through the formal and informal activities of everyday life at colleges and universities (Lamont, 2009). Consequently, disciplines frame the way scholars see the world – they learn to see the world through “disciplinary lenses” (Boix Mansilla, Miller & Gardner, 2000). Successful IDR, however, requires creating and sustaining an interdisciplinary culture.

The following sections refer to widely accepted research worldviews that scholars in the social sciences, referring to disciplines that seek to explain the human world and figure out how to predict and improve it, hold in their respective fields. These views influence not only how knowledge is produced and integrated but also how research quality is defined and evaluated.

A. Epistemological styles to produce knowledge:

Scholars in one discipline cannot count on scholars from other disciplines to share their theoretical and methodological preferences, or what they perceive as being the key cognitive conventions of their discipline. Epistemological styles refer to preferences for particular ways of understanding how to build scholarly knowledge. Differences in epistemological styles frequently culminate in polarizing stances that occur within and across academic disciplines with researchers arguing that there is only one correct approach to both theory and method or that one approach is generally better than the other. In terms of theory, preferences range from the view that authors should acknowledge how the formulation of their theoretical orientation is shaped by their own social location, identity, and political orientation, to the view that theories emerge from the observation of new evidence in light of existing explanations, without being affected by the researcher. In terms of methodological preferences some fields favor empiricism with researchers emphasizing hypothesis testing and privileging the role of formal models for proving theories. Other fields consider interpretation (“story-telling”) an essential ingredient with scholars vehemently rejecting other approaches in favor of a contextual or narrative method. Social scientists, especially those who champion empiricism, often deride interpretation as a corrupting force in the production of truth. Yet others distinguish between the pursuit of pure versus applied knowledge (Lamont, 2009).

Guetzkow, Lamont and Mallard (2004) differentiate among four epistemological styles academics in the social sciences use to produce knowledge:

- The comprehensive style is the most widely used style in social science and humanistic research valuing “verstehen,” attention to details, and contextual specificity in research proposals.
- The constructivist style values reflexivity, that is, consideration of the impact of the researcher's identity and commitment on his/her analysis. It appeals to anti-positivists whose research is politically or socially engaged.
- The positivist style favors generalizability and hypothesis testing and is used most often by social scientists.
- The utilitarian style resembles the positivist style, but it values only the production of instrumental knowledge. This is the least popular style.

Overall, explanation and interpretation, and positivism and hermeneutics, together with qualitative and quantitative research methods are fault lines separating the social sciences from other disciplines such as the humanities (Lamont, 2009). Finding ‘common ground’ requires researchers to discover what concepts they have in common with their collaborators and agree on the terms they will use to denote these concepts. This grounding process evokes high transaction costs because due to their different backgrounds researchers have to negotiate common ground to bridge the epistemological gap (Bromme, 2000; Miller et al., 2008; O'Rourke & Crowley, 2013).

B. Processes of interdisciplinary knowledge integration:

As IDR deals with complex problems and often appears to be an interdisciplinary team effort, integration is a core methodology for successful IDR (O' Rourke, Crowley & Gonnerman, 2016). However, empirical IDR tackling the

phenomenon of interdisciplinary integration and the human conditions that make it possible is scarce – especially with regard to interactional processes. So far, research on interdisciplinary integration has dealt mainly with either cognitive/epistemological, social or institutional concerns while few studies have attempted to integrate these perspectives (Boix Mansilla, 2006; Gorman, 2010; Repko & Szostak, 2017; Repko, Newell & Szostak, 2012).

Research conducted by a group of researchers around Veronica Boix Mansilla and Michele Lamont at Harvard University investigated the intricate workings of IDR collaborations of academics based on multiple method case study research involving six different interdisciplinary research networks in North America. Interdisciplinary success was defined as a multidimensional reality that centers not only on cognitive achievement but also on emotional and interactional aspects of interdisciplinary collaboration. Hence, their study aimed at understanding how cognitive, emotional, social and institutional conditions operate in the creation and sustenance of interdisciplinary groups from the perspective of group members (Boix Mansilla, Sato, Chua, Hoidn, Ivanier & Lamont, 2010).

The main findings show three analytically distinct and empirically sound dimensions – cognitive-intellectual, emotional, and socio-interactive – as well as constitutive markers of success and facilitating conditions for each dimension that enable successful IDR (Boix Mansilla, 2010; Boix Mansilla et al., 2016; Hoidn, 2014; see Table I).

- The cognitive-intellectual dimension refers to the problems deemed significant and worthy of IDR, the selection of adequate collaborators, theories and methods from various disciplines, and the criteria by which findings are validated. The empirical study found the following markers that constitute successful interdisciplinarity: Mutual learning (impact each other’s research, interdisciplinary leverage), favorable conditions for further productive collaboration, and clear common intellectual ground for exchange. Intellectual factors that facilitate interdisciplinary success are: Participant qualities (expertise, open mindedness, interest, interactional styles), a clear collective mission with a sense of mutual need of expertise and commitment to a shared agenda, and productive problem framing (inviting different expertise, optimally ambiguous and intellectually engaging process).
- The emotional dimension refers to the participants’ intellectual excitement and emotions (e.g., passionate thoughts, surprise, connection, frustration of incoherence) that they experience when collaboratively tackling challenging problems in new ways and maintaining collective effervescence. Markers of success for the emotional dimensions are the “joy” of working together and shared the emotional dimensions are the “joy” of working together and shared excitement about the work. Conditions that facilitate success are feelings of trust, respect, admiration (identification) and feeling good about self, contributing and being recognized. On the flip side this can also include the feeling that one is “dissed,” not valued or not fully integrated in a collective project.
- The socio-interactive dimension refers to the ways in which participants interact with their peers giving rise to a group’s unique emerging working style or shared repertoire of behaviors, beliefs, values and artifacts. This dimension embodies the processes by which individuals build (or fail to build) trust, belonging, meaningful attachments, and a group-specific “way of doing things.” A growing capacity for deliberation and learning as an interdisciplinary group, a shared sense of group identity, the building of meaningful relationships, strong collective moral norms supporting trust, and the existence of shared working styles were found to be crucial signs of success. Facilitating conditions for success include the construction of a collective identity, a climate of conviviality and openness, effective leadership, and participant qualities like sociability and status. This way, participants experience the pleasures and excitement of working together on something meaningful and interesting.

TABLE I: DIMENSIONS, MARKERS AND FACILITATING CONDITIONS OF SUCCESSFUL IDR (adapted from Boix Mansilla et al., 2010; Boix Mansilla et al., 2016).

Dimension	Definition, characteristics	Markers of success	Facilitating conditions for success
Cognitive-intellectual	Substantive problems worthy of IDR; adequate collaborators, theories and methods from various disciplines; validation criteria	<ul style="list-style-type: none"> - Experts learn from other disciplines - Generative continuation of the group’s research - Clear common ground for exchange (language, framework) 	<ul style="list-style-type: none"> - Participant qualities - Clear collective mission, sense of mutual need of expertise and commitment to the shared agenda - Productive problem framing

Emotional	Participants' emotional relationship with the topic of research and in the collaboration	<ul style="list-style-type: none"> - Joy of working together in ID contexts - Collective intellectual excitement 	<ul style="list-style-type: none"> - Feelings of trust, respect, admiration - Feeling good about self – contributing and being recognized
Socio-interactive	Concerned with relationships, meaning making and emerging work styles	<ul style="list-style-type: none"> - Growing deliberation and group learning competency - More comfort, trust, capacity to interact productively - Meaningful personal/ intellectual ties with peers 	<ul style="list-style-type: none"> - Climate of conviviality, open exchange and sense of possibility - Effective leadership - Participant qualities - (sociability/prestige/ open-mindedness)

These research findings on successful IDR not only specify three dimensions but also lay out constitutive markers of success and facilitating conditions for each dimension that can make successful IDR processes in higher education happen.

C. Evaluative cultures and definitions of excellence:

The evaluative cultures of academic disciplines vary greatly. There is little cross-disciplinary consensus about what excellent research means and how it is achieved. Members of the various disciplines define research quality differently and often also weigh criteria for assessing quality or excellence differently (Lamont & Guetzkow, 2016). “‘The cream of the crop’ in an English or anthropology department has little in common with ‘the best and the brightest’ in an economics department” (Lamont, 2009, p. 2). How is the goal of finding and rewarding excellence understood across disciplines? Lamont (2009) found evidence of disciplinary variations in the extent to which scholars from different disciplines believed academic excellence exists; agreed on what defines excellence; and believed that excellence is located in the object of evaluation (that is, the proposal), as opposed to the eye of the beholder (in the intersubjective agreement that emerges from negotiations among scholars). These variations can be explained in part by the epistemological culture of the field, that is, the extent to which scholars understand criteria of evaluation as valid per se or as expressing and extending power dynamics in terms of who sets the standards (Lamont & Guetzkow, 2016).

Interdisciplinary researchers tend to promote methodological pluralism. But significantly, such methodological pluralism does not favor the use of consistent criteria across disciplines; instead, different research proposals prime evaluators to use different standards. Funding decisions, for instance, are often made by multidisciplinary panels, which have to create shared evaluations across epistemological and other divides. This context primes academics from different disciplines to make explicit their shared, taken-for-granted perspectives as well as their differences (e.g. regarding the proper place of subjectivity or contrasting views on theory, method, and standards of evaluation). This complex, nonlinear method speaks to the pragmatic character of evaluation, which is driven by problem solving and satisficing (i.e. aiming for an adequate outcome), as opposed to a more rigid cognitive coherence. Hence, the standards used to evaluate IDR are not a simple combination of the standards of single disciplines but instead they are an emergent hybrid developing through practice and deliberation (Lamont, 2009).

Pragmatic customary rules that are created and learned by researchers during their immersion in collective work (“customary” because the rules are not formally spelled out) can facilitate interdisciplinary deliberations since they act as constraints on and regulators of behavior as well as justifications that create commitments (Lamont & Huutoniemi, 2011). Customary rules such as:

- deference to group members’ expertise. i.e. researchers mark their territory and draw on previously established proofs of competence,
- respecting disciplinary sovereignty, i.e. group members’ opinions generally are given more weight according to how closely the area of deliberation overlaps “their” fields and
- collegiality, i.e. the quality of how researchers present themselves in cognitive, moral and emotional terms,

help group members with different disciplinary backgrounds to engage in productive interactional processes of collective decision making. These rules also allow researchers working in interdisciplinary teams to draw emotional and cognitive boundaries within relationships of exchange and deliberation. Continuing interactions also seem to contribute to the creation of a repertoire of customary rules organizing members’ behavior and contributing to the group’s identity formation (Hoidn, 2010).

IV. INSTITUTIONAL OBSTACLES FOR DEVELOPING AN IDR CULTURE

Various hindering institutional factors of IDR linger within the existing departmentalized framework at many higher education institutions. These barriers obstruct faculty participation in IDR and impede the successful flow of ideas, people, and resources across disciplinary boundaries. The strong departmental structure of academia, the growing demands on faculty time, and the exigencies of keeping up in one's own field make productive interdisciplinary collaboration difficult according to Lamont (2009; see also Townsend, Pisapia & Razzaq, 2015). Klein (2010, p. 5) points to "(o)rganisational road-blocks, skepticism and lack of agreed-on metrics to gauge quality" as impediments for changes toward IDR. Hence, the main reason why developing a culture of interdisciplinary collaboration is challenging likely lies in the long-standing disciplinary-dominated academic structures and cultures of higher education institutions (e.g. Frodeman, Klein & Mitcham, 2010).

Disciplinary structures: The infrastructure of the modern university discipline-boundedness hampers interaction among different disciplines. Discipline-oriented departments constitute a functional authority structure in charge of degree programs, teaching, faculty recruitment, and promotion posing a major barrier to IDR collaboration. Administrative barriers between academic departments and schools further complicate interdisciplinary collaboration and communication. In addition, buildings often physically delineate collaboration and the dissemination of knowledge with the latter having been divided into components which serve as the basis for academic disciplines. Institutional policies regarding the allocation of laboratory space, hiring, and promotion policies are managed by disciplinary departments with colleges and departments competing for resources. Existing funding mechanisms reinforce the departmental structure since they are regularly aligned with disciplinary research with the lion's share of resources flowing to schools and departments. Hence, many view interdisciplinary centers and programs competing with departments and discipline-based research centers for scarce resources. Last but not least, the academic reward structure is based upon the judgment of disciplinary peers and thus discourages interdisciplinary collaboration (Dubrow, Tranby & Voight, 2009; Klein, 2010; US National Academies, 2005).

Disciplinary cultures: Conflicting values, differences in epistemology, finding "common ground" through deliberation (transaction costs), communication problems and territorial and status conflicts are cultural barriers that constitute major impeding factors for IDR (Hoidn, 2010; O'Rourke & Crowley, 2013). In addition, loyalty to the department or one's discipline can lead to irrational and anti-interdisciplinary decisions. The climates of departments and schools are often indifferent or even hostile to interdisciplinary activities. University faculty members are trained in disciplinary programs with specific majors and departmental affiliations. Disciplinary areas have their own pecking order, and social sciences are often seen as easier and less quantitative as compared to natural sciences. Methods and criteria for evaluation of research quality are different for different disciplines making it difficult for interdisciplinary team members to evaluate each other's research. Some disciplines might even be viewed as less rigorous or important. Practices regarding authorship on refereed publications differ among disciplines and even in different branches within a given discipline. Disciplinary language can also be a major barrier to IDR. Different disciplinary journals use different notations and particular vocabularies (jargon) to describe terms which are often not comprehended by scholars from other disciplines. Each discipline has its own patterns, meanings, symbols and behaviors that are influenced by the "knowledge traditions". Finally learning another field of knowledge compromises time scholars can devote to their own discipline (Bililign, 2013).

The following Table II summarizes specific barriers and disincentives to interdisciplinarity that frequently appear in the literature and often confer "second-class citizenship" on their members.

TABLE II: BARRIERS AND DISINCENTIVES TO INTERDISCIPLINARITY (Klein, 2010, pp. 72–73).

Dimension	Definition, characteristics
Organizational structure and administration	<ul style="list-style-type: none"> - Rigid one-size-fits-all model of organizational structure - Discipline- and department-based silos of budgetary and administrative categories - Territoriality and turf battles over budget, ownership of curriculum and research - Ambiguous status of ID programs, centers and institutions - Piecemeal approaches - Lack of experienced leaders - Resistance to innovation and risk - Dispersed infrastructure - No clear and authoritative report lines for ID units

Procedures and policies	<ul style="list-style-type: none"> - Inflexible guidelines that inhibit approval of new programs and courses - Rigid and exclusionary degree requirements - Lack of guidelines for ID hiring, tenure and promotion and salary collaboration - Unfavorable policies for allocation of workload credit in ID teaching - Unfavorable research policies for sharing indirect cost recovery from external grants and allocating intellectual property
Resources and infrastructure	<ul style="list-style-type: none"> - Inadequate funding and ongoing support for ID units - Inadequate number of faculty lines for interdisciplinary studies (IDS) and IDR - Restricted access to internal incentives and seed funds for ID research and curriculum development - Competition for funds and faculty between departments and ID units - Inadequate space and equipment and inflexible allotments of use - Weak or no faculty development system - Ignorance of ID literature and resources in national networks - Insufficient time for planning and implementing program and project infrastructure - Insufficient time to learn the language and culture of another discipline - Insufficient time to develop collaborative relationships in team teaching and research
Recognition, rewards and incentives	<ul style="list-style-type: none"> - Invisibility and marginality of ID research, teaching, service, advising and mentoring - Reliance on volunteerism and overload - Weak networking channels and communication forums - Ineligibility of ID work for awards, honors, incentives and faculty development programs - Lack of support at department, college or university levels - Negative bias against ID work

A vast array of factors in higher education work against disciplinary and epistemological pluralism. The obstacles presented above show that changes have to be made at the institutional level to intentionally remove these structural and cultural barriers to the facilitation of IDR. Developing an interdisciplinary institutional culture requires shifts in organizational behavior and norms that necessitate institutional support (Klein, 2010).

V. CONCLUSIONS AND IMPLICATIONS FOR FACILITATING IDR IN HIGHER EDUCATION

IDR provides new opportunities to counterbalance specialization and address complex societal problems that are too broad for a single approach. For centuries, interdisciplinarity has been the hallmark of scientific discovery in the natural sciences, as was the case with Charles Darwin's interdisciplinary theory on natural selection, or the elucidation of the function and structure of DNA informed by physics and biology, for example (MacKinnon et al., 2013). Nevertheless, for higher education institutions interdisciplinarity presents challenges due to disciplinary differences with regard to producing knowledge (epistemological styles), integrating knowledge (the conditions that make it possible) and evaluating knowledge (standards for research quality). The problems faced by researchers from different disciplines working together have much in common with the Indian story of the five blind men who together are trying to picture an elephant. Each of them focuses on a specific part of the elephant – the trunk, the ears, the tail, but in fact, the animal is defined by all of its parts (Lamont, 2009).

As Boix Mansilla et al. (2010, p. 17) point out, "The success of an interdisciplinary group pivots on its capacity to amalgamate disciplinary perspectives in order to leverage understanding." Empirical research examining the intellectual and interactional qualities of interdisciplinary and collaborative work of academics (IDR) shows that the effective interdisciplinary integration of knowledge depends on individuals engaging in examining a relatively shared problem and advancing productive insights through interdisciplinary exchange. Three dimensions – cognitive-intellectual, emotional and socio-interactive – and their markers of interdisciplinary success as well as facilitating conditions that enable successful interdisciplinary work (see Table I) need to be accounted for to create and maintain a favorable environment for IDR (Boix Mansilla et al., 2016).

Successful IDR requires creating and sustaining a culture of interdisciplinary inquiry and collaboration in higher education institutions. However, the latter face various institutional obstacles that lie in the long-standing disciplinary-dominated academic structures (e.g. discipline-oriented departments, administrative barriers, dispersed infrastructure, institutional procedures and policies, reward structure) and cultures (e.g. conflicting values, differences in epistemology and knowledge traditions, communication problems, territorial and status conflicts, loyalties).

Overall, IDR requires complex intellectual and social processes enabling information sharing, knowledge generation, integration and evaluation. In general, the need for collaboration and communication increases with the degree of synthesis, that is, the level of integration of the expertise of each group member. The previous discussion indicates that for scholars in higher education to participate in excellent IDR and for research in higher education to transcend disciplinary boundaries, the following facilitating conditions are crucial steps:

- Scholars in the social sciences have to combine disciplinary depth (i.e. adequate grounding in a discipline) with the ability to work productively and collaboratively in interdisciplinary teams. They need to acquire expertise in their discipline and display personal traits as well as interpersonal skills (e.g. intercultural communication, leadership, trust, sensitivity to others, respectfulness, conflict resolution). Moreover, the motivation and willingness to learn and work not only on an individual level but also in interdisciplinary and international teams are crucial (e.g. accept alternative methodologies, defer to group members' expertise, develop a common language).
- Higher education institutions, schools and departments have to further reduce structural and cultural barriers (see Section: "Institutional obstacles for developing an IDR culture") in order to successfully practice and manage IDR. They need to provide more education and training to prepare scholars for interdisciplinary teamwork and to further develop collaborative competencies crucial for interdisciplinary success (e.g. group dynamics, problem-solving, decision-making). Such training can start by introducing graduate students and doctoral students to quantitative and qualitative methodological paradigms relevant to their discipline or by requiring them to work together on interdisciplinary projects. Familiarizing students with different methodological paradigms early allows them to compare the different research worldviews and to apply and examine different research methods and findings according to the nature of the problem at hand (e.g. Hoidn & Olbert-Bock, 2016, for the context of management education).

The shift from primarily single principal investigator, single-discipline work to collaborative, problem-based, interdisciplinary teams that span institutional boundaries has been driven to a large extent by the recognition that innovative research often happens at the intersection of disciplines. Creating and sustaining an interdisciplinary culture for successful IDR practice and management; however, requires time and effort. Commitment to a collective vision, strong leadership, behavioral ground rules, reciprocal inter-cultural learning and institutional support in the face of greater administrative burdens associated with interdisciplinary endeavors are crucial to promote successful IDR collaborations in higher education institutions.

REFERENCES

- [1] Bergmann, M., Jahn, T., Knobloch, T., Krohn, W., Pohl, C. & Schramm, E. (2012). *Methods for transdisciplinary research*. Frankfurt, Germany: Campus Verlag.
- [2] Bililign, S. (2013). The need for interdisciplinary research and education for sustainable human development to deal with global challenges. *International Journal of African Development* 1(1), 82–90.
- [3] Boix Mansilla, V. (2006). Quality assessment of interdisciplinary research: Toward empirically grounded validation criteria. *Research Evaluation* 14(4), 17–29.
- [4] Boix Mansilla, V., Lamont, M. & Sato, K. (2016). Shared cognitive-emotional-interactional platforms: Markers and conditions for successful interdisciplinary collaborations. *Science, Technology, & Human Values* 1–42. doi: 10.1177/01622 43915614103
- [5] Boix Mansilla, V., Miller, W. C. & Gardner, H. (2000). On disciplinary lenses and interdisciplinary work. In S. Wineburg & P. Gossman (Eds.), *Interdisciplinary curriculum: Challenges to implementation* (pp. 17–38). New York, NY: Teachers College Press.
- [6] Boix Mansilla, V., Sato, K., Chua, F., Hoidn, S., Ivanier A. & Lamont, M. (2010). *Building socio-emotional-cognitive platforms for interdisciplinary research collaborations*. Report prepared for the Canadian Institute of Advanced Research. Cambridge, MA: Harvard University.
- [7] Božić, S. & Pohoryles, R. J. (2009). Why bother with interdisciplinarity in the social and human sciences? *Innovation – The European Journal of Social Science Research* 22(2), 143–145. doi:10.1080/13511610903155589
- [8] Bromme, R. (2000). Beyond one's own perspective: The psychology of cognitive interdisciplinarity. In P. Weingart & N. Stehr (Eds.), *Practicing interdisciplinarity* (115–133). Toronto, Canada: University of Toronto Press.

- [9] Cheng J. L. C., Henisz W. J., Roth K. & Swaminathan A. (2009). Advancing interdisciplinary research in the field of international business: Prospects, issues and challenges. *Journal of International Business Studies* 40(7), 1070–1074. doi: <http://dx.doi.org/10.1057/jibs.2009.41>
- [10] Choi, B. C. K. & Pak, A. W. P. (2006). Multidisciplinarity, interdisciplinarity and transdisciplinarity in health research, services, education and policy: 1. Definitions, objectives, and evidence of effectiveness. *Clinical and investigative medicine*, 29(6), 351–364.
- [11] Davies, M., Devlin, M. & Tight, M. (2010). *Interdisciplinary higher education: perspectives and practicalities, international perspectives on higher education research* (Vol. 5). Bingley, UK: Emerald.
- [12] Dubrow, G., Tranby, E. & Voight, C. (2009) (Eds.). *Fostering interdisciplinary inquiry: Proceedings from a conference. November 14–16, 2008. Consortium on Fostering Interdisciplinary Inquiry*. Retrieved, July 14, 2018 from: http://www.academic.umn.edu/provost/interdisc/cfii_conference_proceedings.pdf
- [13] Fiore S. M. (2008). Interdisciplinarity as teamwork: How the science of teams can inform team science. *Small Group Research* 39(3), 251–277. doi: 10.1177/1046496408317797
- [14] Frodeman, R., Klein, J. T. & Mitcham, C. (2010) (Eds.). *The Oxford handbook of interdisciplinarity*. New York: Oxford University Press.
- [15] Gardner, H. E. (2006). *Five minds for the future*. Boston, MA: Harvard Business School Press.
- [16] Golding, C. (2009). *Integrating the disciplines: Successful interdisciplinary subjects*. Centre for the Study of Higher Education. Retrieved, July 14, 2018 from: http://melbourne-cshe.unimelb.edu.au/__data/assets/pdf_file/0007/1761190/Interdisc_c_Guide.pdf
- [17] Gorman, M. E. (2010) (Ed.). *Trading zones and interactional expertise. Creating new kinds of collaboration*. Boston, MA: MIT Press.
- [18] Guetzkow, J., Lamont, M. & Mallard, G. (2004). What is originality in the social sciences and the humanities? *American Sociological Review* 69(2), 190–212. doi: 10.1177/000312240406900203
- [19] Hoidn, S. (2010). Interdisciplinary research collaborations: Characteristics – impeding and enabling factors – implications. In D. Haunreiter (Ed.), *Kommunikation in Wirtschaft, Recht und Gesellschaft* (S. 141–157). Bern: Stämpfli.
- [20] Hoidn, S. (August 02, 2014). *Quality dimensions of successful interdisciplinary research collaborations*. PDW presentation at the 74th Annual Meeting of the Academy of Management (AOM) (01–05 August). Theme: The power of words. Philadelphia, PA, USA.
- [21] Hoidn, S. & Olbert-Bock, S. (2016), Learning and teaching research methods in management education: Development of a curriculum to combine theory and practice – a Swiss case. *International Journal of Educational Management* 30(1), 43–62. doi: 10.1108/IJEM-08-2014-0117
- [22] Hollaender, K. Loibl, M. C. & Wilts A. (2008). Management. In G. Hirsch Hadorn, H. Hoffmann-Riem, S. Biber-Klemm, W. Grossenbacher-Mansuy, D. Joye, C. Pohl, U. Wiesmann & E. Zemp (Eds.), *Handbook of transdisciplinary research* (pp. 383–395). Dordrecht: Springer.
- [23] Klein, J. T. (1990). *Interdisciplinarity: History, theory and practice*. Detroit, MI: Wayne State University Press.
- [24] Klein, J. T. (2010). *Creating interdisciplinary campus cultures. A model for strength and sustainability*. San Francisco, CA: Jossey-Bass.
- [25] Klein, J. T. (2013). Communication and collaboration in interdisciplinary research. In M. O’Rourke, S. Crowley, S. D. Eigenbrode & J. D. Wulfhorst (Eds.), *Enhancing communication & collaboration in cross-disciplinary research* (pp. 11–30). Thousand Oaks, CA: Sage.
- [26] Klein, J. T. & Newell, W. H. (1998). Advancing interdisciplinary studies. In W. Newell (Ed.), *Interdisciplinarity: Essays from the literature* (pp. 3–22). New York: College Board.

- [27] Krishnan, A. (2009). *What are academic disciplines? Some observations on the disciplinarity vs. interdisciplinarity debate*. NCRM Working Paper Series 03/09. University of Southampton: National Centre for Research Methods. Retrieved, July 14, 2018 from: http://eprints.ncrm.ac.uk/783/1/what_are_academic_disciplines.pdf
- [28] Lamont, M. (2009). *How professors think: Inside the curious world of academic judgment*. Cambridge, MA: Harvard University Press.
- [29] Lamont, M. & Guetzkow, J. (2016). How quality is recognized by peer review panels: The case of the humanities. In M. Ochsner, S. E. Hug & H-D. Daniel (eds.), *Research assessment in the Humanities: Towards criteria and procedures* (pp. 31–41). Switzerland: SpringerNature.
- [30] Lamont, M. & Huutoniemi, K. (2011). Comparing customary rules of fairness: Evaluative practices in various types of peer review panels. In C. Camic, N. Gross & M. Lamont (eds.), *Social science in the making* (pp. 209–232). Chicago, IL: University of Chicago.
- [31] Lyall, C., Bruce, A., Tait, J. & Meagher L. (2011). *Interdisciplinary research journeys. Practical strategies for capturing creativity*. London, UK: Bloomsbury Academic.
- [32] MacKinnon, P. J., Hine, D. & Barnard, R. T. (2013). Interdisciplinary science research and education. *Higher Education Research & Development* 32(3), 407–419.
- [33] Miller, T. R., Baird, T. D., Littlefield, C. M., Kofinas, G., Chapin III, F. S. & Redman, C. L. (2008). Epistemological pluralism: Reorganizing interdisciplinary research. *Ecology and Society* 13(2), 46.
- [34] Newell, W. H. (1998) (Ed.). *Interdisciplinarity. Essays from the literature*. New York, NY: The College Board.
- [35] O'Rourke, M. & Crowley S. J. (2013). Philosophical intervention and cross-disciplinary science: the story of the Toolbox Project. *Synthese* 190(11), 1937–1954.
- [36] O'Rourke, M., Crowley S., Gonnerman C. (2016). On the nature of cross-disciplinary integration: A philosophical framework. *Studies of History and Philosophy of Biological and Biomedical Sciences* 56, 62–70.
- [37] Repko, A. F. & Szostak, R. (2017). *Interdisciplinary research: Process and theory* (3rd edition). Thousand Oaks, CA: Sage.
- [38] Repko, A. F., Newell, W. H. & Szostak, R. (2012). *Case studies in interdisciplinary research*. Thousand Oaks, CA: Sage.
- [39] Tight, M. (2004). Research into higher education: An a-theoretical community of practice? *Higher Education Research & Development* 23(4), 395–411.
- [40] Townsend, T., Pisapia, J. & Razzaq, J. (2015). Fostering interdisciplinary research in universities: A case study of leadership, alignment and support. *Studies in Higher Education* 40(4), 658–675.
- [41] US National Academy of Sciences/National Academy of Engineering/Institute of Medicine (US National Academies) (2005). *Facilitating interdisciplinary research*. Washington, D.C.: The National Academies Press.
- [42] Weingart, P. (2010). A short history of knowledge formations. In R. Frodeman, J. T. Klein & C. Mitcham (Eds.), *Oxford handbook of interdisciplinarity* (pp. 3–14). New York: Oxford University Press.