

Learning in Unbounded Landscapes— Conceptualizations and Design From an Ecological Perspective

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Abstract: The symposium seeks to advance an understanding of learning from an ecological perspective. The abundance of digital technologies and rapid changes in knowledge domains generate new epistemic and learning practices, drawing on heterogeneous sets of resources, actors, and forms of knowledge. Consequently, learners must navigate complex and unstructured landscapes to gather resources and structure activities. Little is known about these processes and how they can be studied and enhanced. This symposium argues for the necessity of a paradigmatic shift towards an ‘ecological understanding’ of learning, which takes into account the enactment of the learning ‘act’, the knowledge forms, contexts, relationships, digital technologies and infrastructures that shape learning practices in unbound landscapes. The four contributions in this symposium use empirical illustrations to build an argument leading towards a new learning research and design agenda. These contributions are complementary as they pinpoint practices students, teachers and institutions engage with in this unbounded landscape.

General abstract

The educational landscape is swiftly transforming in the digital age. Established boundaries between educational institutions, industry, the public sector and private vendors become blurred. New epistemic practices emerge, that transcend traditional modes of learning and teaching, drawing on heterogeneous sets of resources, actors, and forms of knowledge. Learning is no longer viewed as the mastering of a given subject, but involves partaking in epistemic processes across a variety of contexts and the ability to connect to remote knowledge resources, communities and sites no longer bound to one particular physical, cultural, or disciplinary context (Akkerman & Baker, 2018; Carvalho & Goodyear, 2015). In this context, new forms of learning are emerging at the crossroads between formal education settings and other contexts (e.g., professional, personal, social). Such transformations require students deliberate efforts to navigate this complex landscape. Understanding this complex and emergent process requires a new perspective on learning, that is, an ecological perspective (Damsa & Jornet, 2017).

An ecological perspective on learning fills the need for an account that adequately describes the intellectual, social, and relational trajectories involved in moving across such contexts’ boundaries (Akkerman & Baker, 2018). Navigating these settings and assembling resources through which individual or collective intellectual goals, needs, and development are addressed by capitalizing on domain knowledge, instruction, resources, and/or infrastructure becomes key (Damsa, Nerland & Andreadakis, 2019; Yeoman & Ashmore, 2018). This implies a view of learning as not only shared and collective process but also as distributed across contexts and materials. The complex landscapes emerging as a consequence of these combination of factors, actors and enhanced connectivity has been framed through the notion of learning ecologies, “a collection of overlapping (virtual) communities of interest, cross-pollinating each other, constantly evolving, and largely self-organizing” (Brown, 2002, p. 63). These are seen to comprise digital, spatial, social, cultural, and knowledge resources and infrastructures the students use during their study work (Akkerman & Baker, 2018; Barron, 2006). The emergence of these ecologies, which transcend the boundaries of established educational institutions, calls into question established notions of a learning, teaching, design and educational structures, and generates challenges for learners, educators and educational institutions alike (e.g. Richter & Allert, 2019). Consequently, there is clear need for a closer look at the ways and epistemic, social, technological, and institutional conditions under which these learning ecologies unfold.

There has been a longstanding interest in learning sciences research in conceptualizations, models pedagogical and technological means that allow for new forms of learning and epistemic engagement that transcend institutional, disciplinary, social, cultural, and technical boundaries. There is also a strong inclination

to still frame and justify these efforts from the perspective of the formal curriculum or learning achievements. As a result, comparatively little emphasis has been placed on the social, cultural, and political implications an ecological perspective on learning would have. In a similar vein, there has also been a considerable interest in the development of learning environments (e.g. Hod, 2017; Kali, McKenney, & Sagy, 2015; Wilson et al., 2007), community-based learning scenarios (e.g. Fischer, Rohde, & Wulf, 2007), or Massive Open Online Courses (e.g. Jeong, Cress, Moskaliuk, & Kimmerle, 2017). However, efforts towards the development of tailorable learning environments pay little attention to the underlying ecological processes and structures supporting these, that is, how knowledge and resources are accessed and worked with, ideas and attitudes are developed and practices are enacted across contextual boundaries and connectivity, in a sustainable way.

The work discussed in this symposium is based on the recognition that learning is a process that involves partaking in epistemic practices across a variety of contexts, the ability to (employ tools in order to) connect to remote knowledge resources, communities and ‘unbounded’ contexts. The symposium starts from the premise that an emergence of learning ecologies that reach beyond institutional boundaries, mobilize new resources and advance new practices of learning and knowledge creation requires an in-depth inquiry into the mechanisms and procedures through which these (volatile) learning ecologies are formed, shaped and eventually sustained. It also assumes that such processes are strongly influenced by affordances offered by the state-of-the-art knowledge, practices and digital technologies, but also by the students, teachers and other stakeholders’ views and actions in relation to these. The symposium engages with critically examining learning *design* in relation to the need, and possible solutions, for designs that take into account learning that emerges in wider ecologies than those framed by formal curricula. In relation to the themes of *teaching, learning and identity*, the symposium examines practices emphasizing a change from traditional ways of conceptualizing these to a more contemporary, ecological framework that builds on interdisciplinary inputs. In addition, *scale* is represented by including the social, relational, technological or digital-material elements as a natural part of a sustainable perspective and approach intended to support learning beyond formal education institutions’ boundaries (Bang & Marin, 2015; Jurrow & Shea, 2015).

The contributions in this symposium approach the notion of learning ecologies from four complementary perspectives, aiming to pinpoint challenges that students, teachers and institutions are facing in light of an increasingly unbounded educational landscape. The first contribution (Damşa and Andreadakis) takes an analytical look at the role of digital technologies and the formation of learning ecologies from a students’ perspective, by tracing and discussing the way students negotiate and articulate their learning processes. The second contribution (Markauskaite, Arthars and Spence) adopts the ecological perspective of ‘niche construction’ to look at how students co-construct their environments for joint knowledge work. The third contribution by Cerratto Pargman focuses on the notion of learning ecologies from a teachers’ perspective, providing an analytic look of digital educational technologies as epistemic infrastructures. Finally, the fourth contribution (Richter and Allert) outlines a critical design agenda for an ecological perspective on learning, pointing towards new fields of design, research, and technological development for computer-supported collaborative learning.

The overall aim of the symposium is to contribute a research agenda that focuses on how students/learners navigate existing learning ecologies, how they employ digital technologies to create and pursue learning opportunities in extended learning ecologies, and how teachers and learning designs play a role in and (can) facilitate such endeavors. Towards this end, the symposium will:

- (a) explore the epistemic, pedagogical, technological, and institutional challenges learners, teachers and institutions are confronted in unbounded educational landscapes,
- (b) suggest a paradigmatic shift towards an ‘ecological understanding’ of learning, teaching and design practices that constitute our educational efforts, and
- (c) outline new routes of research as well as technical and pedagogical design within the field of learning sciences.

Exploring students’ ecologies of digital resources in higher education

Crina Damşa and Zacharias Andreadakis

This contribution sets out to explore the role of digital technologies in the emerging learning practices of higher education students. It poses one fundamental question: how do students of higher education navigate, in practice, within their digital educational landscapes? It takes an ecological perspective on the learning process, wherein the centrality of the students, and their enactment of the learning act, represents the phenomenon in focus.

The mainstream research in the field of higher education takes a rather normative position on the learning phenomenon, by striving mainly to generate knowledge about outcomes, rather than account for the students’

multitude of engagements and experiences with learning situations (and technologies used by students). Notably, some of these engagement and experience take place also outside the 'designed' institutionalized learning environments, such as colleges, universities, etc. At the same time, this type of situations requires students to navigate complex knowledge-laden environments, and employ digital-material resources by assembling what Luckin describes as an *ecology of resources*, 'a set of interrelated resources, including people and objects, the interactions between which provide a particular context.' (2008, p. 4). In such contexts, learning involves an effort to 'assemble a learning space' (Markauskaite & Goodyear, 2017), in which individual or collective learning goals and needs are addressed by capitalizing on domain conceptual and practical knowledge, instruction, digital-material resources. Students face the challenges of the constant (and fast) changes in the domain knowledge, the increasingly versatile technologies that generate new opportunities and challenges at the same time, not all studied extensively. The literature (e.g., Akkerman & Baker, 2018; Damşa, Nerland, & Andreadakis, 2017) identifies a clear need for further understanding of: a) the way sustained (technology-mediated) engagement by the students, with resources, peers, distributed knowledge and sites, emerges; b) how students make sense of the various resources use them for learning; and c) how hybrid, multiple tool-based environments, constitute varied contexts for learning.

The battlelines in educational technologies have frequently been drawn along two salient views of learning where digital technology is involved. First, there is the perception that digital learning is an instrumental force. In this line of research, digital learning is a mediating lens, which simplifies and accelerates access to knowledge, affording students with agency and control over their learning ends (e.g., Henderson et al. 2017). Second, there is the view that digital learning conditions and transforms the process of learning *per se*. Digital learning, according to this school of thought, is a non-linear, iterative exercise in rational conflict (Damşa & Jornet, 2017; Luckin, 2008; Säljö, 2010), challenging the student's sense of learning closure. Our approach takes its conceptual vantage point from a host of socio-material perspectives that have recently gained momentum in the field of educational sciences, tentatively dubbed as "ecologies of learning" (Barron 2006; Damşa & Jornet, 2017; Luckin, 2008). This approach maintains that learning is a transformational phenomenon that influences the learner holistically (i.e. on an intellectual, practical, and affective level), and interactively (i.e. in defiance of reified divisions between agentic subjects and material objects).

To pursue this line of inquiry, our contribution ramifies into two explorative strands. First, we offer a bird's eye view on the bibliographic landscape over the past 15 years. Specifically, we present our review of the trends of published scholarship around the issue of digital learning from higher education student, as featuring in the most prominent journals of the educational field. In this way, we seek to outline the field by means of a consistent and synoptic method, while casting light on a rather underexplored issue, namely, the argumentative assumptions that undergird the debate thus far.

The second strand that this presentation explores is empirical. Based on the lynchpin of empirical data drawn from our preliminary qualitative findings, we seek to parse whether students' construal of the use of digital tools lends itself to identifiable patterns of engagement in an unbound learning landscape. In this way, we try to see how students negotiate and articulate their own learning strategies, in conjunction to the broader learning environments and digital resources at their disposal. The data set employed in these analyses was collected in a Norwegian higher education context, in a large research-intensive university that recently implemented a new learning management system. An exploratory/pilot study was set up to map and interpret students' use of digital technologies related to their study work and learning activities, in courses within four study programs (Informatics, Philosophy, Educational Sciences and Teacher Education). A survey was applied to 120 students, five focus group interviews were collected, and course structures and activities were observed in relation to students learning activities where digital technology was used. In addition, a mini-ethnography session was organized with four students, in which their learning habits and activities, and use of digital tools were mapped along a temporal trajectory. The analysis consisted of descriptive statistics of survey data, thematic analysis of interviews and a qualitative content and pattern analysis of the micro-ethnographic data. As a further corollary of our analysis, we attempt to come to grips with the ways in which digital technologies infuse the students' critical engagement with learning activities of interest and reflection on choices made to certain courses of action (Gilovich et al. 2002).

We envision this contribution as a way to foster the debate of learning ecologies, by critically engaging with broader agendas that shift focus toward students' enactment of learning in a broader context that only the curricular one. Ultimately, this exploratory study seeks to amplify the present debate on educational and technological design by offering an early attempt towards an empirically grounded and rigorous account of the digital learning modalities of students in higher education. In its full consequence, this study will also probe into the practical role that digital learning can perform for informing the debate of sustainable learning environments (see Rowe, 2007).

How students co-construct epistemic niches for joint knowledge work

Lina Markauskaite, Natasha Arthars, and Natalie Spence

Educational research and design increasingly embrace the ecological perspectives of human development, cognition and learning (Bronfenbrenner, 1994; Hutchins, 2010; Jackson, 2016). These perspectives focus on a dynamic coupling between personal resources of numerous agents and their cultural, material and social environments. They see learning—as well as other human intellectual activities—as a process during which both agents and their environments are transformed. However, much of educational research and practices still tend to concentrate on a one-way relationship: how to design ecological environments for students' learning (Barnett, 2017). The feedback loop—how students modify their environments for productive learning—receives much less attention. Even those who focus on the latter relationship, often concentrate on 'individual's learning ecologies' (Jackson, 2016). Collective learning ecologies—how students *co-construct* their environments for joint learning—tends to be overlooked (Markauskaite & Goodyear, 2017).

As the proponents of the ecological perspectives have argued, many living organisms do not just adapt to their encountered environments, they also intervene in the environment and shape it in ways that improve their adaptive fit: living organisms co-construct ecological niches which they co-inhabit (Sterelny, 2010). Similarly, humans modify their environments to support activities that they need to carry out (Clark, 2011; Sterelny, 2010). Further, many complex human activities depend not only on an agent's capacity to intervene in the environment directly by adapting it to their immediate action but also on the capacity to intervene in this environment in a way that enhances their intellectual capacities to carry out activities effectively. That is, humans construct epistemic niches that enhance their learning and knowing. They often do this together with others. As Sterelny (2017) argues:

[A]gents' capacities to carry through temporally deep, intricate, and demanding planned activity does not depend on their internal cognitive resources alone, let alone their genetically entrenched internal cognitive resources. It depends as well on whether these groups and individuals have learned techniques of adapting their workspace to reduce the cognitive demands on individuals, and on the extent to which they have developed techniques of working together in efficient and mutually encouraging ways (p. 241).

Thus, the capacity to co-construct joint epistemic niches that allow agents to carry on such work successfully tends to be vital. This perspective emphasizes the critical role of epistemic agency—the ability to change the informational character of the environment—in enhancing adaptive fit among agents, and between agents and their environments (Fabry, 2018; Sterelny, 2004). How students co-construct epistemic niches when they engage in collaborative knowledge tasks, and what kind of agency they exercise, however, have received little attention.

In this paper, we draw on the ethnographic case studies of 11 groups of undergraduate and postgraduate students (3-5 students each) from education, engineering, business and interdisciplinary courses in which students worked over prolonged periods (4-13 weeks) on diverse projects which required them to develop a solution for a complex problem (e.g., a plan for modernizing a village). We focused on identifying the main ways in which students co-constructed their environments for joint knowledge work, particularly how they carved epistemic niches for joint learning and the emergence of new ideas. Our initial analysis shows that students proactively shaped the informational character of their joint environments by making diverse alterations. Some of these alterations sustained for the duration of the whole project, others were made for a specific task. Examples included:

- Creation of joint online spaces for sharing findings of individual inquiries and, over time, accumulating a fertile knowledge 'heap' for producing a final knowledge artefact (e.g., a shared GoogleDoc).
- Establishment of coordination channels for building joint awareness about progress and coordination of inter-dependent knowledge and functional tasks (e.g., Slack or Facebook group).
- Construction of synthesizing objects, where one team member created an interim artefact drawing on ideas of others (e.g., a sketch of a storyline) which gave a concrete ground for further joint elaboration.
- Construction of representational schemes for creating joint symbolic artefacts, such as deciding about the semantic meaning of colors and lines in constructing a joint systems map.
- Use of metaphors, similes, embodied demonstrations, drawings and other 'folk' teaching methods for explaining to each other complex ideas and blending knowledge resources available for individual team members into a joint solution.

Some of students' alterations in their environment only loosely shaped students' epistemic actions and forms of knowledge (e.g., a shared online document for 'dumping' individual findings). However, some other

alterations imposed significant epistemic constraints (e.g., an online tool for creating a timeline) and were tightly constrained by the form of specific knowledge that students brought to the shared space (e.g., disciplinary concepts, personal experience). Overall, students had a rich repertoire of personal epistemic resources that enabled them to co-construct and work within shared epistemic niches. However, many of these epistemic resources were often enacted intuitively evidencing their weak epistemic agency. Only occasionally students demonstrated their meta-epistemic awareness about the need to construct or alter their environment when it did not function well. Lack of meta-awareness and articulated ‘know how’ for shaping the joint environment was a noticeable impediment, resulting in misunderstandings and minimal cross-fertilization of ideas.

Professional Learning Ecologies as Epistemic Infrastructures

Teresa Cerratto Pargman

This presentation engages with the construct of learning ecologies from the teachers’ perspective. More precisely, teachers are considered learners who, in their experimentation with learning management platforms, digital data, knowledge resources, policy documents and assessment criteria learn to participate in linkages made of both materials and actors. By participating in these arrangements, teachers actively configure professional learning ecologies that play a central role in the development of professional knowledge, practice and identity (Damaşa & Jornet, 2016). Here, we pay special attention to those sociotechnical arrangements by considering their constituents as relational entities and not as things. As such, we focus on the *relations* that make possible the emergence of professional learning ecologies.

Approaching learning ecologies by using a lens focused on their inherent relationships is concomitant with a *relational mode of thinking* on educational practice. According to Decuyper & Simons (2016) the *relational mode of thinking* differs from *representational modes of thinking*. The latter has a tendency to analyze educational practice by separating the human dimensions from their material conditions. In contrast, the relational mode of thinking focuses on the relational composition of practices bound to digital technologies. Taking a relational stance on professional learning ecologies invites us to concentrate on “how humans and things come to be or how they become as effects of the arrangements in which they are entangled” (Sørensen, 2009, p. 13). It also entices us to debate on the relative position that each entity in such ecologies assumes in a web of relations at a specific time and in a specific context. A corollary of this is that student data, for example, only becomes important and valued if and when it succeeds in forming alliances with other entities such as documents, staff, discourse, policy regulations, algorithms, data aggregations techniques etc. Approaching the teaching practices that are associated to data and analytics of digital data, as assemblages constantly emerging brings us to consider professional learning ecologies in a broader sense; namely as constituents of *professional epistemic infrastructures* (Markauskaite & Goodyear, 2017).

The term *infrastructure*, coined by Star and Ruhleder (1994), posits infrastructure as a relational concept consisting of both human social practices and digital technologies. Such a conceptual consideration seeks to challenge the common association of infrastructure to technology artefact. Grounded in this understanding, *professional epistemic infrastructures* consist of both i-constellations of tools, digital data and technologies, and ii-professional practices embodying professional ways of knowing and doing as well as forms of professional knowledge. We bring infrastructure into this discussion because we claim it is complementary to learning ecologies. Infrastructure puts emphasis not only on individual and collective levels of teaching practice but also it accounts for a multiplicity of relations between an array of stakeholders (e.g. government, national agency for education, institutional leadership, industry, politics, researchers, designers, teachers, managers, learners) which configure and give shape to educational terrains. By discussing here professional epistemic infrastructures from the example of data-driven education, we aim to illustrate that professional learning ecologies do not engage with digital data and analytics in a vacuum. They rather engage with them via the value these entities get in the web of relationships between materials (e.g., data, technologies, documents, policy document, rhetoric etc.) and professional practices. As such, professional learning ecologies contribute to fortify or weaken relationships in the epistemic infrastructures they are part of. By doing so, teachers’ ways of knowing and doing, at an individual and collective level, are shaped not by the digital technologies or data in question but by the sociomaterial relations in which such technologies and data take part. It is within these relations that account for economic, political and cultural forces at work that the teachers weave their learning ecologies. In this context, it is important to ask how do teachers configure and shape their learning ecologies? With the growing “datafication” going on at universities, which type of professional epistemic infrastructure is thus in the making? With the increasing interest in data-driven practices in higher education, what are teachers professional ways of knowing and doing? How are such epistemic, pedagogical and even institutional changes reflected in the teachers’ learning ecologies? How do the data generated by teachers and students whilst configuring their learning ecologies contribute to such changes?

From a relational stance, digital data is an evolving entity that constitutes current professional epistemic infrastructures. Embedded in such infrastructure digital data does not mediate but compose professional learning ecologies. The relational place that digital data is given in current sociomaterial assemblages shapes and configures the purpose, breadth and depth of teachers' learning ecologies and more precisely, the teachers' epistemic practices and ways of performing knowledge at the university. Understanding deeply how teachers and students entangle their work through digital data in epistemic infrastructures is crucial to start unpacking the economic, political, and cultural facets of learning ecologies in the digital age.

Design Issues for Learning Ecologies in Unbounded Educational Landscapes

Christoph Richter and Heidrun Allert

While an ecological perspective on learning echoes in new strands of research and development for computer-supported collaborative learning, the pedagogical and technical design issues associated with these developments are frequently approached from an instrumental perspective only. The availability of new technologies, networked knowledge artifacts, and human resources are primarily seen as means to improve learning outcomes and to ensure that students become sufficiently skilled knowledge workers. Yet, such an instrumental perspective does neither account for the cultural dimension of education and knowledge work, nor does it advance a critical understanding of the challenges, students are facing when trying to develop their own learning ecologies. Against this background, we will argue, that in order to leverage an ecological perspective on learning and to become serious about learners as agentic actors pursuing their own epistemic projects, we need to take a critical stance towards our educational design efforts (cf. Richter & Allert, 2017). Education as argued by Alkemeyer and Buschmann (2017, p.22) thereby essentially refers to those processes of enablement 'in which subjectivity comes into being, which allows for people to realize situationally emerging potentials that transcend the given structures of reality'. As a consequence, we also have to reconsider our role as educators, technologists, and researchers in order to advance educational formats and technologies capable to support learners engaged in epistemic endeavors that reach beyond and cut through established boundaries and address them as responsible citizens.

To point out the kind of questions and design issues we are facing when pursuing this agenda, we will draw on two ongoing research and development projects that target new forms of epistemic engagement in a collaborative environment. While the first project is based on a participatory research agenda aimed to engage citizens of different age groups in an auto-ethnographic inquiry into their own cultural and aesthetic practices, the second project is aimed to foster crowd-based research activities on sustainability among students in higher education. Despite the different subjects, educational formats, and target populations, both projects can be seen as attempts to enrich the participants' learning ecologies, by introducing new technical, social, cultural and epistemic resources, as well as to transcend institutional, disciplinary, and physical boundaries. Looking at these projects not as affirmative but as transgressive endeavors (cf. Bardzell & Bardzell, 2013) aimed to explore into new epistemic and educational formats and relations, there are four major design issues we deem particularly relevant. These issues can be understood as a critical take on the epistemic, pragmatic, social as well as reflective types of mediation identified by Paavola, Engeström and Hakkarainen (2012):

(1) *epistemic mediation*: the rules, conventions, and normative commitments that are constitutive for the contexts we are acting in and designing for. It refers to the "ways of knowing that are taken to be legitimate, consequential, worthy of discussion, and useful for justifying actions by people engaged in accomplishing some concerted task" (Suchman 2002, 142). While formal education is strongly driven by disciplinary bodies of knowledge, as well as specific knowledge practices and methodologies, these might be of little relevance if we leave the realm of academic institutions. In our current projects we are facing a multitude of new and alternative knowledge practices, including new forms of crowd-based investigation, activist and collective artistic research, as well as new tribes of (auto-)biographic and (auto-)ethnographic inquiry. If our intent is to support learning ecologies that transcend institutional and disciplinary boundaries, we hence have to develop new sensitivities to the polyphony of epistemic practices not only within but also outside of academia and find ways to accommodate for different epistemic forms and games.

(2) *pragmatic mediation*: organization, coordination, and orchestration. It entails the mechanisms that grant or restrict access, to technical, social, cultural, and epistemic resources. While a focus on personal learning ecologies implies a shift from institutionalized to more decentralized modes of collaboration, it requires us to reconsider the ways in which students' learning ecologies are implicated in social and technical systems and therefore are subject to respective forms of governance and politics (cf. Knox, 2013). For example, aiming to provide students and citizens with a technological infrastructure that allows them to pursue their own (collective) epistemic interests, raises profound questions of authorship, intellectual property rights, the interoperability with other systems, the sustained availability of the resources and technologies provided, as well as the extent to which

the resources can be reused and repurposed. Hence, there is a need to think not only about particular resources and technologies, but also the social, legal, and technical protocols, standards, and infrastructures in which these ecologies take shape (cf. Mansour et al., 2016).

(3) *social mediation*: the seeding and cultivation of social relations and networks in support of the learner's epistemic efforts. Locating learning not within the formats of educational institutions, but striving for more inclusive and networked forms of learning does not simply enrich set of (social) resources, but also entails a shift in power-relations. Such a shift is not a unidirectional effort of empowerment, but a highly dynamic and reflexive process. This holds for the relations between the learners and the educational institutions, as well as the relations between the actors involved. For example, asking citizens to take part in a research project as knowledgeable experts of their own cultural practices challenges established role-models, social expectations, and commitments. Similarly, asking students to actively contribute to research on sustainability interferes with established or emerging forms of scientific and public discourse.

(4) *reflective mediation*: the reflection, evaluation and advancement of collective knowledge practices. It refers to the question of the (educational) outcomes that are actually deemed desirable and worthwhile, and the ways in which the respective aims are negotiated and established. While from an institutional perspective the desirability of outcomes is usually determined by curricula or other educational policies, these are not necessarily relevant to or in line with the aspirations of the learners involved. For example, citizens' inquiries into their own cultural practices, or students' research into sustainability issues might be driven by their own curiosity or their ambition to solve a particular problem rather than by pre-established learning goals. If we are serious about learners as deliberate actors and citizens, desired outcomes cannot be pre-defined by educational institutions alone, but there is a need for mechanisms that allow for the articulation and negotiation of (common) concerns and the kind of outcomes they deem worthwhile and desirable.

While our concern for these four issues is grounded in our current projects, we believe that they might form a starting point for a critical design agenda in the Learning Sciences. Related issues have popped up recurrently among the members of this community, but there has been no systematic debate on their wider pedagogical, societal, political, and technical implications. This is an attempt to broaden the discourse and enter into new strands of design, research, and technological development, to foster the advancement of sustainable learning ecologies.

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