

Chapter 2

A Knowledge-Based Framework for E-Learning in Heterogeneous Pervasive Environments

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ABSTRACT

We propose a ubiquitous learning approach useful not only to acquire knowledge in the traditional educational meaning, but also to solve cross-environment everyday problems. By formalizing user request and profile through logic-based knowledge representation languages, a lightweight but semantically meaningful matchmaking process is executed in order to retrieve the most suitable learning resources. Standard formats for distribution of learning objects is extended in a backward-compatible way to support semantic annotations in our framework. Framework and algorithms are absolutely general purpose, nevertheless an application has been developed where the semantic-based Bluetooth/RFID discovery protocols devised in previous work, support users –equipped with an handheld device– to

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INTRODUCTION

Pervasive e-learning has been investigated in recent research because of its evolutionary impact on the definition of traditional e-learning: learning anytime, anyhow and anywhere. The main goal is to take full advantage from the possibility of performing the knowledge acquisition process also in case of lack of fixed infrastructures. Many studies recognize the independence of the learner's physical location and the availability of powerful learning devices as the main added value of electronic learning with respect to traditional approaches (Maurer, 1998). Hence, a full exploitation of ubiquitous computing technologies can deeply affect the most significant aspects of e-learning systems.

The main issues of the so-called mobile learning (m-learning) are identified and gathered in (Sharples, 2007). Beyond achieving benefits of electronic learning, m-learning allows a higher customization of the learning experience through adaptive techniques for content provisioning and organization. From this point of view, it is important to combine the usefulness of both e-learning approach and mobility technologies within a unified vision. Pervasive and Web-based technologies should be applied together in defining frameworks and guidelines to really allow a user to learn anywhere she is. The main challenge—or opportunity, we daresay—is to enable the knowledge acquisition across contexts and environments, rather than simply exploiting handheld devices for the fruition of learning contents. Hence, there is the need to move away from “adapting” activities and approaches designed for personal computers to mobile devices and contexts. On the contrary, a comprehensive approach should be outlined, taking into account:

- the complexity of mobile scenarios: the benefit of learning ubiquitously by using a portable device is balanced by the technological constraints of such devices (limited

memory capacity, reduced computational capabilities, restricted battery power, small screen size, among others);

- the different dialectic relationship learners establish in those contexts with respect to wired ones.

Flexible and context-aware discovery techniques thus become a key element to build pervasive learning infrastructures allowing a great personalization according to individual requirements, possibilities and context, also coping with the high differentiation of current mobile devices.

In spite of the growth in the diffusion of wireless-enabled handheld devices providing the necessary connectivity for complex applications, in general they are based on short range, low power technologies like Bluetooth (Bluetooth), which grant a limited interaction among hosts. Furthermore, as ubiquitous contexts are very volatile environments, some important issues are still open. Particularly, services or resources are often unavailable because the location of mobile providers can change unpredictably (Chakraborty et al., 2001). Hence, an advanced discovery of learning resources has to be flexible and decentralized, to overcome difficulties due to the host mobility.

We borrow languages and technologies from the Semantic Web vision and adapt them to pervasive contexts in order to produce a framework fully interoperable with fixed approaches as well as with accepted standards for learning contents modeling. In this paper, a coherent knowledge-based retrieval of mobile learning resources has been devised and implemented. Resources are advertised over a mobile ad-hoc environment as *learning objects* according to the LOM—Learning Object Metadata—standard (IEEE, 2002), supported by SCORM—Sharable Content Object Reference Model—specification (SCORM, 2004) for Learning Management Systems (LMS).

The learning content needs to be redesigned to meet the requirements of a mobile exploitation

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