A Transfer-Based Framework for Interdisciplinary Communication, Teaching, and Research

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ABSTRACT

Transfer consists of the ways in which people reshape, adapt, rethink, and challenge what they understand and learn in one context to other contexts. While transfer is often discussed in relationship to student learning and writing (how students transfer their writing and learning across contexts), transfer also provides a crucial framework for faculty, administrators to use in navigating the dynamic, intersecting, and disparate contexts of academia. A transfer framework invites faculty, administrators, and students to actively engage with, reflect on, and position themselves within and across varying and overlapping domains. Doing so can facilitate increased networks of collaboration, cultivate more robust advances in knowledge and research methods, improve pedagogy, and increase student learning gains.

1. INTRODUCTION

One of the most impressive instances of interdisciplinary communication occurred between 850 and 1250 C. E. in what is now New Mexico of the United States. Because of its power to illustrate transfer and interdisciplinary communication, I use this example as an overarching metaphor throughout my writing textbook, *Writing in Transit*. [1] Chaco Canyon was an impressive development that arose at the nexus many intersecting roads, connecting over 150 communities. [2] People with expertise across fields and industries, from economics, religion, and art to engineering, astronomy, and architecture collaborated and communicated to design and grow Chaco Canyon.

Two features of Chaco Canyon resonate particularly well as a metaphor for the complexities and power of the interdisciplinarity that sponsored Chaco Canyon itself. The first is the Sun Dagger, a precise arrangement of stones that lets in sunlight during the solstice, an important agricultural and cultural event. The second dimension of Chaco Canyon that provides an apt metaphor for interdisciplinary communication was the Great Houses. These colossal structures sometimes contained as many as 750 rooms. Each Great House was unique, but all Great Houses also shared precise astronomical alignments that, as with the Sun Dagger, enabled the sunlight to cast in light through the windows and hallways during the summer and winter solstices. [3]

These rare and fleeting, but significant, moments of alignment, where deliberate care generates the space for heterogeneous entities to work together, signal the complexity and potential of the sorts of collaborations and alignments that can occur with interdisciplinary communication. The refraction and alignment of light through the Sun Dagger and the Great Houses, and more broadly at Chaco Canyon itself, offers a useful metaphor for thinking about interdisciplinary communication. The ways in which people from divergent disciplines collaborated and communicated, and the process by which light transects the Sun Dagger and the Great Houses signal a process of transfer, which is integral for interdisciplinary collaboration and communication.

Transfer involves the ways in which people reshape, adapt, rethink, and challenge what they understand and learn in one context to other contexts. [4] While transfer is often discussed in relationship to student learning and writing (how students transfer their writing and learning across contexts), transfer also provides a crucial framework for faculty, administrators, and students to use in navigating the dynamic, intersecting, and disparate contexts of academia.

A transfer framework, developed using research about transfer itself, invites faculty, administrators, and students to actively engage with, reflect on, and position themselves within and across varying and overlapping domains. Doing so can facilitate increased networks of collaboration, cultivate more robust advances in knowledge and research methods, improve pedagogy, and increase student learning gains.

2. INTERDISCIPLINARY COMMUNICATION

Interdisciplinary communication, by many measures, has had continued success long after Chaco Canyon. Many disciplines are themselves interdisciplinary. English Studies, for instance, includes specialties such as American Studies, Media Studies, English Literature, and Composition & Rhetoric. [5] Similarly, scholars in fields such as African-American Studies, Gender Studies, and Cultural Studies conduct research that contributes to and is shaped by many disciplines, including humanities, social sciences, and natural sciences. Other fields are becoming increasingly reliant on interdisciplinary methodologies as well. Ecology, for instance, fuses research in the natural sciences and the social sciences, drawing from and contributing to such fields as public policy, environmental studies, medicine, and sociology. [6]

Further illustrating the wide presence of interdisciplinary communication, many specific areas of research exhibit high transferability. The broad field of human computer interactions, for instance, is informed by research across many disciplines. Much research occurs in computer science and psychology, but human computer interactions also inform, shape and respond to knowledge produced in such fields as design, media, philosophy, math, and sociology. [7]

Similarly, the field of learning theory is also highly transferable and demonstrates the degree to which interdisciplinary communication exists. Research in this broad field spans education, theology, cybernetics, and psychology. Ideas about learning theory from psychology, for instance, include research by Piaget, Bloom, and Vygotsky. From philosophy, scholars such as Dewey have contributed knowledge. And, from education, researchers such as Freire and Fleming have contributed ideas of central importance. [8] Each of these fields is important to bring a discipline-specific epistemology to bear on a common concept. Together, though, these diverse contributions to the broad field of learning theory help make our collective knowledge more advanced and transferable. The overarching interdisciplinarity enables researchers and practitioners to apply, adapt, and build learning theory more broadly.

In the same vein as learning theory and human computer interaction, research in the environmental health, and safety of nanomaterials (Nano EHS) also demonstrates transferability and interdisciplinarity with its applicability across an enormous range of contexts. Nanomaterials are used in conjunction with a variety of applications, from smart drugs that deliver medicine only to cells that need it, materials for car bumpers, airplanes, tennis racquets, and as entities that interact with reactive particles to clean water in affordable ways. Because of this wide applicability and transferability, nano EHS research impacts and develops through such disciplines as ecology, infectious diseases, agriculture, engineering, physics, and neuroscience. [9] Nano EHS research and applications, however, demonstrate not only the presence and importance of interdisciplinary communication, but also the dangers that can arise from a lack of interdisciplinary communication. The range of transferability demands that researchers communicate across contexts to share research, discoveries, failures, and complexities. Without this interdisciplinary communication, lessons learned about nano EHS in one context could compromise the safety and efficacy of their application in other contexts.

The risks associated with a lack of interdisciplinary communication have, at times, had high stakes. In the case of the Challenger Disaster, for instance, engineers sought to communicate to management that the O-rings may have been faulty. However, in doing so they used discourse and language that was highly technical, a discourse that did not translate clearly to management people. In this case, then, the failure of interdisciplinary communication in this case resulted in the Challenger's explosion and deaths. [10]

While failures in interdisciplinary communication of this magnitude may not be commonplace, a closer look at interdisciplinarity does reveal some widespread challenges and limitations. In fact, even alongside the many examples of rich interdisciplinarity and interdisciplinary communication, other data suggests that interdisciplinary communication has much room for improvement.

Network analysis, for instance, suggests that interdisciplinary communication tends to cluster between particular disciplines rather than occurring in a more dispersed manner. In a study of the rates of citation across disciplines in over 6.4 million citations, researchers found that scholars in economics, when citing across fields, tend to cite most often in political science and management. The rate of citations from publications in Economics for other disciplines is significantly less, suggesting that scholars in economics are comparatively less likely to look to research in other fields such as education or medical ethics. Meanwhile, research in psychiatry and psychology tends to integrate frequent cross-

citations (as may be expected), but these fields together rarely cite scholarship in other disciplines. [11] This clustering of information flow between particular disciplines and that avoids other disciplines suggests that monikers such as interdisciplinarity may not be revealing an accurate sense of the degree of interdisciplinarity that is occurring. Research in economics, for instance, might find some of the research emanating from ecology or computer science valuable, and vice versa. And, fields such as psychology might benefit from more nuanced understandings of cultural studies, which would be available through research in a discipline such as East Asian studies. Some of this clustering of information flow across and between particular disciplines makes sense. Some fields have a more justifiable and closely related connection to one another than do others. However, it may also be the case that contextual knowledge in East Asian studies could have an important impact in reshaping or challenging claims and conclusions being made in psychology or economics. And, by turn, East Asian studies might also benefit from a greater influx of research in the fields of psychology or economics.

While some fields tend to have a greater likelihood of cross-disciplinary citation, another significant limitation of interdisciplinary communication involves unevenness in the overall degree of interdisciplinarity across fields. Researchers in the disciplines of arts and health, for example, have a greater rate of citing outside of their own disciplines. Research in clinical medicine and mathematics, by contrast, have much fewer instances of citation across disciplines. [12]

This unevenness of interdisciplinary research has been identified with broader categorization of disciplines. Researchers have found that researchers in the social sciences and humanities are more likely to publish articles with interdisciplinary or interdisciplinarity in the title. Research in engineering and natural sciences, meanwhile, tends to have a lower rate of publications titled explicitly with interdisciplinary or interdisciplinarity. This distinction has been present and consistent since 1950, and the rates of interdisciplinary citation in arts and humanities have increased, while those in STEM fields have remained consistent. [13] These diverging patterns of growth and stagnation in interdisciplinarity are of concern. Such data suggests that interdisciplinarity becomes steeped in research methods and disciplinary conventions and expectations. Increasing the likelihood of interdisciplinarity requires attention to changing long-standing legacies of research and disciplinary culture. Such data, though, also attest to the power of interdisciplinary communication, as researchers who inherit the practices of interdisciplinarity tend to replicate and expand them in their own research.

This cultural dimension of scholarship that leads researchers to be more inclined or disinclined toward interdisciplinarity also points to an even more problematic limitation regarding interdisciplinary communication. Just as interdisciplinary communication tends to cluster between particular disciplines, it also tends to cluster in geographic and cultural terms. Researchers have discovered that citation networks tend to cluster around geographic and cultural proximity. This means that researchers in certain parts of the world are more inclined to cite and collaborate with scholars in nearby areas of the world, and are highly unlikely to cite and collaborate with scholars from a broader global network. According to researchers, "both our collaborators and our citations typically come from our spatial neighborhood. Further, long distance collaborations as well as citations decrease as a power law of distance." [14] Such constraints suggest cultural and structural predispositions. They lead, problematically, to inequities in knowledge and access to research across the world. Research is significantly impacted by culture and global context. [15] As such, greater attention needs to be given to wider networks of cross-cultural interdisciplinary communication.

This section has outlined many instances of interdisciplinarity and interdisciplinary communication, but has also identified several significant problems attenuating interdisciplinarity. The clustering of interaction within constrained geographical proximity, along with the clustering of information flow between a limited range of disciplines, and the disposition of certain disciplines to be more or less inclined toward interdisciplinarity, all highlight the limits that too often compromise what could otherwise be a much more rewarding network of interdisciplinarity communication. As with many contexts describing limitations, such challenges are not often the fault of individual researchers. Instead, they are shaped and maintained by structural conditions. The following section, therefore, addresses some possible structural explanations for these limitations in interdisciplinary communication.

3. ACTIVITY THEORY

The limitations, imbalances, and inequities that delimit interdisciplinary communication are likely not caused primarily by arbitrary individual behavior.

Instead, it is more likely the case that structural factors shape and direct research practices that lead to these problematic dimensions of interdisciplinary communication. While there may be many such structural factors, one that seems particularly helpful to parse out would be structural factors that govern disciplinary communication. Offering an approach to disciplinary communication, David Russell's activity theory provides a way of understanding why scholars may be more or less inclined toward interdisciplinarity, and why imbalances and inequities persist in the context of interdisciplinary communication.

Russell's activity theory posits that all discourse emerges from a highly contextualized set of circumstances, whereby those who are communicating use a set of mediational tools when discussing the objects under consideration. Russell's well-known triangulated depiction of the communication transaction suggests a somewhat closed area for communication: cultural/mediational tools (i.e., writing, speaking, visualizing, performing); subject; and object. [16] Russell's triangle demonstrates that people within that area use the cultural and mediational tools that are also situated in that area, and that the objects they tend to explore are also often already situated within that area as well.

Activity theory has a positive implication. It helps explain, for instance, how disciplines become defined: disciplinary terminology operates as part of a system, a network of knowledge that differentiates one discipline from others and enables people within that discipline to build knowledge in a specific manner. Activity theory explains why people in disciplines carry with them explicit and implicit expectations and conventions for research and communication in that discipline, and why they may be more inclined toward mediational tools, people, and objects of study that are already situated within (or close to) that triangulated area.

However, activity theory also reveals some problems associated with interdisciplinary communication. According to activity theory, if mediational tools, researchers, or objects of study from a discipline seem too alien, researchers will likely be disinclined toward collaborating in those areas or stretching themselves in those ways.

These activity systems that govern communication, therefore, can delimit the potential collaborators scholars consider working with when conducting research, the questions they decide to ask, the areas of research they embark on, and the mediational tools/communication strategies and practices they use. Activity systems impact the epistemologies and research methods researchers tend to use. They shape the networks of knowledge researchers construct.

Activity systems also help explain writing-based divergences that make interdisciplinary communication more challenging, and perhaps more unlikely. If writing in one activity system looks different to someone accustomed to operating in a different activity system, then a researcher may not be as amenable to accessing and relying on that material for their research. That which is respected, anticipated, and expected in one context does not always translate cleanly to other contexts.

One example of differences that might impact the perceptions researchers have about what counts as rigorous scholarship or not is citation rates. While nearly all scholars across disciplines and contexts cite others' research and build upon (or challenge) the work of others, citation rates themselves vary dramatically across disciplines. Studies have found that research in physics and engineering has the lowest rates of citation, while marketing research is among the disciplines with the highest citation rates. [17] Other bibliometric studies have confirmed diverging citation rates across disciplines. One such study found that research in medical and life sciences and natural sciences tends to have higher citation rates, while research in arts and humanities and communication tends to have lower citation rates. [18] Scholarship in behavioral sciences, engineering, and social sciences, meanwhile, has similar rates of citation.

These varying citation rates help explain some of the clustering between particular disciplines that marks interdisciplinary communication. Scholars who use similar rates of citation might be accustomed to citing along particular networks or valuing particular disciplinary research because the citation rates look familiar and seem customary to their expectations. This helps explain, therefore, why scholars in psychology might frequently cite research in sociology, and vice versa: the research may convey more familiarity to these scholars than would research in other disciplines might, by virtue of the amount of citations.

Data on divergent disciplinary citation rates, though, also signal what may be an even greater chasm between the disciplines that tend to be more interdisciplinary and those that tend not to be. If research in the arts and humanities tends to be more

interdisciplinary, and yet these disciplines also have the lowest rate of citations compared to other disciplines, then it may be that research in arts and humanities is not only more interdisciplinary than other discipline-based research but it may be much more substantively so. If research has limited citations, and high interdisciplinarity, then that research is likely using the interdisciplinary citations in a meaningful way. By contrast, research that has many citations could include citations from across disciplines but still be primarily steeped in one discipline.

Citation rate data also signal a deep intra-disciplinarity in those disciplines that are less inclined toward interdisciplinarity. Given the overall rates of citation across disciplines, one would expect that research in fields with high citation rates would have a greater likelihood of citing across disciplines. In fact, though, behavioral and life sciences, which have the highest rates of citation, are also among the least interdisciplinary.

Research into disciplinary differences that define activity systems also suggests that the ways in which scholars cite vary significantly. This variation provides yet further explanation for the limits that can restrict interdisciplinary communication. Summary, for instance, is used with relative parity across many disciplines, but quoting and block quotes are much more present in disciplines such as sociology and applied linguistics. Quotes and block quotes, by contrast, are rarely present in biology, physics, or engineering. [19]

Other elements of communication and writing vary across disciplines, providing yet further insight into why interdisciplinary communication can be challenging and remains hampered by imbalances and inequities. In a study of introductions across philosophy, biology, and linguistics, researchers found that writers in biology and linguistics tend to link their research to real-world relevance, while writers in philosophy do not. Furthermore, the study showed that scholars in philosophy include literature reviews in their introductions to a much greater degree than do scholars working in the field of linguistics. [20]. Such variations in approach to introductions add further dimension to citation-rate data and the likelihood of interdisciplinary communication. A discipline that does not expect literature reviews as frequently as other disciplines may explain why a discipline does not produce as much interdisciplinary research.

Variations across activity systems based on disciplinarity also emerge through sentence-level aspects of writing that reflect disciplinary epistemologies. Research written in history, for instance, often includes adverbials and hedges that emphasize the clarity of evidence such as *certainly, undoubtedly, evidently, invariably,* and *clearly*. Alternatively, research written in economics rarely uses any sort of adverbials at all, and if so, include words that might emphasize prominent data insights, such as *significantly* or *typically*. [21] Self-mention, such as *I, we, us,* and *our*, presents another sentence-level aspect of writing that carries deeper disciplinary epistemologies and research practices that form activity systems. Research in disciplines such as philosophy and applied linguistics often include the self-mention of I. Alternatively, research in physics and engineering, according to a study sample, never employs the self-mention of I. Such differences reflect different disciplinary approaches to research—more collaborative and team-based or more individual—as well as disciplinary divergences in the sorts of questions asked and data considered. [22] Interpretive disciplines create more space for I assertions, while technological and scientific disciplines focus more on analyzing the data in ways that seek deliberately to elide the variations of different individual interpretations.

Together, these variations in disciplinary epistemologies, expectations, conventions, and approaches to writing and research illustrate the differences among activity systems. The chasms between these activity systems, then, help explain the structural factors that play a significant role in the many inequities and imbalances that still limit the larger potential and promise of interdisciplinary communication.

4. THE TRANSFER FRAMEWORK

The imbalances and inequities that limit the potential and promise for interdisciplinary communication may be mitigated by a framework that both acknowledges and challenges activity systems. The concept of learning transfer—the ways in which people adapt, reshape, reconsider, and challenge knowledge from one context to others—provides such a framework. While activity systems explain Adopting a transfer framework for interdisciplinary communication would help address the imbalances and inequities in interdisciplinary communication by promoting greater networks of interaction, facilitating knowledge sharing, enhance pedagogy, and cultivating more productive academic

service/administration such as committee work, programmatic development and curricular design.

Transfer is an area of knowledge with wide applications ranging across disciplinary contexts. Scholars in math have looked at transfer through surface and structural analogs. [23] Mathematics scholars have also studied learning transfer from the perspective of productive failure. [24] Scholars in computer science, meanwhile, have researched online learning transfer for artificial intelligence. [25] And, scholarship in social psychology has researched the role of implementation intention in transfer in professional contexts. [26] that Scholarship in analog transfer science have addressed transfer … management science transfer …. The field of writing-related transfer research, though, is particularly applicable in applications for interdisciplinary communication since it emerges from a perspective grounded in interaction and communication. The transfer framework I am proposing has five inter-related and overlapping dimensions, each of which is drawn from relevant research into writing transfer. This transfer framework can be thought of as a complement to Russell's triangulated activity systems (object, speaker, subject), but also as a challenge to the closed pathways of that activity theory solidifies. For, unlike activity theory, transfer offers not only a recognition of the discourse and epistemological expectations and conventions (systems) that govern communication, but also a way of imagining greater cross-disciplinary communication and interaction.

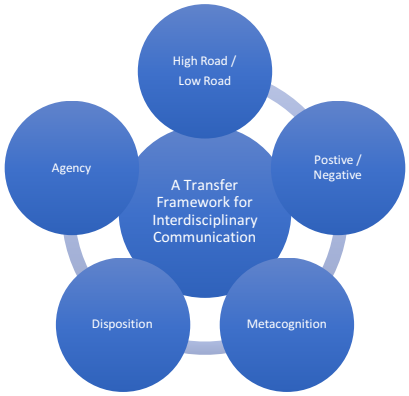

Figure 1. A Transfer Framework for Interdisciplinary Communication

Each dimension of this transfer framework is described below. Then, in the ensuing sections, I will explicate how the transfer framework can be applied to research, teaching, and academic service.

A. Positive/Negative

Research in transfer suggests that transfer can be positive, whereby people transfer ideas, practices, and techniques that are applicable to a new context, or negative, whereby people decide or discover what not to transfer to a new context, or are unsuccessful in attempting to transfer an idea, practice, or technique. Negative transfer is sometimes referred to as interference, where a prior set of practices or approaches interferes with success in a new communication context. [27] With interdisciplinary communication, for instance, examples of positive transfer could be where a researcher working with a new citation style for a journal would transfer to that context the practice of using a bibliographic citation manager to generate citations. By contrast, an example of negative transfer related to interdisciplinary communication might be exemplified by a scholar using scholarly conventions in a publication situated in a more public context.
Well-published scholar Chris Anson, for example, recounted an experience of negative transfer when he embarked on writing brief summaries of his child's football games for a local newspaper. Despite Anson's awareness of different context for writing, he nevertheless brought in elements of his discipline's activity system in a way that was less successful in the context of the local newspaper's expectations for the sports summaries. These included not only sentence-level conventions, but also elements of the writing and research process itself. [28] Along the same lines, an historian accustomed to using hedges such as clearly or evidently, or self-mention, in scholarship for history journals, might find that composing for a journal in a different discipline, such as economics or engineering, would require a different approach to adverbials and self-mention. Negative transfer, therefore, involves a decision about what not to transfer, or an outcome that revealed unsuccessful transfer.

B. High Road/Low Road

Transfer also occurs along both abstract and concrete levels, across contexts that are more or less related. High road transfer, also considered part of far transfer, requires high abstraction. Low road transfer, by contrast, involves similar contexts where ideas can be transferred readily, easily, and intact from one context to a new one. [29] Pedagogically, when faculty move from teaching in seminar formats to lecture formats, both high road and low road transfer occur. Exemplifying high road transfer, a faculty member might find it necessary to transfer expertise

with teaching but to dramatically reconsider instructional design, text selection, and content delivery. Assessments, for instance, might necessitate high road transfer. Expertise in aligning assessment to learning outcomes and lesson plans would need to be transferred between very different assessments. In a lecture format, assessments might be designed using multiple choice, while seminar assessments might be designed in a more open-ended manner, and with more projects and essays. Low-road transfer, in this context, would involve matters that could be transferred readily from one class format to another, such as some of the course texts. Faculty who have innovated with flipped classrooms, as another example, move in-person lectures to recorded lectures, and found themselves designing new tasks and assessments. [30] The former, which involves recording lectures, might be considered lower-road transfer, while the latter, requiring new task development and assessments, involves high-road transfer of pedagogy and learning outcomes.

C. Metacognition

Transfer depends upon sustained, in-depth reflection and a cultivation of metacognition about transfer. [31] People who are more successful with transfer reflect explicitly on what they are transferring, and why, through writing, conversation, and thinking. Opportunities for developing reflection and metacognition regarding interdisciplinary communication might entail keeping a journal where a scholar or student reflects on what has worked or not worked regarding transfer in a particular instance. It might also mean creating space for conversations at the beginning of a project so that participants can think together about how their prior experiences and individual expertise might be brought to bear on the current project. Or, reflection and metacognition can emerge through eportfolios, where students curate, synthesize, and reflect upon transfer through the varying learning occasions they have encountered. [32]

D. Agency

Transfer does not just happen, nor are people passive vessels who stand by as transfer occurs. Instead, it involves people actively engaging in or resisting transfer, deciding what to transfer, what not to transfer, when to do it or not, and reflecting on what has worked or not worked with transfer. [33] In relationship to teaching, the agency dimension of this framework asks that faculty recognize and highlight the agency students have regarding transfer. Integrating into coursework explicit and ongoing opportunities for active consideration of transfer will encourage students to recognize and embrace their agency with transfer. Research has shown that student engagement through active learning practices and reflexivity creates a distributed agency that enhances learning across contexts. [34] Agency might also involve faculty inviting students to consider the ways they can transfer ideas and practices even from heterogeneous contexts. For instance, researchers have investigated how students can invoke agency as they transfer skills from athletic contexts to academic ones. [35] Training undergraduates to think in ways that encourage them to recognize and act upon their agency with transfer can make them more autonomous, active learners who aim to make connections across and within disciplines.

For faculty, approaching interdisciplinary communication with a consideration of transfer agency may also help break the legacies that stymie interdisciplinary communication through imbalances and inequities. If faculty acknowledge their own agency to cite research from disciplines, research areas, or collaborators that seem farther afield (disciplinarily, culturally, or geographically) than others, then they can instantiate similar practices for younger generations of scholars.

E. Disposition

Even with metacognition and agency, both of which hinge on individual action, individual dispositions, which change across time and context, also influence transfer. Disposition in relationship to transfer refers broadly to attitudes, beliefs, and prior experiences. [36] People might be more or less inclined toward transfer based on their own attitudes, personalities, and prior experiences with any writing or communication occasion. They may be more inclined toward transfer if they have had positive prior experiences, or have had training in transfer-related practices such as metacognition, and if they are willing and interested in transferring prior knowledge to subsequent ones. By turn, individuals who have experienced negative transfer may have attitudes that shape a disposition that is less likely to engage in transfer. Individuals also bring their dispositions to bear on how they transfer. If they are accustomed to low-road transfer, then they may, for instance, have dispositions that lean toward low-road transfer and away from high-road transfer. Context also impacts individual dispositions. People may be more likely in some disciplinary contexts, such as math, for instance, to transfer knowledge from one math learning context to another math learning context.

They may be disinclined, though, to transfer what they have learned from a math learning occasion to a humanities-based context. A context involving similar topics, be it in a pedagogic or research context in radically different disciplines, such as computer science and English studies, might generate dispositions against transfer. This may be true even when both disciplines address the same area of inquiry, such as human rights. People's capacity for, willingness surrounding, and attitudes toward the effort that attends transfer in a particular domain play a large role in transfer.

These overlapping dimensions of transfer research, form a framework that can be valuably used to facilitate and improve interdisciplinary communication. Specific applications for this framework—ideas for how this transfer framework for interdisciplinary communication can itself be transferred—will be addressed in the following section regarding teaching, research, and academic service.

5. TRANSFER FRAMEWORK APPLICATIONS

Applying a transfer framework to interdisciplinary communication can positively impact research, teaching, and academic service. This section demonstrates several of these promising applications for the transfer framework for interdisciplinary communication.

A. Research

Discipline-specific research remains crucial to building and deepening knowledge. At the same time, a transfer framework that sponsors interdisciplinary communication would encourage scholars to forge broader networks of collaboration and have greater reach and impact.

Invoking a transfer framework involves researchers reflecting on current research methods, venues for research dissemination, collaborators, and citation networks. This metacognition, combined with an acknowledgement of agency, might help disrupt patterns and legacies of research methods and citations within and across disciplines. These legacies often instantiate certain practices at the cost or omission of others. For instance, reflecting on publication venues, and recognizing one's agency to search for and submit to other venues, would help scholars publish peer-reviewed research in a wider array of venues.

International and interdisciplinary conferences and publications—ones that are as inclusive as possible and as wide-ranging as possible—are good options. Publishing in interdisciplinary journals, or journals steeped in a disciplinary perspective that is less familiar, would broaden impact and create a more diversified citation network.

Considering a broader range of possible publication venues would also productively lead to decisions about high road / low road, and positive / negative transfer. Since disciplines have different activity systems, researchers using such a framework would have the opportunity to consider transfer options with epistemology (what questions are asked and what methods are used for inquiry) and with sentence-level aspects of discourse, which are in and of themselves also reflective of epistemological dimensions of writing and thinking.

Similarly, researchers might use high road transfer to consider how to connect with research and researchers from disciplines that may not seem on the surface closely related. Such an approach would help expand networks of citation and collaboration, as scholars could, through a transfer framework recognize and dismantle the clusters of collaboration across disciplinary, cultural, and geographical registers.

Seeking out more public forums for publication would also be opportune in helping transfer research to broader publics. Public scholarship, though, requires attention to a transfer framework. Discourse varies across publication venue. Science research, for instance, might be rendered through a particular set of discourse conventions when published in peer-reviewed journals, as opposed to more public spaces. Highly popular renderings of science operate under yet different conventions for discourse.

Recent research on the different discourses presenting the same research about how cats drink illustrates the way research transfers across venues [37] An article published in *Science*, for instance, appeared by the title "How Cats Lap: Water Uptake by *Felis catus*." [38] The same article appearing in the *MIT Technology Review*, however, recast the title as slightly more accessible, but still clearly located in academic science: "The Physics of How Cats Drink." [39] The same research, when presented in an even more highly public setting, NBC News, then changes yet again to become "Scientists Reveal Secret of Cat's Lap." [40] The ideas remain valid across these three contexts, but the discourse shifts. A transfer framework, premised on recognizing attitudes toward

transfer, could, through agency, reflection, high road, and positive transfer, help researchers accomplish greater reach by encouraging more transfer such as this.

Attending to publication venue requires time and effort, however. One of the greatest impediments to broadening networks of citation and collaboration involves disposition: mentors convey legacies of norms to younger scholars, who then continue to maintain them. It takes active reflection and a disposition to make change to shift that cycle to be more inclusive and expansive. Researchers can think more broadly about collaborations, networks, publication venues. They can expand discourse conventions.

However, as integral as disposition is, the limitations, inequities, and imbalances that hamper interdisciplinary communication are likely more often caused and sustained by structural factors as opposed to individual dispositions.

Efforts toward interdisciplinarity must be recognized, valued, and supported, institutionally and structurally. Tenure and promotion policies and committees should revisit disciplinary determinations about impact and importance criteria with regard to journals and publishers. They should reward, motivate, and encourage publication outside of one's discipline and geographic or cultural terrain, instead of overlook, discourage, or disdain such efforts.

Structures, however, can be slow to move, and many impediments stymie structural change. Collective dispositions against such change, in the form of institutional and socio-cultural structures, can hinder individual efforts toward interdisciplinarity.

And, again, not all occasions warrant disruption, and disciplinary specific research and publication remains central to knowledge building. Still, a transfer framework motivates researchers to approach scholarship by asking questions about these practices so as to ensure they are being adopted with full justification and sound reasoning, rather than merely being solely promulgated because that is the way others have conducted scholarship in the past.

B. Teaching

A transfer framework approach to interdisciplinary communication would positively impact teaching and learning. Integrating transfer into pedagogy encourages students to actively reflect on and consider the experiences they bring to course learning outcomes, and, by turn, how they might build on these learning outcomes beyond the course. In so doing, students would have more opportunities to engage with and meet learning outcomes successfully. The course itself would have longer term impact for students, and its reach would extend beyond the specific course term and classroom boundaries.

Models for transfer-based approaches in higher education have emerged in several areas with regard to overall curriculum development. Learning communities, for instance, common to but not exclusive in first-year experiences, enable students to integrate and synthesize ideas across disciplinary contexts. [41] Similarly, capstone experiences within majors or with regard to the larger curriculum promote transfer for students as they reflect on, extend, and reshape the ideas they have learned previously into a new project or concept. [42] These integrative experiences have been shown to strengthen student engagement and learning outcomes. [43]

Transfer-based approaches to teaching can and should be integrated into individual classrooms as well. Often this work can be done without radically altering teaching practices and learning outcomes that are already in place. Faculty can ask students to reflect, for instance, verbally or in writing, on how a concept relates to prior knowledge or experiences. Assignment design can include opportunities for students to apply knowledge and concepts from one occasion to others. These pedagogical practices are likely already part of many courses across disciplines.

Teaching with a transfer framework regarding interdisciplinary communication in particular would involve explicit attention to transfer with regard communication occasions. Focusing on metacognitive aspects of communication is especially valuable. For instance, students could be invited to think about how they will transfer, through positive, high road, and low-road approaches, writing or speaking practices or processes from prior learning occasions to current ones. High-road examples might include encouraging students to consider their approaches to learning, reading, and studying in prior contexts and how those might support them in this context. Positive examples of transfer communication could include assignment design that asks students to plot out their writing and research processes based on their prior experiences with writing and research in other contexts. These processes and interim steps would include brainstorming, study design, data

collection, drafting revision, editing, and feedback. Faculty can also encourage students to think about communication transfer across the course texts: what might students recognize with communication and transfer in course texts and how do the communication practices of various authors or scholars reflect and challenge different discourse communities.

Transfer-based pedagogies can be and have been integrated into a wide range of disciplinary contexts. In a collection titled *Teaching for Transfer*, for instance, researchers from disciplines such as math, psychology, and computer science discuss transfer as it applies to teaching in their disciplinary contexts. [44] And, in another collection of essays, scholars address transfer and teaching in many areas of application, including military training and physical education. [45]

Texts such as these which focus on transfer from different disciplinary and pedagogical contexts have important implications. Legacy operates strongly in pedagogy, as in research. Faculty learn how to teach from their own teachers, and traditions persist in governing and shaping our classrooms. A transfer framework recognizes the value of discipline-specific pedagogies, but also motivates explicit consideration of transfer within and across these efforts. Even the smallest intervention towards transfer, such as a brief out-of-class reflective activity, can have an important impact for students as they move across many disciplines and institutional contexts for learning.

C. Academic Administration and Service

A transfer framework can also have significant impact in shaping and strengthening academic administration and service. Faculty attitudes toward academic service are often negative because such service is frequently underrepresented and undervalued. [46] Faculty perceive that academic service suffers from nebulous definitions and vague purposes and outcomes. [47] These negative attitudes and reluctance toward faculty service come out especially stridently with mid-career faculty. [48]

Such negativity is particularly problematic given how much time faculty spend with academic service. One study found that the majority of faculty teaching in undergraduate contexts spends between 6-12 hours per week with administration and committee work. Many faculty report spending 30 or more hours per week with these activities. [49]

Even beyond service, larger structures of academic organization can be fraught by competition for resources and protection of territory.

Efforts toward improving attitudes toward and outcomes from administrative and service work should involve consideration of interdisciplinary communication and a transfer framework. Since university and area-wide committees are customarily comprised of faculty from across disciplines, a transfer framework for interdisciplinary communication could make such interactions—even amidst disagreements and debates—more productive and rewarding.

Because transfer is premised on reflection, agency, disposition, and adaptation, transfer encourages empathy and dialogue. Reflecting on what one's goals are, what values motivate those goals, and what prior experiences or knowledge might be brought to bear on any given situation would be immensely beneficial in the context of academic service and administration. People from across units, with varying perspectives, can have more productive conversations and disagreements within a paradigm where participants consider possible points of connection, ask questions about one's own and others' motivations and epistemological perspectives, and welcome heterogeneous configurations of ideas.

A transfer framework would also enhance communication on academic committees by heightening individual awareness of the ways in which people rely on disciplinary discourse to communicate ideas. Some terms are specific only to a particular discipline, and some terms have multiple meanings depending on the context. Design, for instance, has particular inflection in engineering that has relatedness but also differentiation when deployed in other contexts, such as business, art, or sociology. Transferring concepts, processes, and ideas from a discipline-specific context to others would help foster communication and productivity in academic service and administration. Such emphases can also help offset occasions of negative transfer that might make academic service less productive.

Another dimension of academic service that could be enhanced by more attention to a transfer framework for interdisciplinary communication would be in the realm of precedent. Committees could be more successful if committee members were primed to consider prior situations (of high and low road nature) from a wider range of perspectives and contexts. These areas of precedent could have important impact on the challenges or questions

currently under consideration. And, transfer also encourages a recognition of precedent that is also very much open to adaptation depending on context.

A transfer framework for interdisciplinary communication would also broaden networks of collaboration. Expanding one's attention to be more inclusive of a wider range of institutional contexts, disciplinary perspectives, and geographical locations would render decision making and policy advancement more robust in academic settings.

A transfer framework for interdisciplinary communication can also work to address other forms of inequity as well. Academic service is too often hampered by imbalances across gender and race. Studies have shown that more women faculty engage in service work than male counterparts. [50] Research has also demonstrated that faculty of color are disproportionately engaged with time devoted to academic service. [51] A transfer framework would make these inequities and imbalances more visible as those who participate in and convene committees reflect on how that representation is allocated and why. Invoking a transfer framework would make individual disposition more visible, and thereby would enable faculty to better recognize the roles that their dispositions play in these matters. The agency that informs transfer can be an important mechanism for faculty to invoke their own agency in making committee service more equitable and productive.

Attitudes that inform negativity about academic service come from a sense that academic service is unrelated, non-useful, and disconnected from research and teaching. A transfer framework for interdisciplinary communication would encourage faculty to think about they themselves can make such service more valuable as they work to transfer ideas and practices from academic service or administrative contexts to research and teaching contexts.

A transfer framework for interdisciplinary communication, then, has an important role in academic service and administration. As with teaching and research, interdisciplinary communication is at the center of academic service contexts. Such work can become less onerous, more productive, and more connected with explicit attention to the elements of a transfer framework.

6. CONCLUSION

Although interdisciplinarity has been growing in many sectors, inequities and imbalances remain. Many of these are caused by the challenges inherent in interdisciplinary communication. A transfer framework can help mitigate some of these challenges. The advantages of a transfer framework in the context of interdisciplinary communication are manifold.

Interdisciplinary communication yields greater reach and impact for one's research, teaching, and academic service. Research published with greater interdisciplinarity has greater reach. One study found that scholarship with a greater range of interdisciplinary attention in the introductions receives an increased amount of attention. Thirteen years after publication these more interdisciplinary texts are cited much more often, comparatively, to scholarship that is less interdisciplinary. [52]

Such findings make sense: more researchers are encountering the research, and that research therefore has a greater range of application and extension. Increasing one's readers also opens opportunities for other intersections and collaborations, and even for redirections and challenges, all of which can ultimately strengthen research and build knowledge more productively.

Beyond reach and impact, a transfer framework helps encourage an approach to interdisciplinary communication that forges more inclusive networks of collaboration and hastens knowledge development and production.

Interdisciplinary communication is hard. A transfer framework, comprised of an awareness of disposition and agency, an attention to sustained, ongoing reflection, and a working understanding of high road, low road, and positive/negative transfer, can help unlock the potential within interdisciplinary communication. As illustrated with Chaco Canyon, interdisciplinary communication founded on transfer can illuminate evident and subtle connections and help make possible the most incredible achievements.

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