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Inter- and Transdisciplinarity in One Health

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Chapter Overview

Elevator pitch

Understanding and solving complex health issues requires multiple perspectives and complementary knowledge. Collaborative approaches, such as multi-, inter- or transdisciplinarity, can help us gather and make the best of that diverse knowledge. Far from being a magic bullet, collaborative approaches entail major challenges for science and society as a whole. A deep understanding of the challenges and potential of the diverse collaborative modes is needed in order to mobilize these strategically and harvest their benefits.

Book objectives the chapter relates to

- ☐ 1. Understand what One Health and Ecohealth mean
- ☒ 2. Think in a One Health and Ecohealth way
- ☒ 3. Apply One Health and Ecohealth in their professional and personal life
- ☐ 4. Know how to share One Health and Ecohealth knowledge
- ☒ 5. Integrate One Health and Ecohealth knowledge actively
- ☒ 6. Acquire or enhance core One Health competencies

One Health competencies covered

- ☐ 1. Effective communication
- ☒ 2. Collaborative and resilient working
- ☐ 3. Systems understanding
- ☒ 4. Transdisciplinarity
- ☐ 5. Social, cultural and gender equity and inclusiveness
- ☒ 6. Collective learning and reflective practice
- ☐ 7. One Health concepts
- ☒ 8. Theoretical and methodological pluralism
- ☐ 9. Harnessing uncertainty, paradox and limited knowledge

After having worked through this chapter, you will be able to reflect critically on the need for and constraints of collaborative approaches, identify disciplines and stakeholders to include and propose a plan to mobilize inter- and transdisciplinarity in a given context, including categories of methods to facilitate the process.

Learning outcomes

1. Discuss the meaning of multi-, inter- and transdisciplinarity.
2. Recognize these collaborative approaches as critical components of One Health activities.
3. Identify the benefits, challenges and limits of the different collaborative approaches according to the context and goals.
4. Identify categories of methods, including creativity methods, to be further explored in your other learning.

Summary

Working in multi-, inter- and transdisciplinarity means that more than one scientific discipline and possibly other knowledgeable actors collaborate to tackle complex real-life problems. These collaborative approaches are at the centre of One Health operationalization. This chapter first discusses these distinct collaborative approaches and their respective contribution to One Health. Based on the proposed definition, you learn about barriers and conditions to their implementation. The divides and specificities of disciplines will be presented, considering their diversity as the resource to be harnessed. You will then look at how inter- and transdisciplinarity can be considered as creative processes for collective problem solving, and how these approaches can be implemented in practice.

3.1 Introduction: One Health, the Challenge of Approaching Wholeness

One Health, Ecohealth and Planetary Health, beyond their differences (see Chapters 1 and 2), all embrace the concept that the **health** of humans, animals, plants and, as a whole, the **ecosystems** they share and constitute, are tightly intertwined. In that understanding and for the sake of simplifying the expression, this chapter will refer to 'One Health' in this broader acknowledgement. As you will further discover in the chapters dedicated to **systems thinking** (Chapter 10) and **knowledge integration** (Chapter 4), this wholeness has been approached in manifold ways by a variety of sciences, practices, traditions and spiritualities. Among these approaches, a significant part of modern science has taken a reductionist turn (see Chapter 4 on knowledge integration), cutting this complexity down into manageable pieces and producing the basis of a substantial segment of current education programmes worldwide. Across the globe, professionals are most often trained in a defined set of sciences and practices, with the prospect of taking charge of one of these pieces: forest management, fisheries, urban planning, veterinary medicine, human medicine, and so on. As will be further outlined in this chapter, these segments of **knowledge** and practices are called **disciplines**, the term here referring indiscriminately to scientific branches (e.g. sociology, epidemiology), humanities or professions. Yet, through its subdivision in disciplines, science and science-based professions have lost the sense of the wholeness that is needed to embrace the One Health concept. Also, by the dominant position that it has taken in many societies across the globe and in international spheres, science has regrettably set aside many other forms of knowledge (see Chapter 4 on knowledge integration).

Hence, to address appropriately the complexity of the intermingled health of life forms, multiple 'disciplines' must be involved, as the knowledge required to frame the problem and investigate and implement solutions cannot lie in a single branch of science or a single profession. The One Health approach leads us to raise questions pertaining to many domains of application, hence, to mobilize many disciplines but also to acknowledge, do justice to and leverage other forms of knowledge. Also, well beyond a simple re-branding of current

dominant approaches, One Health must be a complex re-braiding of a diversity of threads of knowledge to produce a colourful and supple fabric. Indeed, as proposed in this chapter, One Health is not 'just' a matter of efficient collaborations but about vivid and fruitful co-creation. This chapter proposes an introduction to these forms of collaboration and creativity, proposing a first set of conceptual landmarks to start your journey across disciplines and beyond.

Throughout your reading, please keep in mind that the authors of this chapter, although they have evolved in very distinct ways away from their initial training, are all anchored in a mix of life and social sciences, leaving out of reach a wealth of considerations that you will be able to discover by reading authors from other disciplinary origins across sciences, arts and humanities. Also, as a joint production, the chapter does not aim at exploring the diversity of thoughts within the team of authors. Rather it proposes a common basis to pave your first steps towards wider and more diverse explorations.

3.2 Multi-, Inter- and Transdisciplinary Work in One Health

One Health dialogues must include a wide spectrum of disciplines and professions, involving or based on life science, social science and humanities, as well as technology, mathematics and engineering. These various disciplines or, better said, the collaborators representing them will bring complementary knowledge and a multitude of perspectives, which enrich our understanding of these complex problems. Therefore, as outlined in the introduction, knowledge sharing and articulation among multiple disciplines, **sectors** and groups in society are at the core of integrated approaches to health (as seen in Chapter 1). Hence, the terms **multi-**, **inter-** and **transdisciplinarity** are often associated with the work conducted using the One Health approach. None the less, these represent distinct modalities of collaboration and should not be used interchangeably.

In the realm of health, Choi and Pak (2006) reviewed the definitions of the three terms according to multiple sources. The results showed that the terms are ambiguously defined, which these authors consider to be a cause of confusion and misinterpretations. While the ambiguity of terms may in fact be appreciated for

the freedom of interpretation and creativity that it allows, at this step of your learning, it seems wise to start from a first set of beacons, under the form of definitions that you will be later able to re-consider and critique. Indeed, for the sake of clarity, we will propose here a brief summary of our current understanding of each type of collaboration. Be aware, nevertheless, that the literature may contain many nuances in the interpretation of these terms, showing that the debate is vivid and that our experience of collaborations between disciplines is still evolving.



MULTIDISCIPLINARITY refers to collaborations that use knowledge and practices from different disciplines but stay within the boundaries of each field. Hence, multidisciplinary collaboration represents merely an addition of different disciplines. Courses at university level are often built in a multidisciplinary fashion: students from health-related areas need to study different disciplines (e.g. microbiology, pathology, parasitology) to complete their course. Due to the lack of integration of the knowledge of different disciplines, this can be considered the least collaborative of the approaches here described. Therefore, multidisciplinary may not be considered an 'integrative' approach.



INTERDISCIPLINARITY requires an intersection of knowledge between two or more disciplines to tackle a common problem. This goes beyond the additive nature of multidisciplinary collaborations because it requires an integration of knowledge from the disciplines involved (for further insight on knowledge integration, see Chapter 4). This means that, in interdisciplinary works, collaborating disciplines hold direct interactions and mutual adaptation of their questions, methods and tools. They are learning from each other and producing approaches and knowledge that would not be reachable by each discipline on its own or by simply adding to each other. During the COVID-19 pandemic, many countries created task forces to control the disease. These task forces included virologists, epidemiologists and clinicians, among others. Actors in such task forces often collaborated in an interdisciplinary fashion to advise authorities about the control measures to be taken. This happened through direct dialogues between the representatives of the various disciplines involved. Such task forces, however,

often failed to integrate other types of disciplines, notably across social sciences and humanities or environmental sciences. Therefore, let us note here that reaching the degree of co-learning between disciplines that interdisciplinarity is conveying does not reveal anything about the diversity of the disciplines involved.



TRANSDISCIPLINARITY often refers to the realm of scientific research, hence to transdisciplinary research (see, for example, Scholz and Steiner, 2015). This then means that the knowledge production efforts involve knowledgeable actors across society, beyond scientific disciplines. Hence, there is an integration of knowledge from scientific and other sources. This transdisciplinary research is focused on solving problems within society, involving the needed **stakeholders** and leveraging the diversity of their knowledge (experiential, traditional, and so on). The scientific realm investigates a given problem while society needs to handle that problem (or a societal group, not necessarily the society as a whole) (Pohl *et al.*, 2017). Along the steps of the transdisciplinary collaboration (framing the problem, analysing the problem and exploring the impact of potential solutions – more detail on this can be found in the One Health implementation cycle, Chapter 10), there is an involvement from both the scientific and the societal actors. Let us use the example of sustainable food systems in the 21st century. Such a complex topic cannot be solved by science on its own. Even if multiple scientific disciplines collaborate to develop technical solutions and a fine understanding of social and economic stakes, their applicability might be limited if critical actors, such as the food industry and the consumers, are not engaged throughout the process. To provide sustainable options, societal actors need to perceive the current system as a problem and be involved in the scientific exploration of solutions.

As illustrated in the definition of transdisciplinarity, these three forms of collaboration are often evoked in the particular context of research, with the term 'disciplines' then covering 'scientific disciplines'. This dominant use can be seen as still influencing the writing of this chapter. However, these terms also apply to the collaboration between different professions, different institutions,

and different sectors of activity. In this case, it may be proposed to apply the term ‘transdisciplinarity’ to cases where the boundary to be crossed is the one delimiting not only science from society, but more generally professional actors (e.g. medical doctor, nurse, social worker, veterinarian, epidemiologist, agronomist) from other knowledge holders who are not commonly considered legitimate to influence the professional decision of the former (e.g. pet holders for veterinary decision making, a patient group for therapeutic strategy, citizen groups for the control of an epidemic). Transdisciplinarity has been a particularly successful and debated term, with some authors pointing more recently to it as being a ‘way of living’ (Rigolot, 2020), significantly opening the box and creating a space that you will be able to inhabit through your evolving practice.

These three modalities can be seen as a collaboration continuum, where multidisciplinary requires the least intense collaboration and transdisciplinarity entails the most engagement from various scientific disciplines and societal actors. Between those extremes, interdisciplinarity covers a wide range of collaborative efforts, depending on the number of disciplines, their diversity and the depth of integration that is meant. In perspective, this does not mean that there is an approach that is *per se* better or has more worth than the others. Much can be achieved by scientific disciplines in isolation, taking advantage of specialization and sharp expertise on well-delimited topics.



The choice of the collaborative modality should be made based upon the problem to be solved. As a matter of fact, not all health problems require a collaborative approach. Social change for health purposes will eventually require wide transdisciplinary collaborations, but these changes will also be fuelled by knowledge produced by disciplines in isolation. Moreover, one given societal problem requiring transdisciplinary approaches will in fact be tackled in different phases. Each of these may require distinct depths of collaboration, with multi-, inter- and transdisciplinary stages (Hurni and Wiesmann, 2004). Thus, there is a dynamic of collaboration, with each form of collaboration holding distinct roles in problem solving. In other words, there is no point in demeaning shallower forms of collaborations or in idealizing deeper ones. The quest will be one of a flexible and adapted course to one or the other form to address challenges in a feasible way.

Interdisciplinarity and transdisciplinarity represent fields of knowledge and practices in their own right, being developed and reflected upon in a plurality of communities of practice, around various concerns and challenges, well beyond integrated approaches to health (see Chapter 6 on reflexivity and Chapter 10 on communities of practice). Therefore, interdisciplinarity and transdisciplinary efforts made in the pursuit of One Health implementation are a particular case of application of these fields, and remain mostly a work in progress, not to say a promise. For instance, in the case of antimicrobial resistance, which is addressed by many One Health endeavours, it is widely accepted by professionals across medical and veterinary sectors that social sciences can help understand practices and habits of farmers, veterinarians, patients and medical doctors that impact antimicrobial consumption. This in turn can help generate more adequate measures to curb the use of antimicrobials and protect the efficacy of these drugs for use in animals and humans, consequently also lowering their impact on the **environment**. Some may even be well aware that social sciences and humanities more fundamentally provide critical analyses of the current ways of living, thinking and doing, which can be leveraged to re-think more fundamentally ourselves and our societies (see Chapter 6 on reflexivity), including obviously the healthcare and the food system that are home to this overuse and misuse of antibiotics. It is also widely understood that environmental sciences will shed light on how antimicrobial resistance affects ecosystems and how it spreads and persists in a diversity of conditions, and eventually how it will respond or not to interventions we aim at. Yet, despite their obvious relevance, social and environmental sciences are often poorly represented in One Health endeavours.

This is to highlight the difficulty of translating these principles into practice and the efforts that remain to be done. Indeed, establishing collaborations across disciplines comes with considerable challenges that will be addressed in this chapter. Before entering into the more systematic discussion of these challenges, let us first stress that a main difficulty in this regard will be that any collaboration is, at the end of the day, a matter of learning and unlearning, a matter of deep reflection and reflexivity (see Chapter 6). This constant effort to deepen our understanding of the world and critically view what we do and how we think, beyond our ‘common understanding’ and ‘good practices’ (Antoine-Moussiaux and Leyens, 2023), remaining open to contradictions, emanating from our collaborators or from reality, is difficult. Nevertheless, if we are to create bright futures, we do not have another option.



Task: Consider a One Health problem of your choice (e.g. control and prevention of a defined zoonosis, non-communicable disease, antimicrobial resistance, food safety and security in a defined socio-economic context). For the sake of this exercise, let us focus on addressing the problem you identified using the most integrative collaboration approach we discussed in this chapter: transdisciplinary collaborations. You can also complete this activity by addressing the identified problem using a less integrative collaborative approach.

1. Describe the One Health problem you aim to address: type of health matter, context (geographic, social, economic, etc.), stakeholders, i.e. people impacting or impacted by the health issue and its control (e.g. health professionals, patients, economic actors, authorities), type of action you would focus on.
2. Identify which scientific disciplines should be engaged in your initiative and explain their relevance to your project. Start with the wide categories of disciplines: life sciences (including biomedical and environmental sciences), engineering and technologies, social sciences and humanities. Then explore each of these categories and be as precise as you can about the disciplines that should be involved. What kind of study/action would each discipline be requested to conduct?
3. Describe which societal actors should also be engaged in your study or initiative and explain their relevance to your project. Be explicit about your expectations: Do you need them to define the questions or actions with you? Do you need them to share their knowledge and produce new knowledge together with scientists?
4. Consider the potential negative and positive consequences of your intervention for the different stakeholders. Who would have something to gain or to lose if an intervention is put in place? Try to think of coping strategies to face the negative consequences.

Reflect on the advantages and disadvantages of your collaborative approach to address the One Health problem under analysis, when compared to other collaborative options (or no collaboration at all).

Once you have concluded this exercise, have a look at the example answers provided below and compare them with your answers. Think about how they differ and what may be the reasons for this difference.

Example answers: Caveat – This example is written in a short and simplified way, from a restricted perspective, for the sake of clarity. Please keep in mind that integrated approaches to health will always call its practitioners to bring up complexity onboard by gathering distinct and even divergent perspectives. This brief and illustrative example cannot be interpreted as a valid analysis. For the same reasons, the proposals are not criticized here for their feasibility.

- **One Health problem description:**

Let us consider antimicrobial resistance in a rural area of a low-income country.

The context may be characterized grossly by a high rate of poverty and low literacy of population with great disparities between small commercial centres and more remote communities. Overall, transport and communication infrastructures are weak. The local authorities lack means of action but are well-rooted in the communities with community-based workers being active across the territory. On average, the access to healthcare services is very low and a high prevalence of self-medication exists, the drugs being purchased in informal markets. Main health concerns in the region relate to maternal health, with a high rate of child mortality tied to poor hygiene, poor vaccination coverage, food and water insecurity and high prevalence of diarrhoeal and respiratory diseases. People live mainly from agriculture, and livestock mainly consist of a few backyard or free-ranging animals (chickens, pigs, goats). Some commercial broiler and layer production is developing near the commercial centre.

The stakeholders include patients, practitioners in health centres, community-based workers, local authorities, animal smallholders, poultry producers, drug sellers on the informal markets, established pharmacies and traditional healers.

Potential topics of focus are the monitoring of resistance, the development of alternative treatments, the control of antimicrobial use, and so on. Let us choose for the rest of the example the case of the delivery of antibiotics in informal markets.

- **Scientific domains and disciplines to be included:**

When considering this part, you will observe it is probably easier to imagine roles for different categories of sciences for different types of actions. Hence, for antimicrobial resistance, life science would find an obvious role in the surveillance of resistance, technologies in the development of alternative treatments, social science in the study of consumption and health-seeking behaviour. However, let us try to focus on one single type of action to increase the ability of these specialists to interact around the same topic and learn together. In our case, focusing on informal markets of antibiotics in low-income countries would call for **life sciences** to characterize the diseases that led buyers to seek antibiotics in informal markets for human use and animal use, to characterize the environmental impact of that supply chain and its waste production; **technologies** would develop capacities for the rapid testing of the quality of antibiotics or communication technologies would increase the access to health expertise despite remoteness; **social science** would study the organization of these informal markets for antibiotics to understand consumer behaviours.

For the sake of brevity, we will develop only one scientific area here. Let us focus on the study of informal markets by social science and humanities. This can include a **value chain analyst** to study the product flows, values, profits and interests of different actors, a **behavioural economist** to study the willingness of consumers to pay for better quality products, a **health anthropologist** to study the representation of health products in general, and antibiotics in particular, among sellers and buyers, a **sociologist** to study social networks of cooperation and influence among sellers, a second sociologist to characterize the types of consumers buying antibiotics in such markets and their motives not to go through formal markets, a **philosopher** to reflect on ethical issues, such as the right to access health products and social justice matters in controlling informal markets of antibiotics for human and for animal use.

- **Societal actors:**

Patients and artists can help in designing effective communication materials. School teachers can help in designing sessions to explain the issue to children. Traditional healers can help in identifying alternative treatments that have better accessibility for people. Local authorities can contribute their knowledge of the context and legal or administrative constraints. It is important here to go beyond the mobilization of stakeholders as mere implementers and to really include them as contributors to problem analysis or solution design.

- **Consequences for stakeholders:**

Drug sellers in informal markets would lose from this regulation. It would be wise in this case to think about a way to compensate for this loss by the development of other business opportunities respecting the sound use of antibiotics. Maybe some would be ready to specialize in drug delivery and find an economic role in collaboration with pharmacists, to increase the access of people to quality products, respecting good conditions of conservation and distribution, as well as waste management. What new scientific questions would this raise?

An improvement of the drug supply chain and better access to healthcare will have a cost. Who would bear that cost? Is it possible to develop local health insurance schemes? What new scientific questions would this raise?

Lowering the use of antibiotics for poultry producers will have consequences on their profitability and will increase the technicality of production, requesting higher biosecurity standards, better use of vaccination and ensuring sources of good quality inputs (day-old chicks, feed). What new scientific questions would this raise?

- **Advantages and disadvantages of collaboration:**

The collaboration will need time to be implemented and will generate some complexity in the coordination of the interventions of experts in the field. However, this might also generate some logistic advantages, by collecting, for example, the needed situational diagnostic information in one single survey. If all these specialists focus on the same topic, we can expect them to learn from each other and

generate new ideas, refine their scientific questions and increase the overall relevance of the study and the ensuing action.

The involvement of stakeholders will also require a lot of time, at first to generate the needed trust between them and scientists, and then to develop a mutual understanding that would allow them to produce new knowledge and solutions together. The advantage will be that the study will produce more adapted solutions, with several stakeholders already being fully convinced of their interest.



Reflexive intermission: You have read the caveat and then the proposed example. What would you think could be other ways to frame the same example from a different perspective? What would you deem not feasible? Would you be able to imagine alternatives to compensate for what you deemed not realistic?

3.3 Institutional Barriers to Collaboration Between Disciplines and Between Sectors



The challenges of putting One Health into practice are more than many. A significant number of those challenges are directly due to the difficulty of fostering the needed collaborations be-

tween disciplines and between sectors. Hereafter, the term 'sector' will be used as an encompassing term to refer to the set of agencies, institutions, professions and actors operating throughout society around one domain of concern. Possibly, the practical division of the concern may define 'sub-sectors'. For example, we may consider human health as a sector, which may encompass a sub-sector of healthcare and one of health promotion. Another sector would be agriculture, which includes crop production and livestock. The latter can be proposed as two 'sub-sectors'. The preservation of ecosystems would be another sector. Other examples of sectors are the bio-pharmaceutical sector, the industry sector, the energy sector, the education sector, and so on. Let us note that people from one given discipline (e.g. mathematical modelling) can be active in different sectors (e.g. one in agriculture, the other in health). A collaboration between them would be intersectoral but not interdisciplinary.

Let us first consider some of the barriers and constraints that are embedded in our current modes of organization (Table 3.1). Indeed, across the globe, administrations, research institutions and private companies commonly work in a highly segmented fashion. Sectors of activity are separated and work in parallel; likewise, governance is based on a clear distribution of roles and competencies. This mode of organization is often mentioned as working in 'silos' (e.g. faculties in universities, departments in ministries or agencies), stressing the lack of communication and collabor-

Table 3.1. Examples of barriers to collaborations, with some solutions and values or competencies that are key to their success.

Categories	Examples	Potential solutions	Key value or competency needed for success	References
Political	Territorial sovereignty	Transboundary and multi-country projects	Transparency, leadership	Pettan-Brewer <i>et al.</i> (2021); Caron <i>et al.</i> (2022)
Economic	Competition for funding	Cost-benefit analysis to prove the value added of collaboration	Equity	Häsler <i>et al.</i> (2013)
Scientific	Ignorance about other disciplines	Joint training in One Health programmes	Inclusivity, knowledge sharing	Sidikou <i>et al.</i> (2022)
Institutional	Lack of established procedures for data sharing	Inter-institutional agreement	Engagement, transparency	See Tripartite and Quadripartite agreements
Ethical	Data ownership	Clear and enforceable agreements on data sharing	Effective communication, responsibility	Capps (2022)

ation between sectors once the work has been distributed. This siloed organization of work is based on historical development and has successfully dealt with specific problems. For example, within an academic context, we can highlight how the division of a university in faculties or colleges can help each of those address more specifically the needs of their curriculum and students. The needs of a student in engineering are distinct from the needs of a veterinary student. It seems wise to allow each faculty to manage their needs separately to provide suitable services to their students, developing and managing their specific infrastructures. This will lead each faculty to develop ways of working that will be distinct from others. Across society, it is easy to imagine the benefits obtained in the last two centuries from the specialization of medicine at large. Considering the development on the one side of a diverse set of medical specialties and on the other side of bio-pharmaceutical industry, we can understand that this allowed the development of an array of high-quality healthcare services. In the first line of healthcare, the recognition and development of nursing as a speciality and profession on its own, with duly standardized curricula and the emergence of very active nursing science, helped improve the services rendered to society but obviously created a distinction between nurses and other professions around the care of people. Specialization in livestock production, e.g. in milk production, has generated considerable gains in productivity, improving the availability and quality of milk products worldwide. Through that specialization, dairy production has gradually distanced itself from other agricultural activities, turning a former peasant system integrating crops and livestock into well-separated activities, sometimes just connected through feed markets. Hence, specialization and division of labour appear almost an inherent feature of human activity once it involves large groups. By tackling issues in a siloed way, however, solutions of one sector will generate new problems outside of the sector, which we call 'externalities'. For example, intensive livestock production and large-scale bio-pharmaceutical production both generate important environmental issues (see Chapter 7 for information on **biodiversity** and food production). It is important to note in this critical domain of One Health, touching on deep and pressing concerns of justice and **sustainability**, that these accounts of the process of specialization are meant as didactic illustrations, leaving aside the otherwise crucial questions of the merit of the goals pursued or of means employed.

Based on jurisdictional divides, each sector has developed distinct practices and modes of working that might not be compatible with one another. Hence, this reinforces a sector's individuality and autonomy. In this context, collaborations are often perceived by a sector as a threat to its sovereignty (Jerolmack, 2013). This may be exemplified in the case of the outbreak investigation of a **zoonotic disease**. Indeed, veterinarians will obviously be in charge of managing animal cases, and they will treat, cull or sample animals according to the state of the art of veterinary science, reporting information to their hierarchy. In the same way, medical doctors will handle patients independently, with due confidentiality. This segmented way of working, each following their own procedures, will not be prone to the sharing of information that would be needed to correctly assess the situation and react accordingly.

Nowadays, the acknowledgement of the interconnectedness and interdependence of many issues, as in the case of One Health, unveiled the fragilities and incapability of these single vertical structures to properly address and solve the multidimensional, complex problems (Destoumieux-Garzón *et al.*, 2018). Therefore, across the world, efforts are underway to build inter-ministerial and intersectoral bridges around One Health, at national and decentralized levels, through permanent commissions (as the National One Health Coordination Mechanisms, also termed 'One Health platforms') or other kinds of agreements (e.g. fusion of scientific institutes or public administrations). However, as a matter of fact, the integrative thinking and interdisciplinary and inter-agency collaborations of One Health often remain trapped in the unique views of each 'organizational silo' and face the difficulty of bridging the articulation with other 'organizational cultures' (Jerolmack, 2013).

Alongside the institutional barriers, the distinct habits of each profession (e.g. ways of communicating, kinds of hierarchical relationships) also contribute to the lack of common understanding, in turn leading to non-sharing practices (e.g. of **data**), many times aggravated by context barriers (e.g. territorial borders), which have long been contributing to the missed opportunities for One Health integrative efforts (Kayunze *et al.*, 2014). Therefore, effective partnerships are often impeded by lack of communication, mistrust and conflicts of ego, entrenched in 'silo' bureaucracies and hierarchy. Coupled with insufficient coordination, these culminate in disarticulation and flawed integration between organizations or sectors (Uchtmann *et al.*, 2015).

Mirroring the segmentation of professional realms, the segmentation of academic disciplines also further cultivates this differentiation and transfers them to the next generation. This segmentation in training and education appears necessary to reach relevant levels of specialization and standardization of practices and competencies (to be sure that diplomas are well certifying the set of expected competencies from a practitioner). Moreover, this segmentation coincides with a hierarchical differentiation between professions (e.g. nursing and medical sciences). Each sector's set of priorities, necessarily aligned to its domain of knowledge and expertise, contributes to the disparities in working relationships (Humboldt-Dachroeden, 2021). Finally, this institutional segmentation within higher education and research produced deeper divides between people, in their mode of thinking and in conceiving the world, its issues and our knowledge itself. The next section will consider those divides in the modes of thinking.

Naturally, as this book illustrates, much effort is devoted in several domains to produce the interdisciplinary curricula that would respond to complexity of world problems: classical or more recent examples can be highlighted here as land planning, public health, environmental management or food systems. Because those problems are all interconnected, however, each of those already integrated curricula will have to establish bridges with the others to build One Health capacities. Since knowledge grows together with its segmentation and since integration efforts must always concentrate on defined problems, interdisciplinarity seems a never-ending effort, always searching for the missing collaboration, with people having the knowledge and abilities we are missing but also distinct ways of thinking and working.



Task: Imagine you are part of a One Health team with secured funding for the next three years. The One Health research project adopts a community-based approach and aims to study a waterborne zoonotic disease that afflicts wildlife, domestic mammals and humans.

1. List the various disciplines and stakeholders that you expect to be involved, and ascribe responsibilities to each of them.
2. Anticipate the barriers to collaboration that you will be confronted with, considering interacting stakeholders.

3. How would you term the competency that we have to foster to overcome your examples of expected barriers to collaboration?

4. Develop working rules that would help in avoiding each of these difficulties.

Once you have concluded this exercise, have a look at the possible answers provided below and compare them with your answers. Reflect on how they differ and what may be the reasons for this difference.

Example answers:

1. We may propose to include in your team an infectiologist, an epidemiologist, a socio-anthropologist, a biologist specialized in aquatic ecosystems, a livestock specialist, an economist and a land planner. Among stakeholders, you may consider hunters, birdwatchers, conservationists, farmers, local veterinarians, public health professionals and healthcare professionals. Regarding their respective responsibilities, among scientists, the socio-anthropologist could characterize the relationship between distinct social categories and the ecosystem (representation of wildlife, perception of the zoonotic risk, cultural role of hunting, etc.). Among stakeholders, one example could be to ascribe a role to birdwatchers in the reporting of mortalities in wild birds or other unusual observations.

2. Let us consider as an example the expected barriers to collaboration between the biologist of aquatic ecosystems and the socio-anthropologist. The latter might have a clear view of human stakes at the community level and be sensitized to poverty issues or the importance of cultural habits that drive poaching behaviours. The former may not have that understanding, being personally more sensitized to the uniqueness of the biotope and the need to protect it from any human-origin disturbance. They will not agree in the way the issue may be expressed. The socio-anthropologist will be used to long stays in the field to interview people and live with them, whereas the biologist will rather consider short interventions to take samples and set up monitoring tools. The socio-anthropologist may not directly understand the relevance of the list of figures and graphs that the biologist will produce to describe the ecosystem dynamic. The biologist may not perceive the general

scientific relevance of an in-depth case study where the socio-anthropologist would detail the people's motives, history, gender relations or familial organization.

3. Both the socio-anthropologist and the biologist will have to gain literacy in the other's methodologies and focus of interest. Fundamental competencies will be humility and open-mindedness, but also a basis in epistemology (see below). Both will require systems thinking to learn the value of connecting their information, respective pieces of understanding and (maybe contradictory) perspectives (see Chapter 4 on knowledge integration to read more on the topic).

4. In our example, rules could be to hold regular meetings to update the other on progress in the understanding of the situation. Such a meeting could rigorously set the same time for each partner to speak, to make sure that each holds an equitable place in the collaboration.

3.4 Divides in the Modes of Thinking

The deepest barriers to collaboration are embedded in the cores of disciplines or professions, i.e. in the way each discipline thinks and conceives of the world (Antoine-Moussiaux *et al.*, 2019). This section will consider two levels of this divide: first considering the different ways in which disciplines tackle complex problems, and then the way each discipline thinks about knowledge itself.

3.4.1 Disciplines and disciplinarity, an evolving set of fuzzy (sub)divisions



Above, we considered implicitly the term 'discipline' as commonly shared and understood; however, its meaning is not so obvious. Let us sum up here the elements already shared about disciplines in an attempt to circumscribe the term. Each discipline will have a distinct focus that defines it. To tackle that subject of concern, a discipline includes a set of methodologies and tools. Disciplines are organized around key concepts (see Box 3.1 for further discussion on the role of concepts in inter- and transdisciplinarity) and key theories, as well as founding authors or even heroes. The members of a discipline thus share a history

and most often sharing this will entail that they share values, and a common representation of what science is or must be, or what a good practice is or must be. To hand over this legacy between generations, a discipline is created by the establishment of a curriculum, a standardized training that makes sure that every member of the discipline holds that common basis of concepts, theories, tools, authors, heroes and values (sometimes very explicitly, as exemplified by the Hippocratic Oath). An important heterogeneity in the size and nature of disciplines emerges from the diversity of nature and degrees of precision of topics of concern. Indeed, a discipline can be organized around a very broad and fundamental topic, such as biology studies life, chemistry the molecular interactions, or physics the principles governing energy and matter. Other disciplines will organize around a practical problem, such as medicine, urban planning or climatology, merging elements from several fundamental disciplines. The focus of interest may be very precise, making the discipline very specialized, resulting most often from a specialization from a discipline of origin. This means that the reality covered by the term discipline may vary greatly and evolve through time, through a continuous process of differentiation and merging around topics of concern.

Even more tricky will be to circumscribe the term disciplinarity, the meaning of which has also been held implicit in the above. In fact, we did not use the term 'disciplinarity' on its own but always with a prefix (multi-, inter- and trans-), on which the first section focused its definitional effort. Let us now spend some time on the term of disciplinarity. From the way it has been mobilized in the above, we can propose disciplinarity to be the way that people will work within and across disciplines. Indeed, given the evolving reality of scientific enquiry and professional practices, it may not be easy for anyone to state the discipline to which they belong or the discipline they practise. Translating this difficulty, quite often, scientists will merge terms to describe the discipline they practise: immuno-pathologist, socio-anthropologist, socio-economist or eco-infectiologist. Disciplinarity may thus be considered as the tendency of anyone to consider her or his own practice as embodied (or not) in the limits circumscribed by the established curricula we mentioned earlier. This points to the individual abilities and mindset that inter- and transdisciplinarity call for (Max-Neef, 2005; Darbellay,

2015), what other authors – playing with words – will call ‘indiscipline’ (Pasquier and Schreiber, 2007; Wolton, 2013). Disciplinarity appears as a field of tension between the societal need to frame and format professional practices (including science) and the need for individuals or communities to evolve, using the available degrees of freedom (or creating them).

As we already mentioned, each discipline will have a distinct focus, and this will translate to distinct ways of approaching a given health concern. For example, biology will study living beings and processes that sustain their development and how they interact in ecosystems, sociology will study the way that humans interact in societies, while epidemiology will study the distribution of health events in space and time and the drivers of that distribution. If we are facing a potential zoonotic risk, the biologist might focus on the ability of the **pathogen** to jump from one species to another and the genetic mechanisms allowing for those jumps; the sociologist will highlight how our way of living is creating special risks for certain categories of people (e.g. women, children, farmers); and the epidemiolo-

gist will work on mathematical models of disease spread to predict the risk and inform policy makers. Certainly – and that is the very interest of collaborative approaches – all these contributions are interrelated, and those professionals would learn from collaborating directly. Indeed, each actor generates information and questions for the others. However, one cannot learn everything and one needs to be anchored in one or a small subset of disciplines, with varied degrees of specialization. Also, it may prove unrealistic to expect to have a complete view of the rapidly changing landscape of scientific disciplines and professions. Therefore, each will have only a partial understanding of what the others study and can bring, if not false beliefs about what others do. In particular, the challenge for life scientists to understand and engage in fruitful collaborations with social scientists has been experienced and commented in the context of One Health research, calling for mutual learning and understanding (Barnett *et al.*, 2020).

To this diversity of contributions by discipline, one must add a diversity within disciplines. Indeed, we

Box 3.1. Nomadic concept

The chapter has mentioned the importance of concepts in the constitution of disciplines, their identity and the way they view and analyse the world. Therefore, the diversity of understanding of concepts between disciplines may be a barrier to collaboration. Yet, concepts can also be bridges between disciplines and their diversity can be a rich source of ideas. This box explores how concepts play a manifold role in inter- and transdisciplinary collaborations, as developed by Antoine-Moussiaux and Leyens (2023).



Working in One Health, one will often face the issue of terms not being understood in the same way by different disciplines. A classical and important example of this is the term ‘resilience’, but widely used terms are just as diversely understood, though central to our actions: justice, poverty, development, nature, environment. The method of nomadic concepts aims at taking advantage of the diversity of understanding to foster critical and creative thinking. Those concepts are called ‘nomadic’ or ‘travelling’ because they have been subsequently used and appropriated by different disciplines. During that travel, they gained an array of distinct understandings and modes of implementation. Taking the example of resilience, it emerged in physics as a property of matter, to gain later uses in psychology, ecology and risk management. Organizing a workshop with different users of the term will first generate a better awareness of that diversity, and of the limits of action derived from an ill-defined term. Later in the process, the confrontation between viewpoints will help the group coin a common understanding of the term and establish together the practical steps that should be followed to act in accordance with that way to conceive the issue or the goal. Creativity may also be fostered by making a concept travel, hence by trying to transpose the terms of one discipline into another to allow cross-fertilization. In this sense, technical terms from one discipline (as was the case for resilience coming from physics) can first appear as a metaphoric use in the other discipline, holding some fuzziness in its practicality but raising interest and curiosity. If the new term proves relevant, going through mutual learning between disciplines, this use may gradually gain precision about its frame of application and limits, as well as practical consequences in the discipline adopting it.

For a detailed explanation of a workshop based on the idea of nomadic concepts, see Rossini (2020).

mentioned here above widely defined disciplines. However, biologists can work from the level of the pathogen to that of the ecosystem. Social scientists may hold very diverse stances in their analysis of society, sometimes holding conflicting views and analyses (Moon and Blackman, 2014). Epidemiologists may be specialized in the design of a diversity of models, mobilizing distinct streams of data, and being more or less acquainted with the use of qualitative or participatory approaches... and resulting in distinct predictions or appreciation of risks. Within each of these 'sub-disciplines', individual scientists tend to focus on particular topics, of which they become specialists. Hence, there is a tendency towards fragmentation of expertise that goes hand in hand with the need for specialization of scientists. Specialization, however, is itself manifold. One can be a specialist of a context (e.g. health in slums in low-income countries), wherein a set of intertwined problems arise. Another may be a specialist of an infectious agent, which may infect a range of hosts in a diversity of ecosystems and contexts. Yet another will be a specialist of a methodology that can be applied to a wide range of problems and in diverse contexts (e.g. network analysis that can be applied to epidemiology, study of innovation, social or economic organization, mindmaps and learning). Hence, we understand that, specializing around different objects, each scientist and practitioner will show some degree of specialization together with some generalist skills that will allow the application of this speciality in diverse ways.

Despite this fortunate plasticity, quite understandably, scientists or practitioners focusing on a defined problem (e.g. one working on the surveillance of chemical risks to health linked to water contamination) will tend to ascribe to their topic of interest a considerable importance. By knowing all the details and ramifications of one topic and by ignoring other dimensions of the same complex problem, one will naturally hold a biased appreciation of the importance of that topic within the complete picture. In that complete picture, each scientist or other professional will tend to see their part bigger than it may be in reality. This will eventually result in an underestimation of the importance ascribed to other dimensions of the same problem. Hence, as a general observation, each professional will have a distinct focus of interest within the range of their discipline, leading them to ignore or downplay the importance of realities outside of that focus (Assmuth and Hilden, 2008). Holding only partial or even false ideas of what other disciplines can

bring can hamper the establishment of needed collaboration. Interestingly, we may note the particular role that specialists in contexts or in methods can play to bridge 'problem-centred' approaches (Antoine-Moussiaux, 2018).

3.4.2 Epistemologies: distinct relations to knowledge and to the world



Let us now consider the diversity in the ways of thinking about knowledge itself. Different disciplines hold unique views on science and on what constitutes valuable work.

These divergent conceptions of knowledge are referred to as the 'epistemological' divides between disciplines. **EPISTEMOLOGY** is the branch of philosophy that tackles questions around knowledge, its nature, origin and limits. Among other topics, epistemology will be concerned by the criteria of validity of knowledge. This means that different disciplines will have divergent criteria to judge the validity of statements or practices. Hence, the proponents of one given discipline might consider what other disciplines produce as being of lesser scientific value because it rests on a distinct epistemological criterion (Albert *et al.*, 2008). To start with a caricatural situation, a natural scientist who works on the statistical analysis of quantitative data collected on a random sample of thousands of people may not easily perceive the scientific value of an approach based on the interpretation of the discourse of a handful of purposefully selected stakeholders (see Box 3.2 for further comments on the divide between 'quantitative' and 'qualitative' methods). For example, an epidemiologist may follow the issue of obesity in a population and be interested in estimating as precisely as possible its prevalence and the correlation with defined risk factors. That scientist will base the assessment of quality of the information provided on the sampling size and method and the sophistication of the statistical models in order to produce objective figures about what influences or causes obesity. Let us consider now a sociologist who would work on a small set of in-depth interviews about the personal history of persons suffering with obesity, in order to understand the social determinants and consequences of obesity and the potential for public preventative action. Our imagined epidemiologist may consider that this interpretative work

lacks scientific value and does not produce generalizable knowledge, being too particular to the few interviewees (Flyvbjerg, 2006). Conversely, the social scientist might miss the meaning that is conveyed by the figures produced by the statistical analysis, considering that the figures miss the depth of how the problem of obesity unfolds in people's life. This social scientist would maybe consider the statistical work as lacking conceptual grounding and missing the question of causation of obesity. To keep our example caricatural, both scientists will eventually consider that the knowledge produced by the other

fails at producing valuable evidence and understanding of the reality of the disease in society. This stereotyped example is just here to illustrate that the scientific rigour and the notion of quality of the scientific work diverge between disciplines. These epistemological divides are major barriers to inter- and transdisciplinary collaborations.



Everybody wants to do quality work. Hence, if one underestimates the quality of what another does, then effective collaborations are hindered.

Box 3.2. Quantitative, qualitative and mixed methods

The example described comments on the difficulties that different disciplines may encounter in understanding each other. Many discussions about these difficulties in interdisciplinary collaborations in science revolve around an opposition between the so-called 'quantitative' and 'qualitative' methods. As a matter of fact, many One Health studies will combine these two types of studies, sometimes in the same protocol, then termed as 'mixed methods'. However, those terms (quantitative, qualitative, mixed) have to be handled with caution, often being imprecise and misunderstood. A first confusion appears when applying those terms to variables or to methods. Regarding variables, the difference is quite straightforward: those that are measured and expressed in numbers are quantitative (e.g. body weight), those that are qualified through words to distinguish between categories are qualitative (e.g. coat colour). But if you count the frequency of coat colours in a cow population, you are mobilizing a quantitative approach to a qualitative variable. Hence, we need to be explicit about what we are doing. Methods that are typically referred to as 'quantitative' in public health are population studies, aiming at establishing the distribution of some variable in a population based on samples. The main concern of validity will then be the 'representativeness' of the sample, i.e. whether or not the values calculated on the sample may be considered as good approximations of those values at the level of the whole population. But one can also mobilize measured values to investigate and characterize a case study, without any claim for representativeness and no will to infer on population values. This then rather pertains to a qualitative approach despite the mobilization of quantitative variables. However, very often, the term 'qualitative' will be used to indicate methods based on a textual analysis of themes occurring in the discourse of interviewees. The quality of the data in such studies will not be tied to its representativeness, but rather to its relevance and how exemplary the situation may be of recurrent situations. The trustworthiness of those data will be tied to a constant rigour to identify possible bias and cross-check all that can be cross-checked (a process known as 'triangulation'). Those qualitative methods often discard any use of quantified measures to qualify a particular case/person. However, psychometric tests exist that allow the 'measurement' of, *inter alia*, people's perceptions, emotional states or degree of agreement with opinions. Those might be used within both quantitative and qualitative approaches. You can observe here that those notions are intermingled and would deserve a richer vocabulary than 'qualitative' or 'quantitative'. Finally, while the joint use of different methods can be easily termed 'mixed', again a more precise description of your methods will be needed if you want to avoid misunderstandings about your work. Therefore, without pursuing any further here the disentanglement of these different terms, this box should raise awareness of the importance for One Health practitioners to keep a critical eye on the rigour of their approaches, with precise notions of what in these approaches may limit data validity and applicability to draw practical conclusions and formulate policies.

Our explanations focused on the cases of scientists. Nevertheless, all these comments apply equally to professional contexts, each profession being trained in a defined set of scientific disciplines. Therefore, both the biased perspective on the relative importance of topics within complex problems and the lack of mutual understanding or appreciation apply to health practitioners, such as veterinarians, medical doctors, nurses, social workers or pharmacists. The more the diversity of professions involved in the collaboration increases, the more these internal barriers will inhibit fruitful partnerships. Yet, One Health approaches naturally call for the involvement of a diversity of professions well beyond the health sector. Let us be clear: these misunderstandings do not totally preclude collaboration; rather, they will keep the collaboration at the level of multidisciplinary, failing to develop a direct co-learning between partners and keeping them working in parallel.



To become an effective One Health collaborator, it is necessary for a person to make the time and effort to learn about, and from, other disciplines and professions. Naturally, the goal is not to become a specialist in all these disciplines. Rather, one will aim at gaining just enough knowledge to understand others and be able to develop collaborations. This means that we have to understand at the very least what others can bring, what their areas of interest are and their overall way of working.



Task:

1. Consider the following four domains of knowledge: (i) life science, (ii) social science, (iii) humanities, (iv) technology, engineering and mathematics, and provide for each three names of (sub-)disciplines that are relevant to obesity. Try to elaborate on the kind of contribution they may bring.
 2. Taking the case of rabies, try to formulate questions you think that a statistician, a sociologist and a philosopher would formulate about the management of that disease.
 3. Taking the case of antimicrobial resistance, try to formulate questions you imagine that a veterinarian practitioner, a nurse and a policy maker would formulate about its management.
- Once** you have concluded this exercise, have a look at the possible answers provided below and

compare them with your answers. Think about how they differ and what may be the reasons for this difference.

Example answers:

1. **Life science:** medical doctors and nutritionists to care for individual cases, epidemiologists to follow the evolution of the problem, its drivers and co-morbidities, agriculturalists to analyse the orientation of current food production, zootecnicians and veterinarians to work on animal nutrition, lowering fat content of animal products and influencing the fatty acid ratios, and so on. **Social science:** anthropologists to investigate the representation of food, nutrition for people and how it evolves in particular social categories that are more prone to obesity, sociologists to investigate the social drivers and consequences of obesity and how this problem can be shared by people and their pets, value chain economists to analyse the orientation of food systems towards more healthy food, behavioural economists to study the consumers, habits, and so on. **Humanities:** philosophers to raise ethical questions around social exclusion or stigmatization of obese persons and the extent to which obesity has to be considered as a disease, media analysts to explore the place of bodyweight in cinematographic productions and television series, historians to analyse how obesity emerged as a public problem through the last century, and so on. **Technology and engineering:** bio-engineers and food technologists to develop transformation and conservation methods to improve the shelf-life of fresh fruits and vegetables, data analysts to explore how big data and natural language analysis can help track food habits, their drivers and detect emerging tendencies.
2. **Statistician:** Can Bayesian methods generate more accurate estimations of prevalence of rabies? **Sociologist:** What are the social drivers of dog vaccination? **Philosopher:** Can a level of risk of rabies be considered acceptable?
3. **Veterinarian practitioner:** What alternatives can I use to lower my prescriptions of antibiotics? **Nurse:** How can I improve my practice to avoid hospital-acquired infections? **Policy maker:** What antibiotics should we forbid the use of in veterinary practice?

3.5 Implementation of Inter- and Transdisciplinarity as a Creative Process



We have proposed that the realization of inter- and transdisciplinarity entails the need for all contributors to engage in a process of mutual and shared learning. Facing complex issues and ever evolving challenges, this learning process must also be a creative one. Inter- and transdisciplinarity indeed appear as a way to mix knowledge, line looks very cramped with little space between words; please improve spacing world issues. Indeed, researchers describe our time as a 'transitional time', where issues are identified as radically new and increasingly complex (e.g. global warming). Also called 'interregnum', this expression stresses the need for new approaches and new skills for today's and tomorrow's professionals (Montuori and Donnelly, 2016). These 21st-century skills are communication, collaboration, critical thinking and creativity (Reilly, 2010). Inter- and transdisciplinarity are a way to foster the latter skill of creativity, especially needed to face the lack of ready-made answers. Hence, collaborations between disciplines centrally call for methods to foster creativity. This last section of the chapter explores inter- and transdisciplinarity as a source and soil for creativity, discussing its social and individual parts and the need for specific spaces and methods.



First, creativity insists on its social nature. Along with this view, **creative thinking** does not appear as a point-in-time event. Rather it is a process needing interactions between people in a defined context. Being recognized as a social process, creativity then requires stimulation by social interactions hosted by a favourable environment (Johnston, 2008; DeHaan, 2009; Hugill and Smith, 2013; Klein, 2017). Inter- and transdisciplinarity have been recognized as an enhancing environment, where these interactions are facilitated and opportunities for novelty are always present. To be successful, collaborative initiatives have to offer flexibility and dynamism, developing core qualities such as centrality of communication, curiosity, commitment, critical awareness and connectedness, fostering creativity (Hall and O'Rourke, 2014). Also, inter- and transdisciplinarity must create

spaces of perceived freedom, allowing individuals to voice views not normally expected in their prescribed roles. Environmental factors thus seem crucial to enhance and sustain these creative processes. The pressure of time, money or other resources needed can, however, force people to settle with the 'first or easiest' answer to their problem, preventing the longer process of maturation, ideation and exchange that creativity is calling for. The provision of an enhancing environment has to be critically considered, in ways that have to adapt to circumstances and to the actors involved, addressing the diverse dimensions of the identified problem. The thinking about inter- and transdisciplinary spaces is still relatively new. Therefore, their evolution and adaptation often require participants to be supported by experienced facilitators and always to share their respective experiences to foster valuable context for creativity (Pineo *et al.*, 2021).



Design theory to renew research on antimicrobial resistance in animal health:

Antimicrobial resistance (AMR) is a highly complex issue that requires innovative solutions. Therefore, current AMR research should expand the boundaries of knowledge, ways of conducting research and transcending disciplines. It should include many types of actors, researchers and stakeholders to foster innovative approaches. To this end, Vourc'h *et al.* (2018) created a research network (R2A2, Réseau Recherche Antibiotiques Animal) focused on antimicrobial use and microbes' resistance to antimicrobials in animals. The objectives were the development of cross-disciplinary thinking and to enhance the emergence of atypical research projects. According to the network evaluation, it was a successful approach to raise important applied questions to fight against AMR and to build cross-disciplinary research projects. This evaluation also identified key factors behind the success of the network. First, it adopted the concept-knowledge (C-K) design theory from the start, which is a theory that seeks to understand the reasonings according to which innovation occurs. It models that pathway as a diagram and helps explore new innovative design paths. Developing such a diagram at the onset of the network allowed the participants

to keep an overview, connecting and understanding the diversity of subjects across workgroups. The diagram was constantly updated, revealing that ‘a more cross-disciplinary approach was emerging, which essentially resulted from the adoption of an alternative mode of partitioning’. The C–K diagram is one important tool, recognized to enhance cross-disciplinary thinking, and already has many successful adaptations. Among others, it helps integrate the point of view of individual interests and collective interest. Finally, adaptability and flexibility of the network were two essential components for the evolution and completion of the project. Among several examples, they changed the frequency of the meetings over time, the number of participants was fluid (open registration in the network), and the network format was adapted to diverse profiles and backgrounds. The network adapted over time to respond to the participants’ needs.



Second, creativity is understood and studied as an individual skill. As such, it has long been perceived as a fuzzy and uncontrollable process or aptitude. However, more and more studies show that it can be encouraged and enhanced in individuals. Individual factors that have been identified as enabling creativity are personality, motivation/individual attraction, knowledge and capacity for problem definition. Traits of personality that would be more prone to creativity are cognitive flexibility, personal experience and feelings, resources for new insights and synthesis. Contextual factors are also pinpointed by this thread of research, such as work conditions and incubation process (Gilhooly, 2016). Interestingly, creativity might not be linked to the time spent working in a field (Mumford *et al.*, 2010). Moreover, adapted training enhances the individual aptitude for creativity and educators developed tools to teach and trigger creativity. Among these tools, one is known as ‘broadening the problem’ (Ness, 2011), i.e. including other aspects and disciplines into a case study, which directly points to the benefits of inter- and transdisciplinarity in problem solving.

Finally, many tools are now available to apply a creative approach to diverse issues (e.g. design theory, TRIZ method, role plays). Many researchers are using them on a daily basis to improve their creativity and problem-solving

skills, with diverse practices developing in distinct disciplines. Thanks to inter- and transdisciplinarity, these tools and approaches can further be shared between disciplines. Creativity has to be understood as emerging from trainable individual qualities, group-working abilities and enhancing contexts. The open sharing of knowledge and ideas is its very substance.



Learning questions:

1. From your experience, how would you describe the process and triggers for creativity? Where do you think new ideas come from?
2. What tools have you already used to create and generate ideas? What kind of expression medium would you be more open to and why: open discussions, structured questions and answers, free drawing, structured diagramming, role play, song writing?
3. If you were to address a One Health problem, in which domain could you see a more creative approach to be implemented? Please describe your targeted One Health problem and the creative approach you can imagine.

For this exercise, we leave it up to your own experience and reflection. No example answer is provided. To further explore the domain of creativity, you might start by reading the literature to which this section refers.

3.6 Conclusions

Far from being a magic bullet, collaboration between disciplines entails major challenges for science and society as a whole. The One Health concept places these collaborations at the very heart of their definition in order to tackle the most pressing health challenges of our times. Therefore, the deep understanding of barriers to such collaborations is essential to every One Health practitioner, who will not be above those constraints but will have, on the contrary, to engage in a perpetual effort to overcome them and harvest the benefits from crossing intellectual, philosophical and practical barriers. Because inter- and transdisciplinarity aim at producing new solutions to old problems by looking at them with fresh eyes and a renewed understanding, their practical implementation must be conceived as a creative effort, one where all professionals involved will get inspired by and learn from other disciplines, to constantly reflect critically on their own practices.



Additional activity: If you are interested in another activity to deepen your learning and think about the practical applications of inter- and transdisciplinarity, you can work through the exercise provided below.

Conceptual map and interdisciplinary contributions

Develop a conceptual map, either on paper or using mind-mapping software (Cmap tool, Institute for Human-Machine Cognition, allows you to create and freely arrange elements and named links), illustrating the main interactions between human activities, domestic animals, ecosystems and the spread of H5N1 Highly Pathogenic Avian Influenza (HPAI).

- Identify key elements for human activities, veterinary services, health systems, domestic animals and ecosystems, and create boxes labelled with their names.
- Establish links gradually between these boxes, labelled with active verbs.

Based on this map, imagine and outline the contributions of different disciplines to solving the issue. Focus on disciplines such as epidemiology, veterinary medicine, environmental science and public health. Consider the specific perspectives each discipline brings and potential blind spots. Identify which discipline could offer insights to address these blind spots.

- Create boxes labelled with these disciplines.
- Create links between the disciplines and the problem's elements, labelled with their type of contribution. If needed, add intermediate boxes in order to keep links labelled only with active verbs.

For at least two disciplines, formulate research questions that would contribute to understanding and managing HPAI. For example, in epidemiology, you might ask about disease spread patterns, and in veterinary medicine, you might explore effective vaccination strategies for domestic poultry.

Role play scenario

Imagine a dialogue between different actors involved in addressing HPAI. Assume roles such as epidemiologist, veterinarian, environmental scien-

tist, etc. Think individually about the priorities and actions each role would propose within the complexity of the issue. Consider both a conflictual scenario and one that generates consensus.

Nomadic concept

Choose a concept that appears relevant to you to manage HPAI (you may choose from the following examples: resilience, vulnerability, responsibility, precaution). Write down your own definition, being as precise as possible. Look for reference papers exploring the chosen concept (if possible, choose papers in different disciplines). Note any differences in interpretations within your own definitions. Ask colleagues about their spontaneous understanding of the concept.

Based on your personal definition and insights from literature exploration, work towards a common definition of the chosen concept in the context of HPAI. Consider the various elements raised by different perspectives and aim to synthesize a definition that encapsulates interdisciplinary insights.

New perspective? Own action within interdisciplinary partnerships

Did the preceding exercises inspire some new perspectives on HPAI management? Did you identify relevant partnerships that you had not considered before?

Choose an action that your discipline may be responsible for within a project aimed at managing HPAI. Draw a theory of change for that action (linking the actions to their direct outputs, the outcomes that the latter will enable and finally the broader impact these outcomes would contribute to). Identify blind spots in your study and propose improvements that could involve researchers from different disciplines. If possible, reflect on these points with researchers from other relevant disciplines to explore shared interests and potential collaborative work.

Brief comments to guide your resolution of the exercise

While building your conceptual map, please consider the following elements (not specific to HPAI):

- *Human Activities:* Includes various activities that bring humans into contact with domestic animals and ecosystems. May involve

agriculture, animal husbandry, hunting and healthcare practices.

- *Transmission Routes*: Represents pathways through which zoonotic pathogens can be transmitted from animals to humans. Routes may include direct contact, consumption of contaminated food or water, and vectors.
- *Domestic Animals*: Encompasses animals kept by humans, such as livestock and pets. Consider the diversity of livestock-keeping systems: different systems may show unique roles in epidemiology. Consider the potential role of these animals and their products as reservoirs/vehicles for zoonotic pathogens.
- *Interactions and Exposures*: Signifies the various ways in which humans come into contact with domestic animals and potential sources of zoonotic pathogens. In the case of production animals, think of the whole value chain. Also think of other uses of domestic animals.
- *Ecosystems*: Involves the natural environment where wild fauna and vectors reside. Acknowledges the role of ecosystems in the maintenance and transmission of zoonotic diseases.

Here is a list of key stakeholders and their roles in implementing the One Health approach, potential incapacities and challenges. Use this list to confront with your map and exercise.

- **Public Health Agencies**
 - Role: Monitor and respond to human cases of zoonotic diseases.
 - Contribution: Provide expertise in epidemiology, disease surveillance and public health interventions.
 - Blind spots / limits: Focus limited to the human health aspects and sometimes insufficient collaboration with other disciplines.
- **Veterinary Services**
 - Role: Monitor and manage health in domestic animals, including early detection and control of zoonotic diseases.
 - Contribution: Conduct surveillance, implement preventive measures and collaborate with public health agencies.

- Blind spots / limits: Focus limited to animal health aspects and sometimes insufficient collaboration with other disciplines.
- **Environmental Agencies**
 - Role: Monitor and assess the health of ecosystems, wildlife and vectors.
 - Contribution: Contribute to understanding the environmental factors influencing zoonotic disease transmission.
 - Blind spots / limits: Limited focus on clinical aspects of diseases and their direct impact on human and animal health. May not prioritize the immediate health concerns of domestic animals and human populations.
- **Agricultural and Food Safety Authorities**
 - Role: Oversee food production systems and safety.
 - Contribution: Implement measures to reduce the risk of zoonotic transmission through the food chain.
 - Blind spots / limits: May not fully consider ecological and social factors influencing disease emergence.
- **Research Institutions and Academia**
 - Role: Conduct research on zoonotic pathogens, transmission dynamics and innovative solutions.
 - Contribution: Generate scientific knowledge, educate professionals and contribute to evidence-based policy making.
 - Blind spots / limits: Scientific actors may disregard non-academic knowledge.
- **Human and Animal Health Professionals**
 - Role: Diagnose, treat and prevent zoonotic diseases in both humans and animals.
 - Contribution: Provide healthcare services, conduct surveillance and educate communities.
 - Blind spots / limits: A clinical work functions on a case-by-case basis and may miss the overall picture. The health systems may be biased toward curative interventions while neglecting prevention and health determinants.

- **Pharmaceutical Industry**
 - Role: Develop vaccines, treatments and other health devices.
 - Contribution: Support the development of tools to prevent and control zoonotic diseases.
 - Blind spots / limits: If technical innovation generates a potential, this does not translate into impacts if the social, political, economic and cultural context is not enabling that change.
- **International Organizations (e.g., WHO, FAO, WOA)**
 - Role: Facilitate global collaboration and set international standards.
 - Contribution: Provide guidance, support capacity building and coordinate responses to zoonotic outbreaks.
 - Blind spots / limits: Normative approaches have to mind the gap of inequity due to the diverse abilities of actors to follow recommendations and norms. General recommendations may not be suited to some specific local conditions. Working at the international level involves many diplomatic sensitivities and pressures.
- **Policy Makers and Government Agencies**
 - Role: Develop and implement policies to address zoonotic risks.
 - Contribution: Enact and enforce regulations, allocate resources and support intersectoral collaboration.
 - Blind spots / limits: Challenges in translating policies into practical actions and ensuring compliance. Subject to local political and economic pressures.
- **Community and Indigenous Groups**
 - Role: Participate in surveillance, share local knowledge and implement preventive measures.
 - Contribution: Act as key partners in community-based interventions and awareness campaigns.
 - Blind spots / limits: Limited expertise in clinical aspects of diseases and ecological factors.

- **Media and Communication Specialists**
 - Role: Disseminate information, raise awareness and promote behaviour change.
 - Contribution: Communicate scientific findings to the public, facilitating understanding and cooperation.
 - Blind spots / limits: Communication focuses here on the diffusion of information. Yet, listening to the reactions of people, their beliefs and knowledge is a key aspect of successful management.

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