

# A Framework for the Design and Implementation of Learning Objects: a Competence-based Approach

Arnaldo Santos<sup>1</sup>, Inês Direito<sup>2</sup>,  
Miguel Oliveira<sup>3</sup>, Paulo Real<sup>4</sup>, Pedro Antunes<sup>4</sup>, Manuel de Oliveira Duarte<sup>2</sup>

<sup>1</sup> PT Inovação, Grupo Portugal Telecom, Rua Eng. José Ferreira Pinto Basto, 3810-193 Aveiro, Portugal

<sup>2</sup> Universidade de Aveiro / Instituto de Telecomunicações, Campus Universitário, 3810-193 Aveiro, Portugal, [ines.direito@ua.pt](mailto:ines.direito@ua.pt)

<sup>3</sup> Universidade de Aveiro / Escola Superior Aveiro Norte, 3720-232 Oliveira de Azeméis, Portugal,

<sup>4</sup> DreamLab, Rua bento Moura, 1, 3800-114 Aveiro, Portugal

**Abstract.** This paper presents a framework for the design and implementation of learning objects using a competence-based approach. This framework is illustrated by the development of a standalone Windows application (Trilho GOA) whose primary purpose is to create standardized pedagogical contents through the aggregation and standardization of instructional resources in several formats that can be used later on a Learning Management System (LMS) supporting SCORM 1.2. The paper contains a brief introduction to the developed software, its system architecture, main features and several pedagogical advantages for its users.

**Keywords:** Competences, Lifelong Learning, Learning Object Manager, SCORM, Learning Management System, Pedagogically oriented contents.

## I. Introduction

Some years ago, Alvin Toffler said “The illiterate of the 21<sup>st</sup> century will not be those who cannot read and write, but those who cannot learn, unlearn, and relearn”. Accessing information rapidly, being able to transform it in meaningful knowledge and performing its application in real life is essential to economic competitiveness of companies and personal development of individuals. These skills are important not only as a part of initial education but also as lifelong process that most individuals will require throughout their lives. It is in this context that e-Learning strategies designed for learners that have to be autonomous in most of their learning process are crucial for the so called “Knowledge Society”. In fact, the “Knowledge Society” creates, more than never, the need for constantly developing and upgrading knowledge, skills and abilities in order to face labour market demands and changes. This also poses enormous challenges to training programs that increasingly must address competence-based curricula.

The work presented in this paper is the result of a joint project between PT Inovação, Grupo Portugal Telecom, and the University of Aveiro.

On the basis of this work were the following ideas:

- Enterprises need skilled workforce in order to maintain and promote competitiveness. To accomplish that, prospective studies identifying future labour needs and technological transformations taking place in the economy should be based on lifelong learning initiatives, pointing which knowledge and competences are required. Engaging active workers in lifelong learning will significantly improve employee productivity, desired performance and business outcomes, and individual competence development as well.
- Universities and training institutions should prepare their students according to the labour market demands and technological evolution, focusing teaching on competences, in order to face the economic and social challenges ahead. They should also stimulate lifelong learning habits.

The above ideas were further influenced by the fact that the introduction of the Bologna process creates new challenges and opportunities, in particular in the areas of engineering and technical degrees. In these areas, conventional academic *curricula* are undergoing profound modifications, giving rise to learning architectures where the vocational and training components have an increased role and where a strong appeal is made to autonomous work on the part of the learner. A possible approach towards the implementation of the Bologna process is based on the implementation of a problem solving or project led type of learning also known as the Aalborg Model [1], [2]. The Higher Education Classical Model and the Aalborg Model are illustrated by the following table.

**Table 1.** HE Classical Model vs. Aalborg Model, according to curriculum relevance

Classical Model			Aalborg Model			
A	S	Prof	P	S	A	Prof
P	S		P	S	A	
P		S	P	S	A	
P	S		P	S	A	

*Remark:* Applied (A), Specialized (S), Propaedeutic (P), Professionalizing (Prof)

This table illustrates the fact that, in a competence development context the professional or vocational components of the learning process go hand-in-hand with the academic components throughout a course or training roadmap. This is in opposition to the conventional, classical model where subject based learning was the basis on most of course and where professional or vocational components only appeared in its latter stages.

Features like team work, multidisciplinary knowledge management, concurrent learning, etc are some of the requirements imposed to eLearning platforms if used in the context of a problem solving or project led type of education and training, targeted

at competence development. The work reported in this paper addresses the specific needs of an eLearning environment capable of dealing with such requirements.

## **II. Trilho Learning Roadmaps**

Learning roadmaps are conceived with different approaches, methodologies and definitions, according with who is creating them and for whom the education is targeted. The available literature is not consensual, and several companies or institutions that produce learning contents use their own methodology plan. To proceed with research, it is important to clarify and specify what the meaning of a Learning Roadmap is.

Having in mind the semantic framing of words and goals of this project, it is proposed the following definition for Learning Roadmap: *Detailed description of the life cycle of a discipline. It comprehends all contents and associated events and activities that conduce to the goal of a thematic issue. Each thematic issue is indexed with each learning mark.*

Thus, it has been developed a tool, to ensure learning and educational strategies delivered for students and trainees, in order to promote and acquire pedagogical processes in a successful way.

### **a. Description and Outcomes**

Learning Roadmaps tends to be a tool to be easily integrated in e-Learning platforms, in order to stimulate the pedagogical and learning process. It acts upon two fundamental axes: education and learning.

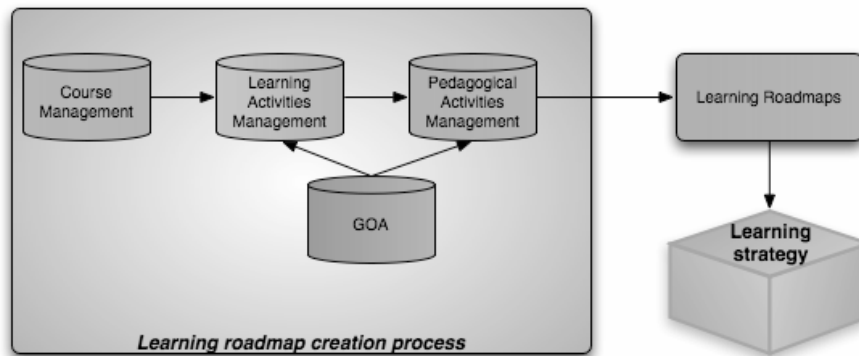
Learning Roadmaps for teachers and trainers tends to be a tool that stimulates the management and organization of disciplines and modules, supporting pro-active didactics and pedagogical issues, curricular structures and learning contents that acts more close to the competence and skills profiles of target audiences.

For students, the Learning Roadmaps primary goal is that it constitutes an instrument to make easier the autonomous study and construction of knowledge, making available means to search, to analyze, comprehend, organize and to value study materials.

Although it is not, at the present moment, the main target of this project, Learning Roadmaps intend to contribute for the development of a embryonic system for training profile and acquired competences. This objective reflects an effort that is currently being made in several contexts in order to value formal and non-formal competences and the growing need to promote lifelong learning activities.

## b. Architecture

Learning Roadmaps Tool (Fig. 1) enables the creation of learning roadmaps, making use of a set of metadata, contents, tools and plugins and its association in one entity that congregates all in one learning strategy and process.



**Figure 1.** Learning Roadmaps Tool Architecture

The learning roadmap manager has two use profiles, coordinator and tutor.

The coordinator has permissions for edition and management of the course guide and other relevant general information and data. Tutors can create, edit and manage, learning actions, modules, units and other relevant associated information, such as sequences, pedagogical marks, events, activities, etc.

Students will be presented with the result of the learning roadmap creation for visualization and use.

## c. Main Features

The application is built according to usability guidelines, taking into account the main accepted standards for Human Computer Interaction (HCI).

Its main features, besides creating SCORM 1.2 compliant contents, include the following:

- Course management - Feature responsible for course creation and management, including the definition and time of learning actions, learning guide, outcomes, typology, etc..
- Learning actions management - Learning actions management, including modules, units and sequences. Enables the edition of data on the learning roadmap. This feature defines and manages the learning outcomes, actions resume and typologies.
- Pedagogical activities management - Manages pedagogical activities and their associations to modules and units. Enables the insertion of pedagogical marks and associations to data. Enables the edition of data on the learning roadmap.

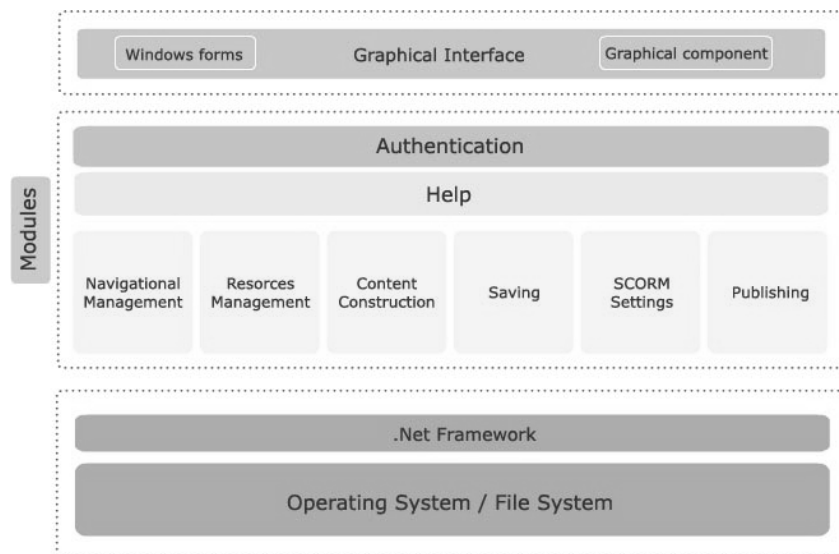
The following sections focus on a fundamental part of Trilho Project: Learning Content Manager (GOA). GOA was developed as a tool to help teachers and trainers to create, organize and manage learning materials according to a competence framework, and support knowledge acquisition and upgrading<sup>1</sup>.

### III. Trilho – GOA Overview

Trilho Learning Object Manager (GOA) is a standalone Windows application whose primary purpose is to create standardized pedagogical contents through the aggregation and standardization of instructional resources in several formats. These contents can be further used on an Learning Management System (LMS) which supports the SCORM 1.2 standard, thus ensuring their reusability.

#### a. System Architecture

Trilho GOA is built on the .Net Framework 2.0, using Windows Forms. The published contents are located on the user's local file system and compressed in a ready-to-use zip archive (Fig. 2). It is a “what you see is what you get” tool, where the user builds the content while seeing it in its final aspect.



**Figure 2.** Trilho GOA System Architecture

<sup>1</sup> GOA is currently being tested at University of Aveiro (namely in post-secondary education programmes), and in life-long training at PT-Inovação.

#### **b. Trilho – GOA Main Features**

The application is built according to usability guidelines, taking into account the main accepted standards for Human Computer Interaction (HCI).

Its main features, besides creating SCORM 1.2 compliant contents, include the following:

- Navigational management – management of the content navigation tree: modules, units and learning sequences (Fig. 3);
- Resources management – management of the instructional resources from which the project is developed;
- Content construction – construction and view of the content while it's being built; selection of different layouts and graphic templates; insertion and viewing of resources in several formats; creation of a glossary; previewing of the content in a browser window;
- SCORM settings – insertion and edition of SCORM 1.2 metadata ;
- Publishing – exporting of the project in its final format, ready to import into an LMS.

#### **c. Trilho – GOA Pedagogical Advantages**

The contents created via Trilho GOA are pedagogically oriented and are geared towards a smooth learning experience.

The existence of a glossary, different usable templates and content layouts, the ability to import video, sounds, images, text, Flash applets and PowerPoint slideshows ensure the content will enable a diversified and compelling learning environment.



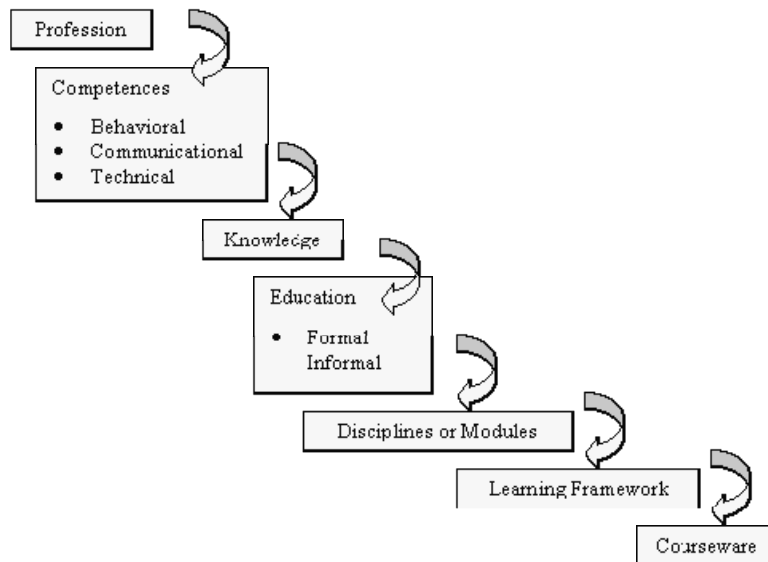
Figure 3. Trilho GOA User Interface

#### IV. A competence-based approach

Competence is the ability to perform an action, knowing what to do and when, and implicates selecting, combining and mobilizing resources [3].

The implementation of learning roadmaps concerning skills frameworks enables objective learning outcomes evaluation. Therefore is possible to know which competences were effectively developed by students. Another benefit of competence-based roadmaps is the promotion of autonomous learning and personal knowledge construction, so important to adults learning.

Trilho's methodology (Fig. 4) begins with a profession analysis, resulting in a specific competences profile. These competences, according to our point of view, are classified as behavioral (knowing to be in contexts), communicational (literacy, numeracy) and technical (know-what and know-how). Knowledge is determined by identified competences, and could be formally or informally acquired. In formal acquisition, courses are organized in disciplines and/or modules, according to a specific learning framework.



**Figure 4.** Trilho's Competence Methodology

**a. GOA's competence-based structure**

As previously referred, GOA's Navigational Management includes modules, units and learning sequences (composed by pages).

There is a correlation between competence-based curricula design [4] and Trilho's design (Table 2).

**Table 2.** Terminology correlation

<b>Competence-based curricula design</b>	<b>Trilho</b>
Module	Module
Competence unity	Unity
Competence element	Page

Learning objects could be viewed as competence elements, including a well defined objective, a learning activity to perform and evaluation standards.

Example: "Students should be able to (action verb) + learning activity + performance standards".



## V. Conclusions

A framework for the design and implementation of learning objects using a competence-based approach has been presented. This framework was illustrated by the development of a standalone Windows application (Trilho Goa) whose primary purpose is to create standardized pedagogical contents through the aggregation and standardization of instructional resources in several formats that can be used later on a Learning Management System (LMS) supporting SCORM 1.2. The paper includes a brief introduction to the developed software, its system architecture, main features and several pedagogical advantages for its users.

This work is set in the context of e-Learning strategies designed for learners that have to be autonomous in most of their learning process, a crucial need for the so called "Knowledge Society". In fact, the "Knowledge Society" creates more than never, the need for constantly developing and upgrading knowledge, skills and abilities in order to face labour market demands and changes. This also poses enormous challenges to training programs that increasingly must address competence-based curricula.

## References

- [1]. Duarte, M. O.: Percursos de Educação/Formação em contextos de acentuada diversidade: o caso do Programa Aveiro Norte. Lecture Notes in "Políticas de Educação/Formação: Estratégias e Práticas", Conselho Nacional de Educação, 7 de Fevereiro de 2006, Lisboa.
- [2]. Blaaberg, F., Kazmierkowski, M. P., Pedersen, J. K., Thøgersen, P., Tønnes, M.: An Industry-University Collaboration in Power Electronics and Drives. IEE Transactions on Education, 43 (2000) 52-57.
- [3]. Le Boterf, G.: Compétence et navigation professionnelle. Éditions d'Organization, Paris (1999)
- [4]. Catalano, A. M., de Cols, S. A., Sladogna, M.: Diseño curricular basado en normas de competencia laboral. Conceptos y orientaciones metodológicas. Competencia Laboral – Diseño Curricular. 1ªed. Banco Interamericano de Desarrollo, Buenos Aires (2004)
- [5]. E. Commission, "THE BOLOGNA PROCESS: Next stop Bergen 2005," [http://ec.europa.eu/education/policies/educ/bologna/bologna\\_en.html](http://ec.europa.eu/education/policies/educ/bologna/bologna_en.html) (accessed in April 4th 2006).
- [6]. Wiley, D. A., "Connecting learning objects to instructional design theory: A definition, a metaphor, and a taxonomy. In D. A. Wiley (Ed.), The Instructional Use of Learning Objects" <http://reusability.org/read/chapters/wiley.doc> (accessed in March 2nd de 2005).
- [7]. Wiley, D. A. "Connecting learning objects to instructional design theory: A definition, a metaphor, and a taxonomy. In D. A. Wiley (Ed.), The Instructional Use of Learning Objects," <http://reusability.org/read/chapters/wiley.doc> (accessed in March 2nd de 2005)
- [8]. IMS Global Learning Consortium, "Learning Design Specification," <http://www.imsglobal.org/learningdesign/> (accessed at 6th June 2006)