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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"

Sergio Miranda [a, *], Antonio Marzano [a], Miltiades D. Lytras [b]

[a] DISUFF, Department of Human, Philosophy and Education Sciences, University of Salerno, Via Giovanni Paolo II, 132, 84084, Fisciano, SA, Italy
[b] School of Business, Management Information Systems (MIS) Department, The American College of Greece – DEREE College, 6 Gravias Street, GR-153 42, Aghia Paraskevi, Athens, Greece

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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

* Corresponding author.
E-mail addresses: semiranda@unisa.it (S. Miranda), amarzano@unisa.it (A. Marzano), mlytras@acg.edu (M.D. Lytras).

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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.

motivational and emotional. It is therefore of paramount importance to differentiate and customize educational programs to facilitate learning. The tools that we intend to propose can be crucial in implementing activities based on smart objects, specifically targeting the individual cognitive needs.

The debate on the approach of situated cognition has recently found ample space in pedagogy (Núñeza, 2012) where it collects a rich and articulated methodological legacy that is a milestone in the work of Montessori (1938); Montessori (1995); Montessori and Gutek (2004) based on respect for the natural psychological development of the child who is favored by the ability to choose for themselves, in a series of preset options, the activities to be performed, thus embracing the constructivist model that is learned through direct contact and work with objects, rather than direct instruction and the use of teaching materials structured. The Montessori teaching material proposed by facilitating the activities of the child who is attracted to them so irresistible. Recall, for example, some of the different materials targeted sensory stimulation of all the senses as the solid insets, tablets smooth-rough, the mystery box, cylinder noises. These materials can all be made "smarter" through the method that we propose in our research project.

Obviously the Montessori pedagogical practice is not the only one who can take advantage of this possibility. For instance, the games of Munari (1972) where the children are invited to the creation and the invention of their own games. In the games of Munari you can start with simple objects, even waste, such as lanyards, feathers, pieces of fabric, they become the vehicle to unlock the potential expressive individual. Other examples of teaching practices based on these assumptions are those dedicated to learning music. We cite, for example, the method Orff-Schulwerk (Shamrock, 1997) that introduces children to music by emphasizing its connection with the movement and encouraging the access of children to musical experience, also in a group.

The secret of success of many current devices such as tablets and other smart technologies that this research initiative aims to develop and use, as well as the effectiveness of the constructivist approaches, lies on their emphasis on a natural and immediate interaction with educational objects, made through gestures and body movements. A common denominator in our project, is enhanced, expanded and implemented by intelligent technologies.

2.2. New generation systems for human-computer interaction

In the design of educational technology, user interfaces play a major role that in the last ten years have had a strong development towards the "naturalization" of human-computer interaction (Ordóñez de Pablos, Tennyson, & Lytras 2014). Conventional input systems such as keyboards and mouses in fact are "unnatural" because they require learning on how to use a new device that stands somehow between the user and the computer. In natural interfaces, instead, the user interacts with the machine using communication methods typical of the interaction between human beings: the voice, gestures, body movements, etc. (Lytras & Garcia-Peñalvo, 2013).

Studies on voice recognition, although initiated in the 50s of last century, begin to have spread only in the 90s with the first software of automatic recognition.[4] However, these applications are still very expensive and not very accurate (80% of profits awards). Since 2008, Google brings back voice recognition[5] shooting down the costs through cloud technology and increasing its accuracy and robustness.

The first device for handwriting recognition dates from the early twentieth century[6] and the first commercial devices that are able to recognize individual letters of the alphabet written with a stylus were PDAs of Palm (Graves & Schmidhuber, 2008). The writing was slow and recognition required a long time and was sensitive to imperfections of the traits. The latest development in the field of handwriting recognition is the use of neural networks developed all'INDSIA[7] that won numerous international awards. The new interfaces are based not only on the recognition of voice and writing, but also on the recognition of gestures and movements. For instance, the technologies recently developed in the field of play with Wiimote[8] and Playstation Move[9] exploiting the motion sensors.

Microsoft made a decisive step forward with Kinect[10] having a 3D camera capable to detect and track human movement up to four users. Another emerging technology that enables the tracking of user actions adopts RFID (*Radio Frequency Identification Device*) and NFC (*Near Field Communication*) (JungHyun Han, 2010). This technology allows the identification of tagged objects to which is assigned a code readable by a particular player. The RFID tags are passive elements consisting of antennas typically having the form of small square stickers and the size of a few centimeters. An object so tagged can be identified uniquely by the numerical code detectable by means of reading devices. RFID and NFC, in particular, will be the focus of the project as a technology that, with others, contribute to the construction, in an economical and reliable manner, of the constructivist educational contexts.

2.3. Storytelling, multimediality and learning in the city

The use of the territory and its resources over the last decade had a remarkable development thanks to the emergence of new languages and new ways of interacting. This allowed "smart" access to multimedia resources (Nostro, Orciuoli, Paolozzi, Ritrovato, & Toti, 2013): a development based on the concept of re-mediation (Bolter & Grusin, 1999; McLuhan, 1964); the replacement of old media in favor of new and more effective cultural itineraries (Parry, 2007). They look at the children as privileged audience and the external environment (outdoor environment) as an important space for the development and knowledge of the child (Hennig & Kirova, 2012; Niklasson & Sandberg, 2010).

The adoption of new technologies, such as iPad, Tablet, Smartphone, allows redefining the cultural spaces (museums mainly) to make them usable in an interactive way for children (Linaza, García, Susperregui, & Lamsfus, 2006) using interfaces that enhance the senses with particular attention to the touch (Sharples, Taylor, & Vavoula, 2007) as a privileged means of knowledge for the 3–6 years range. Thanks, then, to these latest technologies, the emphasis, in the learning process, moves from the recall/transfer to create/discover/interconnect (Sternberg, 2006). The child, in this sense, is considered as a "catalyst for urban revitalization", an active dialogue with the emerging cultural and extended subject/object of initiatives of "cultural citizenship and Early Childhood Education" (Kernan, 2010).

[4] Dragon Dictate, 1990: http://www.nuance.com/dragon/whats-new-version-12/index.htm (evoluzione moderna dell'originario software Dragon); http://www.google.com/mobile/voice-search/.

[5] http://www.google.com/patents/US1117184.

[6] http://en.wikipedia.org/wiki/Graffiti_(Palm_OS).

[7] http://www.kurzweilai.net/how-bio-inspired-deep-learning-keeps-winning-competitions. http://www.nintend.

[8] http://www.nintendo.com/wii/what-is-wii/#/controls.

[9] http://it.playstation.com/psmove/.

[10] http://www.microsoft.com/en-us/kinectforwindows/.

The Horizon Report: 2012 Edition Museum confirms the interest to the development of *mobile apps* for cultural experiences. Examples of it are the *Andy Warhol DIY*, the *American Museum of Natural History*, or the *Philadelphia Museum of Art*, that have already invested in the development of "successful youth-directed apps" (Fabrikant, 2012). In particular, the teaching of narrative has found fertile ground in the field of cultural heritage. It is an opportunity to integrate the city routes and the cultural rights of children with new, ubiquitous and pervasive technologies. Storytelling is one of the educational approaches most suitable for the development of cognitive skills and knowledge in action (Granito, Mangione, Miranda, Orciuoli, & Ritrovato, 2014) supporting the processes of meaning construction through guided and exploration strategies (Gaeta, Loia, Mangione, Miranda, & Orciuoli, 2014).

Storytelling in an educational context extended as that of a city or a theme park has the opportunity to foster meaningful learning as well as the reflective skills and judgment (Petrucco & De Rossi, 2009). The narrative combines with the emotional dimension of learning for the places of cultural interest, creating significant spaces where children can develop knowledge and skills in line with the curriculum of childhood and with particular attention to the linguistic dimension and the creation of "connections" (Chiu, Koong, & Fan, 2011). To Wong and Looi (2011) add a mobile dimension through storytelling in learning contexts produces a seamless learning experience because mobile technologies are integrated in everyday child (Di Blas & Boretti, 2009).

The integration between *mobile* and *storytelling* has seen the development of applications such as KidPad, Klump, Magic Carpet or MM-E (My Museum-Experiences) that allows children to create mini-stories. A porfolio helps them to navigate and to learn in the environments, giving them the opportunity to document their day through an appropriate system of media mix (Hammond-Todd, Feliciano, & Gallagher, 2012). Much attention is paid to the opportunities of creation and cooperation and thus to the development of authoring programs for children as mystory, where preschool classrooms (children from 3 to 6 years) can create stories in an environment where the interface is designed to reduce the complexity of the task associated with the processes of creation. The new technologies, according to the approach of "narrative pedagogy" (Cardarello, 1995; Demetrio, 1995), look at the educational component of the game in the mobile storytelling (Sintoris et al., 2010), improving connections between physical concepts and abstract through affordances Typical of the game (*playfulness, social interaction* and *manipulation*). From the point of view of the devices, the phenomenon of the moment, the tablet, has helped to strengthen the deployment of mobile devices for children. The set of examples includes LeapPad2 (with its app store called LeapFrog Store), VTech InnoTab 2S (with WiFi and a Web site from which to download games, music, etc.), Kurio7 (with Android system, equipped with WiFi and a complete set of configuration capabilities for parental control), Vinci (enriched from its library of educational app built to a real curriculum for children), Nabi2 (built on the structure of the famous Google Nexus 7 with a set of app/educational games pre-installed) and Tabeo (sold with 50 free app and integrated systems for parental control). All these tablets are directed, by the respective vendor, at an age ranging from 3 years old and, typically, are enhanced in terms of the external structure of the rubber material to cushion any accidental impact.

From the perspective of educational software, however, apart from the various app stores that also offer apps and educational games for children of 3–6 years, there are initiatives like DidApp,[11] a series of apps dedicated to preschoolers or those encounter difficulties in learning reading and writing.

In this scenario, in which there is a wide availability of devices and we feel the value and necessity of exploiting ICT to enhance the educational process (eg multi-touch interfaces), to adopt the approach of narrative stories and convey the "emotional" component offered by cultural heritage (and in general the city) to have a positive effect on the learning process, lacks a strong methodological component and a set of shared models that can ensure the process of creation and use (interactive) of digital content-type storytelling dedicated to the 3–6 years kids, delivered on mobile devices, and dedicated to strengthening the informal teaching/learning in the city (outside the classroom). In our view, these methodologies and models will have to consider elements of "security", "control" and "mediation" by including in the process also the adults.

2.4. Artificial Intelligence systems to support learning/teaching processes (Adaptive Tutoring System)

As part of the educational technologies, designers and developers offer software systems to support students and teachers/tutors who are called "adaptive" and/or "intelligent" and can be of two types: AES (*Adaptive Educational System*) and ITS (*Intelligent Tutoring System*). An AES (Brusilovsky & Peylo, 2003) is a system that fits, depending on specific needs or preferences of the student, some aspects of the educational environment such as, for example, the presentation of content, navigation support, the difficulty and type of teaching materials, and so on. Thus, an adaptive system works differently for individual users by considering the information collected and organized in the learner model individual or group (Gaeta, Mangione, Miranda, & Orciuoli, 2013).

The ITSs, however, are computer based learning environments that typically are intended to provide adaptive and customized support (for the individual learner) to solve problems. They are based on Artificial Intelligence techniques (Conati, 2009; Marzano & Notti, 2015) and include computer-based tutoring, collaborative learning, emotional intelligent tutors able to modulate emotion and attention (D'Mello, Craig, Witherspoon, McDaniel, & Graesser 2008), learning through a group of agents acting as classmates and finally the intelligent support for learning in educational games (Johnson, 2007; Manske & Conati, 2005) and in digital storytelling (Gaeta, Gaeta, Guarino, & Miranda, 2015).

A large area of research is represented by the AICLS (*Adaptive Intelligent Collaborative Learning Support*) that aims to define adaptive and/or intelligent systems able to support educational collaborative activities as, for example, the formation of groups, the interaction between "equal", the learner-tutor interaction (Granito et al. 2014).

From a technological and pedagogical point of view, the models relating to the actors of the learning process are implemented through neural networks, fuzzy networks, Markov models and technologies based on ontologies (Gaeta et al., 2015) and semantic web (Ordóñez de Pablos, Nigro, Tennyson, & Gonzlez Csaro 2012). Beyond the particular implementation, their use and development within the project will combine in an organic manner the technological part to the physical manipulation of intelligent device with the didactic part, reducing the number of interactions teacher-pupil required by a constructivist approach like the Munari's one.

3. The description of the research project

Puero-centrism, active and creative learning, personalization of teaching, cultural integration, enhancement of the creative energy of children and recognition of their needs and interests, adherence to the stages of their psychomotor and affective development,

[11] http://www.didapp.it/sito/storia-di-didapp-ed-eppolo/.

conception of the role of teacher as facilitator and guide, attention to the link between teaching and life, exaltation of the operational intelligence and of the experience: these are the keywords that define the philosophy behind our project.

To ensure a methodological uniformity and give a coherent organic address to the research initiative, the activities include a preliminary systematic analysis, carried out using quantitative methods, aimed at diagnosis of the educational-methodological needs and of the organizational and relational criticalities. This transaction was already conducted with the contribution of different groups of information-project target (parents, teachers, school leaders and local authority staff) and the obtained data are being processed and analyzed. The expected outputs from the preliminary investigation are the mapping of needs, the measuring of their distribution and the identification of the different levels of priority, to anchor each line of action of the project to the emerged results. The result is the definition of the main challenges of the project in the form of scenarios, valid as a guide for all research activities. These activities aim to create software prototypes as demonstrators of the innovative learning and teaching methodologies and technologies. These aspects are synthesized by the acronym ESTeL (*Enviroments for Smart Teaching and Learning*). In particular ESTeL aims to facilitate and stimulate children in the acquisition of skills (soft skills: autonomy, problem solving, cooperation, interculturality) and knowledge (hard skills: logical notions on the first elements of geometry and arithmetic, language reading and writing) necessary to face later schooling (from kindergarten to the first year of primary school) (Gaeta, Miranda, & Ritrovato, 2008). The educational activities of the first years of life are geared to support the acquisition of skills and knowledge through body actions, toys manipulations, object building, drawing and, in the range 5–6 years, writing. Everything is inserted into a narrative structure and is achieved through constant interaction with adults (teachers and parents) and with a small group of peers. Methodologies and technologies will strengthen this mode of learning and teaching. This requires finding a balance between a strong and shared theoretical and educational reference perspective and the possibilities offered by today's technologies. The demonstrators have to be born by the convergence of the psycho-pedagogical and the purely technological dimensions. The process of execution and control will then involve teachers, psychologists, educators and technologists on the model of the *Interaction Design*. The following diagram (Fig. 1) describes the various steps of the production process of the ESTeL; they are at the point of convergence between the psycho-pedagogical dimension (horizontal axis: identification of a Theory of the Socio-Psycho-Cognitive development and the consequent definition of the curricular educational activities) and the technological dimension (vertical axis: identification, adaptation and development of hardware and software).

The approach has been set from the *brainframe* of the cultural re-mediation (Bolter & Grusin, 1999) and of the manipulation that is a functional element in the pre-school learning (Williams, Do, 2009). It happens by presenting to the child a natural way of learning that involves the multiplicity of senses in a constructive process that may use FiMs (*Froebel-inspired Manipulatives*) or MiMs (*Montessori-inspired Manipulative*) (Zuckerman, Arida, & Resnick, 2005). It is being developed a method that represent the stories, eventually collaborative where more children can participate to achieve a goal fixed by the teacher. During these experiences, the little learners can interact on the basis of a number of predefined actions (talk, touch, look, assemble, etc.). These stories will be based on a series of methods of active and creative learning (problem-solving, role-play game, etc.).

The natural dialogue environment seems to be the *mobile* devices called *tablets* whose touch-sensitive interfaces may enable interaction with multi-player stories in which collaboration among children is necessary to achieve the objective. These features tend, in fact, to tie the teaching functions with specific actions that the child (possibly driven by their parents) must be done and, at the same time, stimulate sociability, develop the soft skills often neglected by educational technologies. The principle of social sharing of the educational function implies specific attention to the figures of parents and teachers. For these reasons, the initiative described in this paper is carrying out a research on the design of functional interaction environments able to support information, training, collaborative and relationship activities of the various involved actors: teachers and teachers; teachers and parents (school-family); parents and parents. These axes of intervention draw a relational matrix that is the nerve center for the success of any educational project that points to consistency and continuity of teaching and training. If the action of the school should concern with and through the family, by protecting the respective areas and educational roles, then providing teachers, parents and education agencies with tools for sharing practices, for testing new approaches, for shared reflection on employed educational strategies, it can facilitate the action and release their missions. This will benefit the organic stimuli provided to children and in keeping with the unitary nature of their learning processes.

The design of environments intended as integrated areas of work and school-family or family-family exchange of information is based on technologies that ensure data management by means of approaches and languages of the *Semantic Web* and *Linked Open Data* (LOD),[12] in order to offer effective features of research and knowledge sharing. In this context, our intention is modelling and building LOD for the nursery school as a mechanism of transparency and school-family and school-school collaboration, as well as a tool for the maturing of the community of practice for teachers.

Of course, it will be necessary to conduct some trials involving a large number of schools and drawing a credible set of scenarios such as, for example, “school”, “home”, “museum”, “park”, “public authority” in order to evaluate and validate the choices made during the research activities. These experimentation will be conducted by taking into account the satisfaction (measured by behavioral observations, interviews, focus groups, etc.) of the users involved (pupils, parents, teachers, school administrators), the achievement of the learning objectives (assessed through performance test), the achievement of some specific research objectives and the verification of the effectiveness of some teaching choices.

Finally, to give visibility to the results achieved by this initiative, the authors will define and plan activities for dissemination and reuse through the preparation of a plan describing ways and means, events, presentation of business ideas, virtuous meetings between various players in the “education” system (universities, research centers and their spinoffs, schools, businesses and public authorities) and, it is hoped, a possible commercial exploitation of the gained results.

4. Objectives and results

As a synthesis of research objectives, we could say that our project applies the Montessori motto of “*help me in make my own*” to research and experimental development of algorithms, adaptive systems, interfaces and environments that allow the natural capacity of action, exploration and manipulation of children. Because the learning is not just an individual process, as well as the pupil as a single subject in the relationship with the teacher, the project is targeted to: the socialization of the student and to the collaboration

[12] http://www.semantic-web.at/LOD-TheEssentials.pdf.

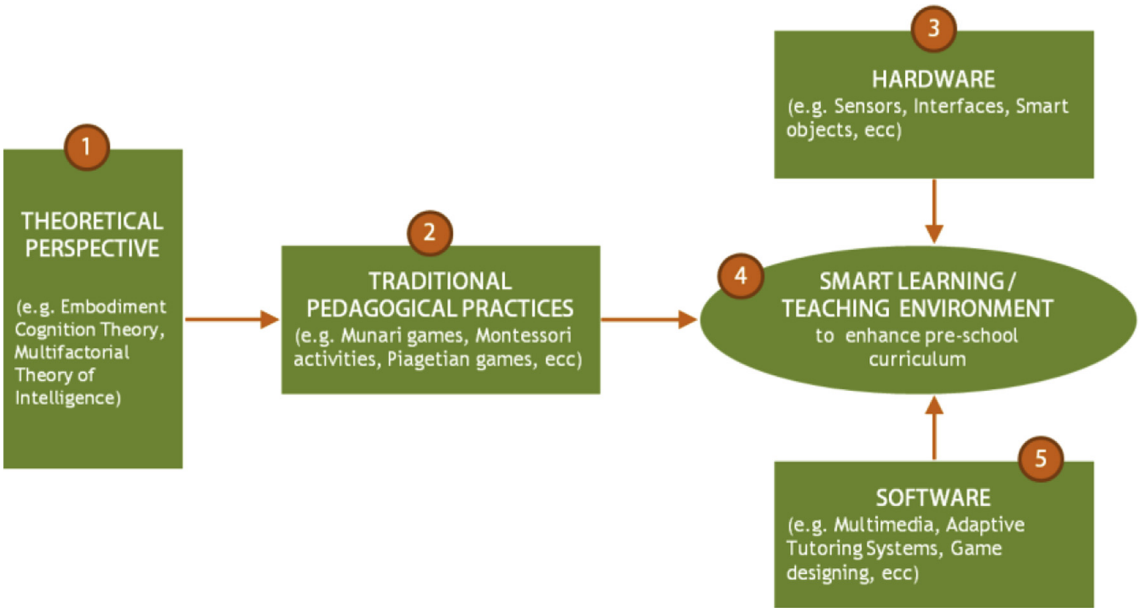

Fig. 1. Phases related to the design and the implementation of demonstrators for methodologies and technologies in support of curricular activities in kindergarten and the first grade of primary school.

with classmates during the school activities; the interaction with peers, friends and parents in the extra school time; the dynamics of the relationship, mediated by the adult, with cultural stimuli that may result from the territory. An overarching objective of the project is to encourage collaborative learning (help each other to cooperative learning) both in the classroom and through the formation of working groups with pupils of classes and of different ages. Not least, in considering "the acceptance of diversity as an essential value" and adhering to the idea of a school that is actively "to one and all",[13] our initiative pays specific attention to the preparation of integrated solutions for the personalized training of students with specific learning disabilities, disabilities or special educational needs, or, sometimes, to the consolidation of inclusive practices in relation to children and young people that are not Italian citizens by promoting their full integration.

Our project will enhance the aspects of digitization and use of cultural heritage materials of the territory. The digital dimension oriented to smart objects allows us reformulating, quickly and effectively, the presentation of content related to the cultural resources of the area. According to the specific educational needs related to the various moments of the child development, the project will support the vertical continuity between the kindergarten and the first grade of the primary school. It will also contain the activation pathways of learning on a continuum school-family-city and the enhancement, within the teaching program, of the attractiveness of the territory, seen as an "extended environment".

To give a more organic representation to the initiative described in this article, the research objectives are outlined and the respective results are identified as deliverables.

Fig. 2 shows the structure of the development objectives of the project, with their deliverables and interactions. The first rectangular block on the bottom, corresponding to the OR1, is graphically placed at the base of the entire architecture of the project, to represent the fact that the results of this OR constitute a reference for all subsequent research activities. The objectives 2, 3 and 4, at the center of the structure as the "pillars of the project", concentrate the fundamental components of the sycho-pedagogical research.

The entablature, circumscribed by the architrave composed by OR5 and OR6, extends the scope of school operations to the two sub-domains of project: *Cultural Heritage and Cloud computing technologies* for *smart government*. They define in fact the "service" environments and applications for teachers, parents and the relationship among schools, administrative services, families and territory. The eardrum, finally, is the metaphor for the OR7 as part of completion of the project culminating in the creation of the integrated framework prototype. All around, following the circular flow counterclockwise, there is the iterative cycle of testing, evaluation and validation, then of exploitation and dissemination, replicability of the project and reuse of its results.

Another area of action related to the research objectives aims at improving the quality and the accessibility of the educational services, by facilitating the activities of teaching staff, thinning the relationship among families and the schools, by means of infrastructure and application resources mainly based on a Cloud paradigm (*Cloud computing technologies for smart government*).

Our project is exploiting the ICT technologies and the most recent paradigms of human-machine interaction in order to define teaching practices that enhance the curricular activities and facilitate the children process of acquiring skills and knowledge on the "fields of experience" that organize the curriculum of the nursery school by enhancing approaches such as those of Munari and Montessori of making, spontaneous exploration, manipulation of artifacts and logic blocks, creating stories (tales), enhancing the physical dimensions, intuitive and creative by means of innovative technologies. In fact, the "pedagogical heart" of the project is engaging specific targets aimed to leverage ICTs for more effective usability of training, facilitate teachers in non-invasively monitoring of the progress of the learners, building new Educational scenarios unthinkable without the use of distributed computing capabilities in an intelligent environment.

A first result is the conception of the city as a discontinuous environment, characterized by interest factors that can favor "walks of sense", narrative, creative, recreational and educational

[13] National indication for the curriculum in the kindergarden and the primary schools (2012).

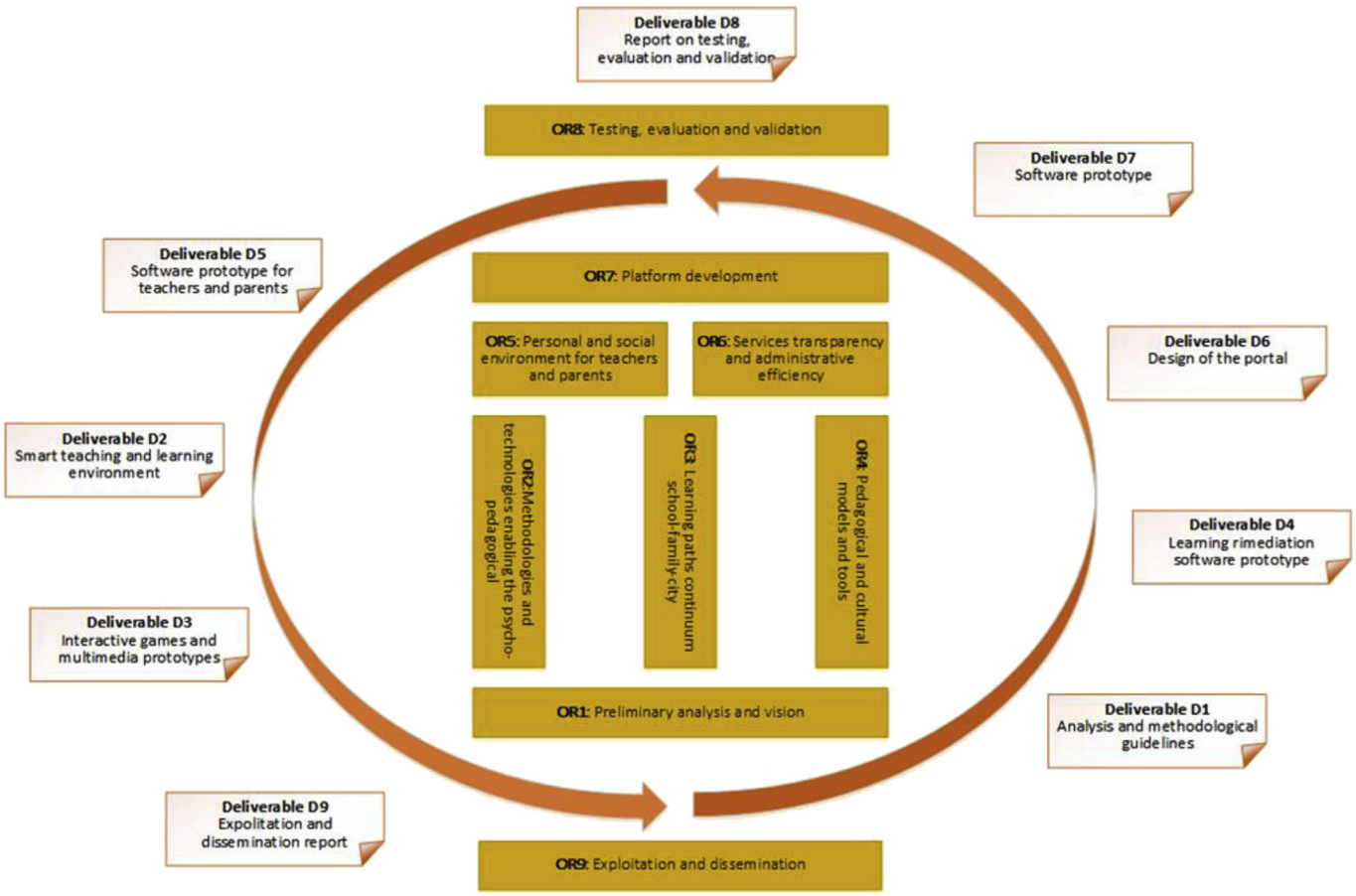

Fig. 2. Structure of the ORs and deliverables of the project.

paths, allows imagining an action of fitting school-territory: an action in which the city itself becomes a learning environment, suitably revised and upgraded from a "relational" point of view (by accessing to dialogical, narrative, social and participatory experiences) and a "mediating" point of view (by using methodologies that guide the structure of a history and that are selected on the basis of the specific type of technology, cognitive and educational remediation). A further objective of the project on relational, organizational and administrative plans, is defining areas of interaction and information exchange school-family or family-family, valid also as a gateway to access services offered by the school administration.

The main objective of the project is the construction of innovative education and learning environments for 3–6 years children. This objective is ambitious because the introduction of the technologies in the early years of life is a socially sensitive subject and it may be susceptible to reactions of rejection. It is very difficult to realize effective methodologies and technologies able to support the psychosocial development of children, that are accepted, co-built and easily used even by teachers and parents. The specific quantitative outcomes can be defined with respect to three main families of indicators:

- Measures to detect the amount and the mode of use of learning environments;
- Indicators of the level of satisfaction and involvement of the various involved actors (teachers, parents, expert panels, etc.);
- Real impact on the socio-cognitive development of children produced by the introduction of methodologies and technologies of our research project.

For the detection of the first family of macro-indicators (quantity and mode of use), the authors will use a statistical analysis of the data of the fruitions and also some *data-mining* techniques and tools. The time series of these indices should tend to highlight the increased use and the diversification of the means of access and use (for example, playing at home and at school, with teachers and with parents, etc.).

For the second family of macro-indicators (detection level of satisfaction and involvement of the involved actors) the authors will use a *Survey methodology* by providings questionnaires at various stages of the life of the project to the various involved actors. Even in this case, a significant increase should happen in the level of acceptance of the project actions of teachers, parents and of a panel of external experts.

With regard to macro-indicators of the third family (assessment of the real impact on the socio-cognitive) the authors will use an experimental methodology: two groups of children of the same age and socio-cognitive level will be observed in the course of their educational activities. The experimental group will use the developed methodologies and technologies, the control group will use traditional teaching methods. For children of both groups some performance indices resulting from the application of established psycho-diagnostic tools (linguistic, logical-mathematical, musical, social, etc.) will be monitored.

5. Conclusions and implications

The described research project aims to enrich the learning contexts of pre-schools involved in the experimentation through the validation of an educational and methodological teaching *proprium* characterized by a plurality of requests and opportunities related to the output of the various solutions with which the children, the teachers and, possibly, the parents will be called to confront. By deepening its roots in the principles of the pedagogical activism and the "new schools", through the most recent rediscovery of the Montessori and Munari thought, up to the current educational policies for the kindergarten, the project applies the theory of *Embodied and Situated Cognition* (according to which our sensory-motor interactions with the environment determine the organization of the neuro-cognitive structures) in the research of psycho-pedagogical practices that enhance the potentialities of the new technologies. This perspective is enriched with an epistemological approach that emphasizes the social dimension of learning as the result of the individual's participation in the communities of practice. In this view, the construction of knowledge is facilitated by the formation of a social identity shared with the community, through the execution of joint activities. This will allow planning, designing and implementing *Smart Learning & Teaching Environments* that will be integrated into the curriculum for kindergarten and primary school; creating situations of learning and teaching that will respect the principles of continuity and balanced growth; building spaces of expression and multi-sensorial experience that will encourage digital game situations mediated by multimedia languages; promoting greater participation and relationship among the different actors of the educational process (teachers, parents and students) that will increase the sense of learning community and the educational co-responsibility. The primary aim of the project is testing the potentialities of the media applied to the design of educational activities able to recover the principles of the spontaneous or guided exploration, the central role of the touch and the manipulation, the involvement of the senses during the course of discovery, by recovering the value of what Hawkins (1974) defined "*doodling*" and Munari (1972) "*hands-on*".

The project started in January 2015 in the territories of Rome, Naples, Salerno and Trento.

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References

Anderson, M. L. (2003). Embodied cognition: A field guide. *Artificial Intelligence, 149*, 91–130.
Atzeni, P., Polticelli, F., & Toti, D. (2011). A framework for semi-automatic identification, disambiguation and storage of protein-related abbreviations in scientific literature. In *Proceedings - International conference on data engineering* (pp. 59–61). art. no. 5767646.
Bolter, J. D., & Grusin, R. (1999). *Remediation: Understanding new media*. Cambridge: MIT Press.
Bruner, J. S. (1990). *Acts of meaning*. Cambridge, MA: Harvard University Press.
Brusilovsky, P., & Peylo, C. (2003). Adaptive and intelligent web-based educational systems. *International Journal of Artificial Intelligence in Education, 13*, 156–169.
Cardarello, R. (1995). *Libri e bambini: La prima formazione del lettore*. La nuova Italia: Firenze.
Chiu, S., Koong, C. S., & Fan, S. H. (2011). Designing preschoolers' story-authoring Software: User requirements and feedbacks. In T. Bastiaens, & M. Ebner (Eds.), *Proceedings of world conference on educational multimedia, hypermedia and telecommunications* (pp. 1309–1314). Chesapeake, VA: AACE.
Clark, A. (1997). *Being there: Putting brain, body, and world together again*. Cambridge, MA: MIT Press.
Conati, C. (2009). Intelligent tutoring Systems: New challenges and directions. In *International joint conferences on artificial intelligence (IJCAI)* (pp. 2–7). Pasadena, California, USA.
Demetrio, D. (Ed.). (1995). *Per una didattica dell'intelligenza. Il metodo autobiografico nello sviluppo cognitivo*. Milano: Franco Angeli.
Di Blas, N., & Boretti, B. (2009). Interactive storytelling in pre-school: A case-study. In *Proceedings of the 8th international conference on interaction design and children (IDC 2009)* (pp. 44–51). New York, NY: ACM.
D'Mello, S. K., Craig, S. D., Witherspoon, A. W., McDaniel, B. T., & Graesser, A. (2008). Automatic detection of Learner's affect from conversational cues. *User Modeling and User-Adapted Interaction, 18*(1), 45–80.
Fabrikant, G. (2012). *The New York times*, 26 October.
Gaeta, A., Gaeta, M., Guarino, G., & Miranda, S. (2015). A smart methodology to improve the story-building process. *JeLKS, Journal of e-Learning and Knowledge Society, 11*(1), 97–124. ISSN: 1826-6223, e-ISSN:1971-8829.
Gaeta, M., Loia, V., Mangione, G. R., Miranda, S., & Orciuoli, F. (2014). Unlocking serendipitous learning by means of social Semantic web. In *CSEDU 2014-Proceedings of the 6th International Conference on Computer Supported Education, 1* (pp. 285–292).
Gaeta, M., Mangione, G. R., Miranda, S., & Orciuoli, F. (2013). Adaptive feedback improving learningful conversations at workplace. In *Proceedings of the international conference e-learning 2013* (pp. 175–182).
Gaeta, M., Miranda, S., & Ritrovato, P. (2008). ELeGI as enabling architecture for e-learning 2.0. *International Journal of Knowledge and Learning, 4*(2–3), 259–271.
Gardner, H. (1983). *Frames of minds: The theory of multiple intelligence*. New York: Basic Books.
Granito, A., Mangione, G. R., Miranda, S., Orciuoli, F., & Ritrovato, P. (2014). Adaptive feedback improving learningful conversations at workplace. *Journal of E-Learning and Knowledge Society, 10*(1), 63–83.
Graves, A., & Schmidhuber, J. (2008). Offline handwriting recognition with multidimensional recurrent neural networks. In *Advances in neural information processing systems 21 (NIPS 2008)* (pp. 545–552). Vancouver, BC: NIPS Foundation.
Hammond-Todd, M., Feliciano, N., & Gallagher, W. (2012). MM-e at the museum: A mobile memory e-portfolio platform application for young children in diverse museum environments. In T. Amiel, & B. Wilson (Eds.), *Proceedings of world conference on educational multimedia, hypermedia and telecommunications* (pp. 601–604). Chesapeake, VA: AACE.
Hawkins, D. (1974). *Imparare a vedere*. Torino: Loescher.
Hennig, K., & Kirova, A. (2012). The role of cultural artefacts in play as tools to mediate learning in an intercultural preschool programme. *Contemporary Issues in Early Childhood, 13*(3), 226–241.
Johnson, W. L. (2007). Serious use for a serious game on language learning. In R. Luckin, K. R. Koedinger, & J. Greer (Eds.), *Artificial intelligence in education. Building technology rich learning contexts that work* (pp. 67–74). Amsterdan: IOS.
JungHyun Han. (2010). RFID-BASED digital board game platforms. *Computing and Informatics, 29*, 1141–1158.
Kernan, M. (2010). European early childhood. *Education Research Journal, 18*(2), 199–213.
Linaza, M. T., García, A., Susperregui, A., & Lamsfus, C. (2006). Interactive mobile assistants for added-value cultural contents. In M. Ioannides, D. Arnold, F. Niccolucci, & K. Mania (Eds.), *Proceedings of VAST 2006* (pp. 83–90). Aire-la-Ville: Eurographics Association.
Lytras, M. D., & Garcia-Peñalvo, F. (March 2013). Ordóñez de Pablos P., Advanced human–computer interaction. *Computers in Human Behavior, 29*(2), 305–306. ISSN 0747-5632 http://dx.doi.org/10.1016/j.chb.2012.11.018.
Manske, M., & Conati, C. (2005). Modelling learning in educational games. In C. K. Looi, G. McCalla, B. Bredeweg, & J. Breuker (Eds.), *Artificial intelligence in education - supporting learning through intelligent and socially informed technology* (pp. 411–418). Amsterdam: IOS.
Marzano, A., & Notti, A. M. (2015). Eduonto: An ontology for educational assessment. *Journal of E-Learning and Knowledge Society, 11*(1), 69–82.
McLuhan, M. (1964). *Understanding media*. New York: Mentor.
Montessori, M. (1938). *Il segreto dell'infanzia*. Bellinzona: Istituto Editoriale Ticinese.
Montessori, M. (1995). *The absorbent mind*. Holt Paperbacks.
Montessori, M., & Gutek, G. L. (2004). *The Montessori method: The origins of an educational innovation: Including an abridged and annotated edition of Maria Montessori's the Montessori method*. Rowman & Littlefield.
Munari, B. (1972). *Design e comunicazione visiva: Contributo a una metodologia didattica*. Bari, IT: Laterza.
Niklasson, L., & Sandberg, A. (2010). Children and the outdoor environment european early childhood. *Education Research Journal, 18*(4), 485–496.
Nostro, P. D., Orciuoli, F., Paolozzi, S., Ritrovato, P., & Toti, D. (2013). ARISTOTELE: A semantic-driven platform for enterprise management (2013). In *Proceedings - 27th international conference on advanced information networking and applications workshops, WAINA* (pp. 44–49). art. no. 6550371.
Núñeza, R. (2012). On the science of embodied cognition in the 2010s: Research questions, appropriate reductionism, and testable explanations. *Journal of the Learning Sciences, 21*(2), 324–336.
Ordóñez de Pablos, P., Nigro, H. O., Tennyson, R., & Gonzlez Csaro, S. E. (2012). *Advancing information management through semantic web concepts and ontologies* (1st ed.). Hershey, PA, USA: IGI Global.
Ordóñez de Pablos, P., Tennyson, R. D., & Lytras, M. D. (2014). *Assessing the role of mobile technologies and distance learning in higher education* (1st ed.). Hershey, PA, USA: IGI Global.
Papert, S. (1993). *The Children's machine: Rethinking school in the age of the computer.*

New York: Basic Books.
Parry, R. (2007). *Recoding the museum. Digital heritage and the technologies of change*. Oxford: Routledge.
Petrucco, C., & De Rossi, M. (2009). *Narrare con il digital storytelling a scuola e nelle organizzazioni*. Roma. IT: Carocci.
Pfeifer, R., & Bongard, J. (2006). *How the body shapes the way we think. A new view of intelligence*. Cambridge, MA: MIT Press.
Rizzolatti, G., & Craighero, L. (2004). The mirror-neuron system. *Annual Review of Neuroscience, 27*, 169–192.
Shamrock, Mary (1997). Orff- Schulwerk: An Integrated Method. *Music Educators Journal, 83*(6), 41–44. JSTOR 3399024.
Sharples, M., Taylor, J., & Vavoula, G. (2007). A theory of learning for the mobile age. In R. Andrews, & C. Haythornthwaite (Eds.), *The sage handbook of elearning research* (pp. 221–247). London: Sage.
Sintoris, C., Stoica, A., Papadimitriou, I., Yiannoutsou, N., Komis, V., & Avouris, N. (2010). MuseumScrabble: Design of a mobile game for Children's interaction with a digitally augmented cultural space. *International Journal of Mobile Human Computer Interaction (IJMHCI), 2*(2), 53–71.
Sternberg, R. J. (2006). Creativity is a habit. *Education Week, 24*, 47–64.
Thelen, E., Schöner, G., Scheier, C., & Smith, L. B. (2001). The dynamics of embodiment: A field theory of infant perseverative reaching. *Behavioral and Brain Science, 24*(1), 1–86.
Varela, F. J., Thompson, E., & Rosch, E. (1991). *The embodied mind: Cognitive science and human experience*. Cambridge, MA: MIT Press.
Vygotskij, L. S. (1934). Trad. it.. In L. Mecacci (Ed.), *Pensiero e linguaggio*. Roma-Bari: Laterza: Ricerche psicologiche, 1990
Vygotskij, L. S. (1973). *Lo sviluppo psichico del bambino*. Roma: Editori Riuniti.
Vygotsky, L. S. (1978). *Mind and Society. The development of higher mental processes*. Cambridge, MA: Harvard University Press.
Wenger, E. (1998). *Communities of practice: Learning, meaning and identity*. Cambridge: Cambridge University Press.
Wong, L. H., & Looi, C. K. (2011). What seams do we remove in mobile assisted seamless learning? A critical review of the literature. *Computers & Education, 57*(4), 2364–2381.
Zuckerman, O., Arida, S., & Resnick, M. (2005). Extending tangible interfaces for education: Digital montessori-inspired manipulatives. In *Proceedings of the SIGCHI conference on human factors in computing systems (CHI 2005)* (pp. 859–868). New York: ACM.