

Openness across disciplines:

Reflecting on a multiple disciplinary summer school

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Academic disciplines – bodies of knowledge and skills – change over time for a variety of reasons, from the systematic integration and convergence of knowledge to the application of skills to reach an evolving goal. While separate disciplines were being taught as far back as Roman times, contemporary academic disciplines are far different in form and number (Alvargonzález, 2011). Today, disciplines range from the general study of human behaviour to the specialised study of consonants and vowels. The academic world reflects this division of disciplines. For example, university degrees are typically mono-disciplinary, and researchers are often grouped in institutional organisations that follow the disciplinary boundaries. With the multiple disciplinary summer school “ColLaboratoire”, we observe an exceptional example of addressing messy and ill-defined problems through several disciplinary lenses. In particular, we discuss the requirements and conditions under which this approach is an effective and appropriate alternative to mono-disciplinary research.

This chapter is structured as follows: first, we critically reflect on the role of openness in multiple disciplinary research. Because ColLaboratoire was modelled heavily on the

organisers' experiences of working across the disciplinary boundaries within CogNovo, we subsequently review selected features, activities, and outputs of this doctoral training programme. We then discuss the organisation of ColLaboratoire including how its decisions drew on the experience from CogNovo as a multiple disciplinary work environment. Following this, we reflect on the experiences of the ColLaboratoire participants and evaluate the outcomes of individual projects and the summer school as a whole. Within this chapter we define openness as "an accommodating attitude towards new, unconventional, and useful ideas and experiences," we reflect on the key factors that contributed to the realisation of ColLaboratoire. We conclude that these were enabled by what we identify as three forms of openness: multi-perspective, inter-perspective, and trans-perspective openness.

With the growth of human knowledge and technology, disciplines have fragmented into smaller and more manageable units. For example, science divides into Natural and Social Sciences; the Social Sciences now include Economics, Psychology, and Linguistics; Linguistics includes Philology, Phonetics, and Syntax; and so on. As human life expectancy lengthens and population increases, so does the "workforce" that contributes to expanding knowledge, leading to increasingly specialised disciplines.

There are some limitations to our narrow specialisations, as "most scientific puzzles do not fit into disciplinary silos" (Yegros-Yegros, Rafols, & D'Este, 2015, p. 3), such as addressing climate change and controlling epidemic diseases. New disciplines, such as Psycholinguistics, Computational Neuroscience, and Bioinformatics, have emerged, where strands of research have joined forces. Scientists are aware of this trend: as Sung et al. (2003) point out, "the most exciting science in the 21st century is likely to evolve among, not within, traditional disciplines." This idea extends to learning environments; pedagogically speaking, Kysilka (1998) pointed out that "knowledge in the real world is not applied in bits and pieces

but in an integrated fashion” (p. 198), thus suggesting that learning should cover different disciplines from the very way in which school curricula, and indeed, university programmes are designed (see also EURAB 2004). Furthermore, creativity and innovation have been noted to emerge from the interaction between disciplines; as Robinson (2001) notes,

creativity depends on interactions between thinking and feeling, and across different disciplinary boundaries and fields of ideas. New curricula must be evolved which are more permeable and which encourage a better balance between generative thinking and critical thinking in all modes of understanding (p. 200).

In resonance with these authors’ views, we take a critical view towards the strictly laid disciplinary boundaries, and shed light on the values and efficacies of cross-disciplinary collaborations. We do this by presenting a case study on how ColLaboratoire, a multiple disciplinary summer school, offered a space for students and researchers to engage in an open and collaborative research context.

The case study of ColLaboratoire

Our case study of the ColLaboratoire summer school was a multiple disciplinary event which took place at the University of Plymouth in August 2016. It was organised as part of CogNovo, a multiple disciplinary doctoral training programme, funded by an EU Marie Skłodowska-Curie Initial Training Network grant and the University of Plymouth. CogNovo included 25 doctoral research fellows, spanning the disciplines of the Arts, Humanities, Social Sciences, and Technology; their multidisciplinary supervisory teams; and industry partners. It aimed to equip each fellow with experience beyond conventional disciplinary borders and intended to address “new ways to link scientific research in cognition with social and technological innovation” as “cognitive innovation” (Denham,

2014, p. 202). CogNovo itself was an exploratory and open-ended enterprise that encouraged the investigation of disciplinary boundaries, collaboration with other disciplines, and the discovery of new ways of enquiry and dissemination with the goal of sustainable innovation (Denham, 2014). Therefore, the programme was an ideal environment in which to organise the summer school. Its name, 'ColLaboratoire, a merging of "collaboration" and "laboratory," was meant to provide an explicit reference to the types of skill that we would be practising. As we will argue, the inherent openness and curiosity which were deliberately incorporated into the structure of this summer school and encouraged in its participants provide an example of a sustainable multiple disciplinary learning environment, which is still producing new publications, source code, and societal impact almost two years later, as illustrated in Tables 1 to 4. In the following sections, we will reflect not only on what characterises an "open" researcher but also on what characterises an "open" learning environment, such as ColLaboratoire; and how such an environment can foster and instil an attitude of openness in its participants. By linking these two aspects, we aim to present a systematic way of implementing openness in the linear and multifaceted process of interdisciplinary research, in the hope that it will be beneficial for young researchers, learning institutions, teachers, and established academics alike. Our critical reflections could be used in the future by other institutions and research groups who are interested in creating an environment centred around multiple disciplinary collaboration.

Openness and multiple disciplinarity

A note on multiple disciplinarity

The terms multidisciplinary, interdisciplinary, and transdisciplinary (amongst others) are frequently used interchangeably and without specific definitions. However, there are differences in their intended meanings (Schmidt, 2007). Multidisciplinarity draws on information from several disciplines while remaining within disciplinary limits; interdisciplinarity both unites and synthesises links between disciplines to form a “coherent whole” (Choi & Pak, 2006, p. 351); and transdisciplinarity brings disciplines together in new contexts, transcending any existing disciplinary boundaries. However, for this chapter, we use the term “multiple disciplinary”, suggested by Choi and Pak (2006), as an umbrella term that encompasses all of these meanings. (See Figure 1 for a visualisation of these four terms.) Here, we recognise that in multiple disciplinary collaborations, individual openness functions as a pathway to move from the first aspect of multidisciplinary (i.e., a gathering of disciplines) to addressing interdisciplinary research questions and further transgressing disciplinary boundaries to transdisciplinarity. Particularly in these research settings, an attitude of openness is crucial to the collective formulation of a new research procedure, so that individuals do not limit their discussions to debates over mono-disciplinary facts and methods.

Multiple disciplinary

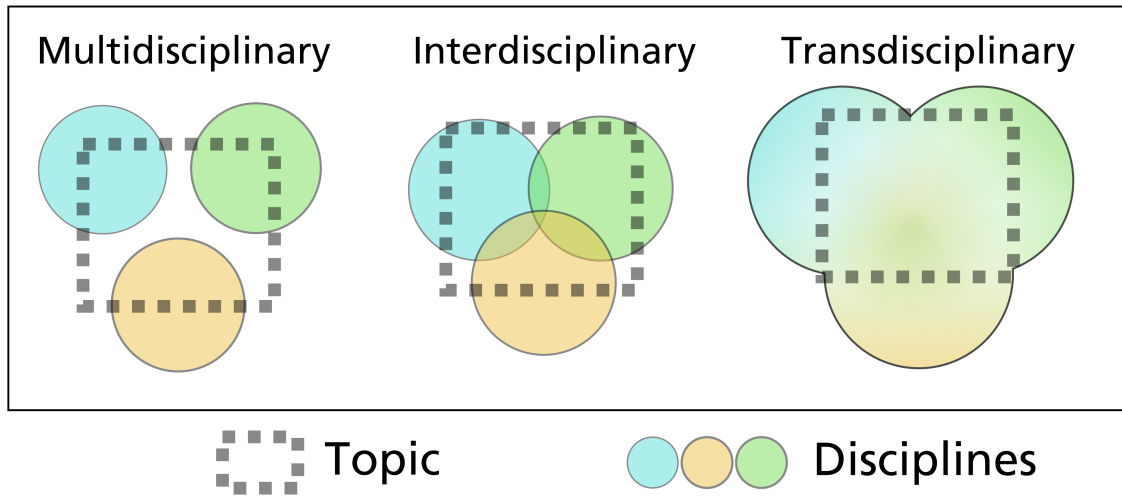


Figure 1: Visualisation of multidisciplinary, interdisciplinarity, and transdisciplinarity as instances of multiple disciplinary. The Figure was created by the authors.

The role of openness in research

Multiple disciplinary has been called upon continuously by newly emerging and valuable research topics, many of which address real-world problems (Callard & Fitzgerald, 2015). Its benefits in enriching research itself have also been identified extensively: from increasing creativity, developing new knowledge, and rectifying individual disciplines' shortcomings, to encouraging and preserving academic freedom as well as the "unity-of-knowledge ideal" (Nissani, 1997, p. 211). While there are institutions supporting this movement towards multiple disciplinary (Nissani, 1997), they do not represent the majority, considering that many institutions still choose to encourage the stability, prestige, and predictability of mono-disciplinary research and preserve its many benefits, including well-established methods, epistemological congruence, and the depth/wealth of specialised knowledge. Multiple disciplinary endeavours also come with added costs, such as difficulties

in coordination and an association with a lack of positive status (Yegros-Yegros et al., 2015). On what, then, could multiple disciplinary research depend on the retention of its momentum and success? Bridle, Vrieling, Cardillo, Araya and Hinojosa (2013) have argued that “openness and communication between individuals” (p. 30) is a crucial aspect for overcoming disciplinary boundaries. After all, any multiple disciplinary collaboration is potentially considered a dynamic and iterative process of crossing disciplinary boundaries, an experience which “has to be lived” (Horizon 2020) by each individual, in order to reach its full potential. Concerning academic research, this entails the mutual acknowledgement towards, and preservation of, methodological and epistemological pluralism as a foreground to any multiple disciplinary research or collaboration (Bruhn, 1995; Miller, Baird, Littlefield, Kofinas, Chapin III, & Redman, 2008). While individual openness on its own may be insufficient to overpower the complex structures and power relations that govern academia, it nonetheless plays a role in the development of interdisciplinarity.

It is typical for collaborations between disciplines to elicit debates about how each discipline defines the value, validity, and impact of its research. For instance, a common source of friction which occurs between disciplines of the Humanities and the Sciences, questions whether the conceptual openness of the humanities is too ambiguous to be considered rigorous and whether scientific rigour necessarily entails a positivist approach (Callard & Fitzgerald, 2015). These frictions may also derive from differences that exist in the objective of the research itself (Bruhn, 1995): is the research asking *why* a phenomenon occurs, or *how* it occurs? Miller and colleagues explain that “in any given research context, there may be several valuable ways of knowing, and that accommodating this plurality can lead to more successful integrated study” (2008, p. 1). Here, we propose that an attitude of openness is an essential foundation in acknowledging this methodological

and epistemological plurality, thereby bridging communication gaps between multiple disciplines. Later in this chapter, we will discuss how this element we are referring to as an open attitude plays a role in practice (i.e. in a collaborative research setting).

Research is often collaborative, possibly even more so when crossing disciplinary boundaries. Ensuring that all parties involved in the process maintain the aforementioned open attitude can be challenging. In an academic climate dominated by mono-disciplinary research, individual researchers receive pressure from various sources such as performance evaluation from their institution, peer pressure from the field, personal ambition, as well as some of the “roadblocks” (Blassnigg & Punt, 2013, p. 3), to invest time and energy to publish work in prestigious journals within their respective disciplines. This pressure creates a “collective action problem” (Nosek et al., 2015, p. 1422), wherein skilled researchers do not publish in journals covering multiple disciplines due to generally low impact, and as such, these journals remain low in impact due to the shortage of high-quality submissions. Such a distribution of publications is consistent with the findings by Solomon et al. (2016) who show a similar degree of interdisciplinary integration for individual articles in monodisciplinary journals as for *Science* and *Nature*. Their findings suggest that the accepted and published articles in leading multidisciplinary journals cross disciplines within one issue, but not within the same article. In addition to this reinforcement effect, Rafols, Leydesdorff, O’Hare, Nightingale and Stirling (2012) also name intellectual inbreeding, avoidance of complex societal questions, and the reduction of cognitive diversity in the research system’s ecology as potential outcomes of mono-disciplinary publication practice. On the other hand, there can be a high price to pay for pursuing open, multiple disciplinary, and collaborative research, such as poor performance evaluation, or even isolation from colleagues in the field. Those who do pursue this direction exude an “honest signal” (see evolutionary signalling theory,

e.g. Zahavi, 1977) of commitment towards interdisciplinarity, actively paying the high cost in order to acknowledge and contribute to its value.

Another aspect of the current research culture in which openness plays a role is the transfer and sharing of disciplinary knowledge. It is easy to overlook the impact that discoveries in one discipline can have in another. For example, research in physics has had many significant applications for medical research, as exemplified in the textbook by Podgorsak (2016). However, when cited in the radically different context of another discipline, researchers based in the original discipline can perceive new interpretations as misrepresentations. Similarly, the accurate sharing of knowledge between disciplines requires another aspect of openness, which is open access to data, ideas, or sources. The accessibility and transparency of work has been regarded as one of the most crucial aspects in facilitating and developing a type of open, dialogical relationship between disciplines (Nosek et al., 2015), with open access research also generating more citations and a more significant impact (Eysenbach, 2006; Piwowar & Vision, 2013). Here, again, we identify the need for openness: a willingness to extend the ownership of one's knowledge, allowing to shed new light on it.

Moreover, in such instances of transferring knowledge, both parties can benefit from an ongoing dialogical relationship, whereby each discipline closely examines the others' theoretical and methodological perspectives, thus creating a collection of mutually acknowledged approaches from which the subject area can be studied. In summary, we argue that openness – an awareness of methodological and epistemological plurality – is a crucial facet which governs the success of multiple disciplinary (and/or collaborative) research at the individual level. If such an attitude of openness was achieved collectively across disciplines

and communities (e.g., publishers, academic institutions, funders), it could play a significant role in enhancing the quality and efficacy of multiple disciplinarity itself.

As much as the idea of openness centres around individual interactions and relationships, organisations also play an important role in fertilising the grounds for successful collaborative work across disciplinary boundaries (Stokols, Misra, Moser, Hall, & Taylor, 2008). Firstly, disciplines coincide with institutions that function as “regulatory systems; as cognitive systems that control and develop their respective knowledge base, and as cultural systems with particular norms and values concerning how issues should be studied” (Buanes & Jentoft, 2009, p. 448). As such, the necessity of having an open attitude – not only to other disciplines, but also to the idea of multiple disciplinarity itself – extends beyond the core researchers who are conducting the research, to its facilitators, managers, advisors, and publishers. In this light, we argue that the gathering of agents, each trained to be competent researchers within their respective “institutions” (i.e., disciplines), enables multiple disciplinary collaborations. These individuals are ready to engage with a different discipline, critically reflect on their disciplinary backgrounds, and embrace their particular roles in the collaborative research project. Secondly, it is also paramount for the organisation to provide opportunities for these agents to collaborate openly and flexibly. Consequently, this means that the environment provides the space and time necessary for researchers – who are experienced and competent in their fields – to explore, contemplate, question, and make mistakes as they venture into the world of interdisciplinarity (Loesche & Łuczniak, 2017). Callard and Fitzgerald (2015) also point out how this open space emerges from the gaps created between disciplines which struggle to merge:

...if there is now an invitation to 'the social' from (some) parts of the biological sciences, then there is simultaneously an openness to think biologically from (some) parts of

contemporary social theory. And if such moves are often partial and contested, they nonetheless form a gap into which the researcher interested in interdisciplinary experimentation might insert herself. (Callard & Fitzgerald, 2015, p. 63)

Thus, we suggest that openness represents both a gap or an opening – created either intentionally or unintentionally – that invites the insertion of an interdisciplinary researcher, and the attitude required to fulfil such a gap. As described in the following sections, ColLaboratoire entailed both aspects, where the learning environment was intentionally left unstructured, and participants and organisers displayed the curiosity and skills necessary to restructure it.

The CogNovo Programme

As mentioned earlier, CogNovo was a doctoral training programme, with fellows from several disciplines in the Arts, Humanities, and Sciences (Maranan, Loesche & Denham, 2015; for an extensive description, see <https://CogNovo.eu>). Between the years of 2014–2017, more than 12 events, aiming to promote interaction and openness among the researchers and the disciplines involved, were organised as part of CogNovo. Previous reflections identified generosity, interdependence, free exploration, and trust as principles contributing to the types of research pursued in CogNovo (Loesche & Łuczniak, 2017). As ColLaboratoire was modelled using the CogNovo fellows' experiences, here we describe and evaluate three additional features which played a significant role in promoting openness in the design of ColLaboratoire: disciplinarity, mobility, and environment.

Disciplinarity

The CogNovo training programme included a series of workshops, as the aim of the programme was to create a foundation for multiple disciplinary works. With broad scope, each week-long event aimed to inform multiple disciplines about the research methods (e.g., information gathering) and experimentation practices from neighbouring disciplines. Designed to focus on information transfer, lectures and seminars were delivered by key experts in an extensive array of disciplines ranging from neuroscience to anthropology. The quality of information delivered in these workshops was rich and informative; CogNovo fellows engaged with a mixture of epistemic sources, from experimental data and written archives to works of art.

In a subsequent workshop on Computational Modelling, in addition to the talks and seminars delivered by experts, group work was scheduled into the week-long programme. This encouraged engagement with the seminar content from different perspectives, producing several outputs. These included robots that helped advance an analogue film in a programmable frame rate, a socially-interactive robot, and a grant proposal, then submitted as part of the StudentsHIP Enterprise Award to the Intellectual Property Office, a national funding agency. This type of group work illuminated the value of actively exchanging information about one discipline's practice with another, thereby uncovering new and alternative ways of transferring the knowledge of methods across disciplines (Marzano, Carss, & Bell, 2006). Several fellows remarked that it became easier to connect with another discipline in a practice-based manner, as this made the discipline more tangible and accessible. Thus, these workshops also encouraged openness through such interactions and discussions. Furthermore, existing misconceptions that disciplines had about one another were addressed, preventing them from being harmful and obstructive (Campbell, 2005).

While these examples of events show a development towards creating a space for multiple disciplines at CogNovo, there was no strict temporal continuity in this pattern of events. The development from one event to another that could, in hindsight, be perceived as moving from combining multiple disciplines to an integrated research space, was, in reality, an intuitive and exploratory process of finding an effective way to collaborate. In fact, one later workshop on Entrepreneurship was based entirely within the discipline of the Business School, at most referencing other disciplines as examples, and remaining mono-disciplined at its core; it did not increase the fellows' experience in multiple disciplinary collaborations, nor did it produce any measurable academic output, such as multiple disciplinary publications. However, this was the first time that the CogNovo fellows closely reflected on the impact that multiple disciplines may have on addressing complex research questions and on the fact that crossing disciplinary borders is not an automatic phenomenon that happens when people from differing backgrounds sit in the same room. Furthermore, it was the first time that the fellows provided organised feedback about the workshops. The CogNovo fellows recognised the significance of this feedback and its ability to help evaluate each event retrospectively and to improve future events. The feedback gained at the end of this event was particularly significant as it ultimately helped to shape the organisation of ColLaboratoire.

Mobility

In CogNovo, as in all Marie Skłodowska-Curie programmes, mobility was encouraged, through an initial relocation for the programme and then regular secondments to external partners. Crucially, relocating to a foreign country for the first time has been linked to increased creativity and openness to experience (Maddux & Galinsky, 2009). This openness involves being available to listen to new ideas, which in turn derives from merely

being open towards the “other”; as Pettigrew and Tropp (2008) suggest, interacting with people belonging to an “other” group reduces out-group prejudice and increases social proximity, as initially observed by Allport (1954). Thus, we inferred that being in a multi-cultural environment contributed to reducing the naturally occurring between-group barriers, and to fostering a feeling of openness. Having CogNovo fellows from 15 countries willing to spend three years in Plymouth, and summer school participants from 14 countries willing to spend one week in Plymouth, highlights a motivation to travel to, experience, and learn about a new country. This willingness and drive to engage in novel experiences may be another foundation for, as well as a corollary of, openness. This willingness is also contingent upon the ability of societal, financial, and political contexts to share a physical or virtual space (Stokols et al., 2008).

Environment – Space and Sociality

CogNovo was a single-centre EU Initial Training Network, with all research fellows based in the same institution, and even the fellows who went on secondments spent most of their time in Plymouth.

Single-centredness was an essential driver in the success of CogNovo for several reasons. Firstly, single-centredness reduces the “expenses to travel over geographical distances” (Yegros-Yegros et al., 2015, p. 4), one of the coordination costs of multi-centred programmes, thus making it possible for the fellows to dedicate time and energy to meet and integrate. Secondly, it allowed CogNovo fellows to share the burden of solving various administrative puzzles since they were all subject to the same organisational regulations (Cummings & Kiesler, 2005). Thirdly, and as a result of optimising the use of time and effort, single-centredness allowed for longer face-to-face interactions. Fellows had

time and opportunities to discover one's own social and professional compatibility with others in the group: with whom one can work, and with whom one cannot. The fourth aspect was the establishment of a single, physically shared workspace. The spatial proximity for the fellows who shared the workspace possibly nurtured the relationship and therefore interpersonal openness. This observation is consistent with previous findings linking shared workspaces to a higher level of reported interdisciplinary collaboration (Stokols et al., 2008). The workspace was both open and modular, allowing for the creation of small environments that afforded both unobstructed movements as well as areas of concealment (See prospect-refuge theory of designing spaces, in Appleton, 1996). It had couches on which fellows could not only relax but even sleep on, and congregate around to chat informally. It was a place that afforded both the opportunity to be alone and the opportunity to have face-to-face interactions. It hosted seminars, work groups, experiments, and social gatherings, as illustrated in Figure 2. It was what the director of CogNovo called a "space for integration," where one could gain exposure to ideas from other disciplines and cultures. The same space was used as a basis for ColLaboratoire and provided, on a much shorter timescale, similar functionality.

Relationships between people, places, and spaces have been investigated in multiple ways including the aspects of territoriality and belonging — as summarised by Vischer (2008) — providing psychological comfort and environmental control at the workplace. For the CogNovo fellows, this sense of place was particularly salient throughout their PhD programme, given that they had a devoted working area and seminar room for all their activities. This permanent location created a strong group identity for CogNovo, and also a sense of control as the fellows could all access, utilise, and influence the physical space (Nova, 2005). Informal reports from the CogNovo fellows suggested that having this

single physical space helped to foster a sense of collective identity. Furthermore, the fellows' personalisation of their working environment helped to establish their own identities in the surrounding community and a sense of belonging (Haynes, 2007).

Beyond the establishment of group identity, previous research has found that physical proximity is also related to a higher number of collaborations (e.g., Olson & Olson, 2000), as initiating conversations is not only easier but also more likely (Nova, 2005). Loesche and Łuczniak (2017) additionally emphasise that both trust and free exploration are central principles in successful multiple disciplinarity. In CogNovo specifically, the proximity of the fellows enabled them to develop their ideas in informal settings and revise them as necessary without leaving their shared office space.

While physical proximity was integral to CogNovo's community, social proximity was also crucial. Many successful collaborations among the CogNovo fellows emerged organically, having been conceptualised and explored in non-work environments. A similar observation was made by Sawyer (2007) while discussing successful collaboration in business. Informal conversation became "the cornerstone of collaboration" (Nova, 2005, p. 122) and many effective ideas were born out of trusting relationships that were not "built on promises" but that needed "time and action to grow" (Loesche & Łuczniak, 2017, p. 15) in shared spaces. Reflecting on the social proximity of CogNovo, a visiting researcher remarked that the programme was naturally social, observing that "you walk into the room and you can sense the sociality of the group" (Hancock & Jenkins, 2016). Thus, physical environments became a central consideration in the organisation of ColLaboratoire, for their crucial importance in facilitating sociality.



Figure 2. The CogNovo workspace at Plymouth University, UK. The photograph was taken by the authors, 2018.

ColLaboratoire: Its organisation and success

ColLaboratoire was modelled heavily on the CogNovo fellows' experiences of working within a multiple disciplinary setting. It was designed to establish a collaborative environment that would best serve multiple disciplinary research. At the same time, it preemptively addressed some of the issues faced by the fellows at the start of the CogNovo programme, at which point many had not had previous collaborative experiences (e.g., communication issues across disciplinary boundaries, poor understanding of other disciplines' research methods, ways of gathering knowledge, and dissemination of knowledge). Modelling the summer school on CogNovo was in order to reduce the number of challenges that ColLaboratoire participants would have to face.

The ColLaboratoire organisational team consisted of four self-selected CogNovo fellows who were responsible for coordinating the logistics of the summer school. These members had regular meetings over the eight-month period until the summer school took place. While each member had various roles (e.g., IT, financial, logistical, advertising), the decision-making was undertaken as a cohort during the meetings. The organisational components included sending out the project calls, assessing project proposals, inviting and selecting participants, inviting leading academics, organising accommodation, arranging catering, choosing and booking venues, and ensuring that everything ran to plan throughout the summer school.

Several factors contributed to the success of ColLaboratoire, stemming from the experience of the CogNovo fellows. These include its project-based structure, the encouragement of mobility, shared spaces, and social aspects.

A Project-based Structure

At the beginning of the organisational process, the organisers agreed that the summer school should be project-based and structured similarly to CogNovo workshops. Building from the sense of personal achievement created in previous events, ColLaboratoire aimed to generate intrinsic motivation to collaborate with people of different disciplines through peer-led and practice-based approaches.

Furthermore, research indicated that experience-based learning is often more fruitful than theory-driven approaches (e.g., Ruben, 1999; Stokols, 2006). Practice-based approaches, for example, for the project described in Table 1, facilitate individual engagement among people whose disciplinary backgrounds are different from one's discipline, and which can provide open and judgment-free platforms to discover and ideate collaboratively (Francis,

Haines, & Briazu, 2017). Many graduate-level summer schools in academic settings are designed to offer discipline-specific skills and knowledge in more traditional formats, with lecturers and workshop leaders focusing on teaching as opposed to facilitating learning. The organisers of ColLaboratoire, however, went beyond these traditional approaches by delivering a novel, peer-led, and project-driven experience that was designed to give participants real-world collaborative opportunities. Furthermore, the organisers intended to foster collaboration between participants through a project-based, open-ended, and semi-structured approach. As Domik and Fischer (2011) note, adopting these flexible and goal-directed approaches allows “students [to] practise meaningful collaboration with other disciplines” and fuels the transformation of students from educational consumers to “socially competent, responsible, self-directed learners” (p. 2).

The first step for realising the organisers’ vision of a multiple disciplinary, open-ended, and project-based summer school, was proposing the projects. The organisational team invited the CogNovo fellows to submit proposals for projects; this call was successful, and bids for seven interdisciplinary projects were received. After circulating the ideas among the project facilitators, some of them decided to merge, so that the final list included four projects. Tables 1 to 4 provide a detailed summary of the projects, describing their associated disciplines, their original purpose, and how they evolved during and after the summer school took place.

Table 1.

Description of project “Remapping the Sensorium: Do You Hear What I See?”

Title	Remapping the Sensorium: Do You Hear What I See?
Disciplines	cognitive psychology, computer science, music
Initial description and goals	In this project, we will develop real-time systems and data processing workflows to reveal hidden brain and bodily processes summoned through the collaborative production of a musical piece or the collective experience of a film. We will sonify and visualise a range of physiological measures collected during collaborative production and collective spectatorship to provide insights into perception, action, and social engagement... With the findings, we aim to gain greater insight into the impact of a collective experience ourselves and providing a toolkit that can be deployed in live events to augment audience participation and immersion in the cinematic experience.
Process of collaboration and results	The idea, to translate experiences from one medium to another, (e.g., the visual experience to sonic one), remained from the initial proposal to the final project. During the preparation phase, a flexible system architecture was prepared to accommodate various developments of the project. As expected in interdisciplinary collaboration, each participant brought a unique approach to interpret the collected data from the experience of collective spectatorship. The final project had a particular emphasis on the quality of sound and eye tracking analysis, as a consequence of specific interests expressed by the participants.
Future developments / collaborations	The project had several follow-ups. The idea of creating a sonification platform consisting of hardware, software, and conceptualisation on how to make different types of real-time and recorded data audible was implemented into “The Exciting Synesthesia Machine” (exhibited, e.g., at OTLip16, and the ESRC Social Science Festival 2016). The same platform was used for multiple other science-art projects such as “Finger Music,” “A Space to Wonder,” and “Experiments in Sonified Magic,” presented at academic, professional and public events, ranging from presentations at University Open Days, International Dance Festivals, the Bizarre Bazaar public engagement event, Off the Lip

Conference, and ESRC Social Science Festival (Loesche, Lemarchand, Kristensen, and Bridges, 2016). Additionally, it inspired one of the facilitators to develop his PhD project in a new direction.

Table 2

Description of project “Are Networks (Becoming) Conscious?”

Title	Are Networks (Becoming) Conscious?
Disciplines	Cognitive Psychology, Philosophy, Computer Science
Initial description and goals	Could highly-connected networks (such as the Internet) be conscious? Is such a network more likely to be conscious if it has a body? Does the Internet have a ‘body’ capable of sensing and acting on its environment? This project will take into account extended, situated, enactive, and embodied theories of cognition, investigating the possibility of modelling networked-based consciousness. The goal of this project is to compose a compelling (and potentially fundable) research proposal including research questions, initial literature review, discussion on methodologies, and proofs-of-concept.
Process of collaboration and results	During the project, the group spontaneously broke off into smaller working groups and explored the aspects of the topic, based on individual expertise and areas of interest. Towards the end of the summer school, these threads were brought together into a coherent theoretical framework and proof-of-concept, creating the conceptual foundation for a research grant proposal.
Future developments / collaborations	While the initial idea of the project was not followed-up, this project resulted in several successful collaborations between the participants, e.g., RE/ME (Maranan, Haines, & Clarke, 2017). The results of this project were documented and are publicly available: http://bobfigueroajr.com/arenetworksconscious/blog/

Table 3

Description of project “‘Nao’ That’s What I’m Talking About”

Title	‘Nao’ That’s What I’m Talking About
Disciplines	Robotics, Performance Art, Philosophy, Social Psychology
Initial description and goals	In this project, participants will have the chance to choreograph and stage a performance with one or more NAO humanoid robots, after a multiple disciplinary discussion on the nature and perception of the robot. Roboticists, performers, artists, philosophers and programmers are welcome to apply: true to the spirit of CogNovo; we want this project to be a fulfilling experience for all of its participants, who will receive stimulating inputs from experts in the fields that this project spans.
Process of collaboration and results	During initial brainstorming sessions, the group decided to produce a ‘robotic theatre’ performance. Additionally, participants decided to collect audience feedback alongside with data on social perception of performing robots. This idea, which was not included in the initial proposal, enriched the outcomes of the project and created the possibility of publishing the project results in the field of Human-Robot Interaction.
Future developments / collaborations	After the summer school, the team kept working together analysing the data collected from the audience; this resulted in a paper that was submitted to “HRI,” one of the most important conferences in Human-Robot Interaction. Even though it was rejected, the team received three peer reviews which will be used to further develop and re-submit the paper.

Table 4

Description of project “Let’s Improv It”

Title	Let’s Improv It
Disciplines	Cognitive & Social Psychology, Dance, Improvisation, Computer Science
Initial description and goals	This project aims to explore psychological theories of shared experience and its physiological basis. We will engage in playful dance and movement improvisational tasks, studying the notion of social entrainment, empathic projection and theory of shared flow experience through observation, visualisation and sonification of physiological changes and improvised scores. It is a practice-based research project, resulting in an improvised movement light and sound performance.

Process of collaboration and results	From the beginning, the group decided to shift the initial goal into providing “an experience” for the audience to engage with. As a consequence, the group explored how to share embodied knowledge and used an improviser’s way of understanding the social reality with people who had no experience with dance or movement improvisation. The initial proposal of sonification and visualisation of physiological dynamics of movement was excluded as it did not fit the new goal. As a result, the group provided a participatory improvised experience that explored the notion of social, nonverbal communication through the experience of mimicry, touch, and kinaesthetic empathy.
Future developments / collaborations	Most of the members of the group (both facilitators and participants) continued the development of the project in the following year. The idea and the practice of collaborative, interdisciplinary work, were disseminated at “Dance Fields,” one of the largest dance research conferences. Furthermore, the group produced a participatory performance that was shared at “International Dance and Somatic Practices Conference.” The project was also described and published in a paper (Łuczniak, Jackson, Sakuta & Siarava, 2017). The collaboration continues; the group is planning further performance work to be exhibited at dance festivals.

As ColLaboratoire was a peer-led summer school, the CogNovo fellows placed themselves as project facilitators, rather than leaders. Project facilitators were required to be from at least two different disciplines (see Figure 3) to achieve Choi and Pak’s (2006) criterion for multiple disciplinarity. While outlining each project’s structure and offering guidance and technical assistance when appropriate, project facilitators prioritised flexibility. For example, the organisers agreed that participants should navigate the research and be allowed to shape the processes and outcomes of the work. In addition to the project facilitators, leading academics who had professional collaborative experience were also invited to share their views and participate in some of the projects, providing valuable suggestions and input. Crucially, ColLaboratoire built on an intrinsic commitment to multiple

disciplinary goals with the aim of nurturing productive and rewarding collaborations between disciplines (Loesche & Łuczniak, 2017; Stokols, 2006).

Participants: Recruitment and mobility

After finalising the project proposals, the next stage was the recruitment of participants. Even though Stewart (2006) found a positive effect of team size on performance in his meta-analysis, they observed a peak at around seven team members. Together with other factors such as available funding, space, and logistic constraints, the organisational team decided to keep the project size below seven participants. CogNovo fellows emailed invitations to their networks, institutions, and research groups with interest in collaborative research. Upon application for specific projects, the applicants were asked for a description of their research and experience, previous collaboration experience, and skills or knowledge that they would be willing to share with the project group. Applications from 42 people were received. The following two primary selection criteria were adopted for selecting participants: applicants' previous collaborative experience and/or their willingness to collaborate, and whether their existing experience provided valuable expertise within their preferred project(s). These selection criteria coincided with the "degree of openness and interest of participants in interdisciplinary working" that was used by Bridle et. al. (2013, p. 26) for the selection of participants within a similar context; these criteria led to the selection of participants who were open to interacting with people from other disciplines. While each organisational team member completed the ratings independently, they made the final decisions at the group level and on a case-by-case basis. The final attendees were 20 PhD and Master-level researchers with expertise in a variety of disciplines, including Music, Dance, Applied Arts, Philosophy, Communication Science, Cognitive Psychology,

Computational Neuroscience, and Computer Science This distribution of topics was identified posthoc, reflect to some extent the disciplines within CogNovo, and certainly contributed to the success of the projects. (See Figure 3 for an overview of these disciplines and their distribution across projects).

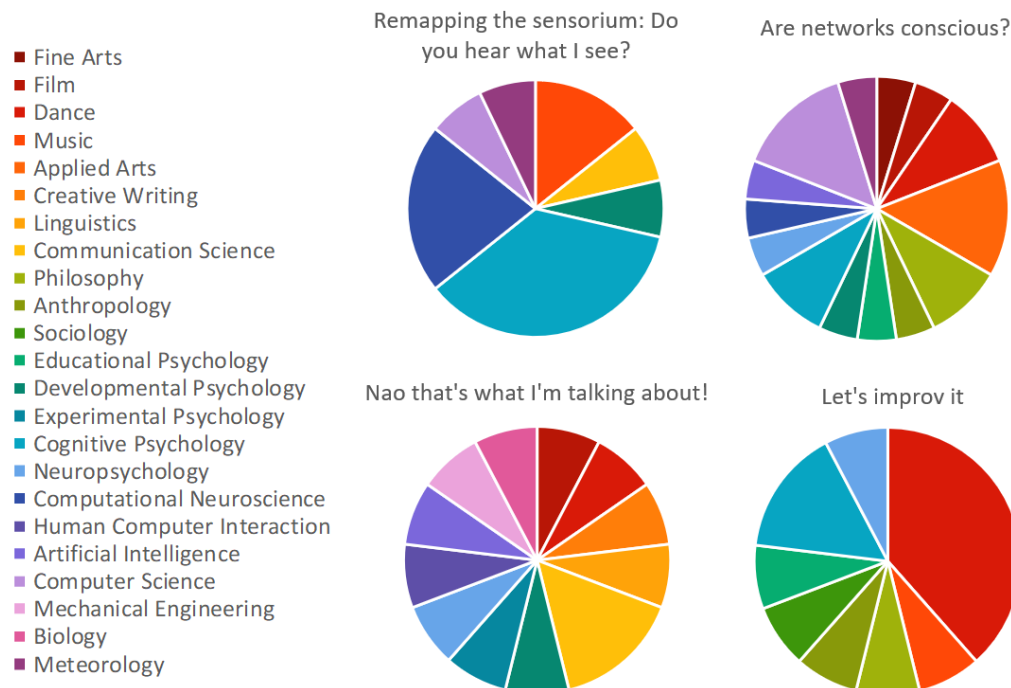


Figure 3. An overview of participants' and facilitators' disciplines and their distribution across the ColLaboratoire projects.

In the same way that the funding for CogNovo was designed to facilitate cross-border mobility, ColLaboratoire organisers decided to allocate a substantial amount of the funding to student bursaries, with the result that ColLaboratoire was able to cover travel from as far away as Southeast Asia and the Americas. This distribution of funding allowed participants to make contact with others from different cultures and backgrounds; as framed by Allport's (1954) Contact Theory, the organisers used this diversity of people as leverage for

openness and creativity (Maddux, Adam, & Galinsky, 2010), both in social and in work settings.

Environment: Space and Sociality

As mentioned previously, the ColLaboratoire organisers decided to use the CogNovo workspace as the central location of the summer school (see Figure 4). Organisation centred on physical proximity: participants ate breakfast together every morning in a campus cafe, refreshments and snacks were supplied in a central location to bring teams back together in the late mornings and afternoons in between project work, and regular summary sessions also reunited project groups in a common place to share their progress with one another. Participants were also provided accommodation in a shared building where they had opportunities to meet and talk during their free time. With this approach of physical proximity, and by providing informal and unstructured time, ColLaboratoire instilled and nurtured openness to work across disciplines and summer school projects. It also enabled many face-to-face contact opportunities, and this “allowed conversations to happen at dinner, at breakfast, at lunch” (Hancock & Jenkins, 2016). This exchange of ideas and relationship-building promoted confidential discussions and developed the trust necessary in multiple disciplinary communication (Bridle et al., 2013).

For group work specifically, project facilitators were encouraged to take advantage of any available space on the university campus that they felt would foster creativity, openness, and trust. For example, in the “Let’s Improv It” project group (Table 4), this involved active movement in a dance studio and public spaces, while for the “Are Networks (Becoming) Conscious” group (Table 2), it often involved close-knit discussions in smaller seminar rooms. These spaces were often in neutral or “inspiring” locations, allowing the initiation of

conversations during ColLaboratoire with less intimidation from organisational climates (Bridle et al., 2013).

Furthermore, existing evidence underlines the importance of social factors in multiple disciplinary work (e. g., Fiore, 2008; Klein, 2008; Marzano et al., 2006; Stokols, 2006), although a longitudinal study showed that social factors such as friendship did not predict success as much as intellectual ties (White, Wellman & Nazer, 2004). However, these findings may not necessarily be applied to a short and open-ended venture such as ColLaboratoire. To ensure successful open-ended collaboration, it may be more applicable to consider elements such as psychological safety –the “shared belief that the team is safe for interpersonal risk taking” (Edmondson, 1999, p. 354). After all, multiple disciplinary collaboration is a social process which arguably involves higher levels of risk-taking than mono-disciplinary collaborations (e.g., Bridle et al., 2013). Therefore, together with the strong focus on physical proximity and own-group space, the summer school was constructed around unstructured time and a vibrant social programme to ensure that participants were able to interact and express their ideas informally and in low-risk settings. This plan involved the following activities across the week-long programme: research speed-dating, a social reception held at the National Marine Aquarium, a fireworks night, an international cooking evening, sports activities at a local climbing centre, a games night, shared daily breakfasts, and a group dinner.



Figure 4. ColLaboratoire participants and organisers during project work. The photograph was taken by the ColLaboratoire organisers (2016).

ColLaboratoire: Processes and outcomes

In the previous section, we described how ColLaboratoire was designed to replicate CogNovo's physical structure on a smaller scale, and from the perspective of the research fellows who had worked in close social proximity to one another for three years. In this section, we first discuss additional considerations in the process of facilitating projects, such as the management of teams and resources. We also note some objective and subjective outcomes from the event and individual projects.

Management of teams and resources

The project facilitators supported their teams with their research process in a variety of different ways. An event such as ColLaboratoire involves bringing together people with different cultural and disciplinary backgrounds, which inherently raises challenges in weaving together a diverse range of understandings and practices. Moreover, in an intensive one-week course, time management and resource availability are crucial factors for success. The facilitators were overseeing the work and helping participants to find a common point of contact, even when different parts of the team worked separately. It is notable that this was achieved in different ways by each project; for example, in the “Do You Hear What I See” and “Are Networks (Becoming) Conscious” projects (see Tables 1 and 2), the facilitators placed themselves as messengers and moderators between different segments of their groups. In contrast, the “Let’s Improv It” group worked closely throughout the week, dedicating daily time to group discussions centred round clarification of ideas and the direction of the project (see Table 4). In the “Nao that’s what I’m talking about” group (Table 3), facilitators assisted with task assignment and the moderation of group discussions in order to support the less experienced members of the group, ensuring that their ideas would be heard.

Projects were designed so that participants were required to acquire new skills to work towards the project goal. The facilitators, alongside expert guests, shared their knowledge in the practical sessions which were then immediately applied to the research problems in subsequent group work. Through practice, each group member could increase his or her understanding of how different perspectives from other disciplines could be applied, and their practical value. As discussed earlier, the CogNovo fellows’ experiences indicated that opportunity for practice makes the perspective of another discipline more tangible and accessible.

The open-ended form of the research projects required facilitators to display flexibility and openness to participants' ideas. As Tables 1 to 4 illustrate, each project adjusted from its original proposal to reflect the specific interests of the participants. The facilitators accommodated these alterations in a variety of ways. For example, in the "Nao That's What I'm Talking About" project, the group decided to provide extra materials and enrich their investigation by collecting perceptual data, as documented in Table 3. Alternatively, in the "Let's Improv It" project (Table 4), group members decided to exclude some aspects of the planned research. After researching possible new technologies, the group decided not to engage with them. Another example of how the flexibility of the projects was useful, involved a participant who initially did not feel that she belonged to her project group, as she struggled to find a way in which her expertise could provide relevant insights into the topic. However, she was able to find the group to which she felt she could best contribute. Even then, a significant number of arguments, concepts, and the processes felt foreign to her, despite her sincere interest. Instead of treating this as a failure, the head of the programme appointed her as a general observer with the freedom to move from one group to another, identifying her critical eye as a valuable asset for the improvement of each project and the programme as a whole.

In the after-event feedback questionnaire, participants indicated that this additional effort was rewarding, with each of those changes resulting in stronger and more innovative projects. As mentioned earlier, ColLaboratoire reflected the CogNovo fellows' belief that successful collaborations are born out of a dynamic and iterative process. Thus, researchers wishing to facilitate this should be prepared to adapt their ideas and practice to the changing landscape afforded by interacting with people outside of their discipline (Loesche & Łuczniak, 2017).

Experiences and outcomes

The success of ColLaboratoire is evident in a variety of ways. Some of the outputs include peer-reviewed articles (e. g., Łuczniak, Jackson, Sakuta, & Siarava, 2017), an engineered body-awareness-enhancing tool (Maranan et al., 2017), a sonification platform (Loesche et al., 2016) which was used in multiple other science-art projects, and conference workshops (e.g., Łuczniak & Jackson, 2016) - including one that was organised by participants belonging to two different ColLaboratoire groups (Maloney & Sakuta, 2017). For further details, see the “Future developments/collaborations” rows in Tables 1 to 4. These turnouts illustrate that interdisciplinary events such as these can result in innovative research projects leading to a variety of outcomes to raise the participants’ research profiles. Importantly, many of the ColLaboratoire participants have continued working together. For example, the group of “Let’s Improv It” developed the ideas of their projects further, while elements from the project “Do You Hear What I See” were the basis for “The Exciting Synesthesia Machine”, a multimodal exhibition to make visual input audible in real-time (Loesche et al., 2016; also see Tables 1 and 4).

In addition to these outputs, which provide an objective measure of the continued success of the summer school, its positive impact can be evidenced by the participants’ evaluations of the event. Many of these reactions mirrored a sense of stepping into new territory and feeling a strong sense of excitement. For example, one participant remarked that “The project work was so outside of my comfort zone. I learned an awful lot and loved every second of it”; while another commented that, “The summer school has taken me out of my comfort zone and allowed me to question many things”. These remarks about learning were often emotive, with one participant stating that “This week resulted in a powerful experience. I’ve learned so much and found lots of pleasure in our collaborations.” These comments also

provide evidence for the development of positive affect, mutual trust, and genuine openness towards other individuals in ColLaboratoire (Hancock & Jenkins, 2016). One participant wrote that “[ColLaboratoire] was an absolute hit with me and I have been telling people that it was one of the best weeks of my life”. In a final film interview with the participants, one remarked that, “I’ve always dreamed of a place like this where everyone is curious, active, and where amazing ideas just emerge naturally...what I can take home, is that this does exist”; another concluded the interview by saying: “This, ColLaboratoire, is life-changing.”.

ColLaboratoire’s legacy: Multi-perspective, inter-perspective, and trans-perspective openness

Reflecting on the knowledge and experience gained throughout the organisation and execution of ColLaboratoire, we note that many collaborations between groups of participants are still on-going and are building on what was only a one-week long event. In this final section, we discuss how the aforementioned “attitude of openness”, shared by both the organisers and participants, likely played a role in realising this richly condensed one-week programme and in producing a sustainable model of collaboration. We suggest that an attitude of openness entails the following three facets:

- ❑ Multi-perspective openness: being open to the idea of interacting with individuals from other disciplines and listening to their opinions with an open mind to eliminate any prejudice against one another. This openness derives conceptually from Allport’s Contact Hypothesis (1954): an ample duration of cooperative contact with the “other” reduce prejudice between groups and enhances empathy and understanding, as shown in the meta-analysis by Pettigrew and Tropp (2008).

- ❑ Inter-perspective openness: softening the disciplinary borders of philosophical perspectives and theoretical frameworks to allow multiple avenues of inquiry to surface together (drawing from Miller et al.'s "epistemological pluralism", 2008).
- ❑ Trans-perspective openness: allowing for methods, data, and knowledge to transcend disciplines, so that they can be used and interpreted in new and different ways (drawing from Bruhn, 1995, and Nosek et al., 2015).

These three facets can be thought of as different, albeit intertwined, components of openness, whose content naturally overlaps. Some of these facets are part of the psychological construct of "openness to experience," generally defined as one of the Big Five personality traits (McCrae, 2009). Here, in particular, we refer to states that can fluidly change (e.g., through experience) within an individual. As such, we address these three facets as original ideas, independent from pre-existing definitions. In all three, there is a process of suspending disciplinary beliefs (and disbeliefs), wherein one's own disciplinary standards and traditions are loosened to entertain other perspectives. There is also an affective dimension in realising this open, inclusive environment, which is a sense of placid neutrality towards entertaining competing perspectives; an unbroken and collective delight in suspending traditionally accepted answers.

While it could be argued that the three facets of openness were already present in CogNovo, it might be premature to assess the outputs generated from a three-year initiative as opposed to a one-week event. The scope and impact of the CogNovo programme itself will be investigated in the future when its outputs come to fruition, and we invite readers to provide additional much-needed long-term analyses of similar programmes. Here, we focus our reflection on ColLaboratoire specifically. ColLaboratoire and its participants realised the three facets of openness in several aspects of the programme:

- ❑ **Disciplinarity.** Trans-perspective and Inter-perspective openness were established through the transference of knowledge and methods between disciplines, and consequently, a loosening of traditional disciplinary borders. Furthermore, the practice-based structure of the event encouraged trans-perspective openness by facilitating extensive interactions between participants from different disciplines. ColLaboratoire also serves as an example of how openness effectively facilitates the creation of new knowledge among participants through less restrictive interaction (multiple disciplinary), which is common among open learning environments and approaches, hinged on Vygotskian social constructivism (Bruner, 1996; Vygotsky, 1978).
- ❑ **Mobility.** Bringing people together from different regions facilitated multi-perspective openness, breaking barriers between individuals.
- ❑ **Environment.** Multi-perspective openness was facilitated through the physical environment, which was a combination of open and modular spaces. In this sense, the aforementioned CogNovo fellows' "space for integration" was an immersive experience of multi-perspective openness.
- ❑ **Sociality.** The process of building relationships and establishing trust relates to the development of multi-perspective openness, and, more broadly, to the Contact Hypothesis (Allport, 1954; Pettigrew & Tropp, 2008); existing personal and disciplinary prejudices are overcome through direct social experiences between researchers and the development of empathy. These are essential components that have been found to foster positive intergroup contact (Beelmann & Heinemann, 2014).

Crucially, multi-, inter-, and trans-perspective openness are both enablers and outcomes. Already inherent in many of the summer school participants, these facets of openness enabled free discussions and motivated collaborations. Further, and as a result of

explicit facilitation, participants emerged throughout the event having been inspired and nurtured in the summer school's organisation. As such, the venture of ColLaboratoire raises two important considerations for prospective and much-needed multiple disciplinary collaborations. Firstly, that collaborative successes may be more likely if researchers possess the three aspects of openness introduced here and secondly, that summer school initiatives such as ColLaboratoire can assist in the acquisition of such disciplinary openness. After all, the success of multiple disciplinarity lies with those who are not afraid to interact, learn, unlearn, and reshape in the face of challenge.

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