Chapter 7
What Happens to Infoteachers and Infostudents After the Information Turn?

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7.1 Introduction

> *The information revolution has changed the world profoundly, irreversibly and problematically, at a pace and with a scope never seen before. It has provided a wealth of extremely powerful tools and methodologies, created entirely new realities and made possible unprecedented phenomena and experiences. It has caused a wide range of unique problems and conceptual issues, and opened up endless possibilities hitherto unimaginable.* (Floridi 2003)

Philosopher Luciano Floridi describes our era as the result of an *information revolution*. The information turn has made of us *infogs* (connected information organisms) evolving in the *infosphere*: a place where distinctions between learning from digital on-line – as opposed to physical, off-line one – interactions and contents

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are less and less relevant. Let us imagine walking in the street with our mobile phone in our pocket (not a huge leap of imagination, in fact). Someone calls from far away, we answer and engage in a conversation about a strange art object we are looking at, right in front of us; a picture of the mysterious object is soon taken, and sent to the phone-friend. The phone-friend, tickled by curiosity, searches the Internet for street exhibitions in our town. Meanwhile, we approach the object, and find a code; we then point the camera of our smart-phone onto the code, and an artist appears next to the mysterious object – on the screen of our phone, of course - ready to explain the meaning of the artwork, and to guide us – GPS activated – through an entire maze of no-more so mysterious objects of art that are physically installed in town and through another maze of artworks that the same artist has created with digital tools: representations that are activated by special codes disseminated in the town and that we see on the screen of our telephone, when we point the camera on the real spot. By simply using a smart-phone one can experience that "*The digital is spilling over into the analogue and merging with it*" (Floridi 2007, p. 64), and that the real world is part of the infosphere (the picture you sent to your phone-friend). This is why the infosphere is "*now vast and infinite*" (Floridi 2007, p. 62), ICT (Information and Communication Technologies) being "*among the most influential factors that affect the ontological friction in the infosphere*" (Floridi 2004, p. 63). Friction is the resistant force to the flow of information within a certain region of the infosphere; when friction is low, information freely circulates in a way that makes inforgs – as inhabitants of the infosphere – not necessarily savvy, but at least *informed*: they have no right to claim ignorance, and they know that others know. Mobile phones have done much to reduce *friction*. They are so portable, *always in* (the pocket) and *always* (switched) *on*, that they are much more similar to glasses for short-sighted people, than to sophisticated ICT. But they *are* sophisticated ICT. This fact transforms those who wear them in nicely sophisticated *ITentities* with troubles in sight. Troubles mainly concern ethical issues, such as the risk that the digital divide – the unequal distribution of information technologies, hence: of friction in the infosphere – will generate new populations of "excluded" across and within societies.

> *As a consequence of such re-ontologization of our ordinary environment, we shall be living in an infosphere that will become increasingly synchronized (time), delocalised (space) and correlated (interactions). … Although this might be read, optimistically, as the friendly face of globalization, we should not harbour illusions about how widespread and inclusive the evolution of information societies will be. The digital divide will become a chasm, generating new forms of discrimination between those who can be denizens of the infosphere and those who cannot, between insiders and outsiders, between information rich and information poor. … But the gap will not be reducible to the distance between industrialized and developing countries, since it will cut across societies.* (Floridi 2010, p. 9)

At the same time, developing countries are showing a great deal of ingenuity in exploiting the potentialities of ICT so as to create economical and educational otherwise absent possibilities. Forms of mobile banking in Kenya and in other African countries (Greenwood 2009), as well as educational mobile practices in South Africa and India – that I will illustrate later in this chapter – even suggest a

possible counter-colonisation of ingenuous ICT practices from developing to developed countries.

Despite the potential effects (and side-effects) of the massive introduction of ICT in our daily life, the information revolution has barely modified the way we teach and learn (at least in school). Rather than happening, the information revolution is invoked, funded, measured, asserted as a goal for the wealth of the nations. However, the pace of its implementation is not the same as in business, daily social life, banking, and administration. Why? And how can ICT change the educational scenario? The first part of the present chapter discusses why education seems to be at least in part recalcitrant to the information revolution. The second part of it discusses the potential effects of the information turn on education. An exhaustive list of the best practices with ICT at school is beyond my scope, but maybe also beyond feasibility: new educational uses are invented daily for tools that were initially not conceived for education. I will thus discuss what is likely to happen to education when the Fordist model of the classroom – walls separating the school as *the* special place for learning, tables and chairs so that everybody has her own specific place, the teacher as instructor, the pupils as passive listeners – is breeched by mobile phones, video games, and, of course, the computer.

7.2 Why the 4th Revolution Hasn't Revolutionized Education, Yet

In an interview of 2004, MIT educational guru Seymour Papert proposed the following thought experiment: imagine a country where a sophisticated civilization has arisen, and where philosophy, arts, and sciences flourish in spite of the fact that nobody has ever had the idea of writing (Papert 2004). The moment arrives when paper and pencils are invented; rapid and huge transformations happen in the domains of commerce, as well as of science, and someone asks: why not education, as well? This starts a debate: should we begin with one pencil per class, or three pencils per class, or wouldn't it be better to create special classes with mountains of pencils? It is clear, Papert comments, that teachers could do interesting things even in these circumstances; but this scenario has nothing in common with the role of paper and pencils in our civilization. Yet, our society assigns to computers a crucial role in the capacity of operating with knowledge, e.g., scientists do work with computers. Only kids aren't entitled to do the same. Is it because computers are fragile objects, or is it because the "*infostudents – and infoteachers scenario*" (students and teachers inhabiting the infosphere) entails a radical change in the way we conceive education and learning?

Things have naturally changed since 2004: schools are more and more equipped with computers, as well as with other digital devices especially designed for teaching. UK is one of the leading countries for the diffusion of ICT in schools, from primary to high schools. ICT widespread in schools mostly consist in computers (1 computer per 6 pupils in primary schools), electronic interactive whiteboards,

but also game consoles; more rarely mobile phones. The number of computers naturally increases when moving from primary towards higher education, and the same is true for Internet access and bandwidth (Rudd et al. 2009). Meanwhile, teachers who have no digital literacy *at all* are becoming rare (less than 7% in Europe in 2006). And yet, the information revolution has not happened: a rough picture of the use and different distribution of computers in schools – which is not limited to the gap separating developed and developing countries - of the challenges of an evolving digital literacy, of the ambivalence towards new forms of interaction made possible by mobile phones, video games, wikis and other forms of social networking, shows a relative resistance of the world of education in terms of information friction.

7.2.1 The Recalcitrance of Education to ICT Penetration: A Rough Picture

In spite of the wide diffusion of ICT tools, even the very optimistic report produced in 2009 by Becta (the late British agency for the introduction of technologies in education) admits that there is still room for improvement, for instance in what concerns the *use* of otherwise widespread new technologies for interactive and engaging forms of learning and teaching that go beyond the projection of presentations on electronic whiteboards (Rudd et al. 2009, p. 26). In other words, even in technologically advanced contexts such as the educational British system, the *use* of digital tools is not as developed as one could hope. Electronic whiteboards and computers can still be *used* as traditional tools. This is maybe explained also by the fact that infoteachers are still far from being an established reality:

> *In the following five countries, more than 5% of all teachers are not using computers because they say they see "no or unclear benefits": Germany (10.5%), Latvia (8.6%), France (7.5%), Belgium (5.8%) and the Czech Republic (5.5%). There exists a strong correlation between this scepticism and lack of motivation to use ICT in class and the age of teachers: the older the teachers, i.e. the longer they are teaching, the more likely they are to lack motivation for ICT use in class because they do not see benefits in its use for pupils.* (Korte and Hüsing 2007, p. 22)

Moreover, the distribution of digital resources is not uniform. Let us take the situation of Europe in 2006:

> *The clear European leaders are Denmark (27 computers per 100 pupils, 26 of which are connected to the internet), Norway (24 computers per 199 pupils/23 internet connected), the Netherlands (21/20) and the UK (20/19) and Luxembourg (20/18). The figures in these countries are significantly higher than the European average of 11 computers per 100 pupils (of which 10 are internet computers). Almost all new member states belong to the group of laggards which include countries such as Latvia, Lithuania, and Poland; however Portugal and Greece also find themselves in this group of countries, with 100 pupils having to share only 6 computers.* (Korte and Hüsing 2007, p. 20)

The part of the picture devoted to the use and distribution of ICT would not be complete without considering the situation of developing countries. It is true that these are the best candidates for becoming *digital slums* (Floridi 2010); but developing countries can also surprise us, and inspire education in unpredicted ways. ICT for education is a major concern for international organizations supporting development in poor countries – such as the World Bank – and it has become one of the topics of developing countries policies. However, as stressed by Kozma (2008), policies and changes in the classroom practice (where classrooms exist, or are attended) can significantly diverge. Accurate policies can crash against digitally illiterate teachers, or pre-existing educational programs based on rote learning. It should be added that ICT policies are expensive choices, and must be justified against results, especially when developing countries are at stake. Outcomes expected from the introduction of ICT in education should hence be stated in *measurable* ways, and *actually measured* in order to monitor their effects (Wagner et al. 2005). Maybe one good reason why information and communication technologies haven't revolutionized education, yet, is because persuasive *evaluations* of the capacity of ICT to enhance, or to transform education, are still lacking.

It should also be reminded that, unlike other forms of literacy, digital literacy is an evolving competence. The 2010 version of the Horizon report (the annual issue of a research project established in 2002 with the aim of identifying emerging technologies likely to have a meaningful impact on the following 5 years' education, training and research) describes the situation as follows: everybody agrees on the importance of digital literacy, but training in digital skills is still rare in education programs; this lack is made more salient by the continuous transformation of the technology, which changes the very notion of literacy. As opposed to learning to write and compute, digital literacy is in fact always evolving, so training quickly becomes obsolete (at least training focused on tools).

> *This reality is exacerbated by the fact that as technology continues to evolve, digital literacy must necessarily be less about tools and more about ways of thinking and seeing, and of crafting narrative.* (Johnson et al. 2010, p. 7)

E.g., the Horizon report 2010 indicates the following four key trends for the period from 2010 to 2015: first, the pervasiveness of information, which challenges educators to revisit their capacity in sense-making and credentialing information that is *everywhere*. Second, the desire and possibility to work and learn *wherever and whenever*, to access information *just in time* and *on demand*; this second trend is potentially disruptive for the distinction between formal (school) and informal learning, and is especially made possible by ubiquitous computing. Pragmatically: by the development of mobile phones and mobile learning, and by the decentralisation of the IT support, we are becoming more and more used to the idea of browser-based software independent from a specific hardware device, and this is the third trend. The fourth trend is: *collaboration*. This looks more like wishful thinking, when it comes to education, but the idea is that (some) schools have created an environment and a climate in which students and teachers work together toward a common goal. So, if these are the trends for the next 5 years, what do the technologies

to keep watch over (the emerging technologies that present remarkable potential from an educational perspective) look like? Mobile computing devices (e.g. smart phones) and open content are expected to reach mainstream use in the next year; electronic books and augmented reality accessible to everyone should hit education in 2–3 years; and finally, gesture-based computers and visual data analysis are foreseen to have an impact on education in a 5 years long term perspective. Definitely, digital literacy cannot be bound to computer related skills, but becomes a matter of gaining an *attitude* towards the opportunities (and side-effects) represented by new media technologies and practices. A situation that could represent another reason for the recalcitrance of education to the information turn: because of the necessity of continuous updating, and of the acquisition of a general attitude on the side of (info)teachers.

Among new media and practices, are also included controversial items such as mobile phones and videogames. The active engagement and diffusion of videogames among learners – representing an opportunity for education for more engaging experiences – is absent from the Horizon Report 2010, but strongly present in the reflection about educational technologies; e.g., the proceedings of the 2006 Summit on Educational Games sponsored by the Federation of American Scientists (FAS 2006) open with an enthusiastic endorsement of the introduction of videogames in education:

> *Modern video and computer games offer a rich landscape of adventure and challenge that appeal to a growing number of Americans. Games capture and hold the attention of players for hours as they struggle to operate a successful football franchise, help Romans defeat the Gauls, or go through the strict regimen of Army basic training in virtual landscapes. People acquire new knowledge and complex skills from game play, suggesting gaming could help address one of the nation's most pressing needs – strengthening our system of education and preparing workers for 21st century jobs.* (FAS 2006, p. 3)

Both mobile phones and video gaming are hence foreseen (by different communities) as potentially disruptive technologies for learning and education. Their diffusion forces training in digital literacy to evolve. At the same time, the two are strongly fought by many teachers, and parents – not the indiscriminate, compulsory use of videogames, or the bad habits that teens seldom/often show with mobile phones, but their very existence and use by kids and pupils. So, while Mobile Learning (or Mobile Computing) becomes a domain of research – structured by a community of practice, a series of conferences, an association, a number of national and international projects involving developed countries as well as developing ones[1] – mobile phones are banned from schools in a number of countries (BBC 2005; Bremner 2009). Health issues and misbehaviour (from cheating to bullying) are the reasons adduced for the ban, not adverse effects on learning. The fate of educational videogames is less dramatic, but still controversial. The success of videogames for simulating

[1] E.g.: The International Association of Mobile Learning: http://mlearning.noe-kaleidoscope.org/; Handheld learning conference: http://www.handheldlearning.co.uk/; MoLeNET: http://www.molenet.org.uk/; MobileActive: http://mobileactive.org/

military and other 'serious' situations has reached the world of training, vocational training and education and produced a domain of studies called Game-Based Learning. Like Mobile Learning, Game-Based Learning gives rise to a number of conferences and projects, and the ground for a certain number of educational products (the diffusion of both is much more evident in the UK than in other countries, due to the activity of several organizations).[2] It is however not easy to evaluate the effective gain in learning that Game-Based Learning or Mobile Learning produce: controlled test are an absolute rarity in classrooms; studies on the positives effects of (video)gaming mainly concern visuo-motor coordination (Byron 2008; Mitchell and Savill-Smith 2004). Again, the *lack of evidence*, of proper measures – and more generally: of methods for evaluating the effects of technologies as complex as videogames on skills as complex as those required by schooling – could be one reason for the slow penetration of this technology, when added to the fact that videogames have raised strong, negative reactions. In the US, the National Institute on Media and the Family[3] (a private association) has been conducing a strong fight against video games, arguing from studies such as Gentile (2009) and Anderson et al. (2006) on videogame addiction and on the arousal of violent behaviours (the data only refer to immediate reactions after the game, long-lasting effects not having been measured). Supporters of videogames at school, oppose to the naysayers' view that studies on videogame addiction do not prove any causal effect of video games on negative behaviours, but just show that – in a minority of children – negative schooling attitudes and an excessive use of videogames occur together (Prensky 2006; Gee 2007a, b). However, the lack of a large, solid, shared body of evidence certainly undermines both the positive and the negative attitude. A gap exists between trends and penetration that is reinforced by the difficulty of updating skills on an evolving domain and the absence of assessments capable of proving opportunities, and measuring side-effects.

The purpose of this chapter is not to take a stand in the debate, but to show that when it comes to school education and to young learners the introduction of digital technologies is far from being neutral and technologies raise strong suspicions and resistance. What about more common tools: blogs, Wikipedia, and all the manifestations of the Horizon Report's trend number one, in a nutshell, the pervasive circulation of information? In educators' talk, we found the same ambiguity that affects games and mobile phones. Wikipedia is perhaps the most controversial issue with its "cut and paste" easy solution to homework. On par with searching a solution on the web during in-class exams, or receiving tips via the mobile phone, cut and paste in homework research and composition is perceived as a form of cheating (Bulstrode 2008; Johnson 2007). Cheating is in fact one of the bad habits attributed to technology. It is true that it becomes quite easy to answer pre-shaped, factual questions with Google,

[2] E.g.: Games Based Learning initiative, The Consolarium, LTS Scotland: http://www.ltscotland.org.uk/ictineducation/gamesbasedlearning/index.asp; Games Based Learning conference: http://www.gamebasedlearning2010.com/; Educause http://www.educause.edu/EDUCAUSE+Review/EDUCAUSEReviewMagazineVolume39/GameBasedLearningHowtoDelighta/157927

[3] http://www.mediafamily.org/

or Wikipedia. But the question is: Why blame technology, and not (at least also) the questions? It is a fact that not all questions are easily answered by copying Wikipedia entries, and that just asking students to *write* an entry would block them from copying it (and teach them about the process of writing and modifying entries). But this example shows that introducing and using new technologies in education might involve an additional change of attitude that goes beyond adjusting to evolving technologies: a change in the goals of education and in the understanding of how learning occurs. Before dealing with this issue in the second part of this chapter I will analyse the ways the information revolution could take for overcoming the recalcitrance of education.

7.2.2 The Way Up and the Way Down

One consideration arising from the quick tour we have taken in the (promised) land of infoteachers and infostudents is that formal education seems to be recalcitrant to the information revolution, or at least to approach this revolution with the pace of a slow penetration, and a huge amount of doubts. Another consideration is that policy makers seem to be totally sold to the idea that the 4th revolution should/will change school.[4] The information turn thus is really a *promised* land for educational policies, e.g. for the European Commission.

> *The Commission's policy of "information society for all" (European Commission, 2000, 2004) emphasizes the need to bring every business, school, home, and citizen into the digital age. One goal of the policy is to promote digital literacy that would provide students with new skills and knowledge that they will need for personal and professional development and for active participation in an information-driven society.* (Kozma 2008, p. 1086)

Changing educational systems from a *top-down perspective* is however a hard job. Educational systems are big machines, which have their habits and resist change. Moreover, even when policies change and rational considerations exert pressure, practices do not necessarily follow. In his influential book *Mindstorms*, Seymour Papert tells a story about how difficult it can be to change a system from inside, to unravel established habits, and ask people to move to new ones, even if the new ones are more effective or less expensive from some point of view (but are they proved to be? The problem of evidence, and proper measures cannot be underestimated). The introduction of the QWERTY keyboard on which I typed this chapter is the result of a solution to a perfectly contingent problem. In the time of old typewriters (computers ancestors in text writing), typing two letters one after the other could produce errors if the two letters were adjacent. So, it was decided to set letters

[4] E.g.: Becta: http://www.becta.org.uk/; European Schoolnet: http://www.eun.org/web/guest;jsessionid=C88D79E4E3EE7B1A7E8583DF559DF3D6; National Education Technology Plan: http://www2.ed.gov/about/offices/list/os/technology/plan/2004/site/edlite-default.html; InfoDev: http://www.infodev.org/en/index.html

that are commonly close in our words very distant from one another: professional courses in typewriting had adopted the QWERTY model, and developed training that fitted with that particular keyboard. Very soon, better machines were produced, and the original QWERTY model became useless. Nonetheless, since then nothing has changed, and we are still struggling with our illogical keyboards, and trying to explain to our kids why their so technologically-advanced computers and gesture sensitive, born-for-natural-interaction devices do not allow to quickly identify letters. The story of education could be the same as QWERTY keyboards, resisting change coming from top-down claims for rationality, efficiency, cognitive functioning. This is a good reason, Papert says, for believing that change will come from *outside* the system of education. In 1980 he prophesied that the day every child and adult would possess a computer, learning would undergo a seachange, and schools would have to follow (Papert 1980).

It is on these premises that the One Laptop Per Child (OLPC) was born, claiming that each and every child in the world should possess a computer, especially kids from developing countries.[5] The day this will happen the very idea of teaching and learning and of teachers and learners as we conceive of them will dissolve (and a big amount of social injustice will dissolve too, overcome by knowledge and global participation). For this reason, low cost (the goal – not quire reached – was to keep the cost under 100 $), low power, robust laptop computers (called "XO") have been designed, and given to about 1.6 millions of kids in the world (with governments paying for the computers). The XO is delivered with programs not directly aimed at learning, but rather at creating and interacting: each laptop is in fact connected with the XO laptops of the area so as to allow distance collaboration and sharing of the contents that kids are able to create with their personal computer. At the heart of the OLPC project hence lie the idea that a quantitative factor can translate into a qualitative revolution (a revolution hitting both education and poverty), and the view that learning is a constructive process: *children* are the agents of change, once they become active in their learning, and in teaching as well – for instance teaching their parents to read and write, as it happens in Peru. When this occurs, the information revolution has a major effect in blurring the boundaries between teaching and learning, as *infostudents* become *infoteachers*. But does this happen? In 2009, OLPC has met a big objective: a contract with the government of Uruguay to bring a green computer to every child in the country. In March 2010, Rwanda's government decided to endow every Rwanda kid from 9 to 12 with a XO laptop. Despite all this, many consider OLPC a failure (Nussbaum 2007; Dukker 2007). The number of XO sold to governments has not reached the expectations that could make it economically viable – big 'clients' such as India and China have not followed the OLPC sirens. Additionally, OLPC computers require maintenance and have to travel in difficult conditions, requiring a large and distributed organization and lots of diplomacy.

[5] The director of the project is Nicholas Negroponte, but Seymour Papert and Alan Kay (all three from MIT) are amongst the educational theorists and computer scientists recognized as being at the same time inspirers and supporters of the initiative that has seen light in 2005. OLPC: http://laptop.org/en/

Above all, even the OLPC project has somehow taken the *top-down path to the information revolution*, rather than the bottom-up path. Customers (the kids) have been involved only at the later stage of the project; the laptop, its programs and concept, have been delivered as ready-to-use – unsolicited – "gifts". Everybody knows how it feels to get a birthday gift one didn't ask for. A big surprise, but well, we so badly needed or wanted that other beautiful whatever-it-is. This could be in part the story of OLPC. Just in part because OLPC remains an inspiring and influent project, and because meanwhile the OLPC initiative has contributed to lower the price of laptops in a meaningful way. Nevertheless, some critics have expressed the idea that OLPC designers should have spent more time in India, Africa, South America villages, observing uses and needs of the local populations, namely children; and influent experts in ICT in education have contrasted the OLPC top down-model with a *truly* bottom-up approach: the steady, spontaneous multiplication of mobile phones in developed countries as well as in developing ones (Trucano 2009).

7.2.3 The Bottom-Up, Practice-Bound Stance

This is an example of the bottom-up rising of an educational project involving sophisticated but widespread technology. In 2003 a South African mobile provider launches a free instant messaging service supporting both texts and multimodal messages: MXit.[6] Penetration of mobile phones in South Africa is high, but messages are expensive. MXit thus becomes a hit, especially among teens and pre-teens. The success immediately calls for restrictions at school: MXit is seen as a drug eroding school results and social behaviour.

> *Schools are calling for tough new rules to curb the use of a cellphone instant messaging service that is becoming an obsession affecting pupils' work. And one school has already a support group for pupils who are addicted to the service, designed by a South African and called "Mxit"… Immaculata High principal Kubeshini Govender, where pupils addicted to Mxit are getting support, said: "Mxit is a drug. The learners become dependent on it." … Some chatted all night and were tired in class the next day. Others spent most of the day on Mxit.* (Keating and Williams 2006)

It is at this point that Laurie Butgereit of Meraka University launches an educational project which exploits the strengths of MXit (its diffusion, the existence of strong practices amongst teens) in order to address the need teens have for a better education in mathematics. The project (called "Math for MXit" or "Dr Math") consists of one to one remote assistance in mathematics via SMS texts (Butgerteit 2007). The tutor (a student in mathematics or engineering) sits in front of a computer and remotely answers the questions asked by students having trouble with their

[6] Mxit: http://www.mxitlifestyle.com/

homework; he never solves their problems directly, but guides them step by step to the solution, and to an understanding (as we can read from the transcriptions of the interactions). This model cannot but remind us of the way forums work. Results of the evaluation of Dr Math project are still to come, but users' comments are positive and a new project has been launched (Imfundo Yami Imfundo Yethu) which involves a Finnish organisation, the South Africa Department of Education, Nokia, and 260 Grade 9 and 10 learners from six schools for producing controlled evaluations (Vecchiatto 2009).

What do we learn from the Dr. Math (on MXit) case?

> *Math on MXit takes advantage of the fact that teenagers are* already *using MXit to communicate with their friends.* (Butgereit 2007)

First, the educational activity provided by Math on MXit is not the reproduction of something that exists in traditional education: one-to-one tutoring being a very desirable but expensive situation (Bloom 1984). We also know that African families are hungry for tutors for their kids, but these tutors are often amateurish and expensive. We hence thus a clear *need* on the educational and social side, which traditional systems can hardly fulfil. Secondly, rather than inventing new practices, and trying to make them popular, Dr Math *colonises* existing, common practices with educational purposes. In a perspective that is coherent with the information revolution described by Floridi, the principle of colonisation consists in *grafting* educational purposes into the ecology of the infosphere. When students go to school they are taken away from the "real world": the infosphere, with its practices and its ecology made of phone cells, messages, and a wide variety of ways of producing and sharing information. Once back home they are inforgs again (they start again mxing, gaming, surfing the net). Colonisation represents an ecological approach to bringing the information revolution in the domain of education.

What would the opposite scenario look like? Something like this: a brand new technology that students (and also teachers) do not know how to use is added to the classroom. Moreover, this unpractised technology does not bring a new function into the educational panorama, but it is limited to the *electrification* of pedagogical activities, tools and roles that can be very well realized in more traditional ways (Casati 2009). In other words, technology is used as a modernizing paintbrush or as a form of electrification of books, teachers and blackboards.

To conclude, the 4th revolution is yet to reach education, for several reasons among which we can cite: the lack of appropriate and shared evaluations of effects and side-effects, the difficulty of upgrading to continuous changes in hardware and practices, the challenge to educational habits. Moreover, injecting technology is not enough and changing educational habits is such a hard job – prone to the mistake of simply adding some digital make-up onto traditional activities. The way for the 4th revolution to come and invest education could be then be better represented by a form of *ecological colonisation of existing, widespread technologies and practices*. A double colonisation, since this model comes from brilliant ideas spreading *from* developing countries: will innovation in education be the place for a counter-colonisation?

7.3 What Is It Likely to Happen to Education When the Information Revolution Happens?

Even if it is true that education is recalcitrant to the information turn, it is still reasonable to question whether the perspective of ICT spreading to education is a desirable scenario. There is in fact no consensus on this issue. Some fear the deepening of the digital divide which afflicts developing countries, and which adds its negative effects to those of a number of other gaps. Some (defined by Seymour Papert as "critics") think that the extension of new technologies is not desirable at all, even in the perspective of developed countries (Papert 1980). The critics believe that computers can make a difference, but that this difference is not worth pursuing. So, for example, some critics propend to accept that video games have an effect on young minds, and that video games can "teach", but that what they teach is violence, short attention span, immediate gratification (Anderson et al. 2006). Or that reducing the friction in the circulation of information can endanger education, because it creates a sort of "information overload"; e.g., president Barack Obama has recently rallied technophobics (according to The Economist) asserting that information can become a distraction for learners:

> *With iPods and iPads and Xboxes and PlayStations – none of which I know how to work – information becomes a distraction, a diversion, a form of entertainment, rather than a tool of empowerment.* (The Economist 2010)

President Obama has not condemned ICT as a whole (it would have been rough for someone who has made an exemplary use of the Internet, and is still making an unprecedented use of Twitter and YouTube). According to The Economist's analysis, infopresident Obama's speech implicitly contains a distinction between good, empowering information and bad, distracting information. Still, the discourse was addressed to students of Hampton University, and the quoted sentence could thus be interpreted in the following alternative way: information is not good or bad in itself; yet, when educational environments do not limit the pervasiveness and free circulation of information (when the infosphere becomes frictionless) it becomes difficult to attend to the information proposed by the teacher in the classroom. It is not untrue that sending SMS messages, consulting YouTube or even Wikipedia is incompatible with the Victorian model of the classroom, where a teacher speaks to listening pupils. But this is not the only, possible scenario.

In addiction to critics, Papert introduces two other categories of attitudes towards ICT in education: "optimists" and "sceptics". Optimists believe that computers can make a *qualitative difference* in learning; it is not just a matter of improving instructional teaching and school education, but of empowering individuals to choose the way they want to learn by creating learning tools that can be used outside schools: ICT *augments* education, in the sense that it changes education into something, which can benefit from the entire infosphere. What grounds the optimistic attitude is the view that learning is a cognitive process, which goes beyond dedicated instruction

(school): people learn from their experience, all their lives; children learn from their environment and culture. Changing the furniture of the environment, changing the tools and habits that are part of the culture, also changes the way we learn, and think. Floridi would say that this produces a re-ontologisation of the learning environment, a transformation of its intrinsic nature (Floridi 2007). For instance, infolearners will ask for different schools that correspond to their way of learning, and to their idea of knowledge: knowledge which is accessible anytime, anywhere; knowledge which is constructed by multiple, interconnected intelligences; and knowledge which is gained through active patterns of search, hence meaningful from the searching individual's perspective. In the framework of this massive change information overload no longer is a problem, because the very structure of educational contexts, methods, and aims is transformed by the expansion of the infosphere. On the opposite side, sceptics do not expect the presence of computers to produce a massive change in how people learn, and think; according to them, all that ICT can do is to *enhance* instruction (as opposed to augmentation), by providing a means for better teaching in schools. Interactive whiteboards can be considered as "enhanced" blackboards, which allow teachers to display multi-modal contents (images, videos, charts) and to save exercises and notes; this is a lot more than can be done with a traditional blackboard, but it does not represent (or at least, not necessarily) a revolution in how students learn, and teachers teach.

The three categories described by Papert do not belong to the same "natural kind". Critics and optimists both believe that ICT will produce a radical change on learning and thinking, but they evaluate differently the *desirability* of its effects. Sceptics do not hope or fear, they just don't *believe* (or *estimate*) the information turn to represent a massive change for education. We obtain two axes along which different positions can be aligned. E.g., (Aviram and Talmi 2005) draw a matrix along two axes they call *approaches* and *attitudes*. Approaches range from the assumption that technology can be subsumed under the traditional school and curriculum – and that its introduction has a qualitative but not a "revolutionary" effect – to challenges to the very notion of school as a physical space and to its aims. The transition from one extreme position to the other is represented by seven beliefs: a. that computers should simply be present at school as they are everywhere else; b. that technology should serve curricular purposes, by becoming a discipline (computer science) or by taking advantage of ICT for teaching the subject matters included in the current curriculum (e.g. sciences or maths); c. that new technologies are part of a change in the way contents are taught/learnt at school (for instance, through more constructive and interactive methods); d. that the whole organization of educational spaces and time, roles and curricula is changed by the advent of ICT; e. that school disappears in favour of remote and even virtual schools; f. that ICT in education is part of a deep cultural revolution ; g. that change should be shaped by values (Aviram and Talmi 2005). The cultural approach that characterises f. fits particularly well with the philosophy of information proposed by Luciano Floridi, because it recognises that ICT has a re-defining (re-ontologising) impact on our

way of living and thinking about things, and because it acknowledges the fact that the educational revolution is part of a deeper revolution that has transformed Western culture.

> *The cultural approach is quite rare in discussions on ICT and education. Those who rely on it are mainly academics, intellectuals or futurists. The approach remains unknown to many teachers, and even to many academics. Adherents of the cultural approach maintain that educationists should be aware of the revolutionary, defining nature of ICT, and strive to adapt the education system to the new culture. Such adaptation could take diverse routes. One may judge the rising postmodern culture favorably and recommend radical changes in the school structure in order to adapt it to the new 'human situation' (what we call below the 'radical' attitude). Conversely, one might judge it unfavorably and opt for preserving and strengthening the existing structure of education (the conservative attitude).* (Aviram and Talmi 2005, p. 171)

As for the second axis, Aviram and Talmi distinguish five attitudes, which can be driven by goals: those of i. agnostics, ii. conservatives, iii. moderates, iv. radicals and v. extreme radicals, ranging from those who do not care about what the impact of ICT would or should be, to those who "*believe that ICT is a Trojan horse inside the base of the prevailing educational system, and that the latter will not (and, quite often, should not) survive it.*" (Aviram and Talmi 2005, p. 172).

In what follows I will illustrate some examples of what Trojan horses could look like, and their potential effects on the Victorian school. The process of bringing the effects of the information revolution into formal education is slow because formal education has created special places for learning, and these special places tend to keep learners separated form the world. Trojan horses can enter the heart of the educational system: school; but they can also settle in the periphery of the citadel and slowly change the perception of what education is (i.e., re-ontologise education).

7.3.1 Trojan Horse No 1: Computers

"Hole in the wall" is an initiative aimed at slums and poor villages in India, imagined and realized by Sugata Mitra (now professor of Educational Technology at the School of Education, Communication, and Language Sciences, Newcastle University). In 1999, in Kalkahi (a poor borough of New Delhi) a real hole was made in the real wall separating the NIIT (the learning solutions corporation Mitra was working with) from the adjoining slum: a computer was slipped into the hole, for free use. Children came, spontaneously, and started using the computer to look up information on the Internet (videogames and CDs have also been employed in further settings). Many skills were required, which the kids did not possess yet: to use a mouse, to understand how a web page is structured, and most of all to read English – a major issue for education in India, where English is the mandatory requirement for the access to higher education. The observation of kids operating with the computer, coming back day after day, getting better at digital literacy, and collaborating, came to reinforce the pedagogical stance that Mitra has since then identified as "Minimally Invasive Education" and "unsupervised learning": learning

that develops from the natural exploratory activity of children, especially when children are brought *together* and interact with an object, which is able to deliver *information* in different shapes (Mitra and Rana 2001). This same model has been exported from India to Cambodia, to Africa, and even to UK, as a project named "Self Organised Learning Environments" (Mitra 2009).

> *"Minimally invasive" refers to the least possible, negligible, or the minimum help required by the child to initiate and continue the process of learning basic computing skills. This minimal amount of help from other children at the MIE learning station is necessary and sufficient for the children to become computer literate. This "help", which is the fundamental aspect of MIE, could be from peers, siblings, friends, or any other child familiar with computers. Children are found to collaborate and support each other. The learning environment is characterized by its absence from adult intervention, openness and flexibility. Children are free to operate the computer at their convenience, they can consult and seek help from any other child/children, and are not dictated by any structured settings.* (Mitra et al. 2005, p. 3)

The method is meant to apply whenever there are no real teachers at hand, at least of good teachers (because they will not accept work in remote parts of developing countries; as well as of developed ones). Many solutions have been put in place, in the world, to compensate for this absence – special books, radios transmitting courses to the classroom (and the physical teacher), educational TVs, open universities and what is called e-learning, or learning at distance (through CDs, the Internet or even mobile phones) - all with a common denominator: being addressed to the individual learner, or to the individual learner as immersed in a typical classroom structure (as when learners look and listen to radio and wait for questions posed by the teacher or take their exercises on a mobile phone) (Trucano 2005). In Minimally Invasive Education this modality is challenged twice: first, learners become teachers for other learners (they *peer-teach* each other in groups); and, second, learners *search* information, instead of receiving it as a form of instruction, or of test (which is not to say that instruction and tests are not useful and effective). MIE has turned out to be effective, at least for the acquisition of computer literacy: children collaborating around a computer reach levels of digital literacy, which are comparable with those acquired by the means of traditional classroom instruction (but it should be acknowledged that they normally spend more time interacting with the computer than children using the computer at school) (Mitra et al. 2005). This means that a minimal investment (much less that one computer per child) could make the difference in terms of digital divide (which has been cited at the beginning of this chapter as a major ethical preoccupation in the information age). Moreover, the Hole in the Wall experience points to an issue, which is deeper than the positive effects of MIE on digital literacy and divide: a *different way of learning* is made possible – or at least made easier – by the fact of living with other inforgs in a rather frictionless infosphere (friction being reduced in this case by the presence of just one computer). This form of learning is *self-directed*, *collaborative*, and *independent from formal structures* and settings.

Would it have been possible to achieve the same result before the information turn? In other words: is the fact that information can freely circulate a necessary condition for this form of learning to exist? A thought experiment can shed light on

this question: let us imagine a group of children wandering among the scrolls of the Ancient Library of Alexandria; certainly, they did access large quantities of information; however, those scrolls could not respond to their actions: they would not close in response to a bad search. Computers do. Sugata Mitra describes the discovery of one of the first "Hole in the wall children": he touches touching the screen in a certain way and sees the page disappear, another appear; the kid then goes back and forth in search of new reactions from the machine. Tools of the information turn do react to learners' actions (and to states of the world, if they have a GPS, or whatever kind of sensor) with a change in their informational content. They can thus become part of a dialogue in a way books, radios, cinema (and even just reading a Wikipedia page) cannot afford.

Hole in the wall and MIE is however a rather extreme form of *no-schooling*, confined to places with no school to choose as an alternative. Few parents in Paris, London, Rome, New York, Singapore, Tokyo, would choose to send their children playing with a computer in the street, *rather than* going to school. But some children, even in these big cities, do not want to go to school: they quit, disengage, suffer school phobia, or illness. Is there an alternative to bringing them back to the classroom? Forms of no-schooling or virtual schools have been tested: learners do not meet physically, do not collaborate in presence, but only at distance, and via the computer; they receive some form of follow-up which is somewhat more "invasive" than Minimally Invasive Education. Notschool project, originally founded by Stephen Heppell, aims at reengaging students in the learning process, without imposing a school environment: learners have access to chat rooms, mentors (one for six learners or researchers), and a virtual community.[7] In 2007 the project included 1,000 learners, with 96% obtaining some form of accreditation. The principle behind Notschool is the principle that education can reach learners everywhere: they do not need a *physical* space called school (which does not mean that schools should not exist). What makes it possible is the existence of a continuous flow of information, and of high bandwidth.

7.3.2 Trojan Horse No 2: Mobile Computing

We have seen how computers can transform learners into infoteachers and breach the walls of schools (re-ontologisation of authority and space). Schools are also time-organisers, defining which is the moment for learning, and which for entertainment (not during the lesson: information overload), for play, and for socialising. Does the information turn also affect (re-ontologise) our perception of time and, in particular, the idea that there is a time for learning and a time for doing other things? I think this particular re-ontologisation could depend upon the spread of two practices, which I have cited as influential on education in the first part of this chapter: mobile learning and serious gaming. Let us consider them in turn.

[7] Not School: http://www.notschool.net

Mobile learning is a recently minted label in the domain of technology-based education; it refers to the use of mobile technologies, such as mobile phones, PDAs, and even portable game consoles, or, more deeply, to the notion of *mobility*. Let us go back to the scenario described in the introduction: the mobile phone is used for taking pictures of the real world, digitalizing them, and plotting information of different sorts against real objects. There no fixed time for doing this: the user chooses when to take her phone out of her pocket. This is why it is said that mobile learning is *anytime*, and not only *anywhere* (Ally 2009). This *mobility over time* can represent a great advantage for learners who have strong temporal constraints: working people trying to learn a new language or skill while going to their job, travelling people; but also students going to school and wanting to learn more in between home and school. E.g.: a teacher in India, attending a 1-week course in order to improve her capacity to teach English to her pupils, can also have the same course, and the exercises she needs to practice, on her smartphone, and bring them with her in the small village she has been assigned to. Once there, she will be able to consult the lessons, and revise them through the exercises, at any moment she needs it; she will also be able to send SMS for checking the answers, or asking questions to her tutor.[8] A kid in an isolated village of India, with no Hole in the wall kiosks around, can still be involved in a project like Millee[9]: smartphones are given to kids who can use them at any time for playing special games for learning (serious games; the contents of the game reproduce games that kids "physically" play in their village), as well as build projects in schools (kids take pictures, create their own contents, and show them at school). The incredible growth of mobile phones (even smart phones) in developing countries is then a positive premise for the spread of an educational use of mobile phones, for both children and for adults (Traxler and Kukulska-Hulme 2005). Adult population is a major target for educational actions aimed at reducing the gap between developed and developing countries, in terms of access to knowledge (general and digital literacy). Mobile phones could represent one of the most powerful (in terms of penetration and opportunities) Trojan horse for this population to access the infosphere and, through the infosphere, to raise literacy in developing countries (in all those contexts where literacy is the limit). This is also because mobile phones are flexible tools, in the sense that they can serve at least three kinds of uses. First, as computers, mobile phones allow accessing and producing digital information: taking and sending pictures (and videos), recording and listening to sounds and music, playing games, reading and writing, accessing the Internet as passive and as active users (Prensky 2005). Let us imagine a student spending some time in London in order to perfect her fluency in English. Of course, she has joined a "traditional" course, but she also has a mobile phone. With that, she walks in the street, where she impolitely listens at conversations: she catches words, and phrases she does not know, and she notes them on her phone, using it as a log.

[8] English in Action (Open University): http://www.englishinaction.com/

[9] Millee: http://www.millee.org/

Or better, she searches for their definition on Google, she writes SMS to course mates and tutors and ask their advice on the particular problem she has met (Kukulska-Hulme 2009).

Second, mobile phones sense the environment, and respond to it: bar codes scanners, GPS, compasses, accelerometers gyroscopes embedded in smartphones are sensors that allow multiple applications: from augmenting reality with digital contents[10]; to write on the phone just writing words in the air (Agrawal et al. 2009); or to write on a projected keyboard so that even physical action in the world becomes digital information and command for the machine (Maes and Minstry 2009). Even walking can become digital information, with an iPod (if one wears Nike shoes).[11]

Third, mobile phones are tools for communicating (via voice, texts, and images) with other individuals, and also with machines (Sharples 2005). One can receive tips about lessons, be put in a network with other learners that are interested in the same topics, by automatic systems for managing networking and administration in a University campus (Brown 2008). In some cases individuals and machines can be combined in such a way as to become one indistinguishable information station. Imagine being in a remote village of Cameroon, and badly needing to know who is the richest man in the world, or what is the price of tomatoes today, or which is the right pesticide for your dying plantation. Imagine not having access to Internet, at least not directly, but owing a mobile phone (and some credit), and a number to call, where an operator takes the question, searches the Internet, and provides the answer. A smooth flux of information, a frictionless infosphere is established up to the remotest corners of the planet, if one can make a call, even in the absence of the computer functionalities. This is the lesson of Question box project: a service for calling an operator who searches the infosphere, from dedicated phones distributed in Indian villages, or from one's own mobile phone in Cameroon.[12]

The three uses just mentioned can affect the way we conceive access to information, knowledge and education, in a way that goes beyond the *anytime, anywhere* refrain.

First of all: learners can access information when it is really needed, when it is meaningful. Accessing information *just in time* has potentially large consequences, which go beyond education. Knowledge does not necessarily need to be stored in mind, when one knows where to find information and how, and if one is *confident* that one will be able to access it at any moment. Mobility is hence a premise for considering ICT as a form of *cognitive extension* (Clark and Chalmers 1998), for instance a memory extension, which is not so different from "internal" or "brain" memory. As memory, mobile phones are always with us, always on. This does not mean that there is no difference between internal processes and extended ones, but that ICT tools can be used as cognitive tools with an effect on cognitive actions and performances. It is obvious that the fact of possessing mobile phones wouldn't have changed the necessity for people living in Ray Bradbury's Fahrenheit 451 world

[10] E.g.: Layar http://www.layar.com/

[11] Apple-Nike: http://www.apple.com/ipod/nike/

[12] Question box: http://questionbox.org/

to learn entire books by heart, in order to save them from burning. Mobile phones can burn, too (actually, we could imagine a future where memory can be selectively erased; but it is the future).

Secondly, learning can happen *in context*. While other media tend to set a separation between the learner and the physical world, and between digital information and physical objects, mobile phones allow a perfect integration of the two: they take the learner out of the box (Van der Klein 2008). Thus, in mobile conditions context can affect learning in two complementary ways: objects raise questions, which learners can answer through the help of digital information (augmented reality mode); and objects provide answers to questions raised by digital information (augmented digital representation mode). An educational project developed by Waag, a Dutch company, illustrates the second mode: grouped in small teams, young learners follow a quest in the Medieval streets of Amsterdam; they walk in search of monuments in order to answer the problems raised by a video game for mobile phone; at the same time, they stay in contact with residential teams searching the Internet with computers.[13] Mobile phones thus allow a form of experiential education, as Dewey described it in the last century: where knowledge is acquired through experience (active exploration), and connects to the learners' experiences (interests, motivation, life) (Dewey 1997).

7.3.3 Trojan Horse No 3: Serious Games

Experience is a key word for the vision of education purported by John Dewey, a vision never fully realized. Lack of appropriate means could explain it. So, let us see what happens when new technologies are employed to make experience possible. In the 1990s, a group of researchers of Vanderbilt University, coordinated by John Bransford, launched a long-term project devoted to designing and testing a method for the learning of sciences, which would comply with Dewey's considerations about experience, and with the notion of inert knowledge as introduced in 1929 by another philosopher: Alfred North Whitehead (CTGV 1990). Whitehead had claimed, in front of his colleagues, that Victorian school provides students with a form of knowledge, which is not used for anything but for responding to tests (Whitehead 1929). This knowledge is inert, because schools teach broad, but not deep, and because they disconnect knowledge from the reasons of its existence, from the contexts of its application. But in Whitehead's view, as well as in Dewey's, pieces of knowledge are nothing but tools, which help people coping with the world. This is also the perspective adopted by Bransford and colleagues (and they certainly are not the only ones) in proposing an anchored instruction method for learning maths, pivoting around the videotaped adventures of a fictional character: Jasper Woodbury (CTGV 1990). Jasper finds himself driving a boat or a plane, and facing

[13] Frequency 1550: http://freq1550.waag.org/

problems of fuel, distance, time. At the end of the movie, students are asked to plan the solution to the quantitative problems Jasper is faced with, and to compute. Instruction is thus anchored to "real" contexts, and mathematical tools serve to solve "real" problems.

Twenty years later, this same approach is proposed in the framework of serious (video)gaming: not only are concrete problems posed to learners in the context of the representation of a certain situation; but learners are asked to find the solution and to implement it directly in the game (something that was impossible with non-interactive technologies like videotapes). Serious games, as well as simulations without gaming (the difference being that simulations have no winners, no reward and no competition), have spread in a number of domains: military training – including the simulation of social interactions with civil populations – surgical training – including training on virtual frogs in school using dissections – the training of pilots – also to earn a (real) licence to fly civil planes, with no other experience than driving military planes. Going back to Jasper Woodbury, games have been *designed* for teaching and learning biology, physics, history, and mathematics (Prensky 2005). Commercial Off-The-Shelf games (COTS) are currently used in schools for stimulating children to write and imagine scenarios, for inviting them to collaborate around the organisation of events, for increasing efficiency and speed in elementary computation, and for all those learning activities, which inventive teachers can imagine from diverting commercial products from their original aim and colonising them with educational purposes (again) (Felicia 2009).

Naturally, the idea that play is important for children, and even for learning, is not new: it is not a product of the information age, or of the videogame industry. Historically, the first theories of play were purely descriptive and aimed at finding a role for play in the human development (from the end of the nineteenth century). The normative idea that play should be exploited for learning is more recent; among others it has been asserted by Maria Montessori, and is still implemented by schools inspired by her vision. Still more recently this same idea has been revived by the advent of videogames, and has given birth to what is called Game-Based Learning, or better: Digital Game-Based Learning (Prensky 2005; Gee 2007a, b). It has even been asserted that modern videogames (whatever their original scope) are machines for learning: players must learn how to play in order to enjoy the game; if the game does not facilitate learning, then the designer is out (Gee 2007a, b). This strong constraint would be the reason why videogames embed very efficient pedagogical principles: learners feel like active agents because they make things happen; learners form expertise by practicing skills until they are nearly automatic, then having those skills become insufficient to face new situations in a way that makes it necessary to think and learn anew; learners are put into fish tanks that are similar to real situations for their structure, but without the dangers and excessive complexity of the real world: only certain variables are selected and stressed ("*With today's capacity to build simulations, there is no excuse for the lack of fish tanks in schools*": Gee 2007a, p. 39); players do not start from the manual, but from playing the game and then going to read the manual for knowing more ("*Game manuals, just like science text books, make little sense if one tries to read them before having played*

the game": Gee 2007a, p. 38); hence learners can start from experience rather than from general definitions and principles; and, naturally, learning and pleasure are joined together.

> *Pleasure and learning: For most people these two don't seem to go together. But that is a mistruth we have picked up at school, where we have been taught that pleasure is fun and learning is work, and thus that work is not fun*. (Gee 2007a, p. 10)

So, at the same time, games (digital or not, but it is a fact that the discussion has been revived by so-called Digital Game Based Learning) question the distinction between time for learning and time for pleasure, and make it possible or at least easier to challenge the idea of education as the *transmission to the new generation of bodies of information and skills that have been worked out in the past* (Dewey 1997), because digital fish tanks are ideal tools for experiencing simplified, models of reality that are designed for pedagogy.

New technologies, or better: the way they are *practiced* in some exemplary cases, challenge some of the tenets of a model of schooling and education – a model which probably is not realised in its complete form in any school of the twenty-first century, but that is present in our vision of education, positively or negatively.

7.4 Conclusions

In the preceding sections, I have identified the Victorian school with a number of characteristics: a dedicated space (separated from other social enterprises and physical places), a dedicated time (the time for learning), well-defined roles (one teaches, the others learn), and contents (inert knowledge). I have shown that all these characteristics are challenged by practices that have become possible *after* the information revolution, even if this does not mean that they will be transformed.

The pervasive flux of information is a potential Trojan horse into the traditional structure of education. Firstly, ICT practices spreading in developing countries, and in especially "deprived" conditions (in terms of educational systems and access to literacy), can be colonised by educational purposes; and, secondly, alternative educational practices with ICT can challenge all those who are interested in education to revise their conceptions about education and learning.

Understanding that social structures (as school) and concepts (as education) can also become *different*, opens the door not to one, but to number of alternatives, because it is a process of de-naturalisation. Concepts are not frozen, "natural" entities. They live their life in the middle of contracts, negotiations, practices, and debates. They have a history, and a context from which they take their meaning. When the context changes, concepts can undergo mutations. If they don't, they become obsolete and are replaced (as it has happened to the notion of phlogiston). That's why examples are important to me, and I have used many in this chapter. It is the old Wittgensteinian methodological rule: see this way, and now see it the other way, but do not stop seeing it other ways. The effect is that we acquire what

Robert Musil called the sense of possibility, as opposed to the sense of reality. So, the fact that new, alternative practices spread does not mean that schools will or should be closed – unless they prove ineffective in relationship with the objectives they assign to themselves; or unless these objectives conflict with wider objectives, which become dominant in the society surrounding and supporting schools (principle of reality). However, the spread of new practices certainly forces us to re-conceptualise what we intend when we talk about schools, education, learning, and knowledge (principle of possibility). For example, peer-teaching practices and self-directed learning induce a mutation in the notion of authority and of education as the transmission of knowledge from someone who possesses information to hollow learners. At the same time, the distinction between formal education and informal learning becomes less important, because learning is no longer bound to official places for transmission.

In the context of information, which is accessible anytime, anywhere, on demand and just in time, even the notion of knowledge as something we possess in our brain undergoes some adjustment. In certain respects, our mind can be considered as an extended structure encompassing the brain under the scalp *and* of the tools in our pockets. In this perspective, the idea that school should transmit all the contents, which *may* be needed in the future becomes redundant.

Thus, it becomes more reasonable to concentrate on learning deep, rather than on learning broad; also because of the possibility of learning from experience in concrete – even if digital – settings that are models of reality with a stress on relevant variables, and relevant variables only. If this re-conceptualisation sounds too extreme let us just side with sceptics, and leave big re-conceptualisations to optimists.

7.4.1 Further Research Directions

As we have seen, the main difference between optimists and sceptics lies in the following opposition: on the one side, the idea that when the infosphere extends to schools, frontiers between schooling and no-schooling are redesigned, as it happens to physical and virtual artefacts in augmented reality (*augmentation*); on the other side, the idea that friction in the circulation of information will always make a difference between places inside the educational system and places outside it, because ICT will be functional to enhance the present state of affairs (*enhancement*).

Evaluation (and the definition of proper systems of evaluation that are apt to monitor the achievement stated objectives) is a crucial condition for asserting that (a certain) technology represents the best tool for *enhancing* education. If we can prove it works, it will become easier to foster the use of new technologies in school, in order to enhance students' performances. Accountability and a systematic use of evaluation and test applied to choose the best teaching strategy is the key for the identification of *good tools*, and for the spreading of ICT tools (that are worth spreading). Some (radicals) might argue that this is not a big gain, and certainly not a revolution in education.

If we shift to the *augmentation* scenario, then measures become more difficult. The difficulty stems from the definition of the objectives of education: do they remain the same as traditional school (learning sciences, and maths), or do they undergo a redefinition? Once schooling and no-schooling have blurred their respective boundaries, one could argue, the aims of education will have changed in a meaningful way. If this is the case, it becomes difficult to prove that ICT represent a gain in comparison with more traditional tools. Accountability and the systematic use of evaluation is no more the key for the spreading of ICT in education.

Philosophical choices about what do we want education to be, in relationship to our description of the world, are now at the heart of the problem. For instance, one can assert, as Mitchell Resnick does, that – in order to cope with twenty-first century issues – soft skills are more important acquisitions than plain, factual knowledge: we live in a world, which has accelerated its own pace of change, because of ICT (Resnick et al. 2009). ICT can help us cope, by making learners more creative, and capable of acquiring the twenty-first century skills: capacity of collaboration, of communication, of management, of directing one's own work. Others could adopt a different image of the twenty-first century, or believe that the principles of education are eternal: citizenship, respect of the other, progress of the learner as a human being, self-empowerment. Evaluations are still possible (dues), but it is very important to recognize that they correspond to specific (and clearly stated) objectives.

It is also important to avoid a major mistake, which consists in believing that ICT *per se* is a sufficient condition for transforming Victorian classrooms into playful spaces, where learners make (real and virtual) experiences and learn to evolve in the infosphere thanks to the tutoring of a variety of infoteachers. What we have seen is that *practices with ICT* exist that can challenge the tenets of traditional education. So, it is the diffusion of practices and not simply of technologies that makes the difference. We should fear that infostudents are asked to use mobile phones and the internet for retrieving and memorizing Napoleon's date of death. I claim that up to a certain point, ICT is neutral to educational models and contents. Hence, that an effort towards a rich and innovative use of ICT must be done, which goes beyond endowing classrooms with computers and interactive whiteboards. This effort consists in imagining different forms of education, in defining their scopes, in diffusing *new practices* (or better: in colonising widespread practices with educational aims), and in *evaluating* their results.

Still, this is only part of the story. Another part concerns the development of a new research field in education, capable of integrating research on technologies and information, and studies on the functioning of mind. This field is still in its infancy, but it promises to bring about serious challenges (and eventually confirmations) to the way we conceive school.

Let us take the case of the idea that education consists in transmitting information from teachers to learners. This idea is strongly connected to the metaphor of learners as hollow boxes, which should be filled with knowledge for a supposed future. This metaphor is at the same time challenged by practices with mobiles and games, and by the research on early knowledge in babies, and on the existence of naïve beliefs that pre-exist (and eventually resist) formal education (Bransford et al. 2000).

From the first years of their life, kids perceive the world as being structured: they use criteria for parcelling the flux of stimuli into separated, consistent, dynamically coherent objects; they distinguish between non-animated and animated entities; they get habituated to regularities, and show surprise when faced with violations of expectations. They also develop beliefs about how the physical, the biological, and the psychological worlds work, and interpret events in terms of these beliefs, which, quite often, can reveal false when compared with scientific theories of the same phenomena. Replacing or updating false beliefs is referred to as "conceptual change", and it is a big challenge for education. This wouldn't be the case had the hollow box been a correct image: hollow boxes do not oppose any resistance at being filled in. But learners, whatever young they are, are not hollow boxes. They are rather complicated interpreting machines that use what they know and their previous experiences to make sense of new events and of the world.

As well as technologies, knowledge from cognitive science is challenging some of the tenets of education and suggesting that education should start from *how we learn* (hence from the observation of good practices and the study of mind) rather than from the consideration of *what is useful to learn* (even in the twenty-first century perspective). How their joint venture will be able to affect education is more a matter of *will*, than of divination.

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