Chapter 6
Artefacts and Activities in the Analysis of Learning Networks

Peter Goodyear, Lucila Carvalho, and Nina Bonderup Dohn

Introduction

The main aim of this chapter is to help people who design for networked learning reflect on their ways of thinking about connections between learning activity and the physical world (places, tools and other artefacts etc., digital, material and hybrid). The empirical work informing this chapter is part of a 5-year programme of research into the architecture of learning networks (Carvalho & Goodyear, 2014; Carvalho, Goodyear, & De Laat, 2016; Goodyear & Carvalho, 2013).

Underpinning our approach is the view that *learning networks* are worthy of research in their own right—taking their place as researchable phenomena alongside more familiar topics like learner experiences, learning outcomes, pedagogy, moderation strategies, etc. We take a learning network to be a heterogeneous assemblage of people and things connected in activities that have learning as an explicit goal or as a significant side effect. Coherence among the activities helps resolve the learning agenda of the network, which, in turn, helps trace the limits of the network. As Jones (2004) has pointed out, calling something a network can be seen as bringing the network into being. We agree that calling something a network is an analytic choice. It entails a claim that—for certain sets of research purposes—it is helpful to see something as taking the form of a network, rather than a hierarchy, or a community, or a space or a set of market relations. But, in our view, once some aspects

P. Goodyear (✉) • L. Carvalho
Centre for Research on Computer Supported Learning and Cognition, Faculty of Education and Social Work, University of Sydney, Sydney, NSW, Australia
e-mail: peter.goodyear@sydney.edu.au; lucila.carvalho@sydney.edu.au

N.B. Dohn
Department of Design and Communication, University of Southern Denmark, Copenhagen, Denmark
e-mail: nina@sdu.dk

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of a network have been labelled, many of its other characteristics are real rather than arbitrary. (For example, once one defines what constitutes a link between nodes in a network, one cannot arbitrarily prune the network.) Seeing something as a network necessarily focuses on node-link structures, foregrounding connectivity and topology and backgrounding such things as spatial relations.

Our approach to analysing learning networks is driven by a commitment to identifying reusable design ideas. In other words, our main goal is to understand how existing learning networks function, in order to inform the design practice of people who help learning networks to flourish. A commitment to generating knowledge that can be useful in design means having a sharp eye for what *can* be designed, and what is necessarily emergent (Goodyear, 2000, 2005; Goodyear & Dimitriadis, 2013). We find that it is useful to focus on five main aspects of learning networks: learning outcomes, learning activities, tasks, physical settings and divisions of labour (Goodyear & Carvalho, 2014). The last three of these are (partially) designable; the first two are emergent. The influence of the physical setting (digital and material) on learning activity is often important, but is under-researched and under-theorised: it is often taken for granted. Yet designers need to have some principles, or at least some rules of thumb, to link the physical setting to learning activity. In other words, the design vocabulary for networked learning needs to include a number of terms that can connect the qualities of a learning place, and/or tools, artefacts and other kinds of physical things, to intended learning activities: to suggest what needs to "come to hand" for the activity to proceed successfully. The idea of "affordance" is one such term, but it is quite rightly contested and is insufficient on its own (Dohn, 2009).

Every learning network has an architecture, in which structural relations can be traced, at a number of scale levels, between designable elements and emergent activities and outcomes (Carvalho & Goodyear, 2014, esp. Chapters 1–3 and 16). In other words, (a) any individual activity holds together, and is shaped by, an assemblage of task (epistemic), physical and social entities, and (b) these entities are often nested (e.g. tasks have sub-tasks, places contain tools, etc.). The knowledge needed for design includes understanding the possibilities and constraints held in connections between physical things and physical things (T-T), human beings and human beings (H-H) and human beings and physical things (H-T) (Hodder, 2012; Yeoman & Carvalho, 2014). This is in addition to understanding such matters as the experience of learning and connections between learning activities and likely outcomes (the classic domain of learning theory). Some construals of the world (ontologies) are good for explaining and predicting T-T relations; others are better for understanding human experience and H-H relations. Our focus in this chapter is on H-T relations, but we also comment on whether and how designers can work with multiple, apparently contradictory, ontologies. It turns out that while dualist ontologies (which deal separately with the human and the physical) can be useful in understanding T-T and H-H, they struggle with H-T. To understand the implications of connections between humans and things (H-T), one needs a relational rather than a

dualist ontology: for example, an affordance of a thing for a person depends on qualities of the thing relative to capabilities of the person (skills, perceptual acuity, etc.).

Creating richer understandings of the relations between physical things and human activity is a core concern for social science researchers interested in materials and materiality: notably, researchers involved in archaeology and anthropology (see e.g. Boivin, 2008; Hodder, 2012; Ingold, 2011; Malafouris, 2013; Miller, 2010). "Digital things" are not well covered in most of this literature, and since some of the attributes of (tangible) material things do not apply to non-material technological things, such as software (Faulkner & Runde, 2011), we use the term "physical" to include both the material and the digital. There is some work that speaks from this broad position to address the use of digital technologies: e.g. Suchman (2007), Orlikowski (2007) and Leonardi, Nardi, and Kallinikos (2012). Sorensen (2009) and Johri (2011) provide introductions to materialist perspectives in educational technology, and Fenwick, Edwards, and Sawchuk (2011) offer such a treatment for education more generally. The elements sketched above also draw on aspects of activity theory (e.g. Engestrom, Miettinen, & Punamaki, 1999), though a limitation of activity theory for the work at hand is that it is strangely uninterested in tracing the implications of qualitative differences in materials.

Design for Networked Learning

Much of the networked learning literature about teaching focuses on teaching as a facilitation or moderation activity (Feenberg, 1987; Mason & Kaye, 1989; Salmon, 2000). We are particularly interested in a complementary, upstream and relatively neglected aspect of teaching—*teaching as design*: the kind of educational work that sets things in place prior to a learning activity. It is thoughtful, creative, time-consuming work that entails solving complex problems and balancing (or resolving tensions between) multiple competing demands. Amongst other things, this needs a repertoire of explicit design constructs to link design decisions to intended learning activities and outcomes (Conole, 2013; Goodyear, 2005; Goodyear & Dimitriadis, 2013; Goodyear & Retalis, 2010; Laurillard, 2012). Investing time in design pays better returns for the teacher (and learners) than having subsequently to spend time animating, repairing and redirecting activities. A provocative question, worth asking at this point, is whether it is actually possible to design for someone else's learning. From where can a teacher-as-designer gain some confidence that what they help set in place is likely to have a beneficial effect on what learners subsequently do? What kinds of knowledge can they draw upon to connect designable things to valued learning? If designers cannot provide a structured argument that connects the outputs of their design work to desired learning activities and outcomes, how can they defend what they do?

Connecting Design Ideas

We want to capture some of the ways in which design for networked learning can position itself as a worthwhile, intellectually defensible activity. This involves delimiting what can be designed and identifying some of the analytical connectors that can be used by teacher-designers to think about links between what they design and what learners are likely to do. In short, we want to identify some of the intellectual resources that can be used in creating design rationales—articulating what has been termed the logic of designs (Nash, Plugge, & Eurelings, 2000; Sandoval, 2014). Placing the knowledge needs of the teacher-designer centre stage also creates a useful hook on which to hang research-based ideas, and indeed can help orient and motivate future research. What can be designed, and what cannot? Are these designable things all of one kind, or is a taxonomy needed? In what ways do people (learners) respond to designed things, of various kinds—what types of *connectors* can provide the analytical structure for a design rationale and/or for design thinking? (Overdijk, Diggelen, Kirschner, & Baker, 2012).

In earlier work, we have shown that a distinction needs to be drawn between learner's *activities* (what they actually do) and the *tasks* that are set for them (Goodyear, 2000). The labels are not important, but acknowledging the likelihood of slippage between the task as set and the actual activity is vital. Teachers usually want learners to exercise some autonomy and creativity in responding to the tasks they are set. This allows them to customise a task to suit their own needs and interests, and provides an opportunity for them to strengthen their self-regulation skills. Unless learning is very closely supervised and directed (which it rarely is), there will usually be some slippage between task and activity, for good and bad reasons. This is important to acknowledge, when designing, because what people learn is a consequence of their actual activity, and therefore only *indirectly* a result of the task set for them (see Fig. 6.1).

Tasks are designable, activities are not—they are emergent. In addition to tasks, there are two other major design components, reflecting the fact that learning activity is both socially and physically situated (Lave & Wenger, 1991; Sawyer & Greeno, 2009). We do not have room here to talk about social design (H-H: assigning roles, divisions of labour etc.), so we turn directly to the physical setting (H-T and T-T). This third design component includes digital, non-digital (material) and hybrid entities. Design entails thinking about the kinds of learning places, tools and other resources that students are likely to find helpful, for any particular task, while recognising that students may not follow the recommendations inscribed in designs. They will often make their own choices about tools to use, where to work, what to read, etc.

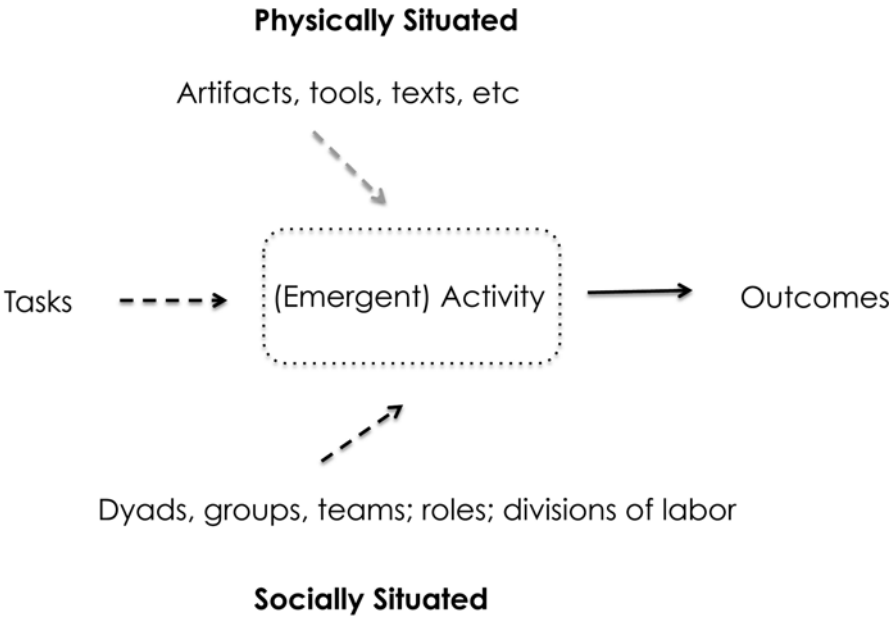

Fig. 6.1 Activity as physically, socially and epistemically situated (adapted from Goodyear & Carvalho, 2014: 59)

Expansive Conceptions of Learning Networks

Like many researchers in the networked learning field, we have a broad understanding of "learning"—one which does not restrict the definition to formal education courses and which also embraces informal, self-directed, vocational and/or interest-based learning, as well as learning that occurs as a by-product of engaging in activity which has some other purpose, such as organisational change, community or political action, or participation in collective scientific and artistic work. Even in tightly circumscribed formal education settings, goals and activities tend to presume fields of application beyond "the (virtual) classroom". Learning is meant to be connected to (the rest of) life. It leaks into, and becomes inextricably entangled with, other activities, as people go on with their lives. We believe a similarly expansive conception is needed of the tools and other resources that are used, and the places that are involved. In the early days of networked learning, research tended to focus on computer-mediated (online) discussions (see e.g. Goodyear, 2014; Henri, 1992; Mason & Kaye, 1989). At the risk of over-simplifying, one might say that people involved in networked learning were generally assumed to be experiencing remote interaction with others: while sitting down, using a desktop computer or terminal; in periods of time they had allocated specifically for that activity; coloured by a sense of slow and/or fragile, unreliable telecommunications links; through

reading text that other participants had written and through crafting carefully considered written responses.

Twenty years later, changes in technology, media habits and expectations mean that this sedentary, exotic, keyboard-tethered image of networked learning is no longer tenable. Mobile, personal, voice-enabled multifunctional devices such as laptops, tablets and smartphones have made it possible to participate in networked learning 24/7 from almost any location, including in workplaces, the home, the bus and the street. Exponential growth of web-based information resources and increased use of social media have also reshaped expectations about access to knowledge and people. Networked learning typically now involves heterogeneous digital tools and resources, used in ways that interweave with the other activities of life. It is no longer exotic (Goodyear, 2014; Hodgson, De Laat, McConnell, & Ryberg, 2014). Approaches to researching networked learning have not quite kept pace with changes in the social practices of technology use. Or perhaps we might say that the dominant images of the objects of our research do not yet reflect the extent to which learning networks now consist of heterogeneous assemblages of tasks, activities, people, roles, rules, places, tools, artefacts and other resources, distributed in complex configurations across time and space and involving digital, non-digital and hybrid entities.

The most important thing in a network is what people actually do (i.e. their activity). That said, our main practical purpose in analyzing networks is to extract reusable design ideas. Activity *emerges*—not in an arbitrary, random, free-floating way, but as a response to tasks (explicit and implied), and shaped by the physical and social context. The physical context is constituted by material and digital tools and other artefacts, including those that are bearers of texts. Some of these *things* appear singly (T), others in more complex assemblages (T-T), including assemblages to which one might apply labels like 'room', 'building', 'place' or 'infrastructure'. Activity includes the purely mental, but—more often than not—it is tightly coupled to things. It involves moving things around, moving around among things, and modifying or composing new assemblages.

Identifying the physical elements of a learning network must go beyond the obvious—beyond the shared digital spaces that historically have been seen as the core of a learning network. Insofar as the activity of networked learning participants connects with the material spaces they inhabit, then the characteristics of those spaces are important. This must be so, because these material spaces offer opportunities for action and impose constraints that can be consequential for learning and its application. For example, in one of our case studies (Robinson & Metcher, 2014), the physical spaces in which some network participants wanted to *apply* their learning were not connected to the Internet. The design team made it easier for them to create printable versions of some of their work—paper providing a very useful interface when sharing ideas and resources with people who do not participate directly in the network. A key point here is that an *expansive* sense of a learning network allows a more complete analysis of the relations between things and human activity: one can "follow the things" as they connect activities into a more coherent whole. In turn, this needs an understanding, in both analysis and design, of the strengths and

weaknesses of different ways of conceptualizing things, humans and their relations—a topic to which we now turn.

Framing Relations Between Things and People: Ontology

If designers are to have a sound base on which to make analytical connections between things that can be designed and human activities, then they need to consider the strengths and limitations of the main ontological positions open to them. We review these here, before moving on to look at some connecting constructs. Simplifying ontology somewhat, one may say that there are *dualistic* and *relational* positions.

Dualistic Perspectives

Dualistic positions fundamentally build on a clear distinction between (1) the physical (rocks, buildings, cars, computers, etc.) and (2) the human (minds, feelings, perceptions, activities). Precisely how the distinction is drawn varies, i.e. which phenomena are seen as the basic 'opposing' categories, with traditional Cartesian dualism focusing on *res extensa* versus *res cogitans* ['extended', material things versus thinking things], Cartesian heirs opposing physicality and so-called qualia (e.g. Dennett, 1991; Jackson, 1982; Nagel, 1986; Rorty, 1980), Husserlian phenomenology emphasizing human intentionality as that which sets us fundamentally apart from the material world (Husserl, 1950), and others contrasting the domain of physical, causal relations with the domain of agency and/or (self-)interpretation (Hacker, 2009; Taylor, 1985; Winch, 1990). On all of these dualisms, however, bodies, information, knowledge, texts and software prove to be awkward terms because they in one way or another cut across the opposed constructs, having both physical/material/causal properties and thinking/intentional/qualia/agency aspects. On the one hand they refer to obvious, hard-to-dispute phenomena, but on the other hand they require quite a lot of easy-to-dispute theorizing to fall into category (1) or (2).

Dualistic positions have inspired two basic contrasting traditions or perspectives—one which focuses on the physical and tends towards the use of positivist methods and explanations, and one which focuses on the human and tends towards the use of interpretive methods to understand personal subjective experiences.

(1) Physical/Positivist/Objectivist
This perspective has the methodological advantage of being concerned with publicly available phenomena and therefore of building on what seemingly are objective, reproducible data. The construction of theories on the basis of such data holds the promise of supplying general, overarching laws rich in both explanatory and predictive power and scope. Philosophically, the approach has

the advantage of enabling—at least in principle—an account of the world where humans are included among other natural phenomena, i.e. where no special ontological and methodological status is given to humans. A limitation to the approach is that it has no room for a concept of *meaning* and therefore—in principle—it cannot capture the phenomenological level of what matters most to us in our everyday life. It can only account for a third person view—from outside the world, from no-where—but not the first person view from within the world—the view of now-here—with which we are all most familiar at the outset (Nagel, 1986). Any overarching laws which can be postulated for the field of design for learning can therefore not grasp the *significance* of activities and experiences *for the learner*. Instead, they are restricted to behavioristic predictions and explanations. Furthermore, any proposed overarching predictive law intended to capture how people will behave may lead people to react *to* the predictions by deciding to behave contrary to them, thus leading to the falsification of the law (Bhaskar, 1986; Popper, 1972).

(2) Human/Subjective/Interpretivist
In contrast, the flip-side approach which focuses on personal subjective meaning is very much concerned, from its theoretical and methodological outset, with personal significance—the first person view. Within the field of design for learning, it focuses on how learners report their experiences of learning, aided by different designs. It is well suited to explaining what the objectivist approach cannot—namely how overarching, predictive laws fail for humans because of their capacities for interpretation and reflection and their ability to change their actions on the basis thereof. However, precisely because of this focus on the first person view, the approach has problems when it comes to accounting for influences (from things and other people) *of which the person is unaware*, and of explaining phenomena such as deception and self-delusion. Philosophically, the approach risks falling into relativism: accepting any sincerely presented account as 'the truth of the matter for that person' (e.g. Sfard & Prusak, 2005). Meta-methodologically, the approach grapples with ideas of objectivity and truth, proposing other ways to construe these concepts than the positivist ones (e.g. as 'inter-subjectivity' and 'coherence', respectively), and with the risk of gaining interpretive depth at the cost of explanatory and applicatory scope. Methodologically, it has problems even at the level of verifying informants' claims to sincerity. In terms of designs for learning, the approach struggles to validate the effect of different designs, beyond what learners believe and are able to say.

Relational Perspectives

Both the dualist approaches suffer from the inherited Cartesian philosophical problem of how to "bridge" between the two postulated worlds. That is, both approaches struggle to answer questions about how a person combines subjective mind and

physical body in activity in the world. Dualist science therefore has a hard time investigating this connection—e.g. how subjective meanings are projected into the physical world; how the natural sciences and the human and social sciences relate; and how they may inform each other. Many philosophical attempts to remedy this predicament have been advanced over the centuries, with Hegel and Marx as very prominent examples, looming also in the background of the contemporary phenomenological and materialist approaches to be discussed below. Characteristic of these contemporary approaches is a non-dualistic starting point from where the phenomena concerned are viewed as *relational*—neither objective nor subjective, or perhaps both at once, to paraphrase Gibson (Gibson, 1986: 129). Without dualism the question of how to bridge between the perceptions of the mind and the events of the "outside world" does not arise. Recently, a number of theories have been advanced within the field of social inquiry, inspired by thinkers such as Latour and Suchman, which give serious attention to the relations between physical/material things and human activity. Thus, Orlikowski has argued for the *constitutive entanglement* of the material and the social, maintaining that "Humans are constituted through relations of materiality — bodies, clothes, food, devices, tools, which, in turn, are produced through human practices. The distinction of humans and artifacts, on this view, is analytical only; these entities relationally entail or enact each other in practice." (Orlikowski, 2007: 1438). Carrying the argument even further, Ingold (2012) talks of an *ecology of materials* which views humans and materials not as pre-existing entities connected in a network, but as always in entangled becoming—"perpetually on the threshold of emergence"—in a meshwork of movement; "the web of life itself" (435).

The strength of these new relational-materialist positions is, firstly, their appreciation of the complexity of material situations, in particular of the way a range of material artefacts, physical structures and "natural occurrences" come together to constitute the significance of any one of the material objects in the given situation. This is in contradistinction to most accounts of the "affordance" of a thing which concentrate on the too-simple question of the relationship between one artefact and a user, thereby neglecting the role which *other* things (T-T) have, not only in determining the affordance of the thing, but in making it what it is. A further strength of this approach is its dynamically emergent view of the relationship between humans and things, avoiding as it does the risk of both social and physical determinism as well as the positing of a gap-to-be-bridged between the mental and the physical. It also emphasizes the fundamental flux of *being* as opposed to the static view presupposed by dualism. It thereby builds on the basic phenomenological point made by Heidegger (1986) and Merleau-Ponty (1962) that humans are always already in the world and that the gap between mind and material comes about only as an abstraction, secondary and derivative, from this "being-in-the-world".

In comparison with the two dualist views, the new "materialist turn" thus allows for a treatment of humans and non-humans within the same ontological framework (a strength of the physicalist side of dualism) whilst also ascribing a central role to the "meaning" of situations, thereby accommodating to our everyday experience of living (a strength of the interpretive side of dualism). In effect, relational-materialism

therefore "combines the strengths" of the two dualisms, without combining the positions (or even bits of the positions), by taking a non-dualistic starting point, and recognizing meaning as a basic category. More specifically, the concept of meaning is transformed from a first-person category into a relational, third-person one and things and people are recognized as having "meaning", not only to people, but to things as well. That is, significance is always already inscribed in the world in the relation between the entities there (human and non-human). Or more accurately, significance is the ever-changing result of the dynamic co-constitution of the entities in the world. As Hodder (2012) puts it, humans need things, but also some things need humans (e.g. for their repair), and some things also need other things (e.g. a roof needs a wall; a word-processing package needs a computer).

We agree with the relational perspective of the materialist turn. Still, for other purposes, we do find it necessary to stress that the *way* things have meaning to humans is different in important respects from the way things have meaning to things. The recognition of a basic non-dualist ontological framework should not lead one to the opposite extreme, i.e. to an unqualified postulate of symmetry between humans and things in all matters concerned. There is room, for instance, for differences in epistemological predicaments: Though humans certainly seldom, if ever, 'fully understand' the meaning of a situation, they do on the other hand have the possibility of understanding in a way which things do not. This is important in designs for learning because learners not only use tools, but *learn* to use tools, use tools *to learn*, and understand that this is what they (have to) do. Although the designer must become much more aware of the entanglement of things and humans than is the case today, still, at the heart of designing for learning there is an asymmetry: human learning is qualitatively different from the ways in which things adapt to people.

Constructs to Connect Things and People

How then, can designers plan to connect physical things to human activity? This question begs three further questions. Who is doing the learning? What kind of learning is entailed? What is it reasonable for designers to try to do, to help participants in a learning network? These questions can be tackled in a variety of ways, but we think the most pressing issues are captured in Figs. 6.2 and 6.3.

Figure 6.2 is an elaboration of Fig. 6.1 and its function is to draw attention to the fact that how one conceives of the relations between the physical world of places and things (T) and human activity (H) depends in part on one's conception of the human: of the person engaged in learning, in this case. There are, of course, many positions that can be taken on this question and Fig. 6.2 simply offers one contrast, albeit a very significant contrast in the literatures of networked learning, human computer interaction (HCI) and theories of action and the mind. On the left hand side ('goal directed action') we indicate what might be thought of as a classic paradigm in cognitive psychology and HCI, reflecting the assumption that most human

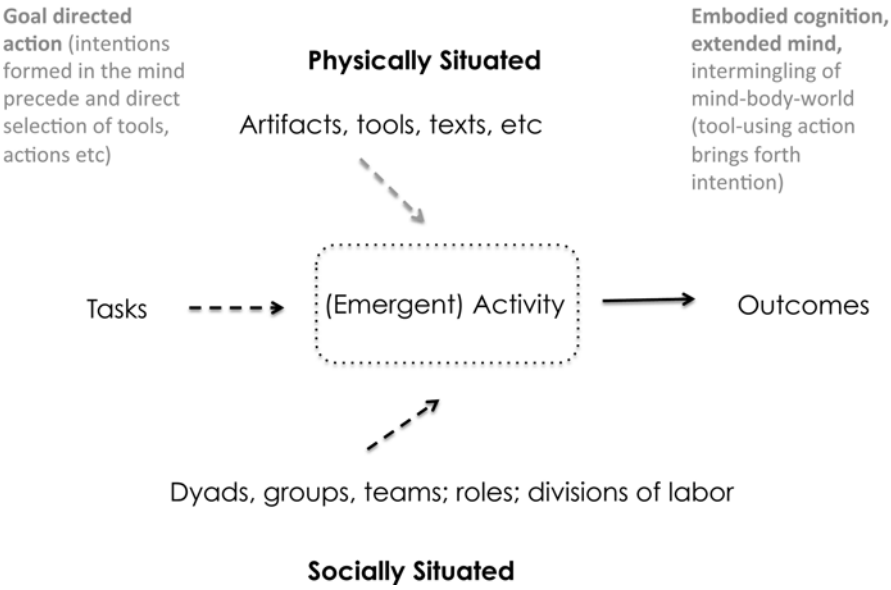

Fig. 6.2 Understanding physical situatedness, and T-H relations, depend upon how one understands the learner

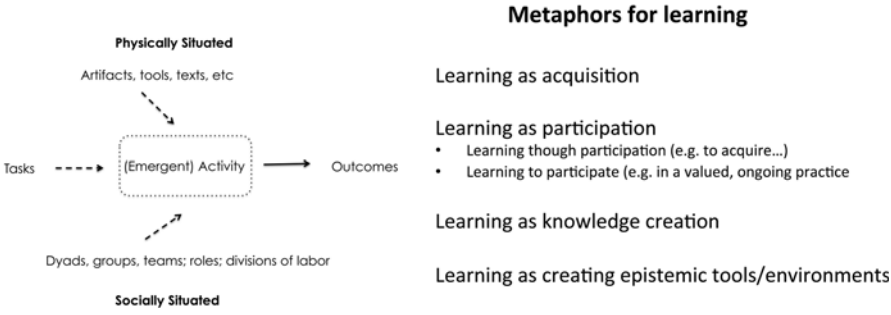

Fig. 6.3 Understanding physical situatedness, and T-H relations, depend upon how one understands learning

action, including that which involves the use of tools (digital and otherwise) can be understood as a working out, in the physical world, of plans formed, prior to action, in the mind (see, for example, Card, Moran, & Newell, 1983; Newell & Simon, 1972; Proctor & Vu, 2009). It is, *par excellence*, a dualist model with a clear separation between the human mind (as the locus of intention and intelligence and the source of action) and the physical world. As Suchman (1987, 2007), Turnbull (1993, 2002), Ingold (2011, 2013) and others have eloquently argued, it is a mistake to insist on always, or generally, understanding human action in the physical world as

the enactment of prior mental plans. There exists a range of alternative views, but many of these foreground: the role of tight, fast, perception-action loops in skilled human action; intentions *emerging* from situated action and perception, and a blurring of boundaries between mind, body and world.

> …cognition is worked out in the practices of engaged daily practices with things. (Hodder, 2012: 37)

> … equipment affects how things are seen because how we act on the world, and the tasks we perform, shape how we perceive (Kirsh, 2013: np)

> … our ways of thinking are not merely causally dependent upon but constituted by extracranial bodily processes and material artifacts (Malafouris, 2013: 227)

> …Our intelligence is not only inside the mind, but in its multi-faceted networking connections and downloaded to various peripherals, i.e., artifacts that can be understood as cognitive prostheses that expand and augment human creativity and intelligence when integrated with the cognitive architectures of the participants' minds (Ritella & Hakkarainen, 2012: 242)

The position sketched on the right hand side of Fig. 6.2 acknowledges both an embodied or grounded perspective on human cognition and a notion of the mind as extended—a so-called 'person plus' or 'human-machine symbiosis' perspective.

> Human-machine symbiosis, I believe, is simply what comes naturally. It lies on a direct continuum with clothes, cooking ('external, artificial digestion'), bricklaying and writing. *The capacity to creatively distribute labour across biology and the designed environment is the very signature of our species*, and it implies no real loss of control on our part. For who we are is in large part a function of the webs of surrounding structure in which the conscious mind exercises at best a kind of gentle, indirect control. (Clark, 2003: 174)

While Fig. 6.2 raises questions about the nature of the H(uman) who is doing the learning, Figure 6.3 reminds us of the availability of different conceptions *of* learning. Here we draw on Anna Sfard's influential suggestion and mention four *metaphors* for learning Sfard, 1998). On Sfard's account, the two most widely used metaphors for learning are 'learning as acquisition' and 'learning as participation'. The first of these sees learning as an individual cognitive accomplishment, in which learning results in a person *gaining* new knowledge, skills, etc. which become theirs and which they can take from context to context. 'Learning as participation' sees learning from a sociocultural viewpoint and equates learning with acts of participation in the social practices of a community. This second metaphor has been widely appropriated within formal education, for example, in the adoption of 'community of practice' pedagogies. Close inspection reveals some ambivalence, within written accounts of such CoP pedagogies, about whether participation in community activities is actually a method for fostering the personal acquisition of knowledge, or is fundamentally about learning to participate in valued social practices. These two metaphors for learning throw up some stark differences with respect to the T-H relations. On the *acquisition* view, tools and other artefacts (T) are the *means* to achieve personal cognitive change: accumulating new knowledge. On the *participation* view, social (or rather, socio-material) practices necessarily involve tools (etc.), so

learning to participate includes learning to master the tools that are bound up in the practices of the community (Lonchamp, 2012). Tool use is part of participation, not merely a means to the end of acquiring personal knowledge. Paavola, Lipponen, and Hakkareinen (2004) have extended Sfard's work to add a third, *knowledge creation* metaphor. On this view,

> Learning is not conceptualized through processes occurring in individuals' minds, or through processes of participation in social practices. Learning is understood as a collaborative effort directed toward developing some mediated artifacts, broadly defined as including knowledge, ideas, practices, and material or conceptual artifacts. (Paavola et al., 2004:569–70)

The H-T relation compatible with this knowledge creation view places T as both a means of creating new knowledge and as embodiments of newly created knowledge. That is, the shared practices of knowledge creation depend, in part, on the use of tools (etc.) but they also create new things in which new knowledge is inscribed: such as conceptual artefacts that have a material existence. Finally, Figure 6.3 offers a further elaboration of the knowledge creation metaphor, in which learning is also seen as involving the creation of new tools and physical environments (T) that are themselves tailored to, and intended for, the creation of new knowledge: *epistemic* tools and environments. (See Markauskaite & Goodyear, 2016).

How designers for networked learning choose to understand learners and learning is, in large part, a personal and professional choice. Theorists cannot compel designers to subscribe to all or any of the viewpoints sketched above. However, we *do* want to assert that any account of H-T relations that is meant to be useful to such designers needs to be comprehensive and nuanced enough to capture the range of issues flagged in Figs. 6.2 and 6.3. Furthermore, such an account needs also to be able to deal with more specific relations between H-T, such as the idea of affordance that we mentioned earlier.

Design of the physical (T) can focus attention and provide scaffolding, helping the participant (H) direct scarce mental resources to the areas that benefit from careful thought. In Goodyear and Carvalho (2013), we argued that the notion of "affordance" works best when it is seen as engaging with the almost automatic cognitive "System 1" described by Kahneman (2011): thought which is fast, intuitive, emotional, if error prone. For example, "affordance" can describe a relationship in which computer interface elements, layout and so on make it easy for people to navigate to the point/place where they need to engage "System 2", which is slower, more deliberate and logical. In a similar vein, Hodder (2012) talks about non-reflective and reflective engagement with things. Such scaffolded navigation depends, in turn, on the skills, perceptual acuity, working memory capacity, etc. of the participant—affordance being a relation between person and thing(s). An assemblage of things does not have affordances *per se*; rather, it has affordances in relation to the capabilities of the people who use them. These evolve over time as people become better at working with the assemblage. Affordance and skill must be understood, not as pre-given, but as co-evolving, emergent and partly co-constitutive (Dohn, 2009). In a learning situation, the interface designers' motto of "don't make

me think" is inappropriate. It should be, "don't make me think, until I get to those points where thinking will help me learn".

Second, design of the physical can help the participant find answers to the question: "what is on offer here?" Not all activity is closely goal-directed. In digital spaces, just as in material spaces, people sometimes wander around, exploring, waiting to see what will happen, or where a path will take them. Notions of "place legibility" are appropriate here: being able to come to at least a partial understanding of the layout and character of a place (online or otherwise) is important if people are to be invited to explore.

Third, design of the physical can help ensure that the tools and other resources needed for satisfactory completion of a task will come to hand when the participant requires them. This is a matter of furnishing learning places with appropriate tools, artefacts, etc. In a similar vein, design might help alert participants to the fact that they will need certain kinds of things at a later point in a sequence of tasks: so that they can set in place the things they will need. Whichever way this is done, design needs to be informed by an ergonomic sense of the match between tasks, activities, things and the capabilities of the participant(s).

In each of these cases, the connecting constructs that give a design its rationale are *relational* constructs. They do not speak about the qualities of a thing *or* the capabilities of a person: both are involved, simultaneously. Extending this idea, one also needs to recognize that the relations are rarely between one thing and one person. Things come in crowds—as assemblages rather than as discrete entities. Gibson made this point when first introducing the concept of affordance: "the *affordances* of the environment are what it *offers* the animal, what it *provides* or *furnishes*, either for good or ill." (Gibson, 1986: 127). Gibson's focus is on a relationship between an animal and the *whole environment* in which the animal is situated. Yet the way the term has been used within the interface design and networked learning communities has almost always been with a focus on individual artefacts, tasks, or social organization structures—or even just features hereof—not on the "environment" or "context" as such. There are several reasons for this, some relating to the history of the term, some to design pragmatics. Despite Gibson's broad introduction of the term, his own examples concern singular things, e.g. a seat, a surface, and a mailbox. Norman (1989), who introduced the term to the field of design, focused still more narrowly on such things as door knobs and Lego blocks. These theoretical beginnings have influenced later usage of the word. When designing new things—a door knob, a button on the user interface, or a collaboration script—it is of course perfectly reasonable to focus on getting the details right and thus on singular aspects of the artefact to be designed. However, in the context of understanding the relationship between things and humans in networked learning, and more particularly in the context of designing the *physical setting* for learning networks, the single-item-approach is far too simplistic. Instead, we must focus on the assemblages of things which make up the environment and on the way they jointly co-constitute a range of affordances for the learners. (Our insistence on a relational understanding of the constructs connecting things to human activity also extends to tasks and to the social

design of networked learning. That is to say, the connection between a person and a tool is not the same for all tasks or all divisions of labour.)

We recognize the danger that insisting on seeing things, tasks and people as coming together in complex assemblages may make design look impossibly complex. If everything is connected to everything else, then where does one begin? How does one avoid an exponential growth in interdependencies? We do not have a complete answer, but we will bring this discussion to an end with three parts of an answer. First, design is a practice that has succeeded in managing complexity in many other fields. Second, an aspect of design expertise is knowing how to find the zones of relatively low connectivity within a richly interconnected system—"carving nature at the joints". Third, development work on educational design patterns is providing ways of representing designs that allow for nesting of design components and for specifying the conditions under which a design may be workable (see e.g. Voigt, 2010). Design for networked learning will need to become more sophisticated if it is to thrive in the midst of complexity, change and uncertainty—but good practical tools and ideas are there for the taking.

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