Living Lab

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Definition

The Living Lab(oratory) inspires as a notion, a setting, and a methodology encouraging participatory approaches to the co-production of knowledge for innovation and transformation. Etymologically, the term refers to a place or space for work and exertion (lat. *lăbor*) where things are made, prepared, or strived for (lat. *lăbōro*), and that is lively (lat. *vivus*) or alive (Lewis and Short 2020, 594, 1146). While alchemist Thomas Knight has been accredited with coining the term *Living Laboratory* in 1749 as a metaphor for the human body, the term eventually became used for research and open innovation processes in real-life or lifelike settings, initially in the context of psychological research on viewers' reactions to television commercials (Leminen and Westerlund 2019, 254). Nowadays, the diversity in projects, programs, and institutions called Living Lab indicates that "the term 'living lab' is at risk of becoming a buzzword in the innovation domain because it lacks a consistent or commonly accepted definition" (Leminen 2015, 29). While the range and amount of projects, programs, and institutions called Living Lab continue to increase, a number of characteristics commonly shared by Living Labs has been identified: (1) a transdisciplinary approach to research and knowledge creation; (2) an iterative, experimental design committed to learning and reflexivity; (3) a long-term orientation towards societal transformation and an accompanying interest in transferability or scalability; (4) a focus on a real-life environment (Compagnucci et al. 2021).

In 2015, the German term *Reallabor* (Real-world Laboratory) was coined to demarcate spaces for transdisciplinary real-life experimentation towards sustainability from the mostly technology-driven living labs (Schäpke et al. 2015). By now, both terms relate to a broad range of real-life experimentation in transdisciplinary settings but a rough distinction can be made between Living Labs focusing on the optimization and application or implementation of innovative technologies and Living Labs engaging non-academic actors in participatory processes for sustain-

ability transformations. Other commonly used terms for the later types of initiatives include Urban (Living) Lab or Transition Lab.

The focus on learning and iterative experimentation in all types of Living Labs suggests a recognition of the complexity characterizing the challenges that societies are currently facing. This complexity also poses a challenge to the educational system that is institutionalized and oftentimes remains organized by scientific disciplines. The remainder of this chapter examines opportunities for transdisciplinary learning garnered through the use of Living Labs for educational purposes.

Background

Historically, Living Labs have always been concerned with interaction – between individual actors, (potentially viewed as representatives of) relevant stakeholder groups, and certain stimuli, tests, experiments, or interventions in a particular setting. Since transformation has emerged as the order of the day and digitalization and sustainability are pursued with increased urgency, spaces for collaborative experimentation, learning, and development appear out of sheer necessity. In this context, Living Labs can function as an infrastructure (Schneidewind et al. 2018) for transdisciplinary experimentation towards societal transformation.

In the 1990s, Living Labs emerged in human–computer interaction research as physical places. Around the same time, Living Labs appeared as innovation spaces in the form of multi-stakeholder processes tackling complex problems in local settings (Leminen and Westerlund 2019, 254). This dual application and development of the concept continues until today. For instance, transformation researchers from diverse disciplinary backgrounds are co-designing Living Labs as catalysts for sustainable living, urban design or regional development in collaboration with local, regional, national, or international stakeholders (Hahne 2019; Matschoss et al. 2021). Likewise, IT specialists and engineers in academia, business, and industry, often supported by professional associations and policymakers, collaborate in Living Labs to improve human–computer interaction (Alavi et al. 2020) and other issues related to technological innovation. This type of Living Lab is primarily concerned with application, implementation, and marketization. Occasionally, for example on open days, it may be used for the purpose of science communication. In other words, the two most easily differentiable types of Living Lab are those addressing challenges pertaining to technological innovation to pave the way for wide-scale use, and those addressing societal challenges pertaining to sustainable development. Both types seek to explore possible future developmental pathways.

A significant part of the state-of-the-art literature on Living Labs is concerned with institutional, procedural, or methodological success factors (Bergmann et al. 2021) or with categorizing Living Labs based on literature reviews (Alavi et

al. 2020; Compagnucci et al. 2021; Hossain et al. 2019) or empirical research. Attempts at classifying empirical examples of Living Labs focus, for example, on research aims, varying degrees of transdisciplinarity and resulting stakeholder constellations (Backhaus et al. 2022) or on objectives such as "commercialisation (1), research (2), teaching and qualification (3), ideation (4), integration of societal actors (5) and sustainable development (6)" (Held et al. 2022, ii). Typically, Living Labs serve more than one objective.

Debate and criticism

Heralded as platforms for open and participatory innovation, Living Labs represent sites of power struggles between hegemonic incumbents and advocates of alternative strategies for technological innovation and social transformation (Stirling 2008, 264). Current debates revolve around the questions of how justice and fairness may be served and how democracy may be preserved or even strengthened through transdisciplinary research and learning. Criticism regarding insufficient participation and reflexivity recurringly erupts at familiar fault lines, many of which also run between scientific disciplines. Living Labs thus present opportunities for the transdisciplinary exploration of problems and participatory experimentation with solutions. Or they may provide the backdrop for practicing "solutionism" (Morozov 2014). Where a particular Living Lab falls on the spectrum between transdisciplinary learning, on the one end, and the pursuit of pathways predefined by select actors or groups, on the other, depends on procedural aspects (such as who is involved in decision-making, when and how) and on the social construction of boundaries around the stakeholders involved, problems addressed, and solutions considered. While some consider this an issue of innovation and expectation management, others view it as a fundamental issue in technology R&D and research policy (Grunwald 2019, 36–42).

Regarding different modes or levels of experimentation and participation, three important "tensions" have been observed in Living Labs, between "controlled experimentation vs. open co-creation; learning from failure vs. public demonstration of success; [and] local embedding vs. scalability" (Engels et al. 2019, 1). Notably, stories of prospective transferability and scalability that are frequently spun around Living Labs blend in well with a "politics of technology" that is preoccupied with "solutionism, experimentalism and future-oriented valuation" (Pfotenhauer et al. 2021). In other words, the significant increase in Living Lab activities and publications since 2015 (Hossain et al. 2019) may at least partially emerge from mission-oriented innovation governance.

Considering that Living Labs are viewed and established as experimental spaces of our collective futures, the dominant focus on technological fixes paired

with an ignorance of questions related to justice, plurality, and equality requires reflection and action. It has been argued that more participatory and pluralist approaches to understanding and addressing sustainability-related challenges would aid in delivering more rigorous and robust scientific findings and ameliorating democratic deficits (Böschen et al. 2021, 294–95).

Current forms of implementation in higher education

Increasingly, the Living Lab is also recognized as an infrastructure or institution for integrated inter- and transdisciplinary education. Aside from fostering students' personal and professional development with respect to conceptual and methodological learning objectives, Living Labs provide a setting for hands-on learning experiences, enabling and empowering students to acquire and advance "21st century skills" (World Economic Forum 2015, 3) and to lead on transformative change. Living Lab approaches – whether simulated or implemented – stimulate learning about system, target, and transformation knowledge (Pohl and Hirsch Hadorn 2021, 36). By encountering successes and setbacks in multi- or interdisciplinary teams, students profit from hands-on learning, receive more immediate feedback, and experience self-efficacy. Moreover, Living Labs can help deliver on the third-mission requirement of higher education institutions by providing a platform for encounters and exchanges with (local) societal stakeholders, including companies, public actors, and civil society . Since Living Labs emerge from particular goals, settings and actor constellations, there is no one-size-fits-all approach or single formula for success. However, countless examples from across the globe, albeit so far concentrated in the Global North, can serve as examples and provide some guidance and inspiration for setting up and operating educational Living Labs.

Since Living Labs first emerged in Europe and North America, it is not surprising that the concept has also spread furthest in these regions. To highlight the earlier noted richness of the concept and the various possibilities for application, institutionalization, and use, the first examples of current forms of implementation are all based at the same institution, RWTH Aachen University, the largest technical university in Germany. Recognizing the importance of transdisciplinary research and teaching, RWTH Aachen University and the Karlsruhe Institute of Technology both integrated Living Labs in their Excellence Strategies, which are funded by the German federal and state governments. At RWTH Aachen University, Living Labs that are exclusively or also used for teaching can be found across faculties and disciplines. Mirroring the dual meaning of the notion, a broad distinction can be made between those Living Labs addressing societal challenges related to sustainable development and those concerned with advancing digitalization and automation in business, industry, and society. The former include the

Büchel:Lab, which provided master's students of architecture and urban planning with the opportunity to develop concepts for temporary usage and participatory urban development for the redesign of an old town quarter (Digi-Sandbox. NRW 2023); the student-led Living Lab *nAChhaltig angezogen* (Sustainably dressed), which started as a graduate project seminar in sociology on the topic of sustainable fashion and has turned into a continuing initiative; the *Waldlabor Köln* (Forest Lab Cologne; Palm et al. 2023), which was set up by the City of Cologne to study the forest of the future, to enable students to test and evaluate design options in forest management, and more recently also to experiment with 3D printing technologies using wood mass, and the *project module "Green Blue Streets"* (lala.ruhr 2021), in which master's students in architecture and urban planning (and recently also students in transport engineering) developed design proposals for the water-sensitive transformation of an urban regeneration area in the city of Gelsenkirchen and presented the proposals to policymakers and other stakeholders. Two noteworthy examples of educational Living Labs addressing puzzles and problems pertaining to Industry 4.0 are the *Learning Factory "Textil vernetzt"* (Textile networked) operated by the Institute of Textile Technology as a real-life learning environment for students and professionals-in-training to address the challenges of the Internet of Things in manufacturing, and the *WIRKsam (Efficacious) Competence Centre*, which provides a collaborative space and develops a comprehensive set of training on the integration of Artificial Intelligence (AI) into industrial processes for industry professionals as well as graduate and undergraduate students from various disciplinary backgrounds such as computer science, sociology, engineering, and psychology (ifaa 2023). In addition, a simulation game which is offered as part of the master's programs in Sociology and Governance of Technology and Innovation challenges students to devise a Living Lab strategy for the Rhenish mining region, which, like many former mining areas, is undergoing large-scale, long-term structural changes. Through this game, students get a glimpse of the complexity of the issues and of what is at stake for the different actors involved.

Since Finland spearheaded the promotion of the notion in Europe, not least by initiating the founding of the European Network of Living Labs when holding the presidency of the European Council in 2006, it is also worth exploring current forms of implementation in higher education in the Finnish context. Laurea University of Applied Sciences, for example, has embraced the concept, running several Living Labs addressing various topics. The most recently set up *Laurea Circular Economy Living Lab* combines education, R&D, and regional development by providing educational modules and a networking space with regional partners for undergraduate students in Hospitality Management and Service Design to devise circular economy solutions (Laurea 2023). The *TAMK Catering Studio Living Lab*, concerned with sustainable food transformation, was created by Tampere University of Applied Sciences (TAMK 2023) as part of the EU project "Fostering

the Urban Food System transformation through Innovative Living Labs Implementation" (FUSILLI) in the new urban area of Hiedanranta, home to numerous sustainability Living Labs, allowing students to participate in grassroots city development and experiment with various ideas, including a business model for regenerative urban micro-farming. Still under construction but promising to provide an institutional and infrastructural home for multidisciplinary research, teaching, and learning, the *Hyytiälä Forestry Field Station Living Lab* comprises a sustainable, wooden building complex to study sustainability, the climate, and well-being in the built environment (University of Helsinki 2023).

Upon gaining a strong foothold in Europe's northwest, the success story of the Living Lab currently continues globally, suggesting that collaborative experimentation with innovative technologies and social innovations yields valuable insights and experiences – also for students. Cases in point are the *Virtual FabLab* (vFabLab 2022) at King Abdullah University of Science and Technology in Saudi Arabia, which provides a web-based state-of-the-art 3D gamified interactive virtual fabrication lab to train students and enthusiasts around the world in nanofabrication techniques including sputtering, atomic layer deposition, and more, in a safe-to-fail virtual environment; the *BELgrade urban living LAB* (Centar za eksperimente i urbane studije 2023), which was set-up as the first Urban Living Lab in Serbia and the Western Balkans to co-create solutions with citizens, the public sector, planning experts, and private companies; and the *Rijeka iLivingLab*, which comprises four labs (a Maritime Navigation, Safety and Security lab, a Logistics lab, an E-learning lab, and an E-government lab), focuses on the entire coastal region of the Republic of Croatia, and has trained over 2,500 students on a range of issues such as artificial intelligence, agriculture and agri-food, culture and creativity, energy, innovation, social inclusion, and (health and well-being in a maritime environment. ENoLL 2023a).

Some Living Labs are specifically set up to increase international and intercultural collaboration. Two examples are the *Living Lab field course*, which forms part of the ICP Connect master's program Sustainable Development at KU Leuven (2023) in Belgium, North-West University in South-Afrika, Vietnam National University and Pontifical Catholic University of Peru during which small teams of students from the Global North and Global South engage in intensive field research, ideally involving key stakeholders, to devise a strategy to address a sustainability challenge in a Global South context; and *LivingLab SHANGHAI*, based at the Sino-Finnish Centre at Tongji University in Shanghai, China, which collaborates with Aalto University in Helsinki, Finland to involve key stakeholders in the development, prototyping, and testing of technological solutions to complex sustainability challenges in megacities surrounded by low-resource surroundings (ENoLL 2023b).

An interesting subset of educational Living Labs engages in large-scale experimentation using the entire campus or – in collaboration with other stakeholders

– additional urban areas for Living Lab experimentation and education. Examples are the *Living Lab Tomsk* (LEVS 2021) in Russia, a network of Living Labs involving seven universities, ten academic institutes, the Tomsk Scientific Center, innovative companies and architectural bureaus, regional and city administrations, and European partners, allowing students to experiment at seven locations, each with a specific focus (public space design, smart greening, water management, smart management, dialog of generations, healthy lifestyle, multicultural environments, street art and creativity), and the *Learn–Live–Lead approach to sustainability of University of Galway*, which uses the campus buildings and estate as a Living Lab to promote sustainability scholarship, environmental stewardship, and global citizenship. Initial successes include the city council working with the university to form a sustainable energy community and, in 2021, *Decarbonization Zones* (areas with a goal of 51% reduction in GHG emissions by 2030) have been designated in the city and on campus (University of Galway 2023).

The collection of examples suggests that educational Living Labs can fulfill the triple role of enabling research and education while at the same time advancing the sustainability transformation of higher education institutions and their local or regional surroundings. As the long and varied history of the notion suggests, Living Labs can function as open spaces for collaborative experimentation beyond disciplinary and social boundaries and offer learning opportunities for every participating individual and (stakeholder) group. Crucially, students' ideas and perspectives also enrich and diversify research and experimentation in Living Labs in novel ways. As an important transformative impulse, the experience, expertise, and in some cases entrepreneurial mindset acquired by students through the use of Living Labs for educational purposes helps transfuse transdisciplinary experimental research and practices into society.

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