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Sustainable education: Uruguay's Plan Ceibal

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Introduction

This meeting on "sustainable humanity and sustainable nature" is a valuable opportunity to introduce and discuss the notion of "sustainable education". We are willing to understand and improve the interactions between "human capital and natural capital". Education is part of the human capital of our societies but the notion of "sustainable education" is still under construction and needs special consideration. In particular it is impossible to imagine a sustainable school system that remains independent of the rapidly expanding digital environment of today. Our society has created a new "virtual ecosystem" which is covering the planet and is modifying the life of millions. The good news is that education can play, and is playing in many cases, an increasing and constructive role in this global process towards equity and solidarity in the human family. We are convinced that a sustainable education must be based on evidences and not on ideologies. A sustainable education must be supported by *political, economical, social, technological and pedagogical* sustainable programs.

Towards a sustainable education

We are facing the formidable requirements of education in a growing population that will reach some 9000 millions in 2050. At a recent meeting of the Pontifical Academy of Sciences on *Bread and Brain. Education and Poverty* (November, 2013) we shared our concern

> on the learning environments of the 72 million children in remote regions of the world today with no schools, and the additional 170 million with schools with so few resources, that little learning occurs. Approximately 800 million human beings, concentrated especially in low-income countries, cannot read. For these children and adults the emerging uses of new technological tools are promising.

The proposal to give a primary education to all is one of the Millennium Goals and we can say that in the first decade of this century we have sub-

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stantially improved the quality and the access to education in many aspects and in many countries but we still face the question of the "sustainability" of the different models of education for this century in front of the increasing challenges of the globalization process. The challenges we are facing today are not necessarily the challenges we will face tomorrow. This meeting is concerned with the conditions of a sustainable humanity and a sustainable nature. Education is key for both aspects. We will try to elaborate these issues on the light of the support that the digital environment of today offers for a sustainable education for all. A sustainable education implies equity, and equity in the case of education means to ensure learning to all children and youth in the new social and cognitive context of this century.

A case study: Uruguay's Plan Ceibal

Our proposal is to show a case of sustainable education in a digital environment that can be objectively evaluated and hopefully improved and expanded. A case study is a good starting point because we can detect errors, failures and obstacles as well as successes, predicted or unpredicted, in order to improve the model. Our case study will focus on the recent implementation of a digital educational platform for all children and youth in Uruguay. We will try to show some of the processes in place that support the sustainability of this plan, called Plan Ceibal (Conectividad Educativa de Informática Básica para el Aprendizaje en Línea), hoping that they will inspire other similar initiatives around the world (www.ceibal.edu.uy).

The one laptop per child model

At a joint meeting of the Pontifical Academies of Sciences and Social Sciences – 16-17 November 2005 – dedicated to Globalization and Education, Nicholas Negroponte, then director of the Media Lab of MIT, presented his project to give to every child and teacher a connected laptop in order to produce a global change in education (Negroponte, 2007). This idea was implemented by OLPC, One Laptop Per Child Foundation, in 2006 and today it has reached forty-seven countries with more than two and a half million laptops and thousands of pedagogical resources (www.laptop.org).

OLPC has established five principles that are enforced in different implementations around the world:

1. *Early age*: Children start to use the laptops in the first years of schooling and even in preschool
2. *Property*: the laptops are the property of the children and teachers. They take them home.

3. *Connectivity*: all equipment should be connected to the Internet. The school server acts as filter to ensure a proper use of the communications. Many public places are specially devoted to the connectivity of the children's equipment.
4. *Free and open source*: all digital resources can be freely used and modified at will by the user.
5. *Saturation*: the laptops are given to all students and teachers of a given community. The scale or the community can be a town, municipality, province, state, country or region.

Uruguay is leading the "one to one model" with Plan Ceibal that supports the full saturation of the public school system reaching 559,836 students and 47,623 teachers and has implemented a robust digital platform with connectivity in 2,750 institutions and distributed a multiplicity of pedagogical and technical resources that are in permanent process of improvement and revision. This year thousands of tablets will be also introduced in pre-school and first grades.

Political and economical sustainability

Uruguay has a population of 3.3 million on a territory of 176,220 sq km. Uruguay has a valuable tradition of public education and started the new millennium with the implementation of Plan Ceibal by Presidential Decree in April 16, 2007. The first laptop (popularly called "ceibalita", the green XO designed and produced by OLPC) was given in 2007 by the President of the Republic Tabaré Vasquez to a child of the first grade at a primary school of the small town of Cardal.

The political sustainability of the plan was established by law 18640 (April 8, 2010) that created the *Ceibal Center for the support of education of children and youth*. The Board of Directors of Ceibal is currently formed by the delegate of the Presidency and president of the Board, the delegate of the National Administration of Public Education, the delegate of the Ministry of Education and Culture and the delegate of the Ministry of Economy and Finance. The President of the Board is Miguel Brechner.

The economical sustainability of Plan Ceibal is currently supported by law 18719 (national budget 2010-2014) that includes the entire public school system of the country: preschools, elementary and secondary schools, technical schools and institutes for teacher education and training. Ceibal is spending 100 dollars per child per year, 5% of the annual budget of the public primary and middle school system (0.12 % of the GDP).

Social sustainability

Plan Ceibal has a very positive image in the population, and its social impact is measured regularly. The main points under survey are related to the digital gap between families, urban or rural, of different social and economic status revealed by the number of computers at home and connectivity to Internet, multiple use of the laptops by the children and other members of the family, changes in the motivation and behavior of the children reported by parents and teachers, increasing social and civic inclusion, in particular for disabled kids, support of the community by exhibits, working groups, public events and media, role of volunteers, new working opportunities for many families, new capacities promoted by digital resources at all ages in urban and rural environments.

Figure 1. Children going to a rural school on horseback with their laptops.

Technical sustainability

Since its inception Ceibal covers the deployment and management of laptops, and now also tablets, platforms, portals, call centers, spares and field service, connectivity, maintenance, Internet services, laptops remanufactures,

support areas (systems, administration, finance, legal), videoconferences and logistics. At the moment Ceibal has installed and is maintaining:

– Priority Access Points (outdoor and neighborhoods): 1,879
– Optical fibers: 1,222 locations, 536,000 beneficiaries
– Solar panels: 220 in 55 schools

And it must be stressed that thanks to Plan Ceibal many teachers and families have acquired more computers and digital devices with the help of special credits and constantly upgrade and extend their own information and communication equipment (RADAR 2013).

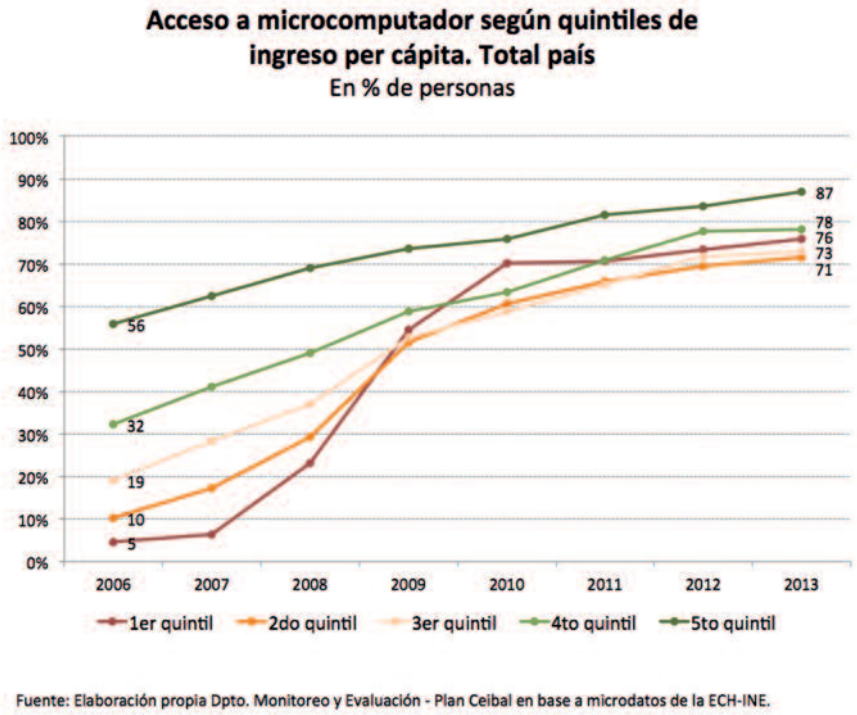

Figure 2. Overcoming the digital divide. Deployment of laptops (2006-2013) per personal income, in % of the population of the whole country.

Pedagogical sustainability

Ceibal is engaged in a multiplicity of pedagogical activities at all levels with a free, open source system that allows a great variety of activities. In particular the XO laptops use the Sugar platform and are equipped with vast resources of connectivity that support collaboration in a variety of common projects (messages, blogs, websites), programming (Logo, Scratch, E-toys), arts (painting, music, photo, video), science (robots, sensors, motors), etc. The new Tablets with Android allow Wi-Fi access and have a large collection of resources. A massive introduction of the Tablets in 2014 will reach children from 4 to 6 years old and will open new learning possibilities to the very young. The earlier the better.

Just to give a feeling of the large spectrum of interests in schools and communities we can mention the titles of the Ceibal presentations by students and teachers at the recent very popular exhibit EXPO APRENDE, November 2013:

Playing science, critical thinking in English (videoconferences), young journalists, we all can study robotics, the XO as source of information for recycling, mathematical art, digital culture in the school, creativity and visual arts, robotics and the disabled, digital and social inclusion, bridging the urban-rural gap, animated families, creating videogames, biology laboratories at home, learning to program with videogames, moving music, nutritional value of transgenic crops, 3D programming, cooking with the XO, chess, robotics and videogames, community work with the XO, the positive use of error in mathematics, health and smiles, learning with PAM (Mathematics Adaptive Platform), empowering our communities, linguistics and the local communities, "beyond access" – libraries for development, online lessons in teacher training, knowledge and self-esteem, videoconferences: beyond the classroom walls, close your eyes and you will see, networking of slums, secure driving, cultural exchange among neighbors, the XO and the environment, promoting artisans, composing music together, learning with CREA (Contenidos y Recursos para la Educación y el Aprendizaje – content and resources for education and learning).

The following numbers give the magnitude of this very large laboratory for learning and teaching that Ceibal represents:

- Educational contents: 8,454
- Books: 3,454 (accessible online at the Ceibal Library)
- Learning Management System, LMS platform: 4,000 resources
- Videoconferences: in 800 schools and teacher training centers (1,000 groups attending English lessons)

– Adaptive Mathematics Platform (PAM): 50,000 users.
– Robotics: 3,871 kits delivered in 707 schools

Because of this heavy investment in pedagogy Ceibal has found considerable support from the general public and the people directly involved, in particular in the urban and rural communities with poor resources (RADAR, 2013). Great emphasis is given by Ceibal to ensure the collaboration and engagement of the teaching community of the country. For this purpose Ceibal has a program of permanent teacher training, which is key.

Digital literacy

The fascinating history of the evolution of the technology of writing and the skills of reading, from clay to papyrus, from paper to digital screens, is a good example of how literacy itself has changed (Dehaene, 2007, Wolf, 2007, 2013). The radical novelty is that the new literacy of the digital era must include the ability to "code", to program. This cognitive skill is becoming a social requirement but the number of those excluded from a sustainable digital education is still considerable. In this sense we are facing a new challenge to construct a sustainable education for all and we urgently need the collaboration of many experts and institutions (Pasquinelli *et al.*, 2013).

It is our responsibility – and the purpose of our meeting – to notice that with the unfolding of the new digital skills the universal requirement of literacy must go beyond basic reading, writing and arithmetic and should include programming. In other terms, elementary literacy in a digital environment is going beyond "concrete operations", such as classification and seriation, and reaches pure "formal operations" (operations upon operations) that can be expressed, for instance, in propositional form such as "if A then B". In the sense of the stages proposed by Jean Piaget, children who can program at early ages collapse two developmental stages, concrete and formal operations, into one. This means a very profound transformation of our culture as we can see in the most advanced digital societies. But even in the rich countries millions are not receiving an appropriate education for the digital era: in fact many of those children and youth that use the Internet or play digital games cannot write a program. There is also an economic side to the ability to program because it is becoming a most required "literacy skill" in many professions, another practical dimension of education sustainability. Education pays.

In other words, we should learn from what we know of the acquisition of traditional literacy skills and make a similar effort to understand the specificity of *digital literacy* by exploring the neurocognitive processes of these new skills. We can say that children growing up in digital environments –

those who are called "digital natives" – "speak digitalese" as a kind of second language, and that they develop a specific "digital intelligence" (Battro & Denham. 2007; Battro, 2009). In particular many children unfold remarkable skills and talents in the new digital environment. This is the case of the two young students of Uruguay who were awarded the Google "Code-in" Prize for exceptional performance in programming. Both were involved in Ceibal activities since their early years.

Sustainable education for the disabled.

Consistent sustainable education also requires a formidable effort towards the inclusion of those who are "in the margins" (Rose, 2000). In particular it is our responsibility to give a sound education to disabled children. It is a recent and promising fact that the use of new digital technologies and prosthetic devices of all kinds are changing the world of special education and we must recognize that our advanced technologies are enhancing the quality of life of many disabled persons but the challenges are still enormous and require the cooperation of many in education, health, economy and politics. The good news is that the trend towards enhancing human capacities with the help of new technologies is significantly growing. For instance, voice recognition and synthetic speech are now the most common examples to overcome the limits of impaired communication. Another dramatic example is the introduction of cochlear implants for hearing-impaired children. In a sense the cochlear implant is the first neuroprosthesis that became effective and has radically transformed the education of the deaf in many parts of the world. And most promising, new brain-computer interfaces are expected to bring hope to many disabled persons (Donoghue, 2013). Ceibal is also ready to perform as a universal platform for research and development in the area of disabilities (Mangiatordi, 2012). Some 300 laptops are already installed in centers for the disabled.

The problem of scale

A change of scale creates new phenomena. Very large numbers of students and teachers change the nature of pedagogy itself. We need an "epidemiological" approach in education to answer to the new challenges (Battro, 2014). For instance, the face-to-face interaction in a sound and manageable learning environment is becoming increasingly difficult as the number of children attending school grows. The good news is that in a digital environment the restrictions in time and space for teaching and learning tend to disappear and new kinds of pedagogic interactions develop in the most different socio-cultural conditions inside and outside the school.

In Ceibal we are creating an *expanded school* because the same digital platform is available in the classroom and at home but we still need a great effort in order to take advantage of this radically new situation. In this sense Ceibal actively promotes the involvement of the whole family at home with the new digital tools with the program "aprender tod@s" in particular in rural environments. In many cases children turn spontaneously into teachers of their parents and other family members and friends. A new "teaching power" is expanding in all digital environments because children teach! And this "natural cognitive ability" must be taken into account in the digital pedagogies of today (Strauss & Ziv, 2013). In a recent evaluation of the impact of the new Tablets introduced by Plan Ceibal, 67% of the teachers recognized that the children helped them to learn how to use the equipment and the resources. This is certainly one of the most important assets of the massive introduction of laptops and tablets by Ceibal: to empower children to teach. In fact, hundreds of thousands of (very young) teachers are practicing their teaching skills every day in Ceibal, and "docendo discimus", when we teach we learn…

The problem of evaluation

The quality of teaching and learning must be constantly evaluated but the great problem is that standard tools for assessment are not always scalable. We must invent new ones to deal with very big numbers of items and students. We need to promote a "new culture" of measurement and evaluation.

In Uruguay, where all public schools are connected to the Internet and all children and teachers own their own laptops, Ceibal has implemented the Online Formative Assessment (SEA), which allows online mathematics, language and science evaluations. These routine assessments can reach some 20,000 students simultaneously. The advantage is that teachers and directors can immediately compare individual performances in different classes and schools throughout the country with sound statistics in a very short time and at low cost (www.anep.edu.uy/sea).

But the main innovation of the Online Formative Assessment is that it enables a dialogue across classrooms. This opens the classroom to other professionals beside the school teacher.

If a school system wants to improve it has to connect all professionals on a path of constant action and reflection, define a set of priorities to achieve and a way to monitor them (www.michaelfullan.ca).

At Ceibal the SEA was clearly an improvement in two ways. Firstly, because it changed the information management about learning within the public education system. Since every teacher knew their results in real time,

the headmaster had on his portal the results of his school – once every teacher had finished the test application – and the inspectors had a glimpse of what happened in their jurisdiction after a test cycle. A new dialogue about the weaknesses and the strengths at different levels started to emerge.

Secondly, the assessment system brought a new discussion about the importance of an enhanced curriculum development. The discussion was not only about what the students had been able to master and what were their weaknesses but also on the nature of the proposed tests and their underlying cornerstones. The online formative assessment system has certainly fostered increasing levels of school autonomy in a continuous dialogue among levels. It has promoted teacher development by proposing a challenging assessment where the teacher should get together with other teachers to analyze persistent student errors and find common school strategies to tackle them. This balance between autonomy and common features was critical for its success.

Finally, the digital platform in place in the whole country allows not only a transversal evaluation but also a longitudinal assessment of each student during the years of schooling. This capacity of the one to one model is unique and must be enhanced and promoted. In fact each child could be followed throughout his years of schooling and the teachers could monitor his or her progress during a long period. Of course we need to develop a culture of "personal mentors on line" to guide the student step by step and we expect that new kinds of "digital dialogues" will hopefully unfold.

The new pedagogies

It seems clear that the irruption of digital tools has made a major revolution in education. We cannot conceive today a sustainable education without the help of information and communication devices. There is a whole expanding universe of innovations of all kinds, from QRs (quick response barcode) to 3D printers, from AR (augmented reality) to videoconferences, from robots to mobile and portable equipment, to mention only some of the relevant resources that are being currently incorporated at several stages of education by Ceibal.

For instance, a child in primary school who has some experience with programming in Logo to create forms and figures on the 2D screen of his or her laptop can easily learn to program 3D concrete objects to be produced with a 3D printer. Ceibal is now introducing 3D printers in technical schools that can be reached online from other schools. We believe that this deployment will produce a significant enhancement in science education and also in the arts. In a sense 3D printer technology opens a new chapter of the success story of the "hands-on" and "learning-by-doing" pedagogies promoted

in many countries by organizations like *La main à la pâte* (www.fondation-lamap.org). The focus is on "doing" and the pedagogy is based on "construction" and on the "dialog" between teacher and student. In this sense, recent neurocognitive research is offering new insights on a pedagogical dialogue at the level of the simultaneous brain activations of teacher and student during a lesson (Battro *et al*, 2013). We can expect that mobile devices for brain imaging will offer plenty of new results in the classroom. These devices will function within the Ceibal digital platform soon.

The Ceibal Foundation

As we can understand, in order to implement new pedagogies it is necessary to expand the scientific basis of the emerging initiatives around the world. In this sense Ceibal is implementing a Foundation focused on research from the academic perspective at an international level. Its goal is to

> develop projects that are specifically designed for the institutions that request the study. It will be able to benefit from experts coming from different countries, receive funding from specialized financial institutions and offer an open space for discussion on education plans. The ultimate goal is to offer all institutions interested in 1:1 education model our specialized knowledge to contribute in the creation of citizens for the future all over the world.

Several prestigious institutions are already interested in collaborating with Ceibal and using the very large digital platform of Uruguay, which must be considered as a *big cognitive laboratory open to all*. In this sense the new Foundation will give the opportunity to engage in multiple international implementations. Some have already been successfully tested in small samples with the XO platform in other countries and will soon be implemented on a large scale in Ceibal (López-Rosenfeld *et al*, 2013). This important change of scale will certainly provide new insights in education.

Conclusions

For centuries education was submitted to a very slow process of change that has shaped the different cultures of the planet. Today the rate of change of innovation has increased by several orders of magnitude and we face a totally different educational environment. This dynamism is intrinsic to the digital environment and is producing profound changes in education. And last but not least these formidable changes are contributing to shape a global appropriation of the digital tools in the most diverse cultures. Sustainable education will become more and more universal without losing the local flavor. Ceibal is a good model of this transformation, which is open to all.

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