Science and Art

Hacking Hearts: Establishing a Dialogue in Art/Science Education

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Abstract

This paper discusses Hacking Hearts, a transdisciplinary educational collaboration between the art school Central Saint Martins (U.K.) and a science and engineering university, the Tokyo Institute of Technology (Japan). The concept of performativity---which was brought into the construction of the workshop setting---is used to explain the mechanisms of interaction across disciplinary boundaries commonly accepted in these institutions and academic areas. The collaboration transformed performative elements into a resource by creating an educational environment that enabled communication through encounters "on stage" between research scientists and art/design students. The discussion is situated within a growing literature on art/science education and offers lessons for establishing collaborative workshops between diverse participants.

In postindustrial societies highly dependent on technology and scientific research, the usefulness of employing art strategies in STEM education to form STEAM is increasingly appreciated [1,2]. As Georgette Yakman, an early proponent of STEAM education, explained, "We now live in a world where you can't understand Science without Technology,

which couches most of its research and development in Engineering, which you can't create without an understanding of the Arts and Mathematics" [3]. Likewise, there is an awareness that art/design schools must be better equipped to interrogate scientific discoveries in their scope. Meaningful exchanges with scientific researchers are still relatively rare events in art schools, despite their potential to trigger original outcomes and reflections. As we continue to ask how educational curricula can break the restrictions set by conventional boundaries, another primary concern is establishing transdisciplinary space [4]. How can we elicit mutually beneficial exchanges between very different institutions? One answer is to generate "hacking" opportunities that can, in turn, yield boundary-crossing opportunities. We define hacking as a process of translation from scientific presentation to artistic re-presentation following a 5-step strategy:

Respond: reviewing a body of scientific research
Explore: considering materiality, function, speculation
Collaborate: working with people with different disciplinary knowledge, methods, and mindsets
Interrogate: asking questions exploring social, ethical, and philosophical dimensions
Reinterpret: presenting back novel questions, ideas, suggestions, and responses

This article examines lessons learned from Hacking Hearts, a pedagogical experiment designed by the Tokyo Institute of Technology (TokyoTech), a national science and engineering university in Japan, and Central Saint Martins (CSM), an art and design college within the University of the Arts London in the U.K. Recognizing the value of transdisciplinarity in education [5], building on the success of previous initiatives [6], and inspired by the value of artist-residence schemes in science and technology institutions [7,8], Hacking Hearts proposed a scientist-in-residence program that could bring professional scientists in close contact with students in an art and design college. The students were invited to reimagine and respond creatively to contemporary research on heart disease, energy harvesting, and cellular sensing by experimenting with hacking. In designing the project, we wanted to test the educational value of such initiatives and contribute to a growing literature on art-science programs in higher education. Hacking Hearts shows how hacking science and technology knowledge through artistic strategies can activate art and design students' communication and creative interpretation.

Hybrid Methodologies: Hacking Meets Performativity

While hacking events (or "hackathons") aim to produce rapid prototypes, quick, innovative solutions, and new discourses [9,10], especially in commercial settings related to digital technologies [11,12], Hacking Hearts incorporated the intense brainstorming of commercial hacks with a longer-term approach typical of scientist-in-residence programs. As a transdisciplinary platform connecting students and science experts, the project offered an arena for experimenting with "hybrid methodologies" [13], attempting to go beyond the reductive logic of "integration" (often resulting in creative visualization on one side and technical problem-solving on the other) and aiming instead to galvanize mutually beneficial spaces of inquiry [14]. We intended Hacking Hearts to explore how such hybrid methodologies can promote transdisciplinarity in higher education.

Findings presented here emerged from qualitative analysis of participant observation, recordings, graphic annotations (by a student), and semi-structured interviews collected by the principal author, who applies a linguistic and social science perspective to illuminate mindset exchange among participants.

We propose performativity [15] as a valuable approach to facilitate productive exchanges between participants in the hacking process. With its ritualized mechanisms, performativity influences everyday interactions [16]. Capacities acquired through performativity amplify how we express ourselves and can enrich the encounter with heterogeneity [17]. Thus, performativity can be boundary-breaking and an enabler of transdisciplinary dialogue [18]. Seen through a dramaturgical perspective, even social contexts become stage sets, influencing behavior. As performative act theories remind us, social utterances have power [19]; they contribute to creating a social reality that is constantly being constructed, formulated, and reproduced by being performed. For instance, the value assigned to "factual objectivity" can be seen as the *habitus* [20] of science as a discipline, systematically enacted through community members' behavior, technical language, and experimental procedures. These patterns are often perceived as boundaries, and the challenge to cross them can pivot into motivation to hack. Hacking Hearts enacted performativity's capacity to disrupt roles and break existing patterns [21] by posing the "science lab" as a stage set and using hacking as a medium of performativity.

Performativity as a Pedagogical Tool

The notion of performativity we evoke here draws on speech act theory [22,23] as well as posthumanist scholarship [24,25]. Performativity, as used here, is the power to bring about something by saying and doing certain things (e.g., the utterance of wedding vows). Integral to performativity's reality-producing ability is the careful engineering (or ritualization) of context. Performativity helps us understand how the desired transformation can be enacted through a controlled *mise-en-scène* (i.e., placing on stage).

Hacking Hearts relied on this notion of performativity to engineer a transformative intervention whose impact could be twofold: as a lever to kickstart mutual questioning between scientists and art/design students, working within and across their respective practices, and improvising a "script" to generate novel questions that could inform the production of tangible prototypes; and secondly, as a meta-level, that would generate insights for pedagogical inquiries for the authors' team and its future application in curriculum development.

The Four Phases of Hacking Hearts

Hacking Hearts happened within the context of CSM/TokyoTech's ongoing collaboration. TokyoTech has been fostering transdisciplinary research and education in recent years, within the university and through partnerships at the Department of Transdisciplinary Science and Engineering (TSE) since 2016 to train engineers and scientists with a global perspective.

CSM's new Grow Lab hosted Hacking Hearts in November 2019. Grow Lab is a Containment Level 1 biology laboratory enabling sterile work in microbiology and microscopy. CSM's art and design school location provided the ideal setting for the lab. It functioned as a hybrid ground where scientific protocols could be employed, appropriated, or adapted creatively within safe parameters and an embodied metaphor for hacking. It was also an embodied metaphor for hacking and a stage set for enacting performativity. The collaboration extended to Queen Mary University of London (Queen Mary) for the event. The five-day program included scientific presentations, demonstrations, group discussions, and prototyping and ended with a public participatory event (Fig. 1).

Twelve CSM Postgraduate students (from art and science; furniture design; graphic communication design; industrial design; jewelry design; and performance design and practice) were selected through an open call. The scientists' team comprised: biologist Thomas Iskratsch (Queen Mary), who shared biotechnological research for preventing and

curing heart disease, in particular how heart cells measure muscular stiffness by using simplified systems to examine specific parameters in isolation, such as rigidity or shape; mechanical engineer Wataru Hijikata (TokyoTech), who presented work on energy harvesting systems that can be implanted in the human body to power artificial heart pumps and used electromechanical models to demonstrate basic principles (Fig. 2); and social scientist Kayoko Nohara, who observed the entire process. Hacking Hearts was led by artist and educator Heather Barnett and created in collaboration with designer Ulrike Oberlack, Kayoko Nohara, and specialist technician Shem Johnson.

While *Hacking Hearts* exposed art and design students to mechanical engineering and biotechnology heart research, it was also an attempt to observe how intersemiotic translation across multiple domains could be realized through social dynamics in the lab. Students were encouraged to consider the societal implications of scientific research in their responses. Forms of practical and conceptual hacking were performed through experimental investigation that used speculative design and material manipulation to prompt questioning. Four distinct phases illustrate the hacking process:

First Phase: Communicating Science

Participants entered the Grow Lab each day as "members of the scientific community." Crossing a small locker room, they were required to wear lab coats and wash their hands. This routine turned into a ritual, channeling a psychological shift toward science protocols. As in Noh theater [26], the lab functioned as the main stage and the changing area as backstage, creating a bridge between the actual (campus life) and the virtual. In this first phase, the scientists presented their research through images (of heart cells), sound sources (of ill/healthy heartbeats), and physical models (of an internal energy generator for artificial organs). In a carefully executed exercise in science communication for non-science professionals, research was presented in a jargon-free, digestible manner utilizing visuals and hands-on demonstrations (Fig. 3). Students could deepen their understanding by questioning and taking notes. Knowledge transfer was primarily unidirectional.

Second Phase: Questioning Science

Unconstrained by the strict requirements dictated by the "correct" way of interpreting science, students began to question those aspects most resonant with their sensibilities,

focusing on the personal, emotional, and the theatrical. While adhering to required protocols, a gradual shift was noted toward more discerning, inquisitive behavior [27]. Students were becoming more active, shifting from being knowledge receivers to becoming testers and critical commentators. Initial questions about methods and results morphed into inquiries around significance, inevitability, and legitimacy of scientific research.

Ethical questions were raised when one of the scientists showed images of *ex vivo* experiments on toads. Discussion of speciesism and the entanglement of scientific and ethical values found expression through material thinking and the creation of props made of non-animal materials (fiber, wire, plastic, clay, etc.). The debate sparked an emotional reaction in one student who requested a follow-up discussion to express strong opposition while appreciating the project and seeking further involvement [28]. This suggested that "ethics" could mean something different for the scientists (ensuring scientific standards), the artists and educators working for the institution (observing university policy), and individual students (expressing personal values). Conceptually, these exchanges led to speculative work proposing plants (rather than animals) for harvesting energy in humans through photosynthesis, explored through rudimental prototypes as stage props (Fig. 4). Translating key ideas through material exploration---such as investigating the elasticity of heart cells by manipulating fabrics---prompted a deeper connection with the research. However, further doubts and frustration about the opacity of scientific procedures ("research is sometimes kind of top secret" [29]) surfaced, galvanizing students' interest and engagement.

Third Phase: Interpreting Science

On the third and fourth days, the students concentrated on producing creative responses. Their role became less prominent as the students appropriated scientific insights creatively, continuing with exploratory experimentation and group discussion. The scientists' role shifted too, from that of presenters of knowledge to that of consultants. Students chatted informally with them to clarify terms or technical aspects and discuss broader research implications. The Grow Lab continued to offer a physical space for encounters and exchange, with students creating prototypes (e.g., latex creatures sculpted in the chemical fume hood), observing heart cells with the microscope (and capturing images to use in a film), and manipulating props that demonstrated the variable elasticity of heart cells under different conditions. This latter inquiry inspired a collective heartbeat performance in the final symposium. Learning that artificial hearts do not emit a heartbeat prompted students to produce a video questioning the

audience's ability to distinguish different "hearts." Exploiting the sound of heartbeats, the video was a poetic meditation on identity and difference, natural and artificial, organic, and inorganic (Fig. 5).

Fourth Phase: Showcasing Responses

The symposium that concluded Hacking Hearts showcased scientists' presentations and students' responses, providing a forum for further discussion. The lecture theater provided another meta-stage set for students to enact their multiple roles as creators, performers, "scientists," and science hackers while interacting with a genuine audience of CSM academics, students, and the general public. While the emphasis throughout remained on the process (of co-inquiry/hacking) rather than on creating sleek, finished material, the public arena of the symposium catalyzed students' effort to produce more resolved outcomes. The performances demonstrated that hacking science and technology knowledge through artistic strategies could stimulate students' creative interpretation while offering participating scientists new perspectives on their specialisms interpreted through different disciplinary lenses and non-scientific values.

Toward Hacking in Action

In a global society affected by changing environmental and social needs, transdisciplinary practices interrogating artistic and scientific thinking help us speculate, carve out, and realize sustainable futures in the physical, psychological, and philosophical sense. Beyond seeing complexity as "some cursed and inescapable source of 'wicked problems'" [30,31], educational organizations must establish collaborative strategies that embrace uncertainty and turn it into a resource: a material to work with [32].

In this context, creative practices are often expected to stimulate creativity and innovation [33], although the exact mechanisms of interaction remain somewhat elusive. Employing collaborative strategies among participants with different expertise and modes of knowledge-making can help solve critical issues today and build an expanded vision, allow sharing of concerns, and raise new questions [34].

Hacking Hearts was a pedagogical experiment with a novel hacking style in action. The performativity generated by its curated settings triggered creative responses through a deeper engagement with scientific thinking. The project exploited this performativity to transgress

boundaries. It provided a platform for participants to perform one another's *habitus*: a "third space" where equipment and experiments, rituals and protocols, roles, and props became aspects of a "theatrical" setting that enabled distinctive forms of hacking. The performativity that developed in the process encouraged the art/design students to creatively mobilize their encounters to translate both contents and culture of science into tangible narratives. The drama collectively created by students and scientists alike highlights hacking as a formidable tool in promoting transdisciplinary interaction.

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Fig. 1. The Hacking Hearts symposium was held Friday, 8 November 2019, and included presentations by the scientists, performances by the students (left), and a Q&A session with the audience (right). (© Hacking Hearts, Central Saint Martins)

Fig. 2. Electromechanical model of an implantable energy harvesting system driven by electrically stimulated muscle, 2019. (© Wataru Hijikata)

Fig. 3. The students and visiting researchers discussing Hijikata's model implantable generator, 2019. (© Hacking Hearts, Central Saint Martins)

Fig. 4. Prototypes created by the students for the 2030 *Beyond Human* performance during Hacking Hearts, 2019. (© Hacking Hearts, Central Saint Martins)

Fig. 5. Stills from *Organic Mechanic,* a short video made for Hacking Hearts, 2019. (© Maciej Rackiewicz, Zequan Lin, Violeta Valcheva, Yasmin Morjaria and Jingyan Yang)