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Classroom 3.0: the real world meets the virtuality through ambient sensing in education

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***Abstract*—Nowadays, Web 2.0 applications – such as wikis, blogs, online forums and content repositories – have been widely adopted to support learning in higher education. Nevertheless, such tools still remain an add-on for traditional education and we are quite far from having a computer revolution in the educational field, i.e. something that can definitively alter the way of teaching in schools. Virtual and mixed reality brings learning to a further step, but the interactions with the real world are strictly limited to a few perceptions (location awareness, chats and callings between virtual and/or on-site actors). New Information and Communication technologies such as Radio Frequency IDentification and Wireless Sensors Network, along with popular commercial devices such as smartphone, tablet and video game consoles can enhance the engagement of pupils and lead to a set of education benefits. My research aims to build a Classroom 3.0, in which not only humans but also computer agents can interact with the environment.**

Classroom 3.0; mixed reality; ambient sensing; education

I. INTRODUCTION

Information and Communication technologies (ICT) are deeply permeating our everyday life, evolving our social interactions in new and engaging ways. Nowadays, a kid receives the first smartphone at increasingly younger ages, and uses chats, social networks and Massively Multiplayer Online Role-Playing Games (MMPORG) to keep in touch with the other digital natives [1]. Being pupils so skillful with technology, Web 2.0 applications (e.g. wikis, blogs, chats) have also merged into the e-learning domain, where the support for the collaborative activities of learners is fundamental for matching the learning outcomes [2].

A recent research made within the Learning 4 All project (L4A) [3] has shown that the most important pieces of technology used in carrying on innovative educational experiences in Italian schools are Web 2.0 offshoots or LIMs [4]. Nevertheless, such tools still remain an add-on for traditional education and we are quite far from having a computer revolution in the educational field, i.e. something that can dramatically alter the way of teaching in schools [5].

Collaborative Virtual Environments (CVE) offer the opportunity to experiment collaborative learning with novel interaction paradigms. In a virtual environment, a pupil can perform actions that would not be allowed to do in the physical reality, e.g. an avatar can fly from an historical site to another. To approach the modeling of virtual environments to learning professionals (i.e. pedagogues and teachers), methods for CVE conceptual designing have been presented [6]. Moreover, standards effort for virtual environments has been spent to describe the semantic of virtual worlds [7].

Mixed reality (MR) approaches for innovative education [8] can foster a sense of community amongst students in virtual worlds, and between virtual and physically present students [9]. MiRTLE [10] provides a mixed reality environment in which physically present and remote students could communicate.

Current technologies available on the consumer market, such as sensing technologies, image and gesture recognition software, may allow for linking the digital spaces to the physical environments. However, existing mixed reality environments for education lack a strong support for sensing technologies, which are not taken into account at present. In MiRTLE, Radio Frequency IDentification (RFID) tags are used for identifying students, but the worlds are mainly smartphone-linked. Optional classroom equipment such as Near Field Communication (NFC) readers, video game consoles (e.g. Microsoft Kinect, Nintendo Wiimote, Sony PlayStation Move), ZigBEE sensors and Ultra-Wide Band (UWB) assets can enhance the engagement of pupils and lead to a set of education benefits.

My research aims to define a Classroom 3.0, namely an augmented smart class, in which real and virtual worlds coexist and interact through a number of sensing technologies. Such format should be highly flexible in order to implement a variety of “mixed” educational experiences, e.g. a smart laboratory, an outdoor treasure hunt, a city path, and should lead to a number of measurable educational benefits. Main requirements of Classroom 3.0 are:

- The possibility to be configured for multiple educational formats;
- Providing a strong cognitive perception with the ability to add semantics to the captured events;
- High flexibility towards any sensing technology, in order to re-use any existing technology;
- A fully open-source architecture;
- Leading to a set of measurable benefits.

In the next section a deeper view over the research issues and the architectural strategies will be discussed.

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II. RESEARCH GOALS

A related work [11] shows how the Open Wonderland framework [12] can be extended into a 3D Learning Environment for sharing multimedia contents (pre-recorded and live A/V) between the physical and the virtual users. Such architecture can be further extended to include the intelligent middleware of Classroom 3.0 (Fig. 1).

Building an intelligent middleware for a mixed reality learning virtual environment is the main goal of my research and its nature is strictly event-driven, because it should immediately react to a state or entity changing in both the real and virtual worlds. Moreover, the possibility of using applications along a wide range of devices, sensors, networks, and protocols raises problems of service responsiveness. Adopting reflective architectures [13] may be a good strategy of evaluating the conditions in which the distribution channel is working at a specific time. This information, built with service, user, and context constraints, can be used to change the current channel characteristics, to new ones satisfying all the requirements.

The Classroom 3.0 middleware should integrate at least a high-abstraction sensing layer and a semantic layer:

- A sensing layer to allow simple configurations of different sensors and protocols; the goal is to let any sensor and actuator be configurable in both worlds:
    - Sensors for capturing events in the real world;
    - Actuators for controlling the physical reality from any world;

  In Classroom 3.0, everything could be a sensor.
- A semantic layer for matching the captured events with the actions to be taken. Here the goal is to combine both a bottom-up and a top-down approach:
    - A set of pre-defined rules (model-based) for governing the system in the transient;
    - A growing set of custom rules. Such rules could be collected with a crowdsource strategy [14], which can cover both conscious user actions ('volunteered') and passive modes ('citizens as sensors').

A set of indicators for evaluating my work will be defined. In particular, the FEatures Extraction method [3] will help in measuring the educational benefits of Classroom 3.0. This method consists in collecting for each educational experience *(i)* an 'expectations' interview to the responsible teacher(s) to be conducted before the beginning of the experience, *(ii)* a 'results' interview to be conducted after the experience's completion, *(iii)* the resources used during the experience and all the "outcomes".

A set of predefined relevant features will be "extracted" from each material by a domain expert (mainly pedagogues), in order to have a synthesis of all the interesting aspects of each Classroom 3.0 format implementation experience.

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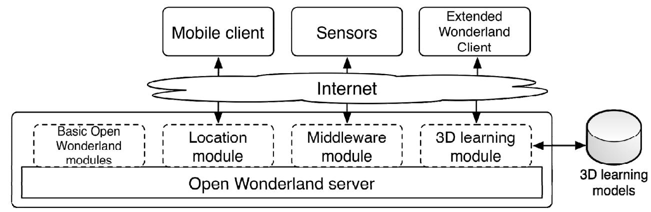

Figure 1. Reference architecture for Classroom 3.0

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