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Lessons from the Edges of Interdisciplinarity - Integrating Artificial Intelligence with the Humanities, Social and Economic Sciences

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ABSTRACT

International calls for the involvement of a broader set of disciplinary experts in the development of artificial intelligence (AI) products are growing. By involving a more diverse set of experts, it is hoped that AI innovations will be more reflective of contemporary societal values and avoid detrimental risks to people, institutions, and the environment. While collaboration between AI experts and scholars from the humanities, social and economic sciences (HSES) has been suggested to tackle the challenge of developing safer technology, little information is available on the mechanics of cross-disciplinary collaboration in this context. This paper aims to examine the nature of cross-disciplinary collaborations between AI and HSES, and to identify enabling conditions and practices essential for meaningful and effective integration. It draws on an interdisciplinary integration process trialed by a small group of Australian artificial intelligence experts, humanities scholars, and social and economic scientists. A collaborative inquiry approach was pursued to detail their attempt to design and participate in a short-term program of activities with the aim of facilitating collaboration and progress toward interdisciplinary integration for the development of shared outputs in the long-term. The paper shares their experiences, challenges, and the lessons captured along the way over an 18-month period. Among the reflections and insights shared, is that achieving true integration is a continuing endeavor, requiring dedicated resourcing, a long-term vision, and room to experiment and learn.

Introduction

International calls are growing for the involvement of a broader set of disciplinary experts in the development, risk assessment, and governance of artificial intelligence (AI) systems and products. This is in response to the rapid increase in applications of AI to solve problems in a range of contexts and sectors (Dwivedi et al. 2023; Zalnieriute, Moses, and Williams 2019) and a sharp rise in concerns about the ethical and societal implications of AI. In particular, the proliferation of new, widely accessible generative AI tools such as ChatGPT, Gemini, and Co-Pilot, and unrestricted AI technology development more broadly have raised alarms about AI innovations' potential to pose significant societal risks and disruptions (Bender et al. 2021; Bengio 2023). This includes perpetuating and amplifying existing biases and inequities across society (see Eubanks 2019; Jobin, Ienca, and Vayena 2019), triggering unanticipated disruptions to traditional workforce structures (see Anthers 2017; Balmer 2023), and undermining research integrity (Blau et al. 2024; European Commission 2024).

High uncertainty and potential for significant harms have mobilized Global North governments to develop stronger AI regulations to reduce risks generated by AI products, with the European Parliament and a recent US executive order leading examples of these efforts (see Council of the European Union 2024). Alongside formal regulatory responses, global professional scientific societies have led the creation of

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responsible AI development principles (e.g., AAAS 2023; ACM 2023) and "living guidelines" (e.g. Avison, Powell, and Adams 1994; Bockting et al. 2023). Complementary to these efforts has been the call for broader audiences to engage more actively in setting a future AI agenda (see Kubzansky 2023; Nee 2023). This call has been extended within the science community, prompting invitations for greater cross-disciplinary[1] collaborations among AI experts and humanities, social and economic sciences (HSES[2]) scholars (e.g. Hannemayer 2022; Zajko 2022).

These numerous efforts to integrate social and ethical protections into new AI systems and outputs face varying challenges. AI regulations, while intended to help put in place formal checks and balances, are having difficulties moving from generic discussions to actual implementation which are further challenged by the rapid pace of change in AI development (Wheeler 2023). Conversely, the creation of universal principles to raise awareness of the consequences of poorly designed products and guidance for developers and researchers to develop AI products responsibly is facing similar bottlenecks. While potentially conceptually helpful, the historically limited utility of applying universal ethical principles to highly contextualized applications, and the lack of regulatory support to guide their compliance, may compromise their intended impact (Hagendorff 2020; Jobin, Ienca, and Vayena 2019; Mittelstadt 2019). Beyond regulatory and principles-based pathways, calls for public engagement and participation in AI governance and agenda-setting remain largely aspirational and opaque albeit spaces beginning to emerge (see Adams and Burall 2019). Similarly, despite collaborations between AI experts and HSES researchers gaining traction, these remain scattered and there is little information on the processes and quality of these collaborations, and on their effectiveness in combining and/or blending knowledge and integrating social and ethical protections into AI. Insights from cross-disciplinary integration efforts in other areas underscore the complexity of successfully bringing together distinct disciplinary expertise and ways of working and the significant challenges and bottlenecks often encountered (see Aagaard-Hansen 2007; Pennington 2008).

This paper aims to examine the nature of cross-disciplinary collaborations between AI and HSES, and to identify enabling conditions and practices essential for effectively bridging diverse disciplinary perspectives and methodologies in a manner that is both meaningful and impactful. In this paper we describe the experience, insights, and lessons learned of a group of Australian AI and HSES scientists who sought to bring together diverse disciplinary camps as legitimate and valued knowledge partners over a period of 18 months. While the group's ultimate aim was to co-develop outputs such as research proposals, publications, and/or AI products that integrated diverse expertise and methodologies, it also set out to better understand the process of building a cross-disciplinary group necessary to undertake this integrative work. Through a collaborative inquiry approach, we share challenges encountered, and key insights and lessons learned for strengthening AI-HSES collaborations.

Cross-disciplinary integration among AI and HSES scientists

Over the past five years, there has been a growing recognition among AI and HSES communities that integration of each other's knowledge is critical for improving AI systems' and products' utility (their usefulness, effectiveness and target user contexts) and for enhancing the integrity of the information used to develop them (for example, the veracity and provenance of the data used in their development) (see Chen et al. 2023). Beyond instrumental reasons, AI-HSES collaborations are seen as fundamental to responsible science and practice (Forsythe 1993; Kusters et al. 2020) and necessary for improving the legitimacy of AI systems and tools in decision-making and for mitigating or minimizing potentially harmful societal consequences (see Balmer 2023).

While cross-disciplinary collaborations between AI experts and HSES scholars are increasingly being embraced conceptually and sought out, in practice they tend to focus on risk mitigation post product development (Hannemayer 2022; Zajko 2022). Notwithstanding the value of carrying out evaluations and risks assessments, HSES expertise tends to be limited to providing input late in the development process which constrains the ability to enhance or improve AI models and their anticipated outcomes, i.e. hampers responsible innovation development. On occasion, HSES experts have been involved in the co-development of AI products with the intention of incorporating diverse knowledge sets in the development of a robust, fair and impactful product (see Donia and Shaw 2021; Kusuma et al. 2022;

Suresh et al. 2022). Less common is the idea that the design of AI tools should involve contributors external to academia in their development to balance and better reflect a broader set of user values and needs (Bruce 2023).

While these efforts to date are important and welcomed, more clarity is required regarding what cross-disciplinary AI-HSES collaboration and integration means, what forms it can take, and the enabling conditions and practices required to successfully integrate vastly different disciplinary perspectives and ways of working in a meaningful and impactful way. As noted in the broader literature on knowledge integration and cross-disciplinary efforts, such practices can take many forms (O'Rourke, Crowley, and Gonnerman 2016), with the most prominent labels used being multidisciplinarity, interdisciplinarity, and transdisciplinarity.[3] While there are multiple, and at times overlapping, definitions attached to these terms, they tend to fall on a spectrum from least integrative (multidisciplinarity) to most integrative (transdisciplinarity), and from involving purely scientific and technical expertise and knowledge (multi-and interdisciplinarity) to incorporating knowledge and groups outside academia (transdisciplinarity) (Bammer et al. 2020). However, what is meant by "integration" in these various modes of cross-disciplinary partnerships is debated (O'Rourke, Crowley, and Gonnerman 2016). Some argue that only inter- and transdisciplinary modes of research collaboration involve genuine integration of different knowledges, expertise, and/or methods (e.g., Cundill, Roux, and Parker 2015; Holbrook 2013).

Having clarity around what modes and levels of integration an AI-HSES collaboration is aiming to pursue is vital as it has implications for how that collaboration is designed; the aims it seeks; and the facilitation, resources, and other considerations needed for its success. Not paying sufficient attention to this consideration risks both disciplinary camps engaging "in-service" to each other. When in-service engagement occurs, one disciplinary camp often assumes primacy over the other (by driving the research focus, for example) or, acts as the subject of study by the other (as social scientists tend to do) – neither arrangement being exemplar of working collaboratively *with* each other. Beyond implications on the quality of the collaboration, a lack of genuine integration across these domains of expertise hampers such efforts' ability to effectively contribute toward the development of AI innovations that are more reflective of contemporary societal values and avoid detrimental risks to people, institutions, and the environment. Yet, as applications of AI continue to expand across sectors and are increasingly considered key "solutions" to intractable global challenges (e.g. climate change, health care), the complexity of integrating social and ethical protections into AI systems and outputs only grows. This increases the need and urgency for new and creative ways of thinking and approaches which can only come from interdisciplinary and transdisciplinary collaborations and integration (see Bammer et al. 2020; Fleming et al. 2023).

Against a context where AI continues to evolve from being simply a technological innovation to a force with the potential to significantly alter the world (see Gruetzemacher and Whittlestone 2022), we contend that the primary goal of cross-disciplinary scientists and developers working together should consist of, at the very least, an intentional approach to collaboration which involves the integration of AI and HSES expertise in a co-development process from the outset of system/product development (McLennan et al. 2022; Stahl and Stahl BC 2022) – i.e. that it extends beyond a multidisciplinary research collaboration to, *at minimum*, an interdisciplinary one. However, presently, the call for cross-disciplinary approaches to improve AI outcomes is missing guidance on the *practice* of working this way. In sharing our experience bringing together AI and HSES researchers in an interdisciplinary collaboration, we provide experiential information which contributes to the current gap in the literature on "*doing* integration science" in this context (see Bammer 2005). By sharing our experience, we offer insights into the following key questions: What constitutes AI-HSES collaboration and integration? What forms can it take? What enabling conditions and practices are necessary for meaningful and effective integration of these diverse disciplinary perspectives and methodologies? Given the pace at which AI development and application are occurring and the growth in need for cross-disciplinary collaborations, we share our insights and lessons from the first year and a half of our AI-HSES collaboration (which is ongoing) so that other research groups and organizations can benefit from our experience in attempting their own cross-disciplinary integration. To our knowledge, little has been written specifically on interdisciplinary collaborations in the context of AI research and development.

Our Project and Methods

Overview of our AI-HSES collaboration

Initiation of our collaboration

Our AI and HSES collaboration began as a loose network of individuals interested in creating a Community of Practice (CoP), an informal partnership among a group of people who share a common concern or passion and want to share experiences, knowledge, and solutions in a free-flowing, creative way (Wenger 1998). The group was motivated by a shared interest in co-producing a set of integrated outputs such as research proposals, development of AI tools (or components thereof), and/or journal publications. Additionally, the group wanted to make sense of cross-disciplinary integration as a goal, test interest in forming a formal CoP (i.e. funded and officially established within our organization), and strengthen relationships across its membership. Once this group was convened, internal funding was sought and secured through organizational strategic science investment.

The establishment of the AI-HSES community of practice

Once the funding was secured, the CoP brought together diverse AI and HSES experts including philosophers, data scientists, psychological scientists, and economists (16 active members in total) (see Table 1). We developed a high-level group purpose statement and charter and created a plan to support interdisciplinary integration through a series of planned activities. The CoP was led by an AI scientist who sought advice periodically from members with philosophy and social science expertise.

Deciding on an interdisciplinary mode of integration

The CoP was not formed with a pre-defined mode of collaboration and integration in mind. However, early in the formation of the group, the AI lead and scientists with expertise in cross-disciplinary collaborations and philosophy of science discussed the range of options for integrating our diverse disciplinary expertise. There was a shared desire to move beyond usual multidisciplinary discussions in AI, motivated by the limitations we saw in working within siloed disciplinary boundaries to address complex problems that demanded we work differently (see Bammer et al. 2020). We decided to take an interdisciplinary approach as we were interested in bringing together different disciplinary perspectives, knowledges and methods to explore our collective interest in topics such as managing bias in AI in a new, holistic way. We considered this to be a good middle ground – aspirational yet a realistic next step in strengthening cross-disciplinary collaborations in our own organization. Transdisciplinary integration, which usually involves broadening the collaboration to include stakeholders outside traditionally defined areas of science (for example, industry and civil society groups), was seen as a potential future step, once the group had developed some experience of working together in an interdisciplinary way.

Some members of the CoP with HSES expertise were familiar with the literature on interdisciplinary approaches. A rapid literature review revealed that the majority of publications were comprised of conceptual and theoretical frameworks and largely focused on questions of "what" disciplines to integrate and "why" interdisciplinary research might be needed (e.g. Barry, Born, and Weszkalnys 2008; CohenMiller

Table 1. Disciplinary diversity of the AI-HSES Community of practice (CoP) members as self-identified across domain categories. For members of this CoP, their disciplinary expertise is often applied to varied scientific contexts including sustainability, agriculture and food security, robotics, energy, technology innovation, and other areas. We recognize there are likely additional disciplinary expertise (e.g. legal scholars) that might be relevant to the CoP's purpose. We would encourage other groups to be as diverse and inclusive as possible when creating a similar group.

Artificial Intelligence domain experts	Humanities, Social, Behavioral and Economic Sciences domain experts
Machine learning scientists (2)	Psychological scientists (2)
Applied mathematician	Philosopher/Social scientist
AI scientist/Conservation of biodiversity scientist	Applied ethicist
Data scientist	Cross-disciplinary social scientist
AI scientist/Natural language scientist	Anthropologist
AI scientist	Sociologist
	Sustainability scientist
	Behavioural economist

and Pate 2019). The question of *"how"* to integrate, including the processes and practices for designing and implementing interdisciplinary collaborations, was underexplored. Of the small pool of papers offering broad guidelines (e.g. Bammer 2012; Lyall et al. 2011); experiences of putting interdisciplinarity into practice (e.g. Villeneuve et al., 2019; Purvis et al. 2023; Forino et al. 2023), and; challenges and barriers encountered and strategies for overcoming these (e.g. Brown, Deletic, and Wong 2015; Choi and Pak 2007; MacLeod 2018; Morse et al. 2007) a common highlight was the absence of a universal approach or recipe for designing and implementing interdisciplinary collaborations. This reflected the experience of our AI-HSES CoP members who had previously designed and implemented interdisciplinary (and transdisciplinary) research projects in other domains. Given the lack, and unsuitability, of a "one-size-fits-all" approach to interdisciplinary collaborations, we decided to adopt an experimental and adaptive approach, where we periodically reflected on the process and adjusted our aspirations, activities and outputs.

Our approach to putting interdisciplinarity in practice

We experimented with multiple activities to integrate in an interdisciplinary manner our diverse AI and HSES expertise and perspectives. These activities were implemented over the course of an 18-month period (2022–2023) over three phases which built upon each other (Figure 1):

(1) Phase 1: To help coalesce the newly formed CoP, we convened a series of reading and discussion sessions around key literature organized along themes that brought together a cross-disciplinary lens, such as making bias transparent in AI. CoP members came together online from geographically dispersed organizational sites.
(2) Phase 2: An in-person, multi-day workshop was held to harness the rapport built in Phase 1 and to further strengthen trust and relationships. The key focus of bringing CoP members together face-to-face was to brainstorm research topics of common interest and progress next steps toward greater integration via identification of joint research proposals and/or coauthored interdisciplinary manuscripts.
(3) Phase 3: Following the workshop, smaller writing groups were organized which met regularly online to progress the outputs identified in Phase 2. This phase was seen as key to moving us out of our disciplinary comfort zones and boundaries and to enabling us to explore in practice how to bring

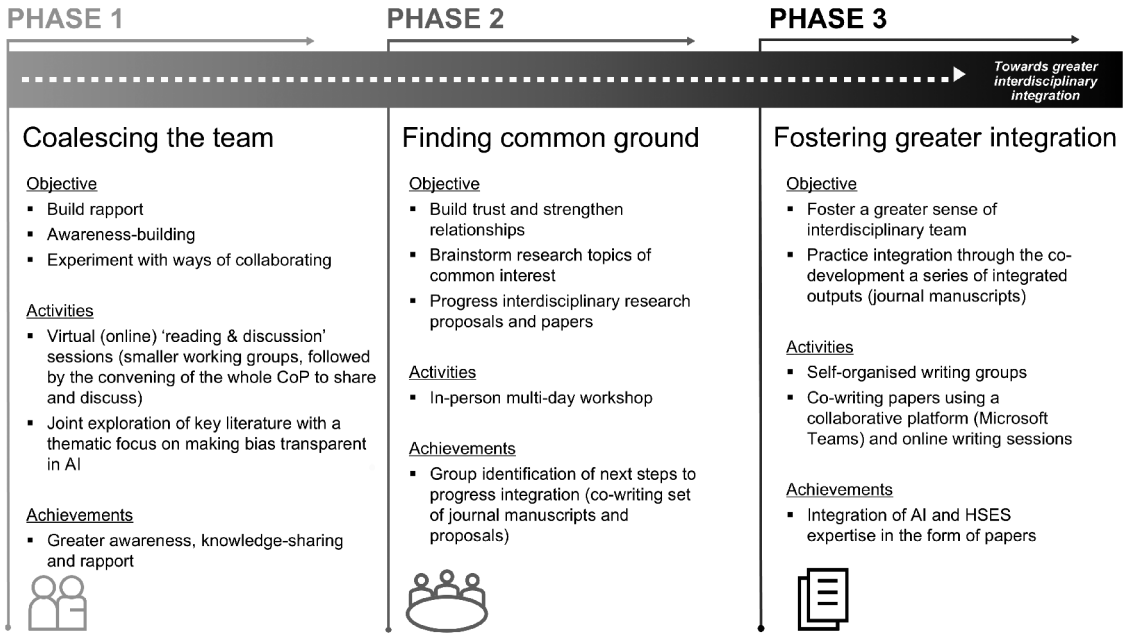

Figure 1. The three phases of the AI-HSES Community of practice (CoP), and activities to foster greater interdisciplinary integration, implemented over the course of one and a half years (2022–2023).

together our diverse disciplinary perspectives to generate new ways of looking at the research topics we had identified in the workshop.

The activities across these phases were explicitly designed to help progress interdisciplinary connections and integration via strengthening relationships and trust among the CoP members; building greater cross-domain awareness and knowledge-sharing; fostering a greater sense of cohesiveness as a team; and working jointly on a set of concrete science outputs (papers intended for peer-review publication in journals). These activities integrated a range of modes of working together (e.g. guided group discussions of science publications, facilitated workshop to brainstorm outputs to collaborate on and ways to progress these, and co-authorship of manuscripts), locations (online, in-person), and work schedules (series of scheduled 1-hour meetings; multi-day dedicated workshop; self-organized writing group sessions) to encourage maximum participation and to cater to different working and learning styles and comfort zones. We describe the activities in more detail below.

Reading and discussion sessions

Group discussions of literature and research from other disciplines is an established practice in interdisciplinary-focused training and higher education (see Frost and Jean 2003). The establishment of reading groups and reading circles has been used as a mechanism to enable participants to engage with concepts and literature that extend beyond their home disciplines (see Chapman 2024). These types of activities are seen as providing a foundation for deeper integration and synthesis of diverse ideas and methodologies that is demanded of interdisciplinary collaborations (Bjorn 2024). In our CoP, we pulled together a curated list papers[4] thematically focused on making bias transparent in AI and exemplifying cross-disciplinary research. Papers were allocated by the lead of the CoP to smaller working groups comprised of CoP members with a mix of AI and HSES expertise, spread across multiple interstate sites. These working groups were tasked with reading a subset of papers and were guided by the following series of reflection questions to focus cross-disciplinary discussion:

(1) *What are the authors' disciplinary backgrounds and their institutional affiliations?*
(2) *What is the problem the authors are trying to address? What did they find?*
(3) *Did the authors encounter any key challenges or issues that require further research or consideration?*
(4) *How does the work integrate AI and HSES? Was it successful?*
(5) *Should the broader group read the paper?*

Each group reported back to the main CoP, inviting reflections, questions and discussion on topics of interest or contention. A total of 5 "reading & discussion" sessions were held online over a 6-month period in 2022, covering a total of 11 papers.

Multi-day, in-person workshop

There is a long history of practice, and extensive literature, on the role of workshops in fostering cross-disciplinary collaboration and building integration across fields (see Gorbet, Schoner, and Taylor 2008; Taylor, Fifield, and Young 2011). Engaging in dialogue in facilitated workshop settings, where individuals are brought together over an extended period of time with the purpose of fostering two-way exchange of knowledge and perspectives, has been shown to foster greater mutual understanding, communication, and integration (see Hubbs, O'Rourke, and Sh 2020). Our CoP held a 4 day, in-person workshop to synthesize our learnings from our reading and discussion sessions, more clearly identify the gaps in the literature, and explore unique interdisciplinary research proposals and journal manuscripts that our CoP could collaborate on. It was held in Lamington National Park, Queensland, Australia, a remote region to enable uninterrupted thinking time. The workshop was structured to allow for dedicated indoor meeting sessions and early morning, lunchtime and evening walks in the National Park to stimulate discussion and cross-learning. The workshop was live-blogged on an online collaborative platform for record keeping and inclusion of group members unable to physically join the workshop.

Day 1 of the workshop began by co-defining the objectives of the workshop. Participants were invited to share ideas for concepts for manuscripts or research proposals for funding. At the end of the first afternoon,

seven ideas were proposed and evaluated. Six proposal ideas were further explored by the group in plenary sessions and focused group sessions for the rest of the workshop (Days 2 and 3).

By Day 4, three ideas were identified and fleshed out as short manuscripts, two ideas were identified as longer-term contributions, and one idea was identified as forming the bulk of a funding research proposal. The workshop concluded with a reflection session on the next steps for the short-term and medium-term horizon.

Co-authorship of journal papers

The workshop was followed up by the establishment of small writing groups (Phase 3) focused on progressing the manuscripts identified during the workshop. Coauthored journal manuscripts can serve as boundary objects that open spaces for dialogue and for strengthening relationships. As noted by Clark et al. (2017), such boundary objects not only help bring people together to share understanding but also can create "meaningful moments of service" that have the potential to be transformative, such as breaking down knowledge silos and genuine interdisciplinary integration.

In our CoP, six writing groups were established, each focusing on the topics of interest identified during the workshop. Examples of research topics advanced for further development include: *Re-imagining AI futures*; *A holistic approach to bias frameworks*; and *Why is integration needed in AI?* The writing groups were largely self-organized and open to cross-membership. Each group was co-led by the original thought leader, plus a representative from the other domain. While CoP members were not formally allocated to writing groups, each writing group made an explicit effort to ensure participation of a diversity of AI and HSES members. Smaller groups enabled members to progress in focused writing at a faster pace. This paper is one of the manuscripts coauthored by the writing groups, detailing the journey and experience of our AI-HSES CoP on putting interdisciplinary integration into practice.

Using a collaborative inquiry methodology to explore our interdisciplinary journey

To understand our interdisciplinary journey and write about it, we took a collaborative inquiry (CI) approach (Bray et al. 2000; Heron 1996; Heron and Reason 1997). At its core, CI is a participatory and reflexive methodology with participants having a role as both co-inquirer and as the phenomena of inquiry (Kakabadse, Kakabadse, and Kalu 2007). We considered CI to be a well-suited methodology for exploring our interdisciplinary process as it is a "discovery-oriented form of inquiry, not a confirming or validating one" (Bray et al. 2000 cited in Kakabadse, Kakabadse, and Kalu 2007), with the aim of "deepening understanding of one's experience, gain from the experience of fellow inquirers and together develop a new understanding of the shared phenomena under inquiry [...] to construct meaningful, practical knowledge" (Kakabadse, Kakabadse, and Kalu 2007, 254). CI is rooted in phenomenology (see Scharff and Stone 2022) and is underpinned by reflective practices (see Mortari 2015). For interdisciplinary collaborations, individual and collective reflection supports groups to develop and implement interdisciplinary perspectives, by fostering new knowledge, mind-sets and capabilities (see Forino et al. 2023).

Our collaborative inquiry approach was initiated with a set of reflection questions that were e-mailed to each member of the CoP:

(1) *From your perspective, what has the AI-HSES collaboration accomplished so far? What has it not yet accomplished?*
(2) *If you had to pick one valuable insight or learning that you have gained from being part of this AI-HSES collaboration, what would that be?*
(3) *Looking to the future, what might some of the biggest challenges be for integrating AI & HSES to improve collaboration outcomes?*

Institutional human research ethics approval was sought early in the formation of the CoP to cover this process of reflection. Responding to these questions was entirely voluntary, and reflections were invited to be shared openly or privately. All members opted to share reflections privately with the first author who made a commitment to preserve anonymity to allow individuals to reflect more freely. Given the small size of the group, no direct quotes have been shared in this paper.

Members' responses were synthesized and incorporated into this paper as a first draft, which was shared with members. The draft served as a boundary object to support further collaborative inquiry. Members were asked to reflect on those syntheses and expand on or clarify existing points raised and add any additional points of view. They were also invited to ask questions, interrogate the reflections synthesized in the paper, and asked to further reflect on key lessons. The draft of the paper was placed on a shared-access platform, thus enabling all members to contribute and see what suggestions and changes were made to the text. This process of collectively revisiting and refining the content of this paper was critical to our collaborative inquiry approach as it provided an opportunity for members to further reflect and provide additional feedback, as well as to come to a more group-level point of view of the experience of working collaboratively toward interdisciplinary integration. In the sections that follow, we distill our collective reflections and key lessons learned collated via the reflection questions above and through the process of co-writing this paper.

Our experience of interdisciplinary integration

Accomplishments, and those yet to be achieved

Reflecting on the group's integration experience for both AI and HSES members revealed a shared strong sense of accomplishment in relation to *creating and maintaining a space for practicing interdisciplinarity*. This sentiment refers to creating both a physical space to come together, and a cultural space for which to practice interdisciplinarity. It also aligns to existing evidence in literature that refers to the importance of establishing dedicated forums to practice without which groups are unlikely to thrive sufficiently to produce shared outputs (e.g. Lamain et al. 2024; Purvis et al. 2023; Villeneuve et al. 2019).

Most members commented on the benefits of having *a planned forum where disparate disciplinary lenses were treated as being of equal* contributing value and where organizational role hierarchies among colleagues were rendered unimportant. For both AI and HSES group members, the CoP offered a safe space to share ideas, engage in intellectual discussion, and benefit from being part of a highly diverse "brains trust." A key valued outcome of this space creation was the enabling of an environment for asking questions and learning. For several of the AI scientists, the CoP also provided an opportunity to improve their science communication skills.

An almost universal reflection among members was that *the CoP was only at the beginning of the interdisciplinary journey*. Almost all members admitted to not feeling like interdisciplinarity had yet been achieved, and this likely stems from the formal project ending,[5] while concrete outputs were still under development.

Most valuable insights

CoP members' insights included reflections on *the process and pace of integration*. For AI members, expected outcomes of collaborative processes included fairly rapid problem definition, perhaps even consensus in problem resolution, as well as timely AI product development being the valued innovation endpoint. For some HSES scholars, problem definition was expected to take considerable time in collaborative settings and oftentimes did not follow expected pathways of consensus and resolution. The pace at which integration progressed across the group was often a tension among members. The slow pace resulted in the CoP not collaborating on the development of an AI tool, or components thereof, which was initially expected by some members.

The complexity of navigating diverse epistemologies, and the effort this process took were also common insights among CoP members. Some examples of the types of conundrums the group tackled in reading papers collaboratively included: understanding how different disciplines generate and value knowledge; the perceived rigor of less conventional scientific methods; and the roles power and disciplinary hierarchies play in science planning and decision-making. The usual tensions between positivist and interpretivist approaches to science (see Moon and Blackman 2014) was a common topic of discussion and learning among the group.

An additional insight identified by members was *the role of personal traits and values in facilitating integration and supporting smooth group function*. Among these were humility, a willingness to learn, generosity and patience. The importance of personal collaborative qualities and values among groups has been identified elsewhere (e.g. Horn, Urias, and Zweekhorst 2022; Nancarrow et al. 2013).

Future challenges for interdisciplinary integration, organizationally and globally

The primary challenge identified by the group centered on the general sustainability of collaborative processes and the enabling environment required to support interdisciplinary integration. A valued feature of this CoP was the formal allocation of funding to support members of the group to trial and adapt an interdisciplinary collaboration that brought together domain experts (AI and HSES) who had not worked together before in the organization. This translated to allowing members to dedicate a proportion of their recognized working hours toward this CoP, along with dedicated leadership to coordinate and steer group activities. However, the *ongoing viability of organisational investment for interdisciplinary processes in projects was a concern* many group members expressed and one that is shared more broadly (Bammer 2012). The literature is clear on the need for institutional support to foster interdisciplinarity (Bammer 2012; Bolger 2021). However, despite good intentions, most interdisciplinary initiatives hold largely aspirational goals without a clear plan for resourcing and managing the integration process over an extended period of time that is required to make these cross-disciplinary collaborations succeed.

The generation of a shared and clearly articulated problem (as opposed to the immediate identification of a technological solution) was also a challenge identified by the group. Both AI and HSES members in the group observed that initial conversations about situating proposed technologies in social and cultural contexts were often led by HSES members, whereas AI members explained the nuances of AI systems and functions in a way that facilitated the grounding of HSES observations in the practical reality of technological product development. These early learning exchanges took considerable time and energy.

Unexpectedly, *the strength and relevance of disciplinary involvement shifted over the course of our interdisciplinary journey*. For example, in the early stages of collaborating, AI members were frequently called upon to provide technical knowledge to enable HSES members to understand the technology in situ. As the conversations progressed, knowledge became more evenly distributed until the group needed to make sense of social concepts like equity, for example, when HSES members' knowledge could better guide discussions. In the literature, this shifting of power, roles, and strength of knowledge contribution among domains is expected to be stronger at different time points across interdisciplinary integration stages (Brown, Deletic, and Wong 2015), yet during these times we questioned whether we were still on the right path. In retrospect, the group acknowledged the importance of fluidity in how interdisciplinarity progressed, despite the uncertainty of not knowing ahead the specific roles and values of each domain at various timepoints in the process.

Finally, a persistent concern expressed by HSES members was that external to this group, their *expertise would continue to be sought in the role of service providers* to improve technological products, or as crisis managers when products were identified as potentially injurious. That this culture is ingrained in many science organizations globally and occurring across numerous scientific domains (see Shapin 2022), was a worry expressed by several scientists in this group. Acknowledging its continued persistence is a first step in shifting perceptions in our organization and beyond.

Our lessons

Interdisciplinarity demands a constant balancing of disciplinary contributions, perspectives, and interests

Diverse disciplines hold contrasting worldviews and involve distinct career drivers and cultures of working. These divergences can become significant hurdles and tensions for interdisciplinary collaborations (Catney and Lerner 2009; Purvis et al. 2023). For example, as noted above, the speed and pace at which output development was expected to commence was a particular point of difference and concern among AI and HSES members. While HSES members expect to wait upwards of 6–12 months for publication of traditional

outputs, AI members consider weeks to be a reasonable timeframe for publication of new work. These differences across the two domains in expectations about speed and pace of co-producing outputs from a collaboration is noteworthy and should not be overlooked as a challenge for incentivizing and sustaining an interdisciplinary collaboration.

There were times in the CoP where one domain assumed primacy over themes of discussion while the other domain became a passive participant. This asymmetry in disciplinary dominance is not unfamiliar to social scientists working alongside natural and biophysical scientists given the primacy of positivist scientific approaches in cross-disciplinary settings (Purvis et al. 2023). Only in retrospect did this ebb and flow of disciplinary dominance make sense to us. During the process, the group found itself questioning whether our efforts to integrate across disciplines were still strong during these times. We now realize the potential for this ebb and flow to calm as interdisciplinarity matures. We would urge others to consider this asymmetry an important condition to monitor given the deeply entrenched ways of working among established disciplinary domains.

The balancing of worldviews and cultures required constant effort from everyone in the CoP to ensure both inclusion and progress. Other research groups have used bridging tools (or boundary objects, like conceptual frameworks) early in collaboration initiatives to overcome hurdles raised by fundamental disciplinary differences sooner (see Wilson et al. 2021). Searching for a tool that we could all relate to in the AI context might have taken significant additional time but, in retrospect, it may have helped us reach greater balance in domain contributions and interdisciplinary integration sooner.

Steering the process of interdisciplinary integration needs leadership and continuous effort among members

Our CoP was led by a dedicated individual, the last author, who periodically sought input from domain leaders within the group about direction, practical methods for stimulating collaboration, and general problem-solving. This leader also had the role of communicating with higher management on the group's progress, taking responsibility for advocating for interdisciplinarity more broadly, and finding avenues for influence beyond the CoP (like forums and speaking spots). Good group leadership is fundamental to the success of collaborative endeavors, especially when needing to manage group diversity, responding quickly to change, and finding points of connection which lead to progress (Deutsch et al. 2021).

In addition to securing good leadership, the group placed significant effort on building relationships among individual members, identifying shared values, and developing shared areas of research interest. This effort enabled us to advance the pace toward interdisciplinarity more quickly. "Relationship work" is an important part of any well-functioning group and should not be overlooked in the benefits, both tangible and less tangible, it provides to support group functioning and the delivery of outcomes (Moirano, Sánchez, and Štěpánek 2020). The responsibility for Relationship work in collaborations needs to be collectively shared (Love et al. 2022).

Interdisciplinarity requires the willingness and ability to be reflective, reflexive, and learn-on-the-go

Interdisciplinarity necessitates not only reflection on the process and members' practices but also reflexivity on the part of participants where individuals periodically enquire, reflect on and adapt their *own* positions and ways of working in order to meet group goals (Choi and Pak 2007; Horn, Urias, and Zweekhorst 2022; Knaggård, Ness, and Harnesk 2018). Emerging research suggests collaborative processes are more likely to attract individuals who hold specific personality traits and motivations (Guimarães et al. 2019). Nonetheless, it is important to recognize that not all researchers entering an interdisciplinary process necessarily possess the skills and mind-sets required for successful collaboration (Cheruvelil et al. 2014). As such, creating conditions within the team for individuals and the team to learn how to be both reflective and reflexive, and learn and work together is crucial (Freeth and Caniglia 2020; Schruijer 2020).

In our CoP, members had varying levels of experience in translating and brokering knowledge, and more specifically in processes involving collective reflection and learning as mechanisms for creating bridges across knowledges. We strove to create a safe space for all individuals, irrespective of their level of experience or comfort with reflective and reflexive methods and learning-on-the-go. We found that

including some researchers who held both disciplinary expertise *and* could also step outside their own disciplinary boundaries to successfully engage in learning and knowledge translation helped encourage practices of reflection, reflexivity and learning. The development of researchers who can demonstrate excellence in their own fields yet show interest and skill in interdisciplinary learning and integration has been recognized by other groups as an important task in integration processes and one that facilitates group functioning and sustainability (see Brown, Deletic, and Wong 2015).

Interdisciplinarity brings rewards yet participation is not without risk

Developing disciplinary excellence through scientific publication and securing successful funding remains the dominant career pathway for early and mid-career researchers. Specialty expertise is rewarded early in science careers particularly during the pursuit of higher degrees (Lamain et al. 2024; Purvis et al. 2023). Expertise continues to be a key driver for workplace rewards and promotions in science organizations, and achieving multiples of domain-specific scientific publications remains the benchmark by which scientists are evaluated. This poses a significant challenge for interdisciplinary collaborations which often call for more innovative work settings and outputs that do not favor high-tier science papers as the most valuable reward (Catney and Lerner 2009; Purvis et al. 2023).

While it is much more commonplace for HSES scholars to participate in interdisciplinary projects, workplace structures and incentives needed to foster collaboration and integration do not always favor scientists' participation in such endeavors. The perception among home discipline peers that interdisciplinary work is subpar can be a powerful deterrent to collaboration for early and mid-career researchers in particular (Catney and Lerner 2009).

Finally, in science forums where experimentation and innovation are still emerging, less capacity (and experience) may exist to support, review and evaluate science that sits at the interface of multiple disciplinary approaches (Bammer 2016). Coupled with often lower impact factor scores for publishing in interdisciplinary venues, interdisciplinary collaborations might be less attractive to early and mid-career researchers keen to demonstrate their potential via traditional science milestones (see Lindvig and Hillersdal 2019; Purvis et al. 2023).

Concluding remarks

The rapid emergence of generative AI tools such as ChatGPT, Gemini and Co-Pilot has the potential to rapidly transform social interactions and systems. Now more than ever, cross-disciplinary initiatives are critical to navigating these challenges and affecting change. Yet interdisciplinary collaborations in the context of AI development faces unique challenges. The incredible fast pace of AI technology evolution and uptake does not easily align to the more deliberative and often lengthy process of relationship building and collective dialogue and learning that are necessary for fostering genuine and sustained interdisciplinary integration. The process of interdisciplinarity demands employing different ways of working together and an enabling environment that supports and champions such efforts (Brown, Deletic, and Wong 2015; Chades et al. 2025; Horn, Urias, and Zweekhorst 2022). It necessitates significant time and practice, which is challenging particularly in large organizations where employees hold various (and at times competing) roles and responsibilities (Brown, Deletic, and Wong 2015).

For groups seeking to create similar initiatives, we would encourage attracting participation from individuals with varied disciplinary expertise and skill sets (including, among others, legal scholars, historians, and political scientists), integration experience and career stages. While integration phases such as *team coalescence* and *finding common ground* might take longer to complete initially, improving membership diversity is more likely to ensure high quality outcomes.

Organizations can assist interdisciplinary integration by creating the right enabling conditions to empower teams to experiment and innovate within a supportive environment. For research institutions, this might entail dedicated funding structures and workplace incentives to encourage integration. For other sectors, brokering research and development partnerships which harness the diversity of knowledges and resourcing needed for integration might be an option.

In our CoP, *finding common ground* among members was the most intensive task. Defining the problem to solve, the approach to take, the methods to use, and the outputs to produce, took time and compromise. However imperfect and incomplete our journey has been, we narrowed knowledge gaps among our disciplinary domains and the common ground we arrived at enabled us to produce a set of cross-disciplinary manuscripts. In doing so, our CoP achieved setting the necessary foundations *towards* inter-disciplinary integration. We recognize that continued collaboration will be necessary before we can further progress and embed an interdisciplinary approach to AI product development. Our journey has been enjoyable yet challenging and has yielded lessons we hope other research groups, AI-HSES and other cross-disciplinary collaborations, find informative on their own interdisciplinary journeys.

Notes

1. We use this term to mean research collaborations that involves two or more disciplines.
2. We define the collective term humanities, social and economic sciences (HSES) to include behavioral sciences. We also assume the shorter AI acronym to include machine learning scientists.
3. Multidisciplinary modes tend to bring together researchers from diverse disciplines who collaborate on a common topic or problem from their respective areas of expertise, without altering their disciplinary frameworks or methods (Klein 1990). This contrasts with interdisciplinary approaches which involve some level of disciplinary integration, such as the transfer of methods or the merging of insights, with the aim of constructing a more comprehensive understanding of the topic or problem at hand (Repko 2011). Transdisciplinary modes of working extend interdisciplinary collaborations to include non-academic knowledge holders (see Darbellay 2015).
4. Papers included, but not limited to.

   Sloane M (2022) To make AI fair, here's what we must learn to do. Nature 605(7908): 9. https://doi.org/10.1038/d41586-022–01202-3.

   Zou J, Londa S (2018) Design AI so that it's fair. Nature 559(7714): 324–326. https://doi.org/10.1038/d41586-018–05707-8.

   Kumar EI, Hines KE, Dickerson JP (2022) Equalizing credit opportunity in algorithms: Aligning algorithmic fairness research with US fair lending regulation. In: Proceedings of the 2022 AAAI/ACM Conference on AI, Ethics, and Society, Oxford, United Kingdom, 19–21 May 2021. https://doi.org/10.1145/3514094.3534154.

   Kusuma M, Wang M, Mohanty V et al (2022) Civil War twin: Exploring ethical challenges in designing an educational face recognition application. In: Proceedings of the 2022 AAAI/ACM Conference on AI, Ethics, and Society, Oxford, United Kingdom, 19–21 May 2021. https://dl.acm.org/doi/10.1145/3514094.3534141.

   Caliskan A, Ajay PP, Charlesworth T et al (2022) Gender bias in word embeddings: A comprehensive analysis of frequency, syntax, and semantics. In: Proceedings of the 2022 AAAI/ACM Conference on AI, Ethics, and Society, Oxford, United Kingdom, 19–21 May 2021. https://dl.acm.org/doi/10.1145/3514094.3534162.

   Adam A, Yang MY, Cato K et al (2022) Write it like you see it: Detectable differences in clinical notes by race lead to differential model recomm endations. In: Proceedings of the 2022 AAAI/ACM Conference on AI, Ethics, and Society, Oxford, United Kingdom, 19–21 May 2021. https://doi.org/10.1145/3514094.3534203.

   Bessen J, Impink SM, Seamans R (2022) The cost of ethical AI development for AI startups. In: Proceedings of the 2022 AAAI/ACM Conference on AI, Ethics, and Society, Oxford, United Kingdom, 19–21 May 2021. https://doi.org/10.1145/3514094.3534195.

   Birhane A, Kalluri P, Card D et al (2022) The values encoded in Machine Learning research. In: Proceedings of the 2022 AAAI/ACM Conference on AI, Ethics, and Society, Oxford, United Kingdom, 19–21 May 2021. https://doi.org/10.1145/3531146.3533083.

   Raji ID, Kumar IE, Horowitz A et al (2022) The fallacy of AI functionality. In: Proceedings of the 2022 AAAI/ACM Conference on AI, Ethics, and Society, Oxford, United Kingdom, 19–21 May 2021. https://doi.org/10.1145/3531146.3533158.

   Hundt A, Agnew W, Zeng V et al (2022) Robots enact malignant stereotypes. In: Proceedings of the 2022 AAAI/ACM Conference on AI, Ethics, and Society, Oxford, United Kingdom, 19–21 May 2021. https://doi.org/10.1145/3531146.3533138.

   Suresh H, Movva R, Dogan AL et al (2022) Toward intersectional feminist and participatory ML: A case study in supporting feminicide counterdata collection. In: Proceedings of the 2022 ACM Conference on Fairness, Accountability, and Transparency, Seoul Republic of Korea, 21–24 June 2022.https://doi.org/10.1145/3531146.3533132.
5. Funding for the AI-HSES Community of Practice (CoP) ended in June 2023. The CoP continues to meet online on a regular basis, primarily focused on progressing the journal manuscripts initiated in Phase 3.

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Data not available – participant consent. The participants of this study did not give written consent for their data to be shared publicly. Ethical restrictions also prevent the sharing of supporting data.

Ethics approval to conduct this project was obtained from the Commonwealth Social and Interdisciplinary Sciences Human Research Ethics Committee (CSSHREC) 172/22. CSSHREC conducts the review and approval of human research in accordance with the National Statement on Ethical Conduct in Human Research 2007 (updated 2018). Ethics approval was provided to record how we approached integration and our lessons from working together through the analyses of: discussion notes and themes during meetings; group notes from reading key literature; structured workshop activities and individual and group reflections collected throughout the project.

Informed Consent

Our submission for ethics approval advocated for not applying a formal consenting procedure in a self-reflection project due to the risk of a researcher-researched dynamic forming in the group. Instead, our ethics committee approved the application of informal, repeated, and verbal group check-ins to ensure members affirmed their involvement periodically over the course of the project. The lead author led these conversations and check-ins.

References

AAAS. 2023. Decision tree for the responsible application of artificial intelligence. Accessed December 11, 2024. https://www.aaas.org/ai2/projects/decision-tree-practitioners.

Aagaard-Hansen, J. 2007. The challenges of cross-disciplinary research. *Social Epistemology* 21 (4):425–38. doi: 10.1080/02691720701746540.

ACM. 2023. Principles for the development, deployment, and use of generative AI technologies. Accessed December 11, 2024. https://www.acm.org/binaries/content/assets/public-policy/ustpc-approved-generative-ai-principles.

Adams, L., and S. Burall. 2019. How to stimulate effective public engagement on the ethics of artificial intelligence. Report. Involve.org, UK. Accessed January 7, 2025. https://www.involve.org.uk/our-work/our-projects/what-does-meaningful-public-engagement-look-ai-and-ethics.

Anthers, E. 2017. The shape of work to come. *Nature* 550 (7676):316–19. doi: 10.1038/550316a.

Avison, D. E., P. L. Powell, and C. Adams. 1994. Identifying and incorporating change in information systems. *Systems Practice* 7 (2):143–59. doi: 10.1007/BF02169661.

Balmer, A. 2023. A sociological conversation with ChatGPT about AI ethics, affect and reflexivity. *Journal of Sociology* 1–10. doi: 10.1177/00380385231169676.

Bammer, G. 2005. Integration and implementation sciences: Building a new specialization. *Ecology and Society* 10 (2):6. http://www.jstor.org/stable/26267751.

Bammer, G. 2012. Strengthening interdisciplinary research: What it is, what it does, how it does it and how it is supported. Report for the Australian Council of Learned Academies. Accessed January 7, 2025. https://acola.org/1-strengthening-interdisciplinary-research/.

Bammer, G. 2016. What constitutes appropriate peer review for interdisciplinary research? *Palgrave Communications* 2 (1):106017. doi: 10.1057/palcomms.2016.17.

Bammer, G., M. O'Rourke, O. D, L. Neuhauser, G. Midgley, J. T. Klein, N. J. Grigg, H. Gadlin, I. R. Elsum, M. Bursztyn, et al. 2020. Expertise in research integration and implementation for tackling complex problems: When is it needed, where can it be found and how can it be strengthened? *Palgrave Communications* 6 (1):5. doi: 10.1057/s41599-019-0380-0.

Barry, A., G. Born, and G. Weszkalnys. 2008. Logics of interdisciplinarity. *Economy and Society* 37 (1):20–49. doi: 10.1080/03085140701760841.

Bender, E. M., T. Gebru, A. McMillan-Major, and S. Shmitchell. 2021. On the dangers of stochastic parrots: Can language models be too big? *FAccT* 21:610–23. doi: 10.1145/3442188.3445922.

Bengio, Y. 2023. AI and catastrophic risk. J Democr Accessed January 8, 2025. https://www.journalofdemocracy.org/ai-and-catastrophic-risk/.

Bjorn, G. 2024. The ceric method plus social collaborative annotation improves critical reading of the primary literature in an interdisciplinary graduate course. *Frontiers in Education* 9:1257747. doi: 10.3389/feduc.2024.1257747.

Blau, W., V. G. Cerf, J. Enriquez, J. S. Francisco, U. Gasser, M. L. Gray, M. Greaves, B. J. Grosz, K. H. Jamieson, G. H. Haug, et al. 2024. Protecting scientific integrity in an age of generative AI. *Proceedings of the National Academy of Sciences* 121 (22):e2407886121. doi: 10.1073/pnas.2407886121.

Bockting, C. L., E. A. M. van Dis, R. van Rooij, W. Zuidema, and J. Bollen. 2023. Living guidelines for generative AI-why scientists must oversee its use. *Nature* 622 (7984):693–96. doi: 10.1038/d41586-023-03266-1.

Bolger, P. 2021. Delivering on the promise: How are sustainability research institutes enabling interdisciplinary research? *International Journal of Sustainability in Higher Education* 22 (8):167–89. doi: 10.1108/IJSHE-10-2020-0415.

Bray, J. N., J. Lee, L. L. Smith, and L. Yorks. 2000. *Collaborative inquiry in practice*. London: Sage.

Brown, R. R., A. Deletic, and T. H. F. Wong. 2015. Interdisciplinarity: How to catalyse collaboration. *Nature* 525 (7569):315–17. doi: 10.1038/525315a.

Bruce, A. 2023. AI can be a force for good or ill in society, so everyone must shape it, not just the 'tech guys'. Accessed January 7, 2025. https://www.theguardian.com/commentisfree/2023/aug/11/ai-tech-designers-tool-communities?CMP=oth_b-aplnews_d-3.

Catney, P., and D. N. Lerner. 2009. Managing multidisciplinarity: Lessons from SUBR: IM. *Interdisciplinary Science Reviews* 34 (4):290–308. doi: 10.1179/030801809X12529269201129.

Chades, I., M. McGrath, E. Bohensky, L. Carter, R. Coates, B. Harwood, Z. Islam Md, S. Kandanaarachchi, C. S. Ong, A. Reeson, et al. 2025. Four compelling reasons to urgently integrate AI development with humanities, social and economic sciences. *IEEE Transactions on Technology and Society* 1–5. doi: 10.1109/TTS.2025.3556879.

Chapman, D. D. 2024. Faculty reading circles for community building and interdisciplinary discussion. In *Faculty development on a shoestring: programs to support higher education faculty using little or no resources*, ed. D. Chapman and M. Bartlett, 111–23. Information Age Publishing.

Chen, Y., E. W. Clayton, L. L. Novak, S. Anders, and B. Malin. 2023. Human-centered design to address biases in artificial intelligence. *Journal of Medical Internet Research* 25:e43251. https://pubmed.ncbi.nlm.nih.gov/36961506/.

Cheruvelil, K. S., P. A. Soranno, K. C. Weather, P. C. Hanson, S. J. Goring, C. T. Filstrup, and E. K. Read. 2014. Creating and maintaining high-performing collaborative research teams: The importance of diversity and interpersonal skills. *Frontiers in Ecology and the Environment* 12 (1):31–38. doi: 10.1890/130001.

Choi, B. C. K., and A. W. P. Pak. 2007. Multidisciplinarity, interdisciplinarity, and transdisciplinarity in health research, services, education and policy: 2. Promotors, barriers, and strategies of enhancement. *Clinical and Investigative Medicine* 30 (6):e224–32. https://utppublishing.com/doi/pdf/10.25011/cim.v30i6.2950.

Clark, J., K. Laing, D. Leat, R. Lofthouse, U. Thomas, L. Tiplady, and P. Woolner. 2017. Transformation in interdisciplinary research methodology: The importance of shared experiences in landscapes of practice. *International Journal of Research and Method in Education* 40 (3):243–56. doi: 10.1080/1743727X.2017.1281902.

CohenMiller, A. S., and E. Pate. 2019. A model for developing interdisciplinary research theoretical frameworks. *The Qualitative Report* 24 (6):1211–26. doi: 10.46743/2160-3715/2019.3558.

Council of the European Union. 2024. Accessed January 7, 2025. https://www.consilium.europa.eu/en/press/press-releases/2023/12/09/artificial-intelligence-act-council-and-parliament-strike-a-deal-on-the-first-worldwide-rules-for-ai/.

Cundill, G., D. J. Roux, and J. N. Parker. 2015. Nurturing communities of practice for transdisciplinary research. *Ecology and Society* 20 (2):22. doi: 10.5751/ES-07580-200222.

Darbellay, F. 2015. Rethinking inter- and transdisciplinarity: Undisciplined knowledge and the emergence of a new thought style. *Futures* 65:163–74. doi: 10.1016/j.futures.2014.10.009.

Deutsch, L., B. Belcher, R. Claus, and S. Hoffmann. 2021. Leading inter- and transdisciplinary research: Lessons from applying theories of change to a strategic research program. *Environmental Science and Policy* 120:29–41. doi: 10.1016/j.envsci.2021.02.009.

Donia, J., and J. A. Shaw. 2021. Co-design and ethical artificial intelligence for health: An agenda for critical research and practice. *Big Data & Society* 8 (2). doi: 10.1177/20539517211065248.

Dwivedi, Y. K., N. Kshetri, L. Hughes, E. L. Slade, A. Jeyaraj, A. K. Kar, A. M. Baabdullah, A. Koohang, V. Raghavan, M. Ahuja, et al. 2023. So what if ChatGPT wrote it? Multidisciplinary perspectives on opportunities, challenges and implications of generative conversational AI for research, practice and policy. *International Journal of Information Management* 71:102642. doi: 10.1016/j.ijinfomgt.2023.102642.

Eubanks, V. 2019. *Automating inequality: how high-tech tools profile, police, and punish the poor*. (NY): Picador.

European Commission. 2024. Living guidelines on the responsible use of generative AI in research. Accessed January 7th, 2025. https://research-and-innovation.ec.europa.eu/document/2b6cf7e5-36ac-41cb-aab5-0d32050143dc_en.

Fleming, A., E. Bohensky, B. B. Lin, B. B. Lin, J. Melbourne-Thomas, T. Moore, S. Stone-Jovicich, C. Tozer, J. M. Clarke, L. Donegan, et al. 2023. Perceptions of co-design, co-development and co-delivery (co-3D) as part of the co-production process – insights for climate services. *Climate Services* 30:100364. doi: 10.1016/j.cliser.2023.100364.

Forino, G., J. Barclay, M. Teresa Armijos, J. Phillips, M. Córdova, E. Sevilla, M. Evangelina Filippi, M. Apgar, M. Snijder, S. Daniel Andrade, et al. 2023. Reflexivity and interdisciplinarity: The reflexive journey of an interdisciplinary research team in disaster risk reduction. *Disaster Prev Manage*. doi: 10.1108/DPM-09-2023-0222.

Forsythe, D. E. 1993. Engineering knowledge: The construction of knowledge in artificial intelligence. *Social Studies of Science* 23 (3):445–77. doi: 10.1177/030631279302300302.

Freeth, R., and G. Caniglia. 2020. Learning to collaborate while collaborating: Advancing interdisciplinary sustainability research. *Sustainability Science* 15 (1):247–61. doi: 10.1007/s11625-019-00701-z.

Frost, S. H., and P. M. Jean. 2003. Bridging the disciplines: Interdisciplinary discourse and faculty scholarship. *Journal of Higher Education* 74 (2):119–49. doi: 10.1080/00221546.2003.11777193.

Gorbet, R. B., V. Schoner, and B. Taylor. 2008. Best practices for enabling effective cross-disciplinary learning in interdisciplinary project groups. *International Journal of Engineering Education* 24 (3):495.

Gruetzemacher, R., and J. Whittlestone. 2022. The transformative potential of artificial intelligence. *Futures* 135:102884. doi: 10.1016/j.futures.2021.102884.

Guimarães, M. H., C. Pohl, O. Bina, and M. Varanda. 2019. Who is doing inter- and transdisciplinary research, and why? An empirical study of motivations, attitudes, skills and behaviours. *Futures* 112:102441. doi: 10.1016/j.futures.2019.102441.

Hagendorff, T. 2020. The ethics of AI ethics: An evaluation of guidelines. *Minds and Machines* 30 (1):99–120. doi: 10.1007/s11023-020-09517-8.

Hannemayer, A. 2022. *Artificial intelligence and its discontents: critiques from the social sciences and humanities*. Cham: Palgrave Macmillan. doi: 10.1007/978-3-030-88615-8.

Heron, J. 1996. *Co-operative inquiry: research into the human condition*. Sage, Thousand Oakes.

Heron, J., and P. Reason. 1997. A participatory inquiry paradigm. *Qual Inq* 3 (3):274–94. doi: 10.1177/107780049700300302.

Holbrook, J. B. 2013. What is interdisciplinary communication? Reflections on the very idea of disciplinary integration. *Synthese* 190 (11):1865–79. doi: 10.1007/s11229-012-0179-7.

Horn, A., E. Urias, and M. B. M. Zweekhorst. 2022. Epistemic stability and epistemic adaptability: Interdisciplinary knowledge integration competences for complex sustainability issues. *Sustainability Science* 17 (5):1959–76. doi: 10.1007/s11625-022-01113-2.

Hubbs, G., M. O'Rourke, and O. Sh, eds 2020. *The toolbox dialogue initiative: The power of cross-disciplinary practice*. Boca Raton: CRC Press.

Jobin, A., M. Ienca, and E. Vayena. 2019. The global landscape of AI ethics guidelines. *Nature Machine Intelligence* 1 (9):389–99. doi: 10.1038/s42256-019-0088-2.

Kakabadse, N. K., A. P. Kakabadse, and K. N. Kalu. 2007. Communicative action through collaborative inquiry: Journey of a facilitating co-inquirer. *Systemic Practice and Action Research* 20 (3):245–72. doi: 10.1007/s11213-006-9061-1.
Klein, J. T. 1990. *Interdisciplinarity: history, theory and practice*. Detroit: Wayne State University Press.
Knaggård, A., B. Ness, and D. Harnesk. 2018. Finding an academic space: Reflexivity among sustainability researchers. *Ecology and Society* 23 (4):20. doi: 10.5751/ES-10505-230420.
Kubzansky, M. 2023. Reimagining our high-tech world. *Stanf Soc Innov Rev* 21 (4):26–33. doi: 10.48558/DKKQ-2K86.
Kusters, R., D. Misevic, H. Berry, A. Cully, Y. Le Cunff, L. Dandoy, N. Díaz-Rodríguez, M. Ficher, J. Grizou, A. Othmani, et al. 2020. Interdisciplinary research in artificial intelligence: Challenges and opportunities. *Frontiers in Big Data* 3. doi: 10.3389/fdata.2020.577974.
Kusuma, M., M. Wang, V. Mohanty. 2022. Civil war twin: Exploring ethical challenges in designing an educational face recognition application. Proceedings of the 2022 AAAI/ACM Conference on AI, Ethics, and Society, Oxford, UK. Accessed May 19–21, 2021. https://dl.acm.org/doi/10.1145/3514094.3534141.
Lamain, C., S. Brugman, M. Boes, C. Schoevaars, D. Tetteroo, M. D. Veldhuizen, J. P. Wijnen, D. Lakens, F. Albronda, S. Hofmann, et al. 2024. Finding joy, creativity and meaning through unusual interdisciplinary collaborations. *Humanities and Social Sciences Communications* 11 (1):1159. doi: 10.1057/s41599-024-03634-w.
Lindvig, K., and L. Hillersdal. 2019. Strategically unclear? Organising interdisciplinarity in an excellence programme of interdisciplinary research in Denmark. *Minerva* 57 (1):23–46. doi: 10.1007/s11024-018-9361-5.
Love, H. B., B. K. Fosdick, J. E. Cross, M. Suter, D. Egan, E. Tofany, and E. R. Fisher. 2022. Towards understanding the characteristics of successful and unsuccessful collaborations: A case-based team science study. *Humanities and Social Sciences Communications* 9 (1):1–11. doi: 10.1057/s41599-022-01388-x.
Lyall, C., A. Bruce, J. Tait. 2011. *Interdisciplinary research journeys: practical strategies for capturing creativity*. London: Bloomsbury Academic.
MacLeod, M. 2018. What makes interdisciplinarity difficult? Some consequences of domain specificity in interdisciplinary practice. *Synthese* 195 (2):697–720. doi: 10.1007/s11229-016-1236-4.
McLennan, S., A. Fiske, D. Tigard, R. Müller, S. Haddadin, and A. Buyx. 2022. Embedded ethics: A proposal for integrating ethics into the development of medical AI. *BMC Medical Ethics* 23 (1). doi: 10.1186/s12910-022-00746-3.
Mittelstadt, B. 2019. Principles alone cannot guarantee ethical AI. *Nature Machine Intelligence* 1 (11):501–07. doi: 10.1038/s42256-019-0114-4.
Moirano, R., M. A. Sánchez, and L. Štěpánek. 2020. Creative interdisciplinary collaboration: A systematic literature review. *Thinking Skills and Creativity* 35:100626. doi: 10.1016/j.tsc.2019.100626.
Moon, K., and D. Blackman. 2014. A guide to understanding social science research for natural scientists. *Conservation Biology* 28 (5):1167–77. doi: 10.1111/cobi.12326.
Morse, W. C., M. Nielsen-Pincus, J. E. Force, and J. D. Wulfhorst. 2007. Bridges and barriers to developing and conducting interdisciplinary graduate-student team research. *Ecology and Society* 12 (2):8. doi: 10.5751/ES-02082-120208.
Mortari, L. 2015. Reflectivity in research practice: An overview of different perspectives. *International Journal of Qualitative Methods* 14 (5). doi: 10.1177/1609406915618045.
Nancarrow, S. A., A. Booth, S. Ariss, T. Smith, P. Enderby, and A. Roots. 2013. Ten principles of good interdisciplinary team work. *Human Resources for Health* 11 (1):11. doi: 10.1186/1478-4491-11-19.
Nee, E. 2023. Technology for the people. *Stan Soc Innov Rev* 21 (4). doi: 10.48558/40G4-C447.
O'Rourke, M., S. Crowley, and C. Gonnerman. 2016. On the nature of cross-disciplinary integration: A philosophical framework. *Stu Hist Phil Sci C: Stud Hist Phil Biol Biomed Sci* 56:62–70. doi: 10.1016/j.shpsc.2015.10.003.
Pennington, D. D. 2008. Cross-disciplinary collaboration and learning. *Ecology and Society* 13 (2):8. [online] URL: http://www.ecologyandsociety.org/vol13/iss2/art8/.
Purvis, B., H. Keding, A. Lewis, and P. Northall. 2023. Critical reflections of postgraduate researchers on a collaborative interdisciplinary research project. *Humanities and Social Sciences Communications* 10 (1). 1. doi: 10.1057/s41599-022-01494-w.
Repko, A. F. 2011. *Interdisciplinary research: process and theory*. Los Angeles: SAGE.
Scharff, R. C., and D. A. Stone. 2022. Transdisciplinarity without method: On being interdisciplinary in a technoscientific world. *Human Studies* 45 (1):1–25. doi: 10.1007/s10746-021-09616-0.
Schruijer, S. G. L. 2020. Developing collaborative interorganizational relationships: An action research approach. *Team Performance Management: An International Journal* 26 (1/2):17–28. doi: 10.1108/TPM-11-2019-0106.
Shapin, S. 2022. Hard science, soft science: A political history of a disciplinary array. *History of Science* 60 (3):287–328. doi: 10.1177/00732753221094739.
Stahl, B. C., and Stahl BC. 2022. Responsible innovation ecosystems: Ethical implications of the application of the ecosystem concept to artificial intelligence. *International Journal of Information Management* 62:62. doi: 10.1016/j.ijinfomgt.2021.102441.
Suresh, H., R. Movva, and A. L. Dogan. 2022. Towards intersectional feminist and participatory ML: A case study in supporting feminicide counterdata collection. *Proceedings of the 2022 ACM Conference on Fairness, Accountability, and Transparency*, Seoul, Republic of Korea. Accessed June 21–24, 2022. doi: 10.1145/3531146.3533132.

Taylor, P. J., S. J. Fifield, and C. C. Young. 2011. Cultivating collaborators: Concepts and questions emerging interactively from an evolving, interdisciplinary workshop. *Science as Culture* 20 (1):89–105. doi: 10.1080/09505431.2010.512046.

Villeneuve, D., D. Durán-Rodas, A. Ferri, T. Kuttler, J. Magelund, M. Mögele, L. Nitschke, E. Servou, and C. Silva. 2019. What is interdisciplinarity in practice? Critical reflections on doing mobility research in an intended interdisciplinary doctoral research group. *Sustainability* 12 (1):197. doi: 10.3390/su12010197.

Wenger, E. C. 1998. *Communities of practice: learning, meaning, and identity*. (UK): Cambridge University Press.

Wheeler, T. 2023. The three challenges of AI regulations. Brookings. Accessed January 8, 2025. https://www.brookings.edu/articles/the-three-challenges-of-ai-regulation/.

Wilson, M. N., A. E. Laufer, E. M. Howard, and J. A. T. K. Wong-Ala. 2021. Lessons from the trenches: Students' perspectives of their own marine transdisciplinary education. *Frontiers in Marine Science* 7. doi: 10.3389/fmars.2020.592368.

Zajko, M. 2022. Artificial intelligence, algorithms, and social inequality: Sociological contributions to contemporary debates. *Sociology Compass* 16 (3):e12962. doi: 10.1111/soc4.12962.

Zalnieriute, M., L. B. Moses, and G. Williams. 2019. The rule of law and automation of government decision-making. *Mod Law Rev* 82 (3):425–55. doi: 10.1111/1468-2230.12412.