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Smarter universities: A vision for the fast changing digital era ☆

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ABSTRACT

In this paper we analyze the current situation of education in universities, with particular reference to the European scenario. Specifically, we observe that recent evolutions, such as pervasive networking and other enabling technologies, have been dramatically changing human life, knowledge acquisition, and the way works are performed and people learn. In this societal change, universities must maintain their leading role. Historically, they set trends primarily in education but now they are called to drive the change in other aspects too, such as management, safety, and environment protection. The availability of newer and newer technology reflects on how the relevant processes should be performed in the current fast changing digital era. This leads to the adoption of a variety of smart solutions in university environments to enhance the quality of life and to improve the performances of both teachers and students. Nevertheless, we argue that being smart is not enough for a modern university. In fact, universities should better become smarter. By "smarter university" we mean a place where knowledge is shared between employees, teachers, students, and all stakeholders in a seamless way. In this paper we propose, and discuss a smarter university model, derived from the one designed for the development of smart cities.

1. Introduction

At times, technological innovations have contributed to the creation of neologisms by introducing novel buzz-words such as, e.g., *micro*, *cyber*, *virtual*, which are used to identify the latest cutting-edge solutions. As an example, let us consider the prefix "e-". The massive adoption of Internet and web-based solutions has suddenly given birth to e-mail, e-commerce, e-banking, e-learning, and many other modern terms. In many cases, the "e-" has been replaced by the suffix "2.0" to move the attention to a further evolutionary step of the same product. Now we have entered the smart-*something* era, in which the prefix "smart" is attached to devices with computing and/or network capabilities. Moreover, such devices offer some form of *smartness* since they are easy to use and designed to improve users experience in common operations. Hence, we make a daily use of smart-phones, smart-TVs, smart-fridges, and so on. Riding this wave, the prefix smart has also been applied to places (e.g., smart-city,

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smart-building, smart-museum), and concepts (e.g., smart-work, smart-power, smart-grid). In this context, the design of a smart-system should follow the human-centered design approach and exploit all available technologies to improve sustainability, environmental friendliness, reliability, mobility, and flexibility. In conclusion, smart systems and smart solutions are green, robust, personalized, responsive, interactive, and adaptive as well as accessible anytime, anywhere, from any device, according to the ubiquitous Internet paradigm.

In this scenario, we consider the concept of smart-university too. First of all, we notice that a commonly accepted definition is lacking in the literature. In particular, a tentative interpretation is given in [1], describing smart university as *"a platform that acquires and delivers foundational data to drive the analysis and improvement of the teaching & learning environment,"* by retrieving sensor-data, and using linked (open) data and formalized teaching knowledge. However, this is a merely technological approach and we observe that technology is just one among the many variables to take into account. In fact, recent modifications in laws and policy, also driven by economics and market analysis, are influencing universities' learning environments and processes as well. Moreover, social issues, more recent innovations, and enabling technologies have been changing the way humans learn and thus are reshaping the relationship between learners and teachers.

These changes must be reflected in the university organization, which is asked to supply high quality services in order to stay competitive in a global scenario. This leads to the need for many modifications including the way in which teachers should work and in the creation of new models of students' evaluation and assessment. As an example, one of the main changes recently observed in university teaching is the decrease in the amount of time for face-to-face lectures and accordingly, an increase in the amount of time for individual study, which is carried on by students mainly over the Internet. This new independent learning ability must be empowered by supplemental resources such as, e.g., video lessons, and scheduling of individual learning activities followed by self-evaluation. Moreover, the globalization process has dramatically accelerated the dynamics in production techniques and methodologies, thus requiring a more flexible education model, able to react quickly to unexpected changes whilst maintaining a high level quality. In addition, there are many human factors affecting the whole educational process. Among these, one of the most influential factors is that today's students have different attitudes and learning styles, derived from the highly interactive world they live in. Furthermore, the advent of social-media has influenced the way people use their knowledge across a distributed environment in a new collaborative fashion.

To cope with this reality, technology is no longer sufficient. We suggest that a paradigm change is necessary to transform a smart university into a *smarter university*, hence more efficient, more effective, and with a higher participation of both students and teachers, collaborating to achieve the common objective of better learning. In this respect the smarter university offers rich, interactive and ever-changing learning environments by exploiting the suite of technologies and services available through the Internet, by empowering individuals' abilities and attitudes, and by encouraging them to interact and collaborate in a framework in which people are co-responsible for raising and appraising the inclination of everyone. To achieve this objective, in this paper we analyze the issues of the current reality and, finally, we propose a model for the smarter university.

The remainder of this paper is organized as follows: Section 2 is a review of smart education including users' perspectives and a look at current and future trends; in Section 3 we outline the issues and the challenges of a smart educational ecosystem with reference to technologies, competences, and processes; in Section 4 we propose the model of a smarter university. Conclusions follow in Section 5.

2. Smart education

Education in a smart environment supported by smart technologies, making use of smart tools and smart devices, can be considered smart education. In this respect, we observe that novel technologies have been widely adopted in schools and especially in universities, which, in many cases, exploit cloud and grid computing, Next Generation Network (NGN) services and portable devices, with advanced applications in highly interactive frameworks. Thus, we can say that smart universities are already here. Nevertheless, smart education is just the upper layer, though the most visible one, and other aspects must be considered such as:

- Communication.
- Social interaction.
- Transport.
- Management (administration and courses).
- Wellness (safety and health).
- Governance.
- Energy management.
- Data storage and delivery.
- Knowledge sharing.
- IT infrastructure.
- Environment.

In this respect, six key areas are identified [2] for the design of an *iCampus*, where *"i"* stands both for *integrative* and *intelligent*. Namely, these areas are: *learning*, *management*, *governance*, *social*, *health*, and *green*. Other researchers focus on the Knowledge Management (KM) aspects, stating that KM is the foundation of a smart university, since it is the corner stone to fulfill business goals. Reference [3] describes a smart university as composed of five entities: *smart people*, *smart building*, *smart environment*, *smart governance*, and, last but not least, a *knowledge grid*. Other works address only technological solutions by outlining a smart space based on the use of Radio Frequency IDentification (RFID) technology [4] or providing Near Field Communication (NFC) support [5,6]. To carry on with the overview of enabling infrastructure solutions, we must mention cloud computing as a resource for improving efficiency, cost, and convenience in the educational sector. Traditionally, cloud computing has been a convenient tool used in research laboratories for the