The 'One Laptop Per Child' XO laptop as a PLE

A cognitive artifact beyond hardware and software

Fabio Serenelli, University of Milan Bicocca, Italy – fabio.serenelli@unimib.it
Andrea Mangiatordi, University of Milan Bicocca, Italy –
a.mangiatordi@campus.unimib.it

Abstract

Personal Learning Environments can be defined under different points of view:

- *technically, they are a hub for contents and contacts related to the learning experience of a single person. They can be composed by both desktop and web applications, with every piece of software supporting the user in a particular task;*
- *in opposition to Virtual Learning Environments and LMS, they prefer the usage of independent (even if interrelated) web 2.0 applications, following the 'Software As A Service' model;*
- *socially, a PLE is a set of instruments which gives value to individual contributions in a learning ecosystem.*

What we wonder is if a PLE can be at the same time a cognitive artifact and a physical object. Can it have a concrete form, can it also be hardware? What can turn an 'object' into a PLE? The OLPC XO laptop seems to answer these questions. Its Graphical User Interface (GUI), called Sugar, can balance individual and collaborative learning instances. The whole user experience is based on social networking. The XO is a child-centered device, reflecting the way children think and interact with the social and informative context. XO is an inclusion instrument in the learning environment, by the fact it is an equalitarian, basic dotation for everybody. But this laptop is also an inclusive learning environment: it is in the hands of all the actors of the educational process, from teachers to children. In OLPC deployments, technology becomes a commodity, the computer becomes invisible. Being a context-variable, being part of the infrastructure for networked learning, the XO is:

1. a cognitive amplifier: a machine designed for children and equipped with software which can empower their cognitive potential (computation abilities, memory, writing skills, etc.);

2. a relational amplifier which can connect (automatically) its owners on various levels (Metcalfe law: the network value increases as saturation increases);

3. a platform to access instructional contents which can be online or can be hosted by the machine itself;

4. an instrument for sharing knowledge and, in presence of internet access, for publishing;

5. a knowledge-creation tool by the means of individual and collaborative activities.

1. Introduction

This paper introduces the idea that a particular *cognitive artifact* composed by a hardware device, together with the special software designed for it, can be considered a Personal Learning Environment. This machine could be the "XO laptop" designed by the NGO known as 'One Laptop Per Child' (http://www.laptop.org).

By allowing its users to share contents, relationships and user experiences, this ubiquitously present machine is surely having an impact on the communities of learners in which it is deployed.

Even if OLPC has been criticized for its uneffectiveness in enhancing the learning experience of the children involved in the various deployments around the world (Fox Buchele, 2007), the fact that a possibility of building a PLE was given to those children is still there.

The paper is organized as follow: chapter 2 describes the background of the OLPC project and explores the most accepted definitions of PLE. In chapter 3 the Sugar Learning Platform is described as a PLE for children. Chapter 4 introduces the hypothesis that a PLE can be considered as a *cognitive artifact*. Chapter 5 explores a new concept of PLE as a "*borderware*" beyond hardware and software and presents the last XO-3 hardware concept as a concrete example of *borderware* PLE. Finally, chapter 6 draws some conclusions and depicts some research ideas for the near future.

2. Backgrounds

This chapter describes the foundations of the OLPC project and explores the most accepted definitions of PLE which can be found in literature.

2.1 The "One Laptop Per Child" project

According to the milestones listed at http://wiki.laptop.org/go/Milestones, the One Laptop per Child project was first announced by its founder Nicholas Negroponte at the World Economic Forum in Davos, Switzerland, in January 2005. The initiative was founded by a strong group of hardware, software and digital services producers (http://laptop.org/en/utility/people/members.shtml).

The mission statement of the project clearly defines it as "an education project", and not "a laptop project" (http://laptop.org/en/vision/mission/). The initiative produced a low-cost laptop - known as the XO laptop - with low power consumption and resistant to physical damage. The Operating System is totally open source, based on the Fedora Linux distribution (http://www.fedoraproject.org), and adopts the Sugar (http://www.sugarlabs.org/) graphical interface. Sugar adopts a zooming metaphore instead of the classic desktop paradigm.

Among the five principles which constitute the pillars of the project (http://wiki.laptop.org/go/OLPC:Five_principles) there are three which are considered of particular interest for this work: *child ownership*, *saturation* and *connection*. By owning the laptop, children feel free to customize it, in order to adapt it to their preferences and needs. The saturation of the schools with laptops turns technology into an environmental variable, which is present by default and is the same for all schools and all children. Connection fosters exchange and cooperation, allowing every node of the network to communicate and share resources with the others.

2.2 The emerging PLE paradigm

E-learning vision is still focused on trainers' needs and e-teaching processes rather than on the invoked learner centered approach. In the last decade, a lot of improvements have been implemented in e-learning environments such as LMS and VLE; they actually offer a rich range of features based on constructivist and socio-constructionist principles (E.g.: moodle, http://docs.moodle.org/en/Philosophy). Unfortunately, teachers and trainers often rely only on the basic functionalities of these complex tools in order to easily replicate the offline formal education experience. This also occurred in the vocational learning field, which has often

implemented a form of *taylorism* applied to the educational context, turning learning interactions into conformist behaviours (Whaymand, 2004). The discussion about the new PLE paradigm is fostering a more libertarian vision of educational technology.

According to literature the most common definitions of PLE include various views:

- technically, they are a hub for contents and contacts related to the learning experience of a single person. They can be composed by both desktop and web applications, with every piece of software supporting the user in a particular task (Attwell, 2007);
- in opposition to Virtual Learning Environments and LMS, they prefer the usage of independent (even if interrelated) web 2.0 applications, following the 'Software As A Service' model; as (Downes, 2006) suggests *"it is not just Web 2.0, but it is certainly Web 2.0 in the sense that it is (in the broadest sense possible) a read-write application"*;
- socially, a PLE is a set of instruments which gives value to individual contributions in a learning ecosystem (Chang, 2007);

According to the above definitions, Personal Learning Environments provide learners with the possibility of combining the tools they need for searching, editing, mashing up and sharing contents, information, networks of contacts. Both the perspectives of self-directed learning and peer-to-peer learning are involved. The role of the teacher seems to loose (part of) its centrality, becoming a facilitator. The whole process leads to *disintermediation* (Cann, 2008): by building a personal set of tools, the learners consolidate their social network as a learning community.

3. Sugar as a PLE

According to Hannafin (2007), technology-enhanced student-centered learning environments have been touted as means to support the processes of *"divergent reasoning, problem solving, and critical thinking"*. This statement fits perfectly with the OLPC educational mission and describes the ideas on which the Sugar Learning Platform is based.

A PLE is, at first, *personal*. It is composed by a selection of software tools on a *personal computer*. This selection must be made by the computer owner. Children involved in OLPC deployments own the computer they use (as said above, it is one of the five principles of the project) and the Sugar GUI allows them to install a wide range of applications. Sugar applications - called "Activities"- are structured as plug-ins and a large collection of them is available at http://activities.sugarlabs.org/ website. There is no limit, other than disk space, to the Activities which can be installed on a XO laptop. Sugar allows to mark an Activity as "favorite", which determines its visibility in the "Home" screen. When a user boots into Sugar the Home screen is the default view, showing the user's avatar and the software resources surrounding her/him.

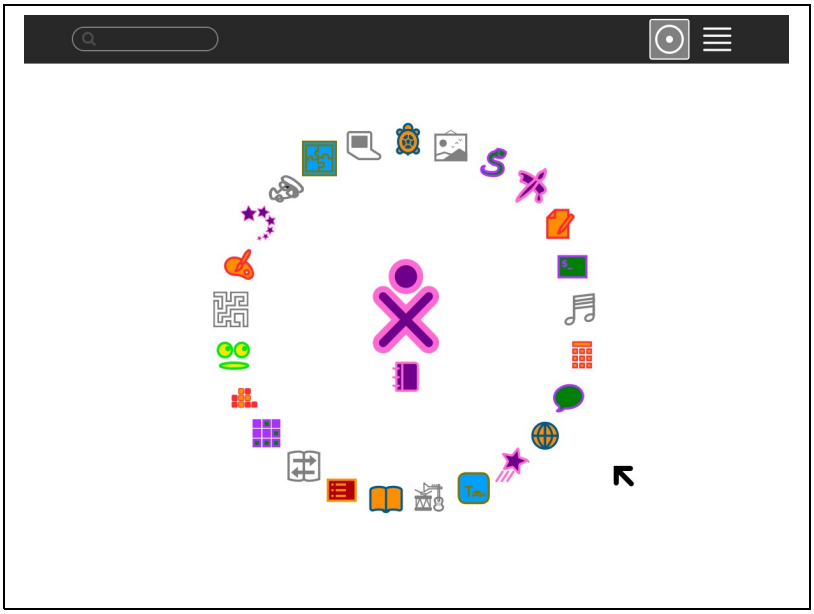

Fig. 1 - The Sugar Home screen: its graphical organization recalls the idea of a child-centered environment

A PLE is for *learning*: Sugar can be useful in different learning settings:

1. *self-directed learning*: a user can read, write, record audio, watch videos, search information;
2. *teacher-directed learning*: in the classroom context, the teacher can use the computer as a means to support contents presentation;
3. *cooperative and peer-to-peer learning*: Sugar allows sharing contents and whole activities in a real-time collaboration environment. The special hardware of the XO allows point-to-point connection even without network infrastructure such as an Access Point, favoring the creation of flexible social networks. When connected, the GUI shows the presence of other users by the means of their avatars. A single user can start an Activity and then share it with his/her neighborhood, or directly invite someone else to join it.

A PLE is an *environment*: the Sugar UI adopts a spatial metaphor where the user's avatar is located at the center of the screen. This child-centered environment is not isolated: every XO laptop can become automatically a node of an interconnected, shape-changing network. Every node can connect to the internet and to the other nodes, with no hierarchy.

4. PLE as a *cognitive artifact*:

According to Attwell (2007), the only thing on which the existing literature seem to agree about PLE is that it is not just a matter of software applications. There is a border category between interaction design (ID) and cognitive psychology that we propose to use as a definition of what a PLE is. A PLE could be represented as a *cognitive artifact*.

In the ID perspective, *cognitive artifacts* are *"...man-made things that seem to aid or enhance our cognitive abilities, and some examples are calendars, to-do lists, computers, or simply tying a string around your finger as a reminder."* (Interaction-Design.org, 2006).

According to Norman (1993), *cognitive artifact*s may also be defined as *"those artificial devices that maintain, display, or operate upon information in order to serve a representational function and that affect human cognitive performance"*.

An authoritative educational point of view is offered by Seymour Papert with the constructivist learning theory. This theoretical framework suggests that the mind involved in a learning process needs to build objects and devices in order to generate ideas. It also needs to use appropriate materials, adopting the "trial and error" procedure.

Papert considers this kind of learning materials as *"objects to think with"* (Papert, 1980) and calls them *cognitive artifacts*.

Each attempt in the trial and error cycle aims to represent the world around the learner by the construction, dismantling and reconstruction of *cognitive artifacts* and at the same time developing analysis, comparisons, and discussions with pairs.

According to Papert, this condition applies at any age, to children, adolescents or adults. PLE development satisfies the need for a life-long and life-wide learning tool adaptable to personal learning styles.

Norman says that *cognitive artifacts "make us smarter"* (Norman, 1993), allowing us to overcome the limitations of human memory and reasoning by enhancing our cognitive abilities through external devices.

PLE development can reach this ambitious outcomes by implementing a meta-artifact: an aggregator whose main purpose is the straight access to a set of self-empowerment key resources. This ideal PLE puts together, in a single customizable dashboard, entire collections of tools, contents from different sources and links to smart networks organized on learning context or personal objectives.

5. A new perspective: PLE as a bridge *cognitive artifact* between hardware e software

Personal Learning Environments seem to fit perfectly with the concept of *cognitive artifact* introduced above. Their commonly accepted definitions describe them mainly as software suites, but during our learning sessions we do not only need software. Let us think to the most common activities in which we engage while studying and learning:

- we read texts;
- we manually highlight important passages, take notes and sketch diagrams;
- we look for information and contents, then we directly manipulate and share them with our peers;
- we collaborate, online or offline, with other people.

In order to do all these things, we need an ergonomic support designed to cope with our needs. This physical device, which could also be a collection of devices, can be considered as part of our PLE. Following the ideas about *cognitive artifacts* described by Papert, the hardware cannot be separated from the use we make of it.

When the *cognitive artifact* is ubiquitous it starts to "melt" with the background (Norman, 1999): its pervasive presence is no more a novelty or an oddity, but a precondition in the learning environment. When this kind of devices are treated as basic learning enablers they become invisible, in the sense that nobody pays any attention to them: all the interest is for the service which is being offered.

5.1 XO: a first step towards a ubiquitous PLE device

The first version of the XO laptop hardware, which is commonly called the XO-1, can be considered as an attempt to create a PLE oriented hardware.

XO-1 is an *inclusion* instrument in the learning environment, by the fact it is an equalitarian, basic dotation for everybody. But this laptop is also an *inclusive* learning environment: it is in the hands of all the actors of the educational process, from teachers to children. As explained above, it allows to create and to share knowledge in a multidirectional, non-hierarchical way. Being highly recognizable as "the OLPC laptop" and not as "an ordinary laptop" it helps aggregating its users in a community oriented to learning objectives and not only on technology.

In the first OLPC deployments, technology becomes a commodity, the computer is a context-variable, an element of the infrastructure for networked learning. This means that this *cognitive artifact* is starting to fade out and is becoming invisible, in the sense exposed above.

Functionally, the XO is:

1. a *cognitive amplifier*: a tool designed for children and equipped with software which can empower their cognitive potential (computation abilities, memory, writing skills, etc.);

2. a *relational amplifier*, which can connect (automatically) its owners. According to Metcalfe law, the network value increases as saturation increases. The XO actually multiplies the opprtunities for creating social links.

3. a *platform to access instructional contents* which can be online or can be hosted by the machine itself;

4. a *knowledge-creation* tool by the means of individual and collaborative activities;

5. an *instrument for sharing knowledge* with peers and, in presence of internet access, for publishing.

6. an *e-portfolio*: with the journal Activity that Sugar uses to store every single action, the children can dispose of a chronological archive of all the instructional activities, the working sessions and the materials produced and shared.

But the XO laptop presents a few issues that do not permit to identify it as a complete PLE device:

- *pluggability*: Sugar allows to easily add instructional activities as plugins. Children can choose, download and install hundreds of applications from http://activities.sugarlabs.org/, but this software collection cannot be run natively on the rest of the operating systems. This limits Sugar in a closed environment. A PLE should be totally open to web 2.0 resources and integrated with its services;
- *widget based interface*: a PLE is often represented as a customizable dashboard composed by widgets that visualize data flows from different learning resources and networks. Sugar presents a unique GUI that puts the child at the center of the graphical space among activities and learning networks. It does not provide any useful and handy way to monitor real time information flows (Kompen, 2009);
- *life-long learning and life-wide learning tool*: a key objective of a PLE is to provide an environment for tracking learning outcomes deriving from both formal and informal experiences. Hence the PLE is an artifact structured around the life-long and life-wide learning concepts. XO and Sugar look more like a *"childhood-long" learning environment* because the hardware

ergonomics and the software characteristics are straightly addressed to K6-K12 targets.

5.2 XO-3: a *borderware* PLE device?

On May 21, 2008 a new version of the XO laptop hardware was announced, which was composed by two multi-touch screens. This new prototype was called XO-2[1] and later, at the end of 2009, was substituted by a new design. The new concept device which will result, called XO-3, is a flat tablet PC with a large multi-touch screen and low power consumption[2].

Fig. 2 - The XO-2 (on the left) and XO-3 (on the right) concept designs

As the XO-1, the XO-3 will help bridging the digital divide and will be a tool and an environment for contents fruition, creation and sharing. The social nature of the OLPC project will be preserved and empowered, but there is also something new: the XO-3 will not only fit the children needs, but will be something useful at all ages, favouring both life-long and life-wide learning. Its new appeal, together with the fact that it will be probably commercialized in the countries which are not part of OLPC deployments, should favour its adoption by a wider community of users and developers.

In our opinion, the introduction of such a device could cause a shift in the OLPC initiative towards the Long Tail model (Anderson, 2006): applications and contents could be produced and distributed worldwide, with any kind of licence.

The XO-3 could complete a transition which started with the XO-1. This transition is from computers on which a PLE can be set up (pre XO-1) to computers made for PLE (XO-1 and similar initiatives, such as Intel Classmate (http://www.intel.com/intel/learningseries.htm) and finally to computers which cannot be abstracted from the PLE.

If XO-3 deployments are successful and saturate the learning environment with this technology, then hardware concept will vanish behind the software and the learning situation in which it will be used. Even talking of "hardware" and "software" will loose meaning: we are talking of a device which could be reasonably considered as something that goes beyond hardware and software. A device we dare call "*borderware*".

---

[1] two other devices exist, called XO-1.5 and XO-1.75, which are externally identical to the XO-1 but differ for the internal hardware specifications

[2] At the time of writing, OLPC has recently announced that the XO-3 will be based on a Marvell ARMADA device, capable of supporting various Operating Systems, including Linux, Android, Windows CE.

6. Conclusions and research ideas

The XO laptop, in both its actual and future form, is a machine which is gradually changing the relationship between hardware and software. Its latest concept design, which in this work we defined with the term "*borderware*", has the potential to shift from being *child-centered* to being *human-centered*. It can become an effective instrument that could link formal and informal learning experiences .

This particular PLE embraces both the dimensions of life-long and life-wide learning.

By adopting a "long tail oriented" approach, OLPC can disclose the possibility to provide a global learning platform for a universal target, crossing technological, physical and political boundaries.

Some future research ideas on these topics will include the study of:

- the impact of OLPC deployments on community empowerment in rural, isolated areas, critical contexts;
- strategies of self directed learning and peer teaching among children;
- PLE "templates" for different age users, varying from children to elders;
- instructional strategies customized according to the learning context and the individual needs;
- the impact of XO-3 deployments on the integration and the inclusion of disabled children;
- the impact of the usage of tactile interfaces versus traditional "mouse and keyboard" devices on learning outcomes.

7. References

Anderson, C. 2006. The Long Tail. *Wired Magazine*, 12-10-2006

Attwell, G. 2007. Personal Learning Environments - the future of eLearning?. *Published online at http://www.elearningpapers.eu/* - retrieved in February, 2010

Banks, J., Au, K., Ball, A., Bell, P., Gordon, E., Gutierrez, K., et al. 2007. *Learning in and out of school in diverse environments: Life-long, life-wide, life-deep.* Seattle, WA: LIFE Center and SRI International

Bruner, J. 1990. *Acts of meaning*. Cambridge, MA: Harvard University Press

Cann, A.J. 2008. Web 2.0 comes of age: disintermediation and the long tail in higher education. *Higher Education Academy 2008 Conference,* Harrogate, July 2008.

Chang, V. and Guetl, C. 2007. E-learning ecosystems (ELES) - a holistic approach for the development of more effective learning environment for small-and-medium sized enterprises (SMEs), in Chang, E. and Hussain, F. K. (ed), *2007 Inaugural IEEE International Conference on Digital Ecosystems and Technologies*, 21 Feb 2007, pp. 440-445. Cairns: IEEE.

Downes S. 2006. Learning Networks and Connective Knowledge, http://it.coe.uga.edu/itforum/paper92/paper92.html, 2006 – retrieved in February, 2010

Fedora project, http://www.fedoraproject.it/ - retrieved in February, 2010

Fox Buchele, S., and Owusu-Aning, R. 2007. The One Laptop Per Child (OLPC) Project and Its Applicability to Ghana. *Proceedings of the International Conference on Adaptive Science & Technology 2007 (ICAST'07)*, Dec. 10-12

Intel Classmate, http://www.intel.com/intel/learningseries.htm - retrieved in February, 2010

Hannafin, M. J. and Land, S. M. 2007. The foundations and assumptions of technology-enhanced student-centered learning environments, *Instructional Science*, Vol. 25, pp. 167–202

Interaction-Design.org. 2006. Cognitive artifacts – retrieved 11 March 2010 from Interaction-Design.org: http://www.interaction-design.org/encyclopedia/cognitive_artifacts.html

Kompen, T. R., Edirisingha, P. and Mobbs, R. 2008. Building Web 2.0-based personal learning environments - a conceptual framework, *EDEN conference*, Pairs, October 2008

Li, S. C., Pow, J. W. C., Wong, E. M. L., & Fung, A. C. W. 2009, July 27. Empowering student learning through Tablet PCs: A case study. *Education and Information Technologies*. Retrieved in February 2010

Moodle philosophy http://docs.moodle.org/en/Philosophy – retrieved in February 2010

Norman, D. A. 1993. *Things That Make Us Smart*, Reading, MA: Addison-Wesley Publishing Company

Norman, D. A. 1999. *Invisible Computer: Why Good Products Can Fail, the Personal Computer Is So Complex and Information Appliances Are the Solution*. London: MIT Press

One Laptop Per Child website, http://www.laptop.org/ - retrieved in February 2010

One Laptop Per Child milestones, http://wiki.laptop.org/go/Milestones - retrieved in February 2010

One Laptop Per Child members, http://laptop.org/en/utility/people/members.shtml - retrieved in February 2010

One Laptop Per Child mission, http://laptop.org/en/vision/mission/

One Laptop Per Child principles, http://wiki.laptop.org/go/OLPC:Five_principles - retrieved in February 2010

Papert, S. 1980. *Mindstorms: Children, Computers and Powerful Ideas*. New York, NY: Basic Books

Pelgrum, W. J., Anderson, R.E. 1999. ICT and the Emerging Paradigm for Life Long Learning - Worldwide Educational Assessment of Infrasrutcture, Goals and Practices. University of Twente / International Association for the Evaluation of Educational Achievement

Sugar Activities archive, http://www.sugarlabs.org/ - retrieved in February 2010

Sugar Labs, http://www.sugarlabs.org/ - retrieved in February 2010

Whaymand, M. 2004. Is open and distance learning the Taylorism of the twenty-first century? The changing role of academics in open and distance learning environments. Paper presented at the *European Distance Education Network (EDEN) research workshop*, Oldenburg, Germany