

## Soft is hard and hard is easy: learning technologies and social media

---

**Jon Dron**

*Technology-Enhanced Knowledge Research Institute, Athabasca University, Canada,  
jond@athabascau.ca*

### Abstract

---

Questo articolo riguarda principalmente la natura delle tecnologie per apprendere, con una particolare attenzione ai social media. Muovendo dalla definizione fornita da W. Brian Arthur delle tecnologie come un insieme di fenomeni orchestrati per un qualche uso, l'articolo amplia la teoria di Arthur ridefinendo e allargando la distinzione comunemente accettata tra tecnologie soft e hard, laddove le tecnologie soft sono intese come quelle che richiedono l'orchestrazione di fenomeni da parte degli esseri umani, mentre le tecnologie hard sono quelle per le quali l'orchestrazione è predeterminata o incorporata. Le tecnologie per apprendere sono quelle in cui le pedagogie (anch'esse tecnologie) sono parte dell'insieme. Le conseguenze di questa prospettiva vengono esplorate nel quadro di diversi modelli pedagogici e in relazione agli approcci basati sul social learning in una varietà di contesti, dai corsi per corrispondenza ai MOOC.

**Parole chiave:** tecnologie per l'apprendimento, connettivismo, social media, progettazione tecnologica, educazione.

### Abstract

---

This paper is primarily about the nature of learning technologies, with a particular focus on social media. Drawing on W. Brian Arthur's definition of technologies as assemblies of phenomena orchestrated to some use, the paper extends Arthur's theory by re-specifying and extending the commonly held distinction between soft and hard technologies: soft technologies being those that require orchestration of phenomena by humans, hard technologies being those in which the orchestration is predetermined or embedded. Learning technologies are those in which pedagogies (themselves technologies) are part of the assembly. The consequences of this perspective are explored in the context of different pedagogical models and related to social learning approaches in a variety of contexts, from correspondence courses through to MOOCs.

**Keywords:** learning technology, connectivism, social media, technology design, education.

## Introduction

If we are to use them effectively, then it is vital to know the nature of the technologies we use for learning. This paper is concerned with the nature of learning technologies and what that means in terms of different families of pedagogical models that are common in education. Particular attention will be paid to emerging uses of social technologies for learning which can be highly beneficial for learners but, as often as not, are not. If we understand the dangers, we can overcome them. This paper presents a framework for thinking about how and why we use and enact technologies for learning that is both descriptive and predictive and that may be of some use to anyone engaged in the process of education.

## Technologies

The English word “technology” has evolved over the past 200 years or thereabouts to become what Nye (2006) describes as “an annoyingly vague abstraction” (p. 15). Some have almost given up entirely – Franklin (1999), for instance, simply calls technology “the way things are done around here” (p. viii). Others have invented or conscripted new terms to describe technologies such as “technique” (Ellul, 1970) or “techniks” (Mumford, 1934). There is, however, much to be gained from a more precise examination of how the term is actually used. Unfortunately, dictionaries are of little help here. Most define technologies as the application of scientific principles, which is simply wrong. Even if we accept that inventions such as the wheel, farming, writing and metallurgy are therefore not technologies, science is at least as much the application of technology as vice versa (Arthur, 2009; Zhouying, 2004). “Technology” is often used to refer to devices that might be found in a technology store, such as computers, cellphones, and software. This accords with Alan Kay’s definition of technology as anything invented after you were born (cited in Brand, 2000, p. 16). It is the meaning that is often applied by those bemoaning or promoting technology in the classroom, while seemingly blind to the fact that books, classrooms, timetables, desks, language, assessment regulations and pencils are as much technologies as computers and cellphones. We need a clearer definition.

There is general consensus that the context of use matters: a microwave oven is not the same technology to a cat as it is to a human. But uses may vary. Kauffman (2008) demonstrates that there are infinite potential uses for a screwdriver, such as opening paint tins or stabbing someone, that cannot all be specified or knowable in advance: the technology is not the screwdriver itself but the combination of screwdriver and how and for what it is used. As Kelly (2010) puts it, technology is “not a thing but a verb” (chapter 2).

Papert (1987) sees technologies as tools that are of far less relevance than how they are used. The word “tools”, however, is fraught with the ambiguity of “technology” and the terms are often used interchangeably. This confusion is resolvable if, following Arthur (2009), we recognize that technologies are assemblies that typically contain other technologies. Technologies are made of technologies. A tool is something we use, generally with other tools and processes, in order to enact a technology. We can meaningfully think of language as a tool (Kelly, 2010; Rheingold, 2012; Ridley, 2010; Wilson, 2012), as well as sticks, laws, cars, rocks, computers and spacecraft, even time (Frank, 2011). Sometimes, the use of the tool is sufficient to enlist an object into a technology: a stone for cracking nuts, for example. In other cases, we can treat

technologies as tools that can be used to enact further technologies that, in their turn, can be tools to enact others. But that is not the whole story. We use food to assuage hunger and air to breathe, but eating and breathing can hardly be described as technologies.

Arthur (2009) completes the picture by describing technologies as “the orchestration of phenomena to our use” (p. 53). The concept of “orchestration” evokes the vital meanings of ordering things and of combining them in relation to one another and other phenomena to achieve some end. The definition is appealing because it applies equally well to both process and product: we can describe a computer itself this way as easily as we can describe the use of that computer as a sales terminal or a word processor. In each case, some of the same phenomena are being orchestrated but others are being brought into play, others ignored, adding to or taking from an assembly that we can meaningfully describe as a technology in its own right. A stone that is used to crack or open a nut is a different technology than the same stone used to hold or open a door because different phenomena are orchestrated to achieve different ends in each case.

The same applies to more complex assemblies but, for those, some of the orchestration has been done for us and may be embedded in a device or procedures. For example, the maker of a wristwatch has orchestrated a wide range of phenomena such as the characteristics of springs and ways different cog ratios can speed up or slow down a circular movement, using the product of other technologies like metallurgy and geometry to achieve this. The watch can itself become part of at least two different technologies – time telling and direction finding. In both cases we assemble the orchestrated phenomena of the watch with other phenomena – in the one case, our knowledge of the meaning of the position of hands and how that relates to the passing of time and, in the other, our further application of a technique for establishing direction through knowing the relative position of the sun to the watch’s hands at different times of the day.

Both technologies involve proscribed procedures: any exercise of creativity at all on the part of the person using them would be unwise. The human is a part of the technology but has no real control over the part that he or she plays. By contrast, some technologies demand a more flexible and creative role. A pair of knitting needles and some wool can be used to knit infinitely many things. Furthermore, we can knit skillfully. The technology enables humans to be creative in its enactment, to control what they produce, to be actively engaged in design and production. However, if a pattern is used, we can only knit the pattern correctly: “better” or “worse” than simply describe how accurately we become part of the technology. A similar distinction can be made between inflexible technologies such as objective tests and less prescriptive assessments like essays, projects and portfolios. One is harder (more rigid) and the other softer (more flexible). This matters.

### **Soft and hard technologies**

Many authors distinguish between hard and soft technologies. Unfortunately, the distinction means different things to different people, including:

- Whether the technologies involve physical machines (hard) or are enacted as human processes (soft) (McDonough e Kahn, 1996);
- Whether they are sustainable (soft) or not (hard) (Baldwin e Brand, 1978);

- Whether they accommodate human-oriented ways of doing things (soft) or not (hard) (Norman, 1993).

These different views are somewhat reconcilable if we remember Arthur's definition of technology as the orchestration of phenomena. In hard technologies, the orchestration is determined in advance. It may be embodied in hardware or software, or it may be embodied in inflexible human processes, rules and procedures needed for the technology's operation, or both. The human role, if any, in a hard technology is to follow someone else's orchestration, while in a soft technology it is to perform that orchestration.

There is no a priori reason to prefer hard or soft technologies and there is a continuum of softness to hardness. Most technologies are an assembly of soft and hard technologies and so there are few, if any, technologies that are purely hard or purely soft. Hard technologies provide efficiency, speed, accuracy and consistency. Soft technologies give flexibility, creativity, malleability and adaptability. The degree of softness or hardness needed in any individual case varies according to context.

### **Perspective matters**

The same tool may be soft for one person and hard for another, because they orchestrate different phenomena for different purposes. For example, a learning management system may be soft for a teacher creating and managing a course, but hard for a student using it as part of that course. Here, the technologies are different for the teacher than for the student because different features and interfaces are available to each. However, the principle may apply even when the tools are identical. Most soft technologies become softer with increasing expertise in their use. A violin may be a very soft instrument to almost anyone, but only an expert can consistently coax it into making pleasant noises. Virtuosity in a violinist increases the adjacent possible (Kauffman, 2000). Each new trick that we learn or technique that we refine does not eliminate existing possibilities but adds new possibilities and increases the potential for further possibilities as a result. As we gain expertise we are able to add new tools (vibrato, glissando, bowing techniques, etc.) to the original in order to assemble more complex and more capable technologies.

### **Soft is hard, hard is easy**

Because softer technologies require creative thought in order to enact them, they require more decisions to be made than for harder technologies. That makes them more difficult. Conversely, hardening technologies makes them easier to use, because they require fewer decisions to be made: the orchestration has already been done for us. For instance, an automatic transmission that embeds orchestration of gear changing is usually easier to use than a manual transmission in an automobile, but at a cost of flexibility. It is easier to be a creative and skilful driver when driving a car with a manual transmission, but it is also much easier to make mistakes.

### **Adding tends to soften, replacing tends to harden**

Adding without replacing softens a system, even if both technologies are hard. For example, imagine a coursework submission system in a learning management system and a manual submission system demanding strict deadlines. In combination, things that each facilitate, such as the submission of paper or the ability to upload work from home, are additively combined, allowing more choice on the part of their users. If, on the other hand, a harder technology replaces a softer one, then the overall system becomes harder because it takes away choice.

Harder technologies may be replaced with softer ones, especially when enacted by humans. For example, a rigidly imposed curriculum may often be bent through imaginative teaching. However, when hard technologies are enacted by software or hardware, softening is rare. The major trend in system design over the past fifty years, especially in computer-based systems, has been to replace soft with hard technologies. This is what computer analysts, designers and programmers are mostly taught to do. That is how learning management systems were designed.

### **Hard trumps soft**

The large and slow moving parts of any system determine the actions of the small and fast more than vice versa (Brand, 1997). Cities affect buildings and buildings affect rooms and rooms affect furnishings and furnishings affect us. Mountains affect trees that affect shrubs that affect mice that affect the bugs inside their guts, whose whole existence is defined by the mouse they live in. Hard technologies are, by definition, less flexible than soft ones and are more difficult to change. Soft technologies form around and are in part determined by their harder components and technologies with which they interact or are in turn a part of.

### **Pedagogies as technologies**

Techniques are technologies enacted by people. They cannot and do not exist in isolation but, like all technologies, are constituted in relation to others. A stick lying in a forest without technique is a stick. Used to draw in the sand it becomes a part of a technology, but it remains a stick: the technology lies in the orchestration of phenomena to some purpose that is entirely done by a human mind. Pedagogies are techniques – repeatable methods, procedures and strategies for teaching. In other words, pedagogies are technologies for teaching (Dron, 2012). Learning technologies are technologies that include pedagogies as part of their assembly, implicitly or explicitly.

In an educational context, pedagogies exist within a technological infrastructure such as a school or training department, which impose many constraints such as timing, accreditation, pacing and physical or virtual designed spaces where learning is mandated to occur. Such constraints are not pedagogically neutral: pedagogies must be engineered around them. Pedagogies are, for the most part, soft technologies from the perspective of a teacher or self-directed learner using them. While, to a student on the receiving end, they have the potential to be a lot harder, this means that they are likely to be less structurally deterministic than harder technologies with which they may be combined. If

teachers wish to put pedagogies first, they are likely to face an uphill struggle. From timetabling constraints to the potentialities of training spaces; from assessment requirements to organizational policies; from the design assumptions and defaults of learning management systems to the availability and location of whiteboards; pedagogies are surrounded by harder, less agile technologies that guide their application and limit those that can be used. Pedagogies must work with all of the other tools and processes that make up the assembly of actualized learning technologies. Learning technologies are thus not just those directly used by a teacher but include those of which the teacher and his or her teaching are a part. Timetables teach too.

### **Hard and soft pedagogies**

Distance learning is a field that is defined more by its use of specific technologies than by the physical distance involved. Several authors have described its history in terms of mediating technologies, typically identifying generations defined by publication, use of rich digital media, and networked computer mediated communication (e.g. Bates, 2005; Gunawardena e McIsaac, 2004). Anderson and Dron (2011) have taken a slightly different tack by describing three generations of pedagogies. The first generation employed broadly instructivist pedagogies, either behaviourist or cognitivist in nature. The second generation employed broadly social constructivist pedagogies that placed an emphasis on many-to-many communication. The third generation that has recently emerged has adopted more connectivist approaches, with a focus on distributed knowledge creation, active engagement in networks and self-directed paths with limited structure or predetermination of goals. The generations are deeply entwined with the use of other technologies. Distance education was only possible at all with the availability of means of publication and the postal service. It was difficult or impossible to employ social constructivist models before cheap and effective multi-way communication technologies were available. Connectivist models are only possible and dependent upon the read/write Web, sometimes described as Web 2.0.

### **Behaviourist/cognitivist pedagogies**

Behaviourist and cognitivist pedagogies assume a fixed target. A body of knowledge and skills is known in advance and can be specified with learning objectives and assessed in terms of learning outcomes. The job of the teacher is thus to design a path that makes content or behaviours as easy as possible to absorb or construct. While methods and models of learning vary enormously, from rigid Skinnerian behaviourist methods through to Piagetian approaches that assume individuals construct knowledge in relation to what is already known, the underlying assumption is that actions performed by a teacher bring about specific learning outcomes in the student. Such pedagogies tend towards the harder end of the spectrum for learners. They are expected to engage in a fairly fixed range of activities, normally involving a process model that includes feedback mechanisms and a judgement process at the end, in order to achieve identified pre-determined outcomes. Behaviourist/cognitivist pedagogies fit well within harder technological structures and industrial, mass-production methods of teaching. The abiding metaphor for a teacher in

such contexts is the sage on the stage, though this is a slight over-simplification. The teaching role is, however, a controlling one.

### **Social constructivist pedagogies**

Drawing initial inspiration from the work of Vygotsky and Dewey, social constructivist theories see learning as a fundamentally socially situated phenomenon in which knowledge is co-constructed through engagement with others. It is assumed that all learners are different, and so knowledge construction is an active process of negotiation and meaning-making in a social context. Through pedagogies such as problem- or enquiry-based learning, project-based methods, constructionist activities and reflective portfolio assembly, learners are guided rather than instructed, taking individual paths but engaging in collaborative or cooperative pursuits in which meanings are explored, defined, formulated and reformulated in an iterative cycle of peer and teacher guided development. Although broad goals are normally set, and the process is typically scaffolded and defined in advance, the paths taken by learners cannot be predicted in detail beforehand. Pedagogies are often framed as reactive strategies and tactics to encourage reflection, engagement and construction. Notably, however, at the point at which detailed action must be taken, teachers (and learners) still fall back on cognitivist and sometimes even behaviourist pedagogies. For instance, if a problem-based exercise requires a learner to operate a machine, it is common to provide a form of instruction as and when it is needed that will inevitably rely on methods that apply cognitivist or behaviourist pedagogies. Social constructivist pedagogies are thus partly assembled from small harder pieces that are drawn together on the fly rather than designed in advance. This makes them much softer for both the learner and the teacher than those employing a cognitivist/behaviourist approach throughout. When done well, this means that they are flexible, adaptive and can offer the right balance of softness and hardness for a learner at the right time. The metaphor of “the guide on the side” is appropriate to such methods. But, because they are softer, it is easy for social constructivist pedagogies to be performed badly. Guides may be ignorant, lazy or inadequately resourced. Even and perhaps especially when it works well, this far greater reliance on the skill and the availability of the teacher to offer guidance of the right kind can make social constructivist pedagogies very expensive to implement and hard to scale to many learners (Annand, 1999). Without skilled and devoted application of pedagogies and other technologies, social constructivist methods can leave learners feeling lost, confused and unsupported.

### **Connectivist pedagogies**

The term “Connectivism” is mainly associated with George Siemens (Siemens, 2005), who coined the term in an educational context and defined the area, but there are others in the same family such as communities of practice (Wenger, 1998), heutagogy (Hase & Kenyon, 2007) and networks of practice (Wenger, Trayner e de Laat, 2011). Connectivist models emphasize the distributed nature of knowledge in reified social interactions within multiple networks, the value of co-creation, the importance of diversity, emergent patterns of knowledge creation and adoption, valorization of learner control, and the

situated nature of cognition and learning. The consequences of these perspectives are that connectivist pedagogies are at most implicit, emergent and flexible, part of a multi-faceted experience of intentional learning. The networked environment itself imposes and embodies pedagogical structure, often unplanned. This makes connectivist pedagogies, such as they are, extremely soft and implemented largely by the learner and emergent structures within the network rather than made explicit by a teacher. “Teachers”, such as they exist, model practice rather than determine or guide learning. They are co-travellers on the learning journey.

Connectivist approaches assume an assembly of reified knowledge and hardened technological processes that connect people and knowledge objects, and rely on ubiquitous widespread availability of information and unfettered communication with indefinitely many others. They are therefore really only possible thanks to networked social media. Social media are innately soft, inasmuch as dialogue can be used to negotiate, augment, replace or modify hard procedures and rules. Also, despite the best efforts of companies like Facebook to absorb the rest of the Web into a single monolith, most people engage in a diverse variety of social media. This means that individuals are able to assemble a wide range of social technologies to meet their learning needs, softening the technologies by adding them to the melange. While formal attempts have been made to harden such aggregates in the form of personal learning environments or mashup sites, for most people learning technologies are assembled on an ad hoc basis on computers, tablets and mobile phones. The more that such assembly occurs, the more decisions have to be made by the assembler, who may choose inefficient, mistaken, or unhelpful paths along the way. Although the feedback provided by others can compensate, there is no guarantee that it will be supplied when needed as there is no formal process of support or commitment to help. Soft is hard. Many have noted the confusion, welter of irrelevant information and frustrating dependence on the weakly differentiated tide of activity of others in connectivist learning activities, as well as the low completion rates associated with connectivist courses (Kop, 2011; Mackness, Mak e Wiliams, 2010).

For all that, there are many learning technologies at work in connectivist learning activities. Just as social constructivist models, when viewed at a fine scale, inherit behaviourist/cognitivist methods, so connectivist methods inherit both social constructivist and behaviourist/cognitivist models. Other people, in sharing knowledge and engaging in dialogue, enact implicit and sometimes explicit cognitivist or behaviourist pedagogies and engage in social construction of meaning.

A strange hybrid pairing of a connectivist model of learning with the technological format of a course, as seen in the first MOOCs (Massive Open Online Courses) to bear the name (Downes, 2008) takes this further. At first glance, such a pairing appears incompatible with the lack of boundaries and defined learning outcomes that characterize connectivist learning models. A course, by definition, imposes linearity, intention, methods and external agency on the process. However, although connectivist courses typically involve a timetable, a planned set of topics, and some norms of behaviour, this is typically a softer construct than that of most institutional courses. Events and activities are catalysts and foci but the learning occurs as people create, connect, and discover networks of others, co-creating and emergent body of distributed knowledge.

Connectivist MOOCs are often contrasted with apparently behaviourist/cognitivist MOOCs such those as hosted by Udacity, Coursera or EdX as well as short just-in-time chunks of teaching like those provided by the Khan Academy. However, because of the



nature of technologies as situated assemblies, the distinction between them is smaller than it seems. Although behaviourist/cognitivist MOOCs do appear to follow an industrial instructivist model of teaching in order to cater for the huge numbers that are often involved, their strength lies in the control that they give to learners to adopt their own strategies for getting through the course. As Haughey and Muirhead (2005) observe of even traditional distance learners, what is planned by the teacher is seldom what is experienced by the learner. There are opportunities for learners to get together in many different ways, including through taught formal courses, in self-organized learning groups on social media sites and through networked tools provided by the purveyors of MOOCs themselves, where the massive nature of the courses ensures that there will always be other learners willing and able to engage at any time of day (Severance, 2012). While teachers may be creators of tools for learning, learners are the ones that enact the technologies, and they usually incorporate far more into the assembly than course creators and deliverers provide. Despite the pedagogies of their creators, connectivist learning is commonplace in all MOOCs because the courses themselves are only a part of the assembly.

## **Conclusion**

While hard and soft technologies are both valuable, the worst of all possible worlds are technologies that are both pre-orchestrated and that require humans to enact them. These are both rigid and prone to error. Unfortunately, much institutional learning contains such structural elements that are hard, for learners and teachers, and that require human enactment. Though softened by pedagogies and other social processes, they embody innate rigidity that means learners and teachers may fall behind, become demotivated, and fail. This means that there is an important potential role for social learning technologies, in which engagement with others is assembled into every part of the system. Social technologies are innately soft because they provide opportunities to negotiate and change the technologies that are used, so they can adapt to any learning need. Where teachers are passionate and skilled, and there is time and money available to support them, social constructivist models can be highly effective here because they allow the teachers (including other learners) to use their expertise and adapt to different needs and interests. In the absence of such skills or the time and energy to use them, the results can be abysmal. Connectivist approaches have many of the benefits and weaknesses of social constructivist pedagogies and they scale far better because they distribute the teaching role. However, their extreme softness can make them still less efficient, overwhelming and unsatisfying to any but the most motivated and skilled user of a learning network.

The softer we make our learning technologies, including pedagogies, the more important are the skills to use them. As in any art, it is not just technical skill that matters. Adept painters may mimic the methods of the masters and, in some cases, may produce excellent pastiches, but will seldom reach the heights of genius of those they pattern themselves upon. Conversely, great painters have produced great art with poor tools. The same is true of great teachers, some of whom can even inspire with awful learning technologies, such as lectures.

But what if you are not a teaching guru?

The softest learning technologies are assemblies of hard technologies. When those hard pieces are small enough and choices can be made as to which pieces are used on any given occasion, then control returns to learners and teachers and the overall technology becomes soft again. Like Lego bricks, small hard pieces can be used creatively to assemble a vast array of different structures, while retaining some of the benefits of the hardness of the pieces. More concretely, for those without sufficient expertise, time or talent, hard instructivist tools designed by others, such as textbooks, training manuals and open educational resources, provide a useful means to learn and teach that, if assembled competently, can be effective.

Finally, no matter how hard the pedagogies and other technologies inflicted on them, learners are always able to make a choice to add others, and thus to soften the overall technology. Learners choose their own paths through books, explore Wikipedia outside their courses, ask for help from friends and create their own methods to succeed, independently of what teachers think they should do. Pedagogies that are soft for learners assume this and are thus more likely to succeed than those that do not. It is far better to provide small learner-assemblable hard pieces than to attempt to impose a monolithic structure upon them. But getting the chunk size right is difficult: too large, and it will be too hard. Too small, and it will be too soft, and that size varies from one learner and context to the next. What is needed is that ever-shifting and hard to reach ideal that Goldilocks found in Baby Bear's bed – not too hard, not too soft, but just right. There is no easy formula for finding this, but recognizing the issue is a move in the right direction.

## References

- Anderson T. e Dron J. (2011). Three Generations of Distance Education Pedagogy. *The International Review of Research in Open and Distance Learning*. 12 (3), Retrieved from <http://www.irrodl.org/index.php/irrodl/article/view/890> (ultima consultazione 07.03.13)
- Annand D. (1999). The problem of computer conferencing for distance-based universities. *Open Learning*. 14 (3), pp. 47-52.
- Arthur W. B. (2009). *The Nature of Technology: what it is and how it evolves*. New York, USA: Free Press.
- Baldwin J. e Brand S. (1978). *Soft-tech*. New York, USA: Penguin.
- Bates A. W. (2005). *Technology, e-learning and distance education*. New York, USA: Routledge.
- Brand S. (1997). *How buildings learn*. London, UK: Phoenix Illustrated.
- Brand S. (2000). *Clock Of The Long Now: Time And Responsibility: The Ideas Behind The World's Slowest Computer*. New York, USA: Basic Books.
- Downes S. (2008). Places to Go: Connectivism & Connective Knowledge. *Innovate*, 5(1), [http://www.innovateonline.info/pdf/vol5\\_issue1/Places\\_to\\_Go-Connectivism\\_&\\_Connective\\_Knowledge.pdf](http://www.innovateonline.info/pdf/vol5_issue1/Places_to_Go-Connectivism_&_Connective_Knowledge.pdf) (ultima consultazione 07.03.13)
- Dron J. (2012). The pedagogical-technological divide and the elephant in the room. In: *International Journal on E-Learning*, 11 (1), pp. 23-38.

- Ellul J. (1970). (J. Wilkinson, Trans.) *The Technological Society*. New York, USA: AA. Knopf.
- Frank A. (2011). *About Time: Cosmology and Culture at the Twilight of the Big Bang*. New York, USA: Free Press.
- Franklin U. M. (1999). *The Real World of Technology*. Concord, ON: House of Anansi Press.
- Gunawardena C. N. e McIsaac M. S. (2004). Distance Education. In D. H. Jonassen (Ed.), *Handbook of research for educational communications and technology*. Mahwah, NJ: Lawrence Erlbaum Associates, pp. 355-396.
- Hase S. e Kenyon C. (2007). Heutagogy: A child of complexity theory. *Complicity: An International Journal of Complexity and Education*, 4(1), pp. 111-118.
- Haughey M. e Muirhead B. (2005). Evaluating learning objects for schools. *E-Journal of Instructional Science and Technology*, 8 (1), [http://ascilite.org.au/ajet/e-jist/docs/vol8\\_no1/fullpapers/eval\\_learnobjects\\_school.htm](http://ascilite.org.au/ajet/e-jist/docs/vol8_no1/fullpapers/eval_learnobjects_school.htm) (ultima consultazione 07.03.13)
- Kauffman S. (2000). *Investigations*. New York, USA: Oxford University Press.
- Kauffman S. (2008). *Reinventing the Sacred: A New View of Science, Reason and Religion*. Philadelphia, PA: Basic Books.
- Kelly K. (2010). *What Technology Wants* (Kindle ed.). New York, USA: Viking.
- Kop R. (2011). The challenges to connectivist learning on open online networks: Learning experiences during a massive open online course. *The International Review of Research in Open and Distance Learning*, 12(3), Retrieved from <http://www.irrodl.org/index.php/irrodl/article/view/882> (ultima consultazione 07.03.13)
- Mackness J., Mak S. F. J. e Williams R. (2010). The ideals and reality of participating in a MOOC. Paper, 7th International Conference on Networked Learning, Aalborg, Denmark. <http://www.lancs.ac.uk/fss/organisations/netlc/past/nlc2010/abstracts/Mackness.html> (ultima consultazione 07.03.13)
- McDonough E. F. e Kahn K. B. (1996). Using 'hard' and 'soft' technologies for global new product development. *R&D Management*, 26(3), pp. 241-253.
- Mumford L. (1934). *Technics and civilization*. New York, USA: Harcourt, Brace and Company.
- Norman D. A. (1993). *Things that make us smart: defending human attributes in the age of the machine*. Cambridge, MA: Perseus Publishing.
- Nye D. E. (2006). *Technology Matters: Questions to Live With*. Cambridge, MA: MIT Press.
- Papert S. (1987). A Critique of Technocentrism in Thinking about the School of the Future. Paper presented at the Children in an Information Age: Opportunities for Creativity, Innovation and New Activities, Sofia, Bulgaria, May 1987, <http://www.papert.org/articles/ACritiqueofTechnocentrism.html> (ultima consultazione 07.03.13)

- Rheingold H. (2012). *Mind Amplifier: Can Our Digital Tools Make Us Smarter?* New York, USA: TED Books.
- Ridley M. (2010). *The Rational Optimist: how prosperity evolves*. London, UK: HarperCollins e-books.
- Severance C. (2012). Teaching the World: Daphne Koller and Coursera. *Computer*, 45 (8), pp. 8-9.
- Siemens G. (2005). Connectivism: a learning theory for the digital age. *International Journal of Instructional Technology and Distance Learning*, 2 (1), [http://www.itdl.org/Journal/Jan\\_05/article01.htm](http://www.itdl.org/Journal/Jan_05/article01.htm) (ultima consultazione 07.03.13)
- Wenger E. (1998). *Communities of Practice: Learning, Meaning and Identity*. New York, USA: Cambridge University Press.
- Wenger E., Trayner B. e Laat M. d. (2011). *Promoting and assessing value creation in communities and networks: a conceptual framework*. Heerlen, Netherlands: Ruud de Moor Centrum, Open Universiteit of the Netherlands.
- Wilson E. O. (2012). *The social conquest of earth*. New York, USA: Liveright Pub. Corporation.
- Zhouying J. (2004). Technological progress in history: a survey of evolution and shift of research emphasis from 'hard-tech' to 'soft-tech' development. *International Journal of Technology Management & Sustainable Development*, 3(2), pp.133-148.