

# Issues in Designing Web-based Environments for Learning Communities with Special Educational Needs

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## Abstract

*Web-based learning environments seem to be taking less consideration of the educational needs of special user communities, or trying to improve their accessibility aspect only after the initial design and development is completed. In this paper we describe two basic design considerations for the development of such learning environments: the analysis of the learner special educational needs and the analysis of the learning content characteristics, both in a formal and reusable way. We present how learner and content modeling is carried out in accordance to the international standardization efforts, in respect to the special educational needs of sensitive learner communities. We discuss these issues in the context of the NEMO project, and we present our analysis results for a learning group belonging in the wider community of people with cognitive disabilities.*

## 1. Introduction

Education and training are structural means by which society can help its citizens to have equitable access to prosperity, democratic decision-making and individual socio-cultural development. Unfortunately, the design of most of e-learning environments does not consider communities with special educational needs or considers them from a monolithic point of view. Generally, everyone seems to agree that compatibility to commonly accepted accessibility standards and lack of appropriate adaptation of technologies create obstacles in an area that should be accessible to everyone.

From a survey among the most popular web-based learning environments, it arises that many of them are not accessible for users with special needs [1], [2]. Nevertheless, due to recent legislative efforts web environments seem to be taking into account accessibility issues by making some adaptations in their initial structure (see for example Blackboard and WebCT [3],

[4]). The majority of these adaptations concern the shell of the web environment and fall into the field of assistive technology. Therefore, they are mostly addressed to people who have sensory disabilities (visual or hearing impairments) or motor disabilities, which can mostly profit from assistive technology. Fewer attempts have been made regarding pedagogical issues of web environments and issues such as modifying the learning content and the instructional methods used according to the special learning needs of such user communities [1].

In consequence, the majority of web environments are not properly addressed to users who have cognitive disabilities. The access to a web environment, for instance, might not be very convenient and learning effective for people with learning disabilities, since adaptations in this case should mostly concern pedagogical and instructional issues. System designers select to show less respect on cognitive disabilities than sensory or mobility impairments. They tend to address cognitive and mental disabilities as a broad and general intellectual impairment that cannot be supported by a web-based learning environment, and do not yet seem to understand the specific deficits resulting from mental disabilities. Nor, more importantly, do they seem to fully exploit the possible mapping between those specific deficits and equally specific design solutions [5].

In this paper, we present our experience from the design of a web-based environment aiming in addressing the above-mentioned matters, in the context of the NEMO IST Project. We focus on the definition of two basic axes upon which the NEMO platform is built, which are the learner characteristics modeling (profiling users' special deficits) and the content characteristics modeling (the specific attributes that can be used for serving the users' needs). This definition is carried out in a formal, reusable and interoperable way by utilizing the international specifications in the areas of learner profiling and learning object description. We therefore provide the technical basis in order for the third important axis, upon which the NEMO project will be developed, to be substantiated and specified: the implementation of the

appropriate instructional strategies for learning communities with special educational needs.

## 2. The NEMO project

The NEMO “Non-Excluding Models for Web-based Education” IST project aims in designing and developing a web-based platform for empowering the education and training procedures of learning communities with special needs, in an adaptive and personalized way. NEMO intends to engage the technology element in such a way that it will provide the substantial basis of educational services focusing on individuals’ special needs. The NEMO user groups belong to three wider user communities with special educational and vocational needs: people with hearing impairments, elderly people, and people with cognitive disabilities. The main objective of NEMO thus, is delivering a platform that will provide a framework of educational services to usually excluded learning communities, and validate the project results by specializing the platform for these three user communities.

A sub-objective of NEMO is to elaborate a study of a life-long educational model that will be implemented through the technical solution provided by the project. Through the specification of the different needs for education and training for these communities, NEMO also aims in establishing three sets of requirements comprising by a general, common part, and by a specialized to the specific user group’s needs one; the general aim is to define a proposal that will be able to be particularized to new learning communities. Either combined with the web-based platform of NEMO, or used on their own, these requirements aim to serve as the design considerations and development guidelines for any system supporting the educational needs of a special user community. NEMO has been therefore designed upon three basic axes:

- The need to identify and represent the special interaction and educational needs of the user groups under study;
- The need to identify and represent the special interaction and educational properties of the learning content to be presented;
- The need to built, upon the two axes described before, a concrete structure for defining and implementing those instructional design models that will match the user characteristics with the content characteristics in an educationally effective way to achieve the goals of the learning or training experience.

The technical requirement in order to specify ways to formally describe information related with all aspects of an e-learning architecture has internationally resulted in a

number of standardization activities, aiming to define common learning technologies specifications and standards. Without such standards, universities, corporations, and other organizations around the world would have no way of assuring the interoperability of their learning objects or other instructional technologies. The Learning Technology Standards Committee (LTSC) of the Institute of Electrical and Electronics Engineers (IEEE) was formed in 1996 to develop and promote instructional technology standards [6]. At the same time, the Instructional Management Systems (IMS) Project has been developing learning technologies specifications in the United States, with funding from Educom [7]. Each of these and other organizations (e.g. the Advanced Distributed Learning Initiative – ADL [8]; the European CEN/ISSS Learning Technologies Workshop [9]) began developing technical standards to support the broad deployment of learning objects. In line with the three axes defined before, the specifications that correspond to each of the guidelines driving the project are the following:

- Learner modelling: existing specifications enable the common description of learner-related information with metadata structures based on XML (i.e. the IMS Learner Information Package / LIP, IEEE Public and Private Information for Learners / PAPI specifications).
- Content description: existing specifications enable the common description of learning objects with metadata structures based on XML (i.e. the IEEE LearningObject Metadata / LOM, IMS Meta-data, ADL Shareable Courseware Object Reference Model / SCORM specifications).
- Content organisation: existing specifications enable packaging and publishing content structures built on learning objects (i.e. the IMS Content Packaging / CP, ADL SCORM Content Structure Format / CSF specifications).

NEMO is developed following the guidelines provided by the IMS Consortium, and specifically the IMS LIP, the IMS Meta-data (which is the basis, and therefore almost identical, with the IEEE LOM) and the IMS CP (which provides numerous ways for structuring, organising and presenting learning objects). In the context of NEMO, we are going to focus on studying the application of these specifications in the case of a specific community of learners that fall under the NEMO interest: people with mental retardation.

## 3. The learning community

The main deficiencies in cognitive domain, as they result from research during the last 25 years, are focused in three aspects of information processing in individuals with cognitive disabilities [10]. At the very early stages of

information processing, individuals with mental retardation do not process some basic aspects of visual stimuli such as depth cues or movement cues in the same way as individuals with average intelligence do. The second aspect of information processing that is deficient in individuals with mental retardation is encoding, which refers to the initial aspects of making information meaningful. The third aspect is based on many studies, which suggest that individuals with mental retardation take longer to encode information and are less accurate in encoding information. The most firmly established finding in the study of individuals with mental retardation is that they have deficiencies in the use of cognitive strategies. This does not mean, however, that individuals with particular disabilities do not possess a quantity of cognitive strategies; they rather apply them in inappropriate or ineffective ways, having less control over certain aspects of their thinking [11].

Individuals with cognitive disabilities have a unique disorder that will make certain parts of life more challenging. Their communication difficulties are the most prominent both in every day life and in learning, thus one has to focus on ways that will improve their communicative skills in order that they gain better control over their lives and become more functional in all aspects of life. In this context, the implementation of augmentative communication programs is considered necessary in order to be met the educational needs and requirements of children with cognitive disabilities. A program that has been internationally proven extremely useful for the education of people facing communication difficulties such as children and adults with cognitive disabilities is Makaton: a unique language program that may be used either as a systematic multi-modal approach for the teaching of communication language and literacy skills, or as a source of highly functional vocabulary for both the person with communication needs and their interactive partners.

In Makaton, the language concepts are presented in two vocabularies: in a small, "core" vocabulary including the most basic for everyday life concepts, and a larger, "resource" vocabulary covering broader life experiences. Makaton symbols and signs are matched to all the concepts and the core and resource vocabularies can be used with speech, written word, or on their own. This multi-modal approach, where one mode facilitates another, has been shown to increase opportunities for personal expression and development, leading to interaction and socialisation, and to increase access to education, training and public information [12]. Makaton, which devised over 20 years ago for children and adults with a variety of communication and learning disabilities, then updated and revised in 1996, is used extensively in the U.K. and has been adapted for use in 40 other

countries. Makaton is used by individuals with a broad range of communication needs, often associated with learning difficulties, from those at a very early stage of communication awareness and development to others more able.

Pammakaristos Children's Foundation is a non-for-profit organization that provides education, social welfare and vocational training to children and young adults with cognitive and mental deficiencies, autism and Pervasive Developmental Disorders, speech, language, and communication problems, attention disorders, or combination of the above disabilities. In this context is running a Special Vocational Centre. Apart from being a representative community of the overall community of people with cognitive disabilities, Pammakaristos is also a member of the large Makaton community, so it can serve as the case of study for our research regarding the needs of the community of people with cognitive disabilities – and more specific, people with mental retardation.

As it becomes apparent persons with cognitive disabilities have the capacity to learn, to develop, and to grow. The starting point for successful learning is modifying instruction to meet individual's need. In the remainder of this paper, we will study how these special educational characteristics of this learning community can be formally specified, using the IMS LIP specification, and how they can similarly lead us to the definition of the content characteristics that can be taken into account regarding the special cognition and interaction abilities of the learners, using the IEEE LOM specification.

#### 4. Learner profiling

Modeling the users is a procedure carried out in close collaboration with the tutors (and carers). In order for tutors to record in the best possible way their learners' specific characteristics that are necessary for adopting the content presentation to their needs, we defined a set of actions to be taken. First and foremost they have to describe in details their learners' characteristics that affect interactions with a web-based learning environment (i.e. in case of PAM user group the content presentation should take under consideration learners' communication skills, their attention span, the type of their mental disability etc); then they need to classify these characteristics into the existing IMS LIP categories, and identify whether the existing LIP elements are enough to cover the defined characteristics or propose the appropriate extensions. Next comes the definition of the value spaces of each element identified in the LIP model. In the case the tutors conclude in a set of learner characteristics that respond to a part of the LIP model, they also need to eliminate the elements they don't consider necessary for profiling their learners. Finally, the

process closes with the creation of several examples that will provide the tutor with the necessary feedback in order to correct and verify the model, and the iteration of the procedure until the profile elements are finalized.

For example, let us introduce how this procedure is followed in the case of modeling the knowledge and proficiency of the Makaton communication language for an example learner of the Pammakaristos Foundation. The LIP specification includes a formal way to represent the proficiency levels of a communication language in the accessibility.language element. For each possessed language (for example “Greek”-“gr”) there are four different parameters that have to be defined; that is the four different types of proficiencies for the specific language: level of oral expression, level of oral comprehension, level of reading comprehension and level of writing expression (OralSpeak/OralComp/ Read/Write respectively). The level of possession of each proficiency is expressed by a value taken from [Poor/Medium/Good/Excellent].

In the case of the Makaton language, this standard definition cannot be applied. The experts have indicated that the Makaton symbol language has only two types of proficiencies, that is ‘Comprehension’ and ‘Expression’. And more important, the level of possession of each proficiency is defined through a totally different set of values (as it was indicated in the previous Section), that is taking one or more values from [Stages1-3/Stages4-6/Stages7-9/Core vocabulary]. There is therefore a need for an extension of the LIP model in order for this learner characteristic to be properly specified, stored and reused. This extension (Table 1) is not affecting only profiling of the specific learner of the Pammakaristos Foundation, but is also reflecting the need of the whole Makaton community.

Technically, this goal is accomplished by appropriately defining the XML schema binding with the IMS specification, and by specifying new vocabularies and new elements for the XML structure. This results in an extension of the XML schema, which still remains IMS compliant. Definition of other special learner characteristics is done in a similar way, and can lead to a proposed extension of the LIP schema, aiming in serving the needs of the whole learning community under study [13].

**Table 1: The LIP elements for IMS Accessibility.Language definition.**

IMS Elements	Child elements /Attributes	Values
Language (default, for greek)	OralSpeak/Oral Comp/Read /Write/	Poor/ Medium/ Good/ Excellent
Language (extension, for Makaton)	Comprehension/ Expression	Stages1-3/ Stages4-6/ Stages7-9 /Core vocabulary

## 5. Content properties

The second important aspect in assembling the technical basis of the NEMO environment, is the identification of the content characteristics that can play an important role in the education and training processes of learners with special needs (as depicted from their learner profile) and their formal specification.

The IEEE LOM specification defines a conceptual data schema that describes the structure of a metadata instance for a learning object, by describing relevant characteristics of the learning object to which it applies. Such characteristics can be grouped in different categories, such as: general, lifecycle, meta-metadata, technical, educational, rights, relation, annotation, classification categories. The goal is to identify the existing elements of the LOM specification that are important for describing the NEMO educational content; then, to extent elements, taxonomies or vocabularies in order to include those attributes of the content that are judged necessary for the user community.

Let us present how this goal is achieved for the case of learning objects containing Makaton symbols. In close collaboration with the Pammakaristos experts, a number of educational characteristics were identified that are necessary for semantically describing a Makaton learning object. Those properties of the content fall under the educational element of LOM:

- “Makaton Vocabulary Stage”: for a learning object containing Makaton symbols, an indication of the level (stage) vocabulary in which the symbols belong.
- “Info Organisation”: An explicit identification of the type of information contained in a learning object; when the ‘Symbols’ expression is contained in this content property, the learning object includes Makaton symbols (this extends the usage of the general.language LOM element which refers to other types of languages, and cannot distinguish the use of Makaton in the case of complex objects, i.e. the case of a learning object containing both a Makaton symbol and a word in Greek).

**Table 2: The proposed LOM elements that are associated with Makaton.**

Proposed element	Value space	Description
Makaton Vocabulary Space	CoreVocabulary/Stages1-3/ Stages1-6/ Stages1-9	Use the adequate set of Makaton symbols, i.e. the symbols that refer to the one of the accepted stages.
Info Organization	Text/Pictures/Symbols/Sound/ Text&Pictures/Text&Symbols/ Text&Sound/Pictures&Sound/	It describes the way that the various elements of

	Picture&Symbols/Symbols&Sound/Text&Picture&Symbols/Text&Pictures&Sound/Pictures&Symbols&Sound/Text&Pictures&Sound&Symbols	information (i.e. text, pictures, symbols etc) are organized.
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The table containing those proposed extensions of LOM related with the Makaton language are depicted in Table 2. The LOM specification is also represented as an XML model, using the IMS Meta-data XML schema binding.

## 6. Conclusions

We argue that developing a web-based learning environment should take into consideration the special educational characteristics of the learners and the content, from the very early design stages. We presented how this was carried out for the case of a learning community of people with cognitive disabilities, in the context of the NEMO project. We presented how the special learner characteristics are represented using the IMS LIP specification, and similarly how the learning objects are described using the IEEE LOM specification. Based on these definitions, it is our goal now to design and implement two important elements of the NEMO web-based platform: a model of instruction, aiming to serve the special education and training needs of this learning community, and an adaptation model providing personalized access to the learning material by matching the learner characteristics with the content properties.

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## 8. References

- [1] Antony Quinn, "Why People Can't Use e-Learning", Accessibility White Paper, FrontEnd Usability Infocenter, 2001 (<http://infocentre.frontend.com>).
- [2] AnnMarie Johnson, Sean Rupert, "Accessibility in

online learning management systems", University of Wisconsin Web Accessibility Guidelines and Resources, 2001

(<http://www.uwosh.edu/programs/accessibility/papers/>).

[3] The High Tech Centers Training Unit, "WebCT and Blackboard Accessibility Issues", training presentation, California Community Colleges, summer 2002 ([http://www.htctu.fhda.edu/slideshows/TechEd/Access\\_files/frame.htm](http://www.htctu.fhda.edu/slideshows/TechEd/Access_files/frame.htm)).

[4] Bruce Landon, Douglas College, Greg Gay, "Accessibility Audit for WebCT Courses", WebCT Annual User Conference, 2001.

[5] Ellen Francik, *Telecommunications problems and Design Strategies for People with Cognitive Disabilities*. Rehabilitation Engineering Research Center on Universal Telecommunications Access, 1999.

[6] IEEE, Learning Technologies Standards Committee (<http://ltsc.ieee.org/>).

[7] IMS Global Learning Consortium, Inc. (<http://www.imsproject.org>).

[8] ADL Advanced Distributed Learning Network (<http://www.adlnet.org/>).

[9] CEN/ISSS Information Society Standardization System, Learning Technologies Workshop (<http://www.cenorm.be/iss/Workshop/lt>).

[10] American Psychiatric Association, *Diagnostic and Statistical Manual of Mental Disorders*, American Psychiatric Association, 1994.

[11] Gay, G.R. "Supporting students with Learning Disabilities: an Introduction to Web-based Process Oriented Instruction", *Technology and Persons with Disabilities Proceedings* of the 15th Annual International Conference, "Technology and Persons with Disabilities", Los Angeles, March 20-25 2000.

[12] Grove and Walker, "The Makaton Vocabulary: Using Signs and Symbols to Develop Interpersonal Communication", *Augmentative and Alternative Communication*, 6, pp.15-28, 1990.

[13] N.Manouselis, D. Sampson (eds.), "Best Practice Guide for IMS LIP User Profiling for NEMO User Groups", Internal Report 1, NEMO IST-2000-25308 Project, 2002 (available from the authors).