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A research initiative on the construction of innovative environments for teaching and learning. Montessori and Munari based psycho-pedagogical insights in computers and human behavior for the "new school"

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ABSTRACT

Italians children-students live a strong technological gap among different education instances: on the one hand, they are attending schools technologically still to the '80 years, on the other hand, they can rely on hyper-technological domestic-family environments where videogames, smartphones, internet are always available. In the school, all learnings take place under the supervision of the teacher that stimulates, directs and corrects these important steps in the basic training. On the contrary, in the domestic environment the presence of technology is increasingly pervasive. These new technologies cognitively stimulate the children, but they entertain the little ones often alone and without the participation and supervision of an adult audience.

Thus, the technology gap results in a pedagogical clash among different educational instances and this is the "space" addressed by our research initiative whose objective is the construction of innovative teaching and learning environments for children between 3 and 6 years of age. The specific quantitative outcomes can be defined with respect to three main families of indicators: measures to detect the use of learning environments; indicators of the level of satisfaction and involvement of the various involved actors; real impact on the socio-cognitive development of children produced by the introduction of methodologies and technologies.

1. Introduction

Daily, many Italians children-students live a strong technological gap among different education instances: on the one hand, they are attending schools technologically still to the '80 years, on the other hand, they can rely on hyper-technological domestic-family environments where videogames, smartphones, internet are always available. A technological imbalance recently increased by the introduction of tablet-pc, touch interaction and their countless "educational" applications suitable for very young children (2–6 years).

In Italy, the ministerial *Digital School* program is causing that interactive whiteboards (IWB) are timidly appearing in the schools, but their spread is still marginal and their technology, meanwhile, has been made obsolete by modern touch technologies. Most of the tools used in the nursery and primary schools is not based on ICT. In kindergarten (3–5 years) the use of materials involving manipulative interaction is predominant, as well as in the early grades of primary school (6–10 years) in which the first key learnings are based on the acquisition of cognitive skills through the refinement of natural sensorimotor abilities. For example, in the learning of writing, the child uses his motor skills to go from the design to the writing with a real workout that allows him to reach a fine hand-eye coordination and to automate the movements required to write in a fluent and accurate way. Even the numerical skills learning through the use of hands and manipulation of ancient instruments like the abacus or the rules that represent visually and physically the abstract concept of quantity. In the school, all these learnings take place under the supervision of the teacher that

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stimulates, directs and corrects these important steps in the basic training. On the contrary, in the domestic environment the presence of technology is increasingly pervasive: we expect that the penetration of tablet technology, for example, in Italy will increase from 15% to 28% by 2016 (source eMarketer), while European countries such as UK, Germany, France and Spain provide most important estimates about it. The International Data Corporation (IDC) updated to December 2015 underlined that the world market for tablets reached 211 million units.

The huge spread and the commercial success of educational apps for both iOS and Android (the most popular operating systems) well evidenced the potentiality of tablets in the learning for the age range that starts from two years. These new technologies and contents cognitively stimulate the children, but, and this is a significant criticality, they entertain the little ones often alone and without the participation and supervision of an adult audience.

Thus, the technology gap results in a pedagogical clash among different educational instances and this is the "space" addressed by our research initiative whose objective is the construction of innovative teaching and learning environments for children between 3 and 6 years of age (kindergarten and first year of primary school).

The Italian Ministry of Education, University and Research (MIUR) gives to this nursery school the task of promoting the development of identity, autonomy and competence of children and starting them to the citizenship. In the National Guidelines for the 2012[1] Curriculum, this is the answer to their right to education and care, in line with the principles of cultural and institutional pluralism established by our Constitution, by the Convention on the Rights of the Child and by various addressing documents of the European Union.

Our research initiative directs its attention to 3–6 years old boys and girls with the aim of updating the teaching and learning psycho-pedagogical models in this segment of education.

To confirm the strategic importance of training in the range 3–6 years the 2012 OECD report "Education at a Glance" [2] underlines Italy above the average among industrialized countries for investment in pre-primary and primary education. According to the results of this research, the kindergarten is one of the strengths of the Italian system, with one of the higher levels of frequency in the OECD area: 97% for 4 years children.

2. Related works

In order to achieve an enhancement of the processes of teaching and learning aimed at the age of childhood and based on the use of new technologies (as in Atzeni, Polticelli, & Toti, 2011), it is necessary to adopt a reference framework made up of a balanced and updated overview of the theories of psycho-cognitive development, of the concrete practices or the educational activities currently in use and the actual possibilities offered by the world of technological research. For this reason, we organized the literature review in four sections:

- Psycho-cognitive development theories and teaching practices;
- New generation systems of human-computer interaction;
- Storytelling, multimedia and learning in the city
- Artificial Intelligence to support learning and teaching processes (Adaptive Tutoring System) as the glue that creates *intelligent continuity* among the three previous points.

2.1. Psycho-cognitive development theories and teaching practices

The children from the first days of their life explore/know the world through the use of their bodies. Even when they have not honed their motor (walking) and cognitive (logical and linguistic) functions, they accompany and support their learning processes. Over the years, the human mind gradually "simulate" the "concrete" manipulative acts that become symbolic and cognitive acts. Recently, the *Embodied and Situated Cognition Theory* (approach that describes cognition through a situated component, or being in a given environment, and a physical component bound to have a certain body and an interactive profile) (Clark, 1997; Pfeifer & Bongard, 2006; Thelen, Schöner, Scheier, & Smith, 2001; Varela, Thompson, & Rosch, 1991) proposed an explanation on how our sensory-motor interactions with the environment determines the organization of our neuro-cognitive structures. An example of it is the neural system of mirror neurons (neurons active both when we produce action that when we see her making) for planning and recognition of motor behaviors (Rizzolatti & Craighero, 2004). This approach also highlights the fact that interactions always take place in a social and cultural context which provides concrete or abstract objects, artifacts, technology and cultural backgrounds (Anderson, 2003).

Within this perspective are much more important the contributions of Vygotskij (1934); Vygotskij (1973); Vygotskij (1978), according to which the learning develops itself through an interaction that goes from the external to the internal, of Papert (1993), according to which the children build their representations through the constant interaction with specific cognitive artifacts that enable the development of specific learning paths and, finally, of Bruner (1990), whose work highlights a key feature of the child/adolescent/adult learning: their learning process is basically active. Cognitive development takes place within a context in which the social and motivational factors[3] are fundamental and in which we witness the shift from poor systems to more effective and efficient systems able to process information and engage subjects in learning activities. In line with this point of view, there is the *Theory of Multiple Intelligences* of Gardner (1983), which represents an essential contribution to a personalized approach to learning (Marzano & Notti, 2015).

In the recent decades, the concept of intelligence as a unique capacity as general and inborn genetic trait is questioned, as it makes its way idea of intelligence articulated in various types of mental representations, ideas, images, languages. According to Gardner, humans possess different forms of intelligence. Each of these is represented in different areas of the brain. The combination of these different intelligences defines the specificity of individuals. It should also point out that the same set of individual intelligences is not static, but is dynamically changing as a result of experiences and learning activities.

The educational implications that arise from this vision of intelligence are enormous. If everyone has his own "intelligent footprint" by which he perceives and responds to specific linguistic, mathematical, visual, emotional stimuli, then, the technologies for education should offer to the learners the opportunity to build their own route, based on their personal constellation of intelligences. A criticality is detected: the enormous variability of intellectual and personality profiles of individuals makes it almost impossible to find an activity that is rewarding for all, at the expense of crucial

[1] In Italy, the *Indicazioni Nazionali* (D.L. n°56 del 19/02/04) are the reference document to define the school curriculum (6–14 years).

[2] http://www.uis.unesco.org/Education/Documents/oecd-eag-2012-en.pdf.

[3] The importance of social factors is enphasized by recent approaches that underline the value of communities as enabling mean in the knowledge construction process (Wenger, 1998). These approaches are useful in the design of educational communities mediated by technologies.