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Thinking Across Perspectives and Disciplines

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A fundamental change is taking place in the ways in which knowledge has been organized, produced, and used since the emergence of the Modern university in the late nineteenth century. The disciplinary landscape in which knowledge was arranged is being rapidly reconfigured. In recent years, an unprecedented ease of communications, a fast-paced knowledge production, and important shifts in the kinds of problems addressed by academic and professional communities, have put a premium on the ability capitalize on multiple areas of expertise. Groups of individuals are called upon to gather and integrate multiple forms of expertise to address problems that cannot be satisfactorily engaged through single perspectives (Gibbons et al. 1994). Examples of this emerging demand abound at the frontiers of academic knowledge production and in professional problem-solving alike:

- Ambitious, boundary-spanning research projects and centers draw together experts from different disciplines to address important social dilemmas—for example, to explain and treat tobacco addiction, plan for urban renewal, frame and answer bioethical questions, and understand the relationship between information technology and social life.

- "Cross-functional teams" combine engineers, scientists, writers, social-science researchers, businesspeople, and others to develop products and solutions in corporate settings.

- Teams of health care practitioners—specialist MDs, social workers, nurses, physical therapists, behavioral therapists—value working together to manage a patient's care.

- Educational collaborations link developmental psychologists, teachers, curriculum designers, artists, computer programmers, and others in designing new technologies for student learning.

What are the qualities of thinking that best represent these integrative approaches? How can individuals with distinct areas of expertise come to understand and perhaps

begin to take their collaborator's point of view? What challenges do groups and individuals confront in their efforts to merge areas of expertise? In this paper, we discuss the cognitive challenges of bringing together people and knowledge from different domains to work on a common problem, issue, or puzzle.

Our analysis focuses on perspectives of a particular kind—those that represent accepted bodies of knowledge and modes of thinking in areas such as psychology, political science, microeconomics, sociology, law, or medicine. We generically term them *disciplinary perspectives*. Our contention is that disciplinary perspectives differ in the ways that they structure, produce, and validate knowledge, and that in such differences lie both the challenge and the richness of integrative work. We argue that their different questions, foci, languages and senses of what "counts" as a trustworthy insight, often impede collaboration across disciplinary boundaries. At the same time, such differences account for the synergistic solutions found when individuals can come to think in qualitatively new ways or discover the solution to a problem unlocked by the insights housed in a neighboring domain.

In the first part of the essay, we consider some of the obstacles to coordinating multiple perspectives—the ways in which individuals situated in different disciplinary and role-based perspectives may talk past one another despite their best efforts. In the second section, we consider what successful ways of thinking across perspectives and disciplines might look like, and we briefly describe several cognitive strategies that individuals and groups might use to facilitate their work across knowledge boundaries. We conclude with a description of the varying degrees of integrative depth that often characterize interdisciplinary collaborations. Our thinking, and the examples throughout, grows out of research that we have done at the Harvard Interdisciplinary Studies Project at Project Zero, where we have interviewed approximately 200 individuals working in exemplary interdisciplinary research centers and teaching programs in academic and professional settings.

Perspectives: Disciplinary and Other

Before going any further in considering work that integrates multiple approaches to thinking and problem-solving, we would like to place the notion of "disciplinary perspectives" within the larger landscape of other kinds of perspectives and a definition of interdisciplinary work.

The term *perspective* implies the subjective nature of knowledge and, by its implicit visual-spatial metaphor, the situatedness of the knower in some distinctive *way of seeing things*. We differentiate among several different senses in which the concept of a perspective is commonly used. (See *Table 1*.) Perspective in the first sense refers to an individual viewpoint, belief, or "take" on something, whether that perspective be short-

term (e.g., "my point of view at this moment") or more durable (e.g., "the way I generally think about things in these situations").

Table 1. Three Senses of "Perspective"

	Type of Perspective		
	Individual	**Role**	**Disciplinary**
Description	Based on one's subjective outlook, opinion, beliefs, or knowledge	Based on one's situational or enduring role, actor category, or relative position	Based on commitments to a theory system, profession, discipline, or discourse community
Examples	"My perspective"; "this committee's perspective"	The principal's perspective; the parent's perspective; a board member's perspective (where roles are considered generically)	A psychological perspective; a medical perspective; a statistical perspective; a musical perspective

In a different sense, a perspective can refer to the concerns, questions, attitudes, and ways of thinking that might be common to a class of individuals in shared situations, roles or relative positions. In this usage, we generalize about the student to speak of "student's perspective," and similarly, the "patient's perspective," the "legislator's perspective," the "defendant's perspective," and so on. While sharing a common role or actor's position does not guarantee adherence to a single worldview or set of beliefs, it ordinarily presumes a common set of concerns and a common relationship to other types of actors, roles, and institutions.

Perspective in a final sense—the one on which we focus in this paper—refers to a way of seeing and thinking that is based on commitment to a system of theories, a body of professional knowledge, a discipline, or a discourse community. This category of perspective describes seeing the world through the lens of assumptions, concepts, values, and practices of a shared, often "expert," way of knowing. Here we include the specialized perspectives of the psychologist, the art critic, the statistician, the engineer.

A disciplinary perspective, then, is a special case of a perspective, one typically associated with the expert knowledge-creating communities one finds as specialties within the humanities, arts, social sciences, physical sciences, and biological sciences. One has only to browse the catalog of any U.S. college or university, and a generalization about the disciplines is immediately apparent: they are a primary means for dividing up and organizing both *how we know* and *how knowers get socially grouped* (into academic departments or graduate degree programs, for example). Even within disciplines there are sub-disciplines and sub-sub-disciplines, each with their own focused concerns and tight social networks.

A discipline has both an *epistemic* dimension and a *social* dimension. As a way of knowing—an epistemology—a discipline uses distinctive analytic tools, concepts, and methods. It employs different "languages" or symbol systems (e.g., musical notation, mathematical equations) and different genres for acceptably demonstrating understanding (a musical score, a lab report, a proof, a legal brief). In its social sense, a discipline also entails a body of "disciples" who practice its techniques (with a group of influential members residing often in research universities and in positions of influence in the professions). Disciplinarians share common formative experiences—taking certain classes, doing similar kinds of apprentice work (in the field, the lab, or the wider world), and appreciating a common canon of works by "founding heroes" of the discipline. The shadow side of this form of common experience is the way in which a discipline can often constrain thought—declaring some ways of knowing reasonable and others inadequate or even suspect. According to some sociologists and critical theorists, "disciplining" thought and academic practices, (e.g., disciplinary course requirements) represents an exercise of coercive power and a way of enforcing social and institutional conditions that benefit some groups and perspectives over others. This critique has invited many to revise—rightfully in our opinion—some of the assumptions around which academia organizes its institutional life.

Interdisciplinary work, a kind of integrated work, builds on disciplinary perspectives as defined above and combines them to create a product, develop an explanation, or propose a solution that would have been unattainable through single disciplinary means. Three qualities are at the heart of our definition of interdisciplinary work. In it, integration is not an end in itself but a means to attain a goal worth pursuing; disciplinary expertise is considered seriously; and disciplines are not simply juxtaposed but deeply intertwined—where the findings in one domain raise new questions in another, which in turn illuminate the problem at hand. The following example illustrates this kind of work:

A team of researchers at the Center for Bioethics, housed in University of Pennsylvania School of Medicine, collaborates to understand the challenges imposed on patent legislation by new forms of stem cell research. Their team is composed of experts in sociology, law, philosophy, and medicine. Their goal is to propose new legislation that would distinguish which materials, instruments, and ideas are susceptible to patenting and commercialization and which ought to remain in the public domain. To advance this agenda researchers consider how the multiple perspectives they represent may be mutually informative. For example the team develops a keen understanding of the units of biological material involved in stem-cell research (e.g., types and parts of cells required); basic insights about particular cell functions; and the specialized instruments and technologies used in the research. Such textured understanding of the scientific procedures involved corroborates their view that current legislation on the matter is too generic to allow careful consideration of the central issues surrounding stem cell research—more specifically, too many biological materials and insights fall

ambiguously under intellectual property law. An economic analysis of the ways in which the current generic version of the law has in fact been used to ascertain patentable materials and rule on disputes allows them to assess the consequences (and costs to the public) of a concentration of patents in private hands. (Until 2001, almost all patents in this area were held by private biotechnology companies.) Intertwined in these ways, insights emerging from different fields then inform their proposed policy recommendations, framed in federal legislative language.

In carrying out this work each member of the team holds particular epistemic commitments (about what counts as knowledge), favors specific objects of study (what things and processes make up the world and can be studied and/or acted upon), and employs tools for generating and warranting knowledge (which methods yield desired understanding). Their close collaboration allows them to confront these differences, on the one hand, and on the other, anticipate their colleagues' reactions and priorities. They even begin to incorporate their collaborators' approaches into their own. Likewise, among professionals working with other interdisciplinary agendas, learning how to create and sustain interdisciplinary groups and work settings that are mindful of perspectives and can capitalize on them is a worthy challenge.

The Challenges of Work Across Perspectives

Despite the promise of generativity, effectiveness, dynamism, and intellectual richness, interdisciplinary integrations like the one described above are often difficult to accomplish. To a great degree, this is due to the efforts at coordination required among minds that are alerted to and value different dimensions of the world—minds that frame the world in distinct ways. Contemporary philosophy and research in developmental psychology resist the view that there are brute "facts" that exist independent of the conceptual systems used to understand them. To put this more technically, all observation is, to some degree, theory-laden, shaped by the lenses we wear as part of our mental furnishings. How we process information depends on the concepts, theories, and beliefs we use to structure that information (Kuhn 1962; Kant 1999/1787; Piaget 1952).

To illustrate this point, consider the various categories that could each reasonably describe an individual high-school student named Amy. A political analyst could view her as a citizen who will become a democratic participant. An economist could define her as a consumer or even as $5,000 in per-pupil expenditure, a doctor as a human organism, and a member of a local board of education as one unit in a school-district headcount or as a high-stakes test-taker. A psychologist might view her as a counselee, a developing adolescent, a moral agent, or a constructivist meaning-maker. The list could continue at will. Interestingly, to focus on Amy as $5,000 in per-pupil expenditure, the economist leaves out her role as moral agent, or as member of her peer

group. To examine how she makes meaning, her counselor ignores her position as a standardized-test-taker. In a very real sense disciplinary perspectives "frame" entities and occurrences. In doing so, they disclose and shed light on certain aspects of the world even as they obscure others.

In what follows, we examine three challenges to integration that stem from the distinctive framing approaches of the disciplines: their differing units of analysis, differing languages, and differing standards of acceptability.

Differing Units of Analysis

One important way in which disciplinary perspectives differ is by the *units of analysis* at the center of their theorizing. The unit of analysis describes the kind of attribute or entity that a disciplinarian tends to favor as the appropriate level of granularity at which she focuses on a problem. Examples of units of analysis associated with several disciplinary perspectives are contained in *Table 2*. We tend to associate a particular discipline with a special concern for one unit of analysis over another. For example, it is not uncommon to hear that psychologists are concerned with "the individual," while anthropologists are concerned with "the culture" and sociologists with the "group" or the "society." Yet while every discipline may be associated with typical "molar" units of analysis (we do, in fact, tend to think of cognitive psychologists as concerned with mental processes at the individual level), each discipline also has a way, sometimes unacknowledged, of relating multiple units of analysis to one another.

Table 2. Differences in Knowledge Approaches of Selected Disciplines.

Discipline	Units of Analysis	Methods
Economics	Firm, consumer, market, economy	Econometric modeling
Psychology	Behavior, personality trait, mind, cultural context	Experiments, clinical interviews
Political Science	Actor, coalition, interest group, polity	Qualitative, quantitative, and historical research
Law	Appellate case, contract, statute, the U.S. Code, the legal system	Legal argument (e.g., *argumentum e contrario*, relation to precedent), statutory interpretation

Consider, for instance, how several social science disciplines span units of analysis from the individual to the largest collection or group. Psychologists consider the person, the person-in-context and the cultural context or environment. (Some developmentalists even describe their work as concerned with "the mind in the culture and the culture in the mind.") Economists move from the marginal consumer, to the

market, and to the national and global economy. Sociology focuses on the individual member of a group as well as the system of stratification in a society that creates and maintains groups. A challenge for multiple-perspectives work is ensuring that participants come to understand (1) that multiple levels or units of analysis (e.g., a student, a school, a district, a culture, a society) are potentially relevant to understanding and problem-solving, and (2) that each specialist perspective contributes its own useful resources for understanding the relationship among multiple levels or "grain-sizes" of analysis.

Communicating Across Perspectives

In addition to their differences according to unit of analysis and their resources for relating among units of analysis, disciplines have their own specialized terminologies and forms of communication. This becomes especially apparent as a barrier to interdisciplinary work when assumptions of mutual understanding across perspective cannot be made. Such is the case when a clinical psychologist shares the terms of a case-based, psychoanalytic analysis with a policy analyst concerned with statistically significant evidence of inequity. Identification of mutually shared concepts across perspectives may seem unattainable.

Less obvious and more problematic is the illusion of mutual understanding that stems from the fact that different disciplines often use the same terms to refer to very different phenomena. Take, as an illustration, the term "globalization." To the economist, globalization is increased financial flows across national borders. For an environmental scientist, global warming, species loss, and transplantation of nonnative species are central. For some cultural anthropologists, Americanization and resistance to Americanization in people's daily lives outside the United States may be the essence of globalization. And for artists, globalization may involve fusion of musical styles, hybrid forms of dance, new digital media art, or the emergence of the postcolonial novel.

The problem is not with the multiplicity of views on what globalization means—indeed, there is richness in such intellectual diversity. Instead, the hurdle to be overcome is the fact that individuals approaching this phenomenon from different expert perspectives often assume they are talking about the same thing. A challenge for multiple-perspectives work is ensuring that participants come to understand that (1) terms like "race," "evidence," "significant," "culture," and "development" can have remarkably different senses depending on the disciplinary contexts of their usage; and that (2) asking clarifying questions about what might seem obvious constructs (e.g., "What do you mean by 'development'"?) becomes, in a somewhat counterintuitive sense, an act of higher-order intellectual rigor.

"Measuring Up" to Different, Sometimes Conflicting, Standards

Disciplinary perspectives also have specialized techniques for gathering data and, by the same token, often have conflicting definitions of what counts as data or as acceptable insights. Interdisciplinary professionals are keenly aware of the fact that they are often satisfying multiple—sometimes conflicting—disciplinary standards at once. In borrowing disciplinary theories, units of analysis, methods, and communicative genres they are also adopting epistemic values. For example, seeking to satisfy "two masters," a researcher at the Santa Fe Institute in New Mexico expected that his computer models of political life in Renaissance Florence would meet standards of both scientific elegance and historical significance. In keeping with the values of science, he sought to do work that could coherently explain heterogeneous phenomena "with simple principles." At the same time, he wanted his study to reveal important qualities of this period and hoped his work would be read a century from now, a standard he attributed to historians generally.

Yet serving two masters in this way is not without challenges. Disciplines often conflict in terms of what they view as warranted understanding. In the field of education, a solution that is "good enough" for the organizational analyst by virtue of being efficient, cost-effective and immediately applicable to solve a pressing problem in a school under study, may prove frustratingly insufficient to the psychologist who seeks to understand why individuals are behaving in particular ways. In turn, the psychologist's painstaking approach of data collection, in-depth interviewing, and interpretation may appear blatantly inefficient to her colleague steeped in the management literature. Work across multiple perspectives involves insuring that participants understand that different disciplines hold different—often conflicting and yet internally coherent—standards for what counts as a satisfactory solution. It also demands explicitness about goals in order to enhance the likelihood that different standards and approaches are assessed in view of how they contribute to a common purpose.

In sum, bringing perspectives together confronts groups of individuals with a variety of challenges. How is a group to carry out this complex task? How should its members decide which perspectives, concepts, or tools to include and how? When carrying out integrative work, the question is not which perspective singularly recommends itself above all others (a pitfall groups all too often risk). Rather, we want to know which perspectives *in light of our purposes* contribute valued and relevant forms of understanding and/or enhance our capacity to act in the world. We call this added contribution to understanding or capacity to act the *leverage* of a perspective or discipline. To the question, "which are the right perspectives to use in this situation?" the response is: "that depends on your goals." And this is neither a glib nor an evasive reply. To understand Ohm's Law in thinking about electricity as a physical phenomenon, one need not understand how power plants operate technically or are managed organizationally. To propose options for the reengineering of the northeastern U.S. power grid, however, laws of physics are necessary but insufficient bases of

knowledge. In interdisciplinary work, decisions must be made, tacitly or explicitly, about whether a particular combination of disciplinary perspectives is the best one or whether the introduction of another discipline's approach will prove complementary and yield fruitful results given one's particular aims.

Assessing the leverage afforded by a particular perspective involves mindfulness—a meta-disciplinary form of awareness—about which tools, methods, and bodies of knowledge might serve which ends and when one should "borrow" knowledge from other domains. Interdisciplinary collaborators weigh the leverage provided by each disciplinary perspective in furthering their goals. Focusing on a particular aspect of the problem they study leads them to sense the need to include a perspective that they had not previously considered. In turn, considering a new disciplinary perspective allows them to raise questions and hypotheses that had escaped their considerations before. In both cases, experienced interdisciplinary workers seek a fitting combination of disciplinary perspectives that advances their goals. In the next section, we describe several ways in such combinations may be constructed.

Making Integration Happen: Some Cognitive Bridges

Given the potential paths to mutual incomprehension that we have outlined, it is perhaps surprising to hear that thinking across perspectives can yield powerful new ways of approaching dilemmas and questions. But what does this form of thinking look like in practice?

In what follows, we briefly outline a number of cognitive strategies observed in expert institutions, groups, and programs working to integrate disciplinary perspectives: (1) reasoning through analogies, (2) creating compound concepts, (3) building complex and multi-causal explanations, (4) advancing through checks and balances, and (5) bridging the explanation-action gap. More descriptive than prescriptive, these strategies highlight *some* of the ways that understandings might be achieved in interdisciplinary, collaborative thinking.

(1) *Reasoning Through Analogies*

One powerful means of forging connections across knowledge domains is also, according to cognitive scientists, core to how we learn generally: reasoning through analogies (Gentner, 1983). Analogy involves mapping the properties and relations from one domain onto those of another domain. ("My job is like a prison." "This calculus problem about surface area is a lot like another problem I solved last week.") On one level, analogy is commonplace in our everyday thinking. But apt analogies have also restructured entire theories and domains. The analogy between planetary orbit and the movement of subatomic particles, which allowed transfer of understanding from

astronomy to the physics of the atom, is one celebrated example. The hypothesis that "the mind is like a computer" launched, by some accounts, contemporary cognitive science because it gave us a new way of studying the mind. Analogies—like the one linking computer science and psychology—can be analytically fruitful indeed.

Analogical thinking allows us to apply the theories and concepts of one discipline to those of another domain. For example, in general systems theory this can involve mapping the concepts of "systems," "equilibria," "feedback loops," onto a variety of different discipline-connected objects of study: the human mind, the human body, an organization, an ecosystem. Similarly, a particular object of study can reveal new properties when placed in multiple analogical relationships. What properties, issues, questions, and dilemmas emerge when we see a school as a business? A school as a clinical setting? A school as an organ of the state bureaucracy?

(2) *Creating Compound Concepts*

Another strategy for working across disciplinary perspectives involves creating *compound concepts*. Compound concepts are terms that bridge domains and that summarize and stand for some integrative understanding (e.g., biochemistry, proteomics). These concepts may be either existing terms that get more complexly redefined or neologisms. An example from Stanford's Human Biology ("HumBio") undergraduate program will serve to illustrate the nature of a compound concept.

The HumBio program links the study of the biology of humans with the study of human social life—a clearly interdisciplinary ambition. The program offers a way of conceiving of the relationship between the biological and social sciences by studying how certain traits in groups of humans or our entire species may arise from the complex intertwining of both cultural and genetic factors. In HumBio students study issues that demand a jointly biological and cultural account. The incest taboo, human sexuality, lactose intolerance are examples of themes of problems that benefit from such integrated approaches—approaches combining processes commonly studied separately in the natural and social sciences. Former HumBio director William Durham captured the interactivity between these processes with a compound concept, "**coevolution**" (Durham 1992). In centering the program on the notion of coevolution, HumBio faculty (most of whom are comfortable disciplinarians) and their students have fashioned a new interdisciplinary object of study, one not readily identified in either the social science or biological science literatures. Analysis of coevolution involves describing the way that particular observable traits and behaviors arise from a process of mutually interacting biological evolution and cultural evolution. This conceptual achievement is not simply an act of coining a new term but one of formulating a new approach to inquiry across disciplinary boundaries.

(3) *Building Complex and Multi-causal Explanations*

Another approach to coordinating multiple perspectives involves borrowing concepts and findings from a variety of disciplines to construct complex explanations of a phenomenon under study. A line of inquiry in the HumBio program, Durham's study of *adult lactose intolerance*, illustrates the richness of complex, interdisciplinary explanations. Lactose intolerance is the enzymatic "deficiency" that leaves one-third of the world's population unable to absorb a sugar found in dairy products. Why is it that so many humans are unable to digest lactose? Durham asks. His answer begins with an explanation of the phenomenon at the gene-regulation level. Because this genetically induced trait is distributed unevenly across human populations, he hypothesizes that there must be an evolutionary advantage to having this capacity—a particular environmental condition that favored the reproduction of those individuals who had the trait. Lactose tolerance, he reasons, could only have developed in societies with longstanding adult milk-drinking practices— practices he analyzes through cultural artifacts, mythologies, and historical sources. Durham's explanation weaves together an analysis of ancient cultural narratives about milk consumption, the rise of animal husbandry, and genetic mutations that enabled some groups in the North to absorb lactose into adulthood (Durham 1992). In his analysis, findings from one discipline raise questions to be answered though the tools of another discipline, which in turn reveal causes that had not been previously considered.

(4) *Advancing Through Checks and Balances*

Another way of structuring thought that combines disciplinary perspectives involves a strategy we term *checks and balances*. This involves a continuing use of different disciplinary perspectives as checks on one another. As one informant in our study put it, this involves a process of "keeping one another intellectually honest." One example of this activity takes us again to the work of the University of Pennsylvania Center for Bioethics. Research collaborators at the Center describe a process in which "empirical social scientists" on the team, such as sociologists who do survey research, offer an ongoing critical perspective to philosopher-bioethicists, who acknowledge their own tendency to propose normative courses of action based on thought experiments that are divorced from empirical data. Through a dialectical process, whereby philosophical and empirical perspectives are subjected to continuing mutual scrutiny, understanding advances. A new form of interdisciplinary work is even identified and practiced at the Center: "empirical bioethics" (itself a compound concept!)

(5) *Bridging the Explanation-Action Gap*

Finally, a strategy for integrating disciplinary contributions that is common in applied fields, such as the professions, requires *bridging the explanation-action gap*. In the

simplest application of this strategy, one or more domains may be used to define the nature of a problem or explain dimensions of a problem, while knowledge from other domains may be used to guide interventions, implementations, or solutions. This strategy involves assuming that certain disciplinary perspectives may provide explanatory leverage while other perspectives may offer pragmatic or action-oriented leverage.

For example, consider the problem of developing local educational policy on elementary math instruction. Cognitive-developmental psychology may provide resources for evaluating the technical merits of a particular approach to mathematics instruction for a population of students. However, suppose one is interested in advocating that a particular instructional model, identified as sound in its developmental assumptions, actually be *adopted*. One might then draw on policy studies and organizational theory to understand how policy is influenced, crafted, and implemented. One might also draw on psychological understanding to predict how different teachers may experience the policy. Organizational sociologists might also have insight into what obstacles to implementation might need to be considered given assumptions about organizational structure and regulations.

Under this strategy for integrating disciplines, a particular set of perspectives may serve to better define problems and technical solutions based on relevant domain expertise, while other disciplinary perspectives offer tools for thinking about taking action based on those problem and solution definitions. Importantly, this approach to integrating disciplines may be more successful when explanations and actions are considered in dynamic relationship to one another—as can happen on a multiple-perspectives team—rather than dividing the cognitive work between "explainers" and "implementers" (as too often happens in real-world practice).

Degrees of Integration

In this paper, we have explored a form of work across disciplinary perspectives. In addition, we have presented some of the obstacles to this work and identified some of the thinking strategies used by expert interdisciplinary collaborators. Yet, interdisciplinary efforts differ not only in kind—depending, for example, on the specific disciplines involved—but also in their *degree of integration* (the depth or superficiality of exchange among perspectives). To conclude, we share a simple model for thinking about the different degrees of integration that might be reached in a collaboration across disciplinary perspectives. We outline four modes of increasing integration of bodies of knowledge in groups.

Mutual Ignorance

Individuals demonstrate a lack of familiarity with, or even hostility toward, other disciplinary perspectives.

In this mode, individuals are not collaborators. Instead, they pursue work under separate banners of their disciplines and usually in separate institutional silos (different departments, programs, and projects). Individuals working in this mode may acknowledge that integrative work should be done, but they may not be able or disposed to carry it out. At the same time, their single-perspective work may advance narrower disciplinary purposes and even create discipline-based resources for others to draw upon in doing subsequent integrative work. In this sense, disciplinary and interdisciplinary work may coexist and sustain one another.

Stereotyping

Individuals show an awareness of other perspectives and even a curiosity about them. Still, there is a stereotypical quality to the representation of the other's discipline, and individuals may have significant misconceptions about the other's approach.

This second mode characterizes much activity across perspectives, particularly when work is in its early stages, when collaborations are sporadic, or when goals of the collaborations are unclear. While groups and their members may, in their formation, have abandoned their non-communicating stances, more significant work at clarifying and practicing the application of others' perspectives is required in order to undertake deep forms of knowledge integration.

Perspective-taking

Individuals can play the role of, sympathize with, and anticipate the other's way of thinking. Individuals raise objections to their own preferred ways of thinking by taking account of other approaches. Individuals demonstrate less naïve or stereotyped representations of other disciplines.

An ability to take the disciplinary other's perspective is a hallmark of membership in interdisciplinary collaborative groups. Individuals have, to some degree, brought into their own thought systems perspectives that were once external. In many cases, they can articulate ways that their areas of expertise relate to and mutually inform other collaborating domains.

Merging

Perspectives have been mutually revised to the point that they are a new hybrid way of thinking, and it is difficult to distinguish separate disciplinary perspectives in the new hybrid.

This mode of work moves beyond collaboration in heterogeneous groups. This form of perspectival merging is observed in activities where new specialisms (new "interdisciplines") form through the systematic integration of existing disciplines. The rarity of this deep interdisciplinary commingling is explained by the challenges of creating new theories, methods, and concepts that both bridge and stand apart from existing parent domains. Some examples of these deep integrations include the

composite domains of biochemistry, cognitive science, and cultural studies. While the four preceding models are arranged hierarchically in order of increasing integration of perspectives, we do not argue that these models involve an invariant sequence of development for individuals or groups. Nor do we think it necessarily desirable to function in a way that completely "merges" disciplinary perspectives into whole new interdisciplines. While some activities may lead to the kind of integration that seemingly dissolves borders between knowledge specialties, this is not the demand made in the context of typical interdisciplinary collaborations.

Moreover, the levels of integration described may be more or less domain-, context-, or collaboration-specific. Individuals may function in more "perspective-taking" ways in groups involving certain disciplinary collaborations, while their approach to work in other disciplinary combinations might look more "stereotyped"—depending, in part, on levels of relevant disciplinary knowledge and experience and prior practice at leveraging particular disciplinary combinations. Nonetheless, the movement from *stereotyped* thinking to *perspective-taking* across disciplines may be a threshold step in facilitating work that moves beyond dividing up tasks for autonomous experts to process and towards an embracing of opportunities afforded by deep collaboration.

Conclusion

In this essay, we have attempted to sketch both the possibilities for new forms of work across disciplinary perspectives and potential barriers to that work, particularly the complications that arise from contact between disciplinary epistemologies. In addition, we have offered descriptions of several strategies for bridging the cognitive divides of disciplines. Finally, we have suggested several degrees of integration that typify groups of interdisciplinary collaborators with different purposes and at different phases in their work together. The varieties of interdisciplinary work are, in truth, as diverse as the possible combinations of perspectives and the theoretical and real-world imperatives that might drive collaboration. In considering here the complications and promise of interdisciplinary work, we hope to encourage further reflection on why and how minds meet and forms of knowledge connect. In a world where most of the important dilemmas refuse to fit neatly into disciplinary boxes, fostering the capacity to synthesize knowledge from multiple perspectives, to capitalize on distributed expertise, and adapt to changing disciplinary and professional landscapes becomes an essential aim in our efforts to prepare young professionals for effective participation in contemporary life.

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