Chapter 7.4
A Pedagogical Approach to the Design of Learning Objects for Complex Domains

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ABSTRACT

In this article we describe an approach to the design of learning objects (LOs) suitable to support learning in complex domains. We briefly discuss, from an educational point of view, the methodological choices underlying the design of LOs to be used as didactical materials in a distributed Web-based environment, presently under development, devoted to robotics education at the university level. We show how our pedagogical approach to knowledge acquisition and to the use of technological tools is realised by means of didactical units which can be implemented as LOs with various aims and correspondingly different structures. We also address the issue of supporting students' learning in ways that differ according to the requirements of each situation and illustrate how such support can be implemented by means of our pedagogically oriented LOs.

INTRODUCTION

In an active approach to learning, oriented to the acquisition of nontrivial knowledge, to the solution of complex problems and to the development of self-regulation abilities (Ausubel, 1963; Bruner, 1966; Novak, 2002; Piaget, 1976), students build new knowledge based on their previous one, by means of personal reflection and social interaction (Dillenbourgh, 1999; Jonassen & Land, 2000; Vygotsky, 1978). In this framework, an important role for the teacher consists in supporting the students through this process, increasing their motivation, promoting initiative and control, guiding them in knowledge exploration, and organising the use of tools. Following this theoretical characterisation, learning is seen as developing from activities of three different kinds, that is, (1) individual, (2) teacher guided, and (3) in collaboration with peers. Technology can play a meaningful role in all kinds of activities by offering nontrivial working tools and individually adaptable hypermedia learning materials, easing communication and collaboration with peers, supporting self-assessment, as well as by performing some functions which have always been of teachers, such as scaffolding and problem posing.

The increased possibilities of effectively implementing such an active and articulated approach to learning offered by the current development of information and computer technologies (ICT), turns out very useful when the object of study are complex domains, as for instance, mechatronics education at a university level (i.e., the design of robot control). Actual work on the real tools is crucial for suitable learning in this field, and the use of simple simulation programs cannot be sufficient. For economical reasons, however, most universities put at students' disposal a laboratory where only experiments on some specific class of robots can be carried out, and labs with different equipments are spread across several universities. The possibility of sharing such resources at a distance would allow students to avail themselves not only of tools to simulate the operation of equipment, which is available in other universities, but also of the very robots located elsewhere, by means of telepresence.

Exploiting this possibility is the basic idea of the Telepresence Instant Groupware for higher Education in Robotics (TIGER) project, which aims at building a Web-based environment to operatively access robot labs distributed in several Italian universities, hence providing for the students an educational context that transforms the potential of technology into a real opportunity to build up knowledge and experience.

The considered application field is very complex and is characterised by the need to keep a strict connection among theoretical knowledge, methodological competence, and operational skills necessary for the use of robotic laboratories (Fabri, Falsetti, Ramazzotti, & Leo, 2004). Moreover, students are required to develop good abilities of self-regulated work and to be able to fully avail themselves of virtual environments on the Web.

In order to meet the needs of this application, we designed an educational framework (Busetti, Dettori, Forcheri, & Ierardi, 2005a) where LOs (Littlejohn, 2003) are the central tools used to keep a strict connection among theoretical, methodological, and operational competence. This is obtained by defining a typology of LOs, apt to meet the variety of requirements which characterise education on robot control. In this paper, we characterise these LOs. We then consider the issue of suitably supporting students' learning in ways that differ according to the competence of the students and the characteristics of the tasks addressed. Based on an analysis of the literature, we point out different types of support that students may need in different learning situations and show how they can be realised by means of our pedagogically oriented LOs. With our contribution, we aim to propose an approach to the design of educational environments which combine the