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Transdisciplinarity in HCI

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Abstract
Researchers in the Human-Computer Interaction (HCI) field study, design and encapsulate the rich interaction between different kinds of users, information technology systems, and contexts of use in personal and organizational levels with implications to shaping society at large. HCI addresses different levels of analysis in human-technology interaction, utilizes different theoretical perspectives, practices, and paradigms from other disciplines, cooperates with other academic disciplines to study human-technology interaction, crossing boundaries and contributing to other disciplines, and has the design of human-technology interaction in its core. As research and practice field, HCI is very suitable for and oriented towards inter- and multi-disciplinarity, but transdisciplinarity in HCI is not yet fully explored. This paper outlines and reflects upon the concepts of transdisciplinarity, HCI, and transdisciplinarity in HCI.

Keywords
Transdisciplinarity, Human-Computer Interaction, Socio-Technical Systems

1. Introduction

While some scientific disciplines such as social sciences have been studying technology as part of human life and practices from their own perspectives for a very long time already, other disciplines such as Information and Communication Technology (ICT) have only recently started to address the social science perspectives of technology facing tremendous problems when trying to include them into their own research and practice (Resende et al., 2017). It can be argued that Human-Computer Interaction (HCI), as the most human-oriented discipline within ICT, is responsible for studying and understanding the relationships between individuals, practices, organizations and different contexts in which they use ICT technologies as part of their everyday work and practice to achieve their goals and intentions. As a relatively young discipline, HCI has had freedom in its efforts of developing, expanding and evolving together with technological advances, drawing concepts, theoretical lenses and paradigms conveniently from other disciplines, such as social sciences, cultural anthropology, and engineering, to name a few. HCI is clearly inter- and multidisciplinary by nature, but the role and possibilities of *transdisciplinarity* in HCI have not yet been fully explored. The purpose of this paper is to outline and reflect upon the transdisciplinarity in HCI. We will answer questions such as what are the distinguishing features of the HCI research and practice? what is transdisciplinarity? and what transdisciplinarity in HCI entails.

In the core of HCI research and practice is the interaction between the individual and the computer, technology, software, or hardware through a user interface, which is the only gateway for the user to reach the intended functionalities of the technology. The design of this gateway is at the heart of HCI research and practice (Iivari, 2019). This interaction between humans and technology is encapsulated in the concept of usability.

The international standard ISO 9241-11 (1998) has often been outlined as the classical definition of usability, which consists of the extent to which the users are able to complete their tasks (effectiveness), the time it takes these users to complete their tasks (efficiency) and the subjective experience of the user when completing their tasks (satisfaction). Over time, there have been different variations of the definitions of usability, which act as time capsules, as they outline different approaches, viewpoints and

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conceptualizations to usability, thus representing the views and best practices of their time (see e.g., Marghescu, 2009; Rajanen et al., 2017). These usability definitions have been in turn feeding back into their socio-technical environment, thus creating a feedback loop similar to second-order cybernetics (Rajanen & Rajanen, 2020a).

However, it has been argued (see, e.g., Bentley et al., 2016; Rajanen & Rajanen, 2020b) that individual experiences of users of complex socio-technical systems might be strongly determined by subjective reactions to objective aspects and constraints from design and contexts of use. Therefore, it has been argued that due to this subjectivity of individual experiences, the very definition of usability with its subjective satisfaction dimension could be problematic, leading the HCI researchers trying to find objective measures for subjective experiences, to no avail (Rajanen, 2021). To overcome this problem of subjectivity, there have been calls for adopting concepts from other design disciplines, such as architecture, for substituting this subjectivity in the very definition of usability with more universal and objective notions of symmetry and beauty and retaining the individual subjective experiences within the definition of user experience (Rajanen, 2021). These issues highlight the nature of HCI research and practice that learn and adapt from and contribute to other disciplines, especially design-oriented disciplines such as design which is in the very heart of HCI (Iivari, 2019).

Thus, while HCI is clearly inter- and multidisciplinary by nature, the role and possibilities of transdisciplinarity in HCI have not yet been fully explored. The purpose of this paper is to outline and reflect upon transdisciplinarity in HCI. Therefore, in the next section, we outline and reflect upon the different conceptualizations of transdisciplinarity that provide a basis for discussing transdisciplinarity in HCI. In section 3, we discuss the way transdisciplinarity manifests in HCI and provide future research directions.

2. Transdisciplinarity

The word *transdisciplinarity* originates from the Latin words *trans-* and *disciplina*, where *disciplina* refers to the existing academic disciplines and the prefix *trans-* adds to it the meaning of "across, on the far side, over, beyond" (Nicolescu, 2000; Cole, 2019). Therefore, transdisciplinarity as a word and as a concept refers to something that is across, between, and beyond the confines of traditional academic disciplines (Nicolescu, 2014; Cole, 2019). Piaget has been credited with the origin of transdisciplinarity, since the academic use of the term can be traced to Piaget's presentations in the 1970s (Nicolescu, 2005; Cole, 2019).

In order to clarify the confusions between the concepts of intra-, cross-, multi-, inter-, and transdisciplinarity, Meeth (1978) outlined a hierarchical classification with increasing levels of complexity, which we expand further with the classifications of Nordahl & Serafin (2008) and Nicolescu (2014):

1. *Intradisciplinarity* focuses on a single discipline, operating within the concepts, methods and paradigms found within one single discipline and never venturing outside its borders (Meeth, 1978; Nordahl & Serafin, 2008).
2. *Crossdisciplinarity* crosses disciplinary boundaries by viewing one discipline from the perspective of another (Meeth, 1978; Nordahl & Serafin, 2008).
3. *Multidisciplinarity* focuses on studying research topics spanning several individual disciplines and while any research topic can benefit by studying it by adding perspectives from multiple disciplines, the goal of the research is limited to the boundaries of the original discipline (Nicolescu, 2014).
4. *Interdisciplinarity* on the other hand transfers methods, processes, practices and paradigms from one discipline to another, but a research goal remains within its discipline (Nicolescu, 2014).
5. *Transdisciplinary* research focuses on research goals that are between, across and beyond individual research disciplines, trying to understand the reality (Nicolescu, 2014).

While this hierarchical classification by Meeth clarifies the individual concepts, it is often unclear what the exact roles and the relationships between inter-, multi-, and transdisciplinarity are. It has been argued that transdisciplinary research is not mutually exclusive to either multidisciplinarity or

interdisciplinarity of research, but rather it should be seen as a concept that complements, expands, and enriches these two other concepts and approaches (Nicolescu, 2000; Max-Neef, 2005; Nicolescu, 2014).

For the purpose of this paper, we can identify two schools of thought or theoretical perspectives into transdisciplinarity: A) Theoretical, epistemological and axiomatic perspective and B) Polymath perspective.

As an example of perspective A, we present three axioms of transdisciplinarity as outlined by Nicolescu (2000; 2014) and Max-Neef (2005):

1. *The ontological axiom*: There are different levels of reality as regards the object and reality of the subject in both nature and society as well as in all knowledge about them. Therefore, the spaces between and beyond individual disciplines are full of information, while an individual discipline focuses on one level of reality or its fragment.
2. *The logical axiom*: The passage from one level of reality to another is ensured by the logic of the included middle, and transdisciplinarity tackles the dynamics of several levels of reality at once, passing through disciplinary knowledge.
3. *The complexity axiom*: The structure of all levels of reality and perception is complex and interdependent; every level is what it is because of the interdependency between all other levels of reality existing at the same time.

While Nicolescu and other researchers of transdisciplinarity such as Max-Neef take this theoretical, epistemological and axiomatic perspective, other researchers take a contrasting view on transdisciplinarity which outlines a more historically-oriented polymath perspective. In this polymath perspective (B), transdisciplinarity is a wide personal set of learning and knowledge, where many scientific disciplines are amalgamated within one individual human called a polymath (see e.g. Terjesen and Politis, 2015; Schikowitz, 2021). This polymath individual has extensive learning from different disciplines, has learned from different research communities, and is capable of utilizing this diverse set of perspectives, theories and methods into a multidisciplinary skillset that can be used to solve complex problems of the world (Terjesen and Polities, 2015). Historical examples of such polymaths include for example Da Vinci, Galilei and Francis Bacon (Terjesen and Politis, 2015). A polymath might not feel committed to any individual discipline, but is rather driven by a need for overarching understanding of the world, and may even consider boundaries set between scientific disciplines as "absurd" (Schikowitz, 2021). However, it can be argued that it is now very difficult for any individual to accumulate the necessary knowledge across many different scientific disciplines due to the scientific disciplines advancing, evolving and expanding. Nevertheless, there are examples of modern polymaths who are capable of crossing disciplinary boundaries, contributing to different disciplines, and even creating new disciplines, such examples of modern polymaths include for example Nobel Laureate Vernon Smith (Terjesen and Politis, 2015).

Next, we take a look at transdisciplinarity in HCI in order to reflect on how these two very different schools of thought or theoretical perspectives into transdisciplinarity can be related to HCI, and what challenges and areas of future research can be found.

3. Transdisciplinarity in HCI

From the research areas in HCI, the socio-technical systems approach is perhaps most clearly aligned towards the theoretical, epistemological and axiomatic perspectives of Nicolescu and Max-Neef (for epistemologies for socio-technical HCI perspectives, see e.g., Abdelnour-Nocera & Clemmensen, 2019). The socio-technical systems approach focuses on interactions between technical systems and social systems, aiming to reach a common goal between these two (Bostrom & Heinen, 1977). In order to reach these common goals, it is imperative that the interactions between individuals and technology must be designed well (Mumford, 1983). The socio-technical HCI design focuses on innovative and balanced relations between users, tasks, technology, and organization and has less participatory focus, aiming at designing for organizational capacity, users, and management (Clemmensen, 2021). Some studies have taken the socio-technical HCI further, contrasting the fundamental attributes of usability with classical attributes of architectural design, and arguing that the very concept of usability could act as a mirror of the world (*speculum mundi*) which could be used as a useful lens through which the

impacts of interaction at all levels of socio-technical systems might be observed (Rajanen & Rajanen, 2020b). Therefore, it can be argued that socio-technical HCI as a field can be reflected on the three axioms of transdisciplinarity by Nicolescu (2000), having different layers of reality within the socio-technical context and observing dynamics of these interdependent and complex layers requiring crossing discipline boundaries, and that the relationship between these axioms and socio-technical HCI should be studied further.

Conversely, it can be argued that HCI education is currently leaning towards the polymath approach, aiming at giving the students a wide variety of skills, experiences and expertise to create a holistic understanding which the students can draw from in the future as HCI experts, and drawing from a wide variety of other disciplines, such as psychology, software engineering, information systems, cultural anthropology, game design, data science, business, management, and organization science, to name only a few. Furthermore, it has been argued that the interaction design practices in the HCI field have become more transdisciplinary, requiring a vast variety of skills and expertise, and while this multitude of perspectives to interaction design has potential to support creativity and produce novel design solutions, it can also hinder collaboration between practitioners with different backgrounds in terms of discipline and expertise (Pender & Lamas, 2018). This disconnect between transdisciplinarity theory and practice, where transdisciplinarity on the one hand promises innovative and good design, but on the other hand entails challenges in the very collaboration between different practitioners, poses a challenge for transdisciplinarity in HCI and should be studied further.

4. Conclusions

It can be argued that HCI as research and practice is by its history and by its nature very suitable for and oriented towards inter-, multi- and transdisciplinarity, as it 1) has different levels of analysis in human-technology interaction spanning from individuals to organizations and beyond into socio-technical contexts, 2) has a history of freely utilizing different theoretical perspectives, practices, and paradigms from other disciplines, 3) has been used in conjunction with other academic disciplines to study human-technology interaction, 4) has been crossing boundaries and contributing to other disciplines with its research and practice, and 5) has the design of human-technology interaction in its core, and therefore it is closely related to other design-oriented disciplines, learning from them and adapting their core concepts and paradigms.

For future research and challenges in transdisciplinary HCI, special attention should be paid on keeping the design at the very heart of HCI no matter if discipline boundaries are crossed, to use both axiomatic and polymath perspectives on transdisciplinarity in transdisciplinary HCI research and practice, and studying the effects of transdisciplinarity in design from communication and collaboration perspectives.

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