Exploiting Ubiquitous Computing, Mobile Computing and the Internet of Things to Promote Science Education

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***Abstract*—Project UMI-Sci-Ed aims to investigate the introduction of Ubiquitous and Mobile technologies in science, technology, engineering and mathematics (STEM) education. By carefully exploiting state of the art technologies, tools and educational activities, the project will offer novel educational services, implement innovative pedagogies and enhance students' and teachers' creativity, socialization and scientific citizenship. By putting these technologies in practice, it will enhance the level of STEM education young girls and boys are receiving and at the same time make attractive the prospect of pursuing a career in related domains. To this end, communities of practice (CoPs) will be formed dynamically around STEM projects implemented at schools, including representatives of all necessary stakeholders.**

Keywords—STEM Education, Ubiquitous and Mobile Computing; Community of Practice; Internet of Things

I. MOTIVATION

Ubiquitous Computing (UbiComp), Mobile Computing (MobiCom) and, more recently, the Internet of Things (IoT) – hereafter will be collectively referred to as UMI – represent the most explicit attempts to move ICT beyond the confines of tool usage towards pervasive adoption in everyday situations and activities [2]. Advances in areas such as computational speed, high-bandwidth networking, software development, databases, visualization tools, and collaboration platforms are reshaping the practices of learning and are beginning to transform teaching [1].

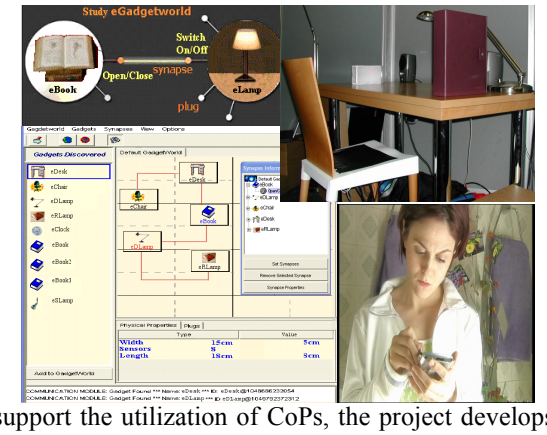
On the other hand, current economic crisis in Europe requires a broadening of political and social support to science and technology. The European society, being knowledge-based, should actively communicate and cooperate with the scientific community, working side by side for the establishment of more responsible scientific practices, so as to enable the structuring of citizen-centric policies. This "Responsible Research and Innovation" would allow the better alignment of research products with the values, needs and expectations of European society. New talents should be recruited for science, to fertilize it and further promote excellence, since the capital of the European science and technology system depends mostly on its capacity for talent and ideas. Thus Science should be made more attractive to young people, regardless of their gender. Society should be aware of scientific results and be engaged to innovation activities. The key factor for the aforementioned is education. Properly and well educated citizens are those who have the ability to follow scientific practices and advances, exploit open access data and contribute to evolution.

UMI technologies emerge both as educational means and support mechanisms for pursuing successful careers in almost every sector of society.

II. DESIGN BRIEFING

The UMI-Sci-Ed project investigates important parameters regarding the introduction of UMI technologies in STEM education with the support of Communities of Practice (CoPs) that can sustain related activities. The CoPs approach provides the tools to deliver meta-level solutions to link school, community and third-level initiatives and foster a model that looks to strongly broaden impacts from the current cohort (e.g. students competing in STEM competitions) to the entire population (Figure 1).

Figure 1. UMI metaphors and tools



To support the utilization of CoPs, the project develops an integrated training environment for 14-16 years old students based on a selection of methodological processes and UMI

applications. The training environment consists of an open repository of educational material, educational means, training activities, a platform to support CoPs through socialization, delivery specific of educational material, entrepreneurship training, showcases, self-evaluation, mentoring, and conceptualization of content and information management.

The project addresses a set of research issues in three dimensions:

- **UMI:** Engineering of a cost effective UMI kit, development of a useful and usable online platform
- **Science:** Design of efficient STEM education scenarios, design and development of innovative instructional design tools for STEM using UMI technologies, link UMI-related qualifications with UMI-related career prospects
- **Education:** Design and development of appropriate training material, establishment and management of CoPs at national and European levels

Three types of activities are foreseen:

- **Research and development activities** include the study, design and application of the pedagogical-educational approach based on CoPs as well as the design and development of the supporting software and hardware tools.
- **Piloting activities** include the design of pilot research according to pedagogical approach, the pilot planning for UMI-Sci-Ed partners and the pilot conducting in real environment.
- **Dissemination activities** will raise young boys' and girls' awareness of the different aspects encompassing science and technology in their societal content and address the challenges faced by young people when pursuing careers in STEM.

III. Expected impacts

The project addresses the expected impacts in short, medium and long terms.

Short term: provides first-of-a-kind synthesis of UMI toolkits and CoPs, built upon a meta-level innovation programmes that links schools, communities and industry directly. Additional, UMI-Sci-Ed provides guidelines and products for establishing small professional networks in European Schools.

Medium term: provides techniques to broaden the relevance of STEM education through needs-based innovation projects built by and through CoPs. It also sets and develops a broader infrastructure for developing UMI applications in authentic school settings providing also documentation and compliance with European Standards. Furthermore, it uses informal learning and learner's preferences to intrigue and maintain motivation in women by promoting gender achievements to broader communities.

Long term: offers novel solutions promoting the use of UMI technologies for STEM with measurable positive teaching and learning benefits to schools and surrounding communities, as well as novel solutions promoting the use of UMI technologies in co-developed innovation projects, supported through CoPs, and linking project actions to accessible industry stakeholders. It also, defines training guidelines, develops educational material and adheres to learning standards incorporating the educational and corporate approach.

IV. Key R&D results

In its three years duration, the project will achieve the following:

- ✓ **Novel educational services:** develop a training platform containing guidelines for UMI learning fostering the establishment of CoPs
- ✓ **Career consultancy services:** conduct a series of piloting activities and scenarios using CoPs and UMI, linking the market needs to the project stakeholders through the platform, formation and management of CoPs using social computing tools and adaptation of specific, specially selected technological tools used for establishing CoPs. Includes the development of educational material to upper high school students aiming at motivating them in subsequently pursuing a career in science education
- ✓ **Supporting software tools:** design and implement an integrated online learning environment which shall actually support all stakeholders to form CoPs as a facilitating mechanism for UMI learning
- ✓ **Supporting hardware tools**: integrate, package and deliver a hardware kit and develop the accompanied programming environment in order to support young students to realize their UMI ideas
- ✓ **Dissemination of the project ideas and results:** disseminate the use of UMI technologies in real educational settings and promote their added pedagogical value to male and female STEM students. Convey project scientific achievements and RTD results both internally among project partners and externally to European and International research communities, potential users and industrial/commercial organizations

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