

Creation and Delivery of Complex Learning Experiences: the ELeGI Approach

Nicola Capuano, Sergio Miranda, Pierluigi Ritrovato
DIIMA – Department of Information Engineering and Applied Mathematics University of Salerno
Via Ponte don Melillo 84084 Fisciano (SA), Italy
ncapuano@unisa.it; miranda@diima.unisa.it, ritrovato@diima.unisa.it

Angelo Gaeta, Francesco Orciuoli
Centre for Research in Pure and Applied Mathematics
Via Ponte don Melillo 84084 Fisciano (SA), Italy
{agaeta; orciuoli}@crmpa.unisa.it

Agostino Marengo
DSS, University of Bari
Via C. Rosalba 53, 70100, Bari (BA), Italy
amarengo@dss.uniba.it

Abstract

The paper presents the main findings of the ELeGI project, namely its learning model and software architecture to support the creation and execution of complex learning processes.

The learning model defined in ELeGI promotes and supports a learning paradigm centred on knowledge construction using experiential based and collaborative learning approaches in a contextualised, personalised and ubiquitous way.

The software architecture has been designed and developed taking into account the learning model for the personalisation of complex learning experiences.

In order to validate our results, the paper presents and describes a case study relating to the implementation of a Unit of Learning for explanation of the Torricelli's law, and its execution on top of the Service Oriented Architecture.

1. Introduction

The dominant learning approach in Technology Enhanced Learning has been for many years the Information Transfer, which is based on the central figure of the teacher whose primary purpose is the provision of educational contents to be transferred to learners that consume these contents in a passive way. As a consequence, many eLearning solutions provide a “digitalization” of this approach and, in most cases, they are distance learning platforms focusing mainly on the educational resources (just an input of the whole learning process), on their delivery and presentation.

The aforementioned solutions are focused on a implementing just a specific educational model and this means to rid off from them all the complexity associated

to the learning process. Just as example, current learning solutions: *i)* superimpose to learners how they have to learn without taking into account learner's dispositions or preferences, and *ii)* are pedagogically closed solutions constraining learners to learn and teachers to teach following a predefined approach.

In our opinion, e-learning solutions have to be subject to a real evolution where the main efforts must be focused on supporting the whole learning process, not only on specific part of it. The matter is how to relate the learning path to the learner and to formative objectives in a dynamic intelligent way to allow personalised, experiential and contextualised learning processes. This has been at the core of our investigations in the European Learning Grid Infrastructure (ELeGI) project [1].

The rest of the paper is structured as follows. Section 2 presents considerations on the human learning as a complex process. Section 3 provides information on the ELeGI project. Section 4 presents the general Learning Model, which the learning experience personalisation process is based on, and the Virtual Scientific Experiment (VSE) model, which the case study is referred to. Section 5 motivates the adoption of Grid technologies evidencing what is, in our opinion, the added value for eLearning of this technology. Section 6 presents the ELeGI software architecture and, lastly, section 7 presents the case study. Conclusions are drawn in section 8 together with the results relating to the evaluation of our case study.

2. Human Learning is a complex process

Among the different definitions of human learning, consider the one proposed in [14]: “*Human learning is the disposition of human beings, and of the social entities to which they pertain, to engage in continuous dialogue with the human, social, biological and physical*

environment, so as to generate intelligent behaviour to interact constructively with change.”

This definition emphasises:

- the importance of the dialogue and, in general, of the collaboration. As any other human disposition, it should be supported and improved taking in account learner needs and preferences
- the centrality of the learner with respect to learning strategies
- that human learning can not be separated from the social context in which it happens
- that the purpose of human learning is to generate intelligent behaviour, allowing human beings not only to act and to react to changes surrounding them, but also to reflect and to acquire knowledge about what surround them.

The above points are key for our approach. We propose, in fact, a more effective approach for human learning and teaching, not based on a particular educational model, but incorporating features of different educational models into a paradigm that focuses on the learner becoming the central and active figure of a complex process aimed to acquire, create and share knowledge.

Human learning is a process that we consider: (i) *complex* – complexity has different meanings in literature, for example [15] and [16], and it is not our purpose to analyse its meaning in this paper. We use the term “complex” to indicate that learning process consists of many interactions among the learner and other entities belonging to his social context. These interactions depend heavily one to each other and one interaction can have no predictable influences on one other. Furthermore, learning process is also function of the learner capabilities, that evolve during his life sometimes in unpredictable way; (ii) *knowledge based* – different levels of knowledge are required in human learning process. Domain knowledge representations are clearly necessary but they are not enough: knowledge about learner and his social context are important as well. Learner features (e.g. his abilities, preferences, dispositions) can not be separated from social context in which learning process happens and both dynamically change during the life of the learner; (iii) *ubiquitous and pervasive* – not only anytime/anywhere but, more generally, the capability to support different pedagogical models and to automatically adapt them. Pervasiveness is another important aspect of human learning that is, by itself, a pervasive process. Every day, through our experiences, we learn something while we are immersed in the real world; (iv) *quality driven* – from the learner perspective, quality is a degree of satisfaction. Our process has to deal with different kind of qualities

from Quality of Collaboration, taking in account dimensions like social cooperation and/or tutoring support, to Quality of (Learning) Experience, emphasising dimensions like interactivity with educational resources and/or multimedia enhancement.

In order to support this process, we need to create dynamic contexts where the learner is free to achieve knowledge and skills in an active way, and in which communities can identify their goals, in terms of knowledge and skills to be acquired [17].

The essence of our approach is, thus, to create contexts that provide adequate conditions for each learner (taking into account his features and social context, providing tutoring and enhanced presence), that support him during his learning process (also using technologies for collaboration, highly realistic virtual scientific experiments, real time simulations, personalized learning path definitions) and, finally, that let him free to reason about what is useful to achieve his goal.

3. The ELeGI project

The purpose of the ELeGI project is to radically advance the use of technology enhanced learning through the design, implementation and validation of a pedagogy-driven, service-oriented software architecture based on Grid technologies [7]. To achieve this goal, the project exploits a strategy, formalized through models, methodologies, and technologies, enabling to overcome the drawbacks of traditional eLearning solutions.

From a pedagogical point of view, a general learning model is defined. This model leverages on scientific studies and educational theories and arranges them in order to allow the implementation of a constructivist approach. To address the issues related to both formal and informal learning, the ELeGI project has been structured according two main Action Lines: ELeGI-f and ELeGI-i. This paper is centred on the main results achieved by the first action line, ELeGI-f, for formal learning.

4. The learning model

In the following a brief description of the theoretical learning model [2] is reported. The learning model allows to generate a “Unit of Learning” automatically and to adapt it dynamically according to the learner’s behaviour. In the proposed model, a Unit of Learning (UoL) is anything delimited as an educational object, such as a course, a module or a lesson structured as a sequence of Learning Activities represented by Learning Objects (LOs) and/or Learning Services.

In order to produce an operational process, the learning model uses three specific models: Knowledge Model, Learner Model and Didactic Model, which interact to define the specific and personalised learning path. Such models allow to take into account the following:

- i) the knowledge that is the learning objective
- ii) context, where the educative process occurs
- iii) the learning method and style
- iv) the learner's preferences and demands.

The Knowledge Model describes the subject-matter to be attained according to the teacher's learning domain representation and acts in the system as a black-box allowing the construction of the UoL. Besides, this process allows an automatic construction and personalisation of the student's learning path thanks to the possibility to link LOs to the concepts of the knowledge domain. The student's personal knowledge will arise from a suitable interaction (implication) of the student himself with the LOs.

The Learner Model (LM) allows to represent the learners' characteristics.

The Didactic Model (DM) allows to formalise different pedagogical approaches to be used in a learning experience, both at macro-level (general structure of the UoL) and at micro-level (i.e. didactic guidelines, according to pedagogical theories, to enable the student creating some knowledge).

The main step of the logical workflow (graphically shown in Figure 1) whose output is the UoL can be summarised as follows:

i) Formalisation of the knowledge domain, taking into account the Context in which the learning experience takes place and the specific learner's characteristics.

ii) Specifications of the Learning Experience to build. This step requires the retrieval of the Learning Experience Model (LEM) in order to fix the whole structure of a course (e.g. if and when intermediate exams occur, test, self-evaluation, definition of general learning strategies such as collaborative or not collaborative, tutoring modalities); the retrieval of the Target of Learning (TL), consisting in a set of elementary concepts (atomic) to achieve in the course.

iii) Design of the Whole Learning Experience. Given a TL, the Knowledge Model allows to infer the Learning Path (LP), as a sequence of concepts to be acquired, while the Didactic Model gives the specifications of the Learning Activities, associated to each concept.

iv) Production of the UoL. The last step is the binding of the previous design with concrete learning material and services. The output will be a highly tailored UoL with respect to contextualisation and personalisation features.

The learner's active involvement and interaction with such UoL allows him/her to construct his/her knowledge.

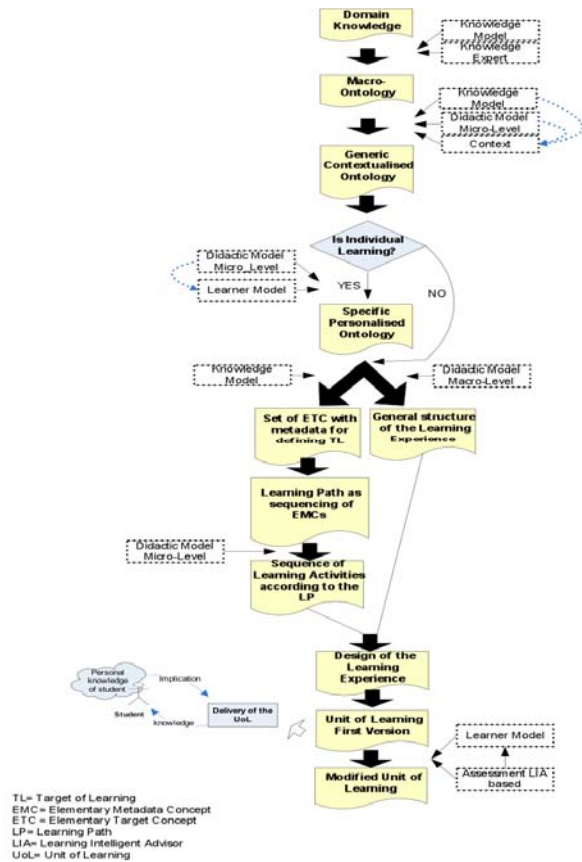


Figure 1 The Learning Model – Processes for UoL creation

v) Updating of the UoL. The UoL produced by the previous process is not a static object but instead a first instantiation. Indeed, according to the assessment procedures, making use of the Learner Model, the UoL can be dynamically updated. In case of failure of the assessment phases, an automatic procedure can be developed in order to compute a new Learning Path. Consequently, the process previously described can restart generating an updated UoL.

4.1 The Virtual Scientific Experiment model

In this section a Virtual Scientific Experiments (VSE) model is presented and large attention is devoted to its relationship with the above mentioned Learning Model.

VSE fits some experiential learning fundamental aspects within a cognitivist / constructivist vision: the

devoted to the execution of the processes related to the Learning Model. This layer can be logically divided in two sub-layers.

The first one, the Environment Management Services sub-layer, provides services and tools to support the creation, operation, evolution, and maintenance of a learning community. Functionalities for semantic annotation, discovery and composition of educational contents and services are provided in the Semantic Annotation, Discovery & Composition subsystem, while functionalities allowing intra and inter community asynchronous and synchronous communications are grouped in the Communication/Collaboration sub-system.

The second one, the Learning Services sub-layer, provides services and tools to support the execution of the three processes of the Learning Model. Of course, there are services and tools to create and manage the Ontologies (Ontology Management sub-system), the Learner's Profile (Learner Model Management sub-system) and the Didactic Model (Didactic Model Management sub-system), that represent the three basic structures of the Learning Model. The Personalization sub-system aims at dynamically adapting and delivering educational contents and services, matching the learner's needs and preferences according to his/her profile.

The Learning Experience Management sub-system allows applications or other services to access and manage courses, modules, and other learning experience (e.g. allocating student, staff, etc.), while Contents & Services Orchestration sub-system deals with issues of UoL execution, which are described using the IMS Learning Design (IMS-LD) constructs [6].

7. The case study: execution of a VSE explaining the Torricelli's law

In this section we present and describe a VSE explaining the Torricelli's law. In this context, we are mainly interested in presenting the research results of the case study. For a detailed description of the case study, interested readers can refer to [10].

Key to execute our case of study is the VCLab¹ tool. VCLab has been originally developed to support learners in control system design. It uses a 3D virtual user environment to recreate and to visualize experimenting plants. A learner can interact with a displayed scene in a similar fashion like with real devices. For more

information and details on VCLab, interested readers can refer to [8] and [9].

From the ELeGI Service Oriented Architecture perspective, VCLab is seen as a set of resources and the process of discovery and instantiation of a VCLab resources is similar to the one implemented for other kinds of LOs. It is presented in the following Figure 5 taken from [9].

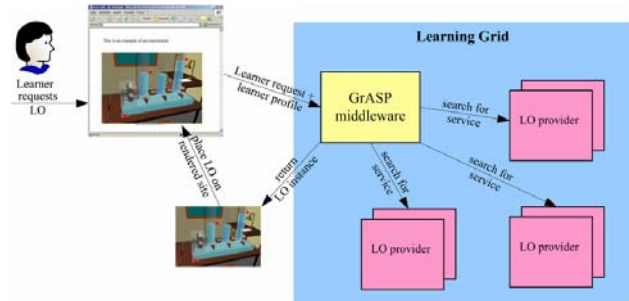


Figure 5 - Process of discovery and instantiation of the VCLab Resource (from [9])

In the above picture, the GrASP middleware [12] is the Service Oriented Grid middleware of the Grid layer of Figure 4.

In the Torricelli's law experiment, the LOs realizing the macro-phases of the VSE model in a UoL are generated using the VCLab Resource. Figure 6 presents the general structure of this resource.

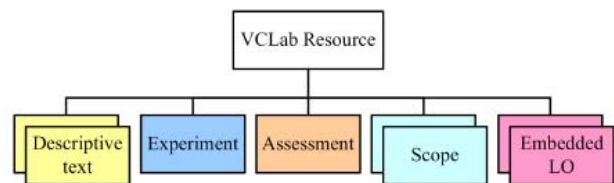


Figure 6 - VCLab Resource structure (from[9])

It consists of a set of optional abstract elements whereby some of elements may occur in multiple instances. Customizing this resource in a proper way will yield the different LOs of the VSE model. The appearance is also fully customizable by the sequence of elements in the resource as shown in

Figure 7. For more information on the single elements of the VCLab structure, interested readers can refer to [9].

¹ Virtual Laboratory for Automatics and Control Engineering developed at the University of Bochum, in the scope of ELeGI. This tool can provide university students with easy access to engineering applications at anytime and from any computing environment

