

# Assembling Content into Dynamic Learning Objects versus Authoring of E-Learning Courses

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**Abstract**—It is our goal to assemble the content into dynamic learning objects (LO), to make the content adaptable to the learners preferences and to all kinds of used appliances by the learner. A three layer e-learning course development model has been defined based on the “conceptual model of content object”. It starts by decomposing the learning content into small chunks which are initially placed in a hierarchic structure of units and blocks. The raw content components, being the atomic learning objects (ALO), were linked to the blocks and are structured in the database. We set forward a dynamic generation of LO's customised to the learner group on point of content and customised on point of presentation, fitting the preferences and the used appliances of the learner. In that view we need a LO assembling system fitting the requirements of interoperability and reusability and starting from selecting the raw learning content from the learning materials content database. The company AGFA Healthcare is using an authoring system that creates SCO's being interoperable. Thanks to a good management is the solution a best practice, even it is not based on a database. Though they can not create dynamic solutions and cannot customise the e-learning module on the fly to the learners preference and the used appliance by the learner.

**Index Terms**—Learning Object, authoring system, reusability of learning content, interoperability of e-learning module

## I. INTRODUCTION

In the new e-learning situation the teacher delivers it as electronic documents and puts it in a learning portal of a learning management system (LMS).

The source learning content has to be converted into e-learning content defined as learning objects (LO)

The source learning content has been decomposed manually into small chunks of content structured in units, blocks and sub-blocks following the logical tree structure of the content. The content belonging to the blocks and sub-blocks have to be decomposed in raw content components or atomic learning objects (ALO) (text, figures, summary of text, keywords of text) and have to be supplemented with additional ALOs to create interactivity and animations.

The LOs include the tree structured learning content presented in a pre-defined layout realised as a scenario composition of the ALOs.

A course can be built by packaging learning objects, to fulfil the requirements of interoperability (content from

multiple sources working equally well with different learning systems) and of reusability (content developed in one course being transferable to another context).

## II. THE CONCEPTUAL MODEL OF CONTENT (LEARNING) OBJECT

The conceptual model of content object shown in Fig. 1, however, describes a technical infrastructure for developing, assembling and managing re-usable granular content objects [6-7].

Each component is composed of a set of elements from a lower level with the two highest levels correspond to the traditional course view. Each lesson is a set of LOs which is composed of a composition of a set of information blocks which are composed of a set of raw data elements, full text, summary text, key terms, figures, and so on, usually referred to as atomic LOs or simply ALOs. However, the raw information blocks are of little use to the learning process if examined as individual information units as they are not bound to any specific application. Those information blocks can be assembled into learning objects by adding context or metadata to them. The resulting LOs, which stand in between the raw information and the e-courses, are rich in content since they incorporate many resources, convey context that serve general learning needs and may be re-used. Thus, all content components and LOs can be stored in a databasewhich could be made accessible for use in e-learning courses.

## III. THE PROCESS OF CONVERTING CONTENT TO REUSABLE LEARNING OBJECTS AND E-LEARNING COURSE MODULES

The production of an e-learning course module can be done in 6 phases:

*Content linked phases:*

- a) Decomposition of the original learning content,
- b) Decision on which attractive and interactive components will be and will where be added
- c) Building those components: content

*Technology linked phases:*

- d) Developing those components
- e) Content storage in the database as ALO's (atomic learning /content objects)
- f) Content objects assembling and packaging to deliver the end product, the learning object LO and the e-learning course module

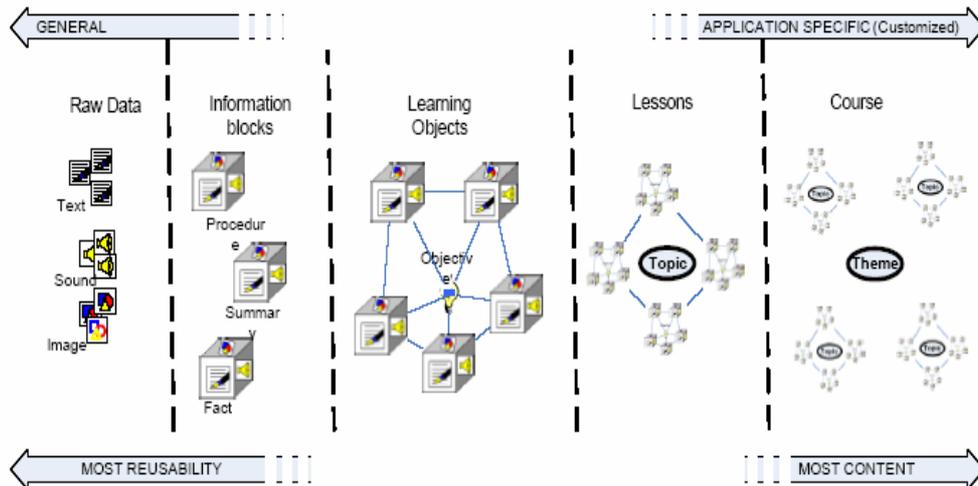


Figure 1. Conceptual Model of Content Object. [6]

The content linked phases a, b and c are the responsibility of the author / instructional designer and the technology linked phases d, e and f are the responsibility of the technical designer and builder of the e-learning course module.

IV. THE DECOMPOSITION OF THE LEARNING CONTENT

A. Units, blocks and sub-blocks

The decomposition of the learning content is a manual process. The source learning content has to be decomposed and structured as a hierarchical tree of chapters, units and blocks. [10-6]. A course is similar with a book while a chapter contains many blocks, being smaller content parts. If the chapter can really be split into more individual content topics, or which can be learned as individual topics, then the learning content is split into two or more independent content units, put together in a sequence. The learner will subsequently learn them as one logical content module. Each unit is composed of a set of blocks, corresponding to smaller content parts, being structured as a relational tree. The course content is decomposed in small chunks of content, being the content of the blocks and evt of the sub-blocks. The example shown in Fig. 2, the course “Business Driven Technologies” with the chapter “supply of ICT professionals” is decomposed into blocks of content.

In a second part of the decomposition phase, that block content is split in raw content elements or ALOs: the full text, its summary, figures and tables, and the key terms of its content. Some other ALOs can be added, such as a video telling the story, Q & A, URL of additional information, etc. Accordingly, metadata will be defined for all content components [9].

B. Decomposition in practice.

The e-learning project development team consists of a content owner/ expert, an instructional designer and a programmer-developer. The instructional designer is

decomposing the original content and creates the tree-structure of the chunks of content.

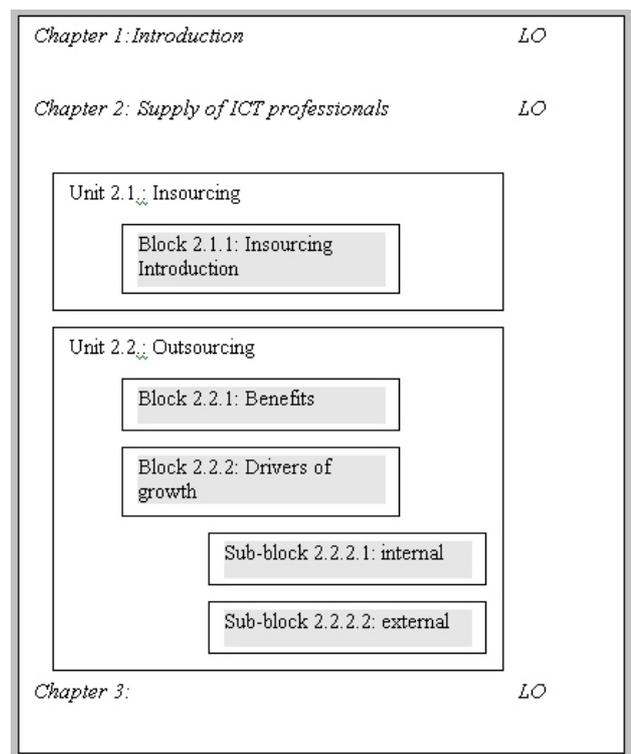


Figure 2. Decomposition of Content in Course “Business Driven Technology”.

To have a visual way of communication with the owner of the content, all components are put in an excel template. The content owner will complete the template with additional Q&A, exercises, key terms, pictures...(Fig. 3)

1	2	3	4	5	6	7	8
TITEL	TITEL	TITEL	TITEL	TITEL	module	numbering	audiotest
screening of passengers	Who should be screened	Group of passengers	Persons with reduced mobility	exempted from screening	AS-M05-U02	2.1	In essence, every departing passenger should be screened unless otherwise specified in the National Aviation Security Programme and listed in an appendix to the Airport Security Programme. Even groups of passengers such as Diplomats, Diplomatic Couriers, VIPs, babies in pushchairs and people with reduced mobility are not automatically exempt under the legislation, although additional measures such as private screening areas may be required.
					AS-M05-U02	2.1.1	
					AS-M05-U02	2.1.2	
					AS-M05-U02	2.1.3	EC 622/2003 makes provision for the handling of potentially disruptive passengers, requiring specific security measures to be introduced for their air transport ANNEX IV.4.D to EC Dec 30, ECA/C policy statement in the field of civil aviation security, provides guidance to assist Member States in producing operational procedures with air carriers to address the security aspects of the carriage of

Figure 3. Decomposition in practice

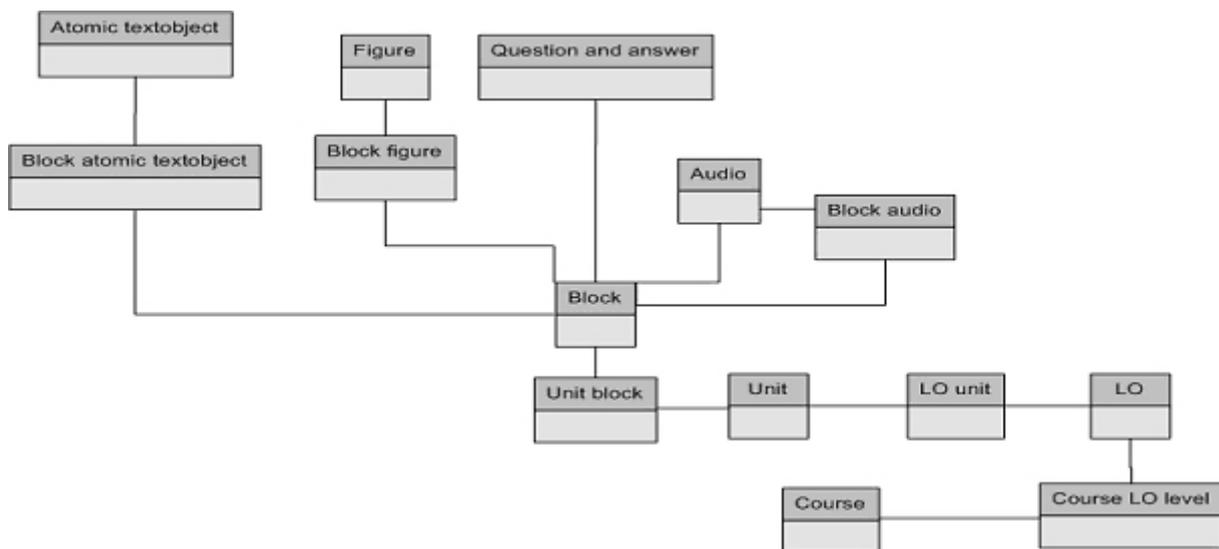


Figure 4. Database structure of decomposition

V. CREATING A DATABASE OF LEARNING CONTENT AND METADATA

A. Metadata for the content

SCORM differentiates between 3 levels of objects and different requirements on point of metadata are set forward for the three different levels:

1. An asset or an ALO, where the compulsory metadata consists of the title, the description and the copyright. Additionally the creation-date, the format and the type can be added.

2. A SCO or a BLOCK, being the smallest content element that is an independent content component that delivers significant information about a topic. The compulsory metadata already required for an asset, supplemented with two additional metadata items, the language and the elapsed time

3. An LO or a course module will be built by packing a set of SCOs, being stored as a content aggregation model or CAM. A special characteristic of a CAM is the possibility of “nesting” different CAMS. A CAM can be compared with the chapter of a course or a book, being a learning path composed of several e-learning units. The compulsory metadata consists of the metadata already required in a SCO, supplemented with the title, the learning level of the content and the required foreknowledge.

B. Storage of Content in Database; database structure for the content

Starting from the source learning content, the hierarchical structure of units and blocks are identified in it. To create the learning objects the content will be structured in the database following the hierarchical

content structure. And to assemble the content linked with the blocks the content components or ALOs are tracked from the data tables. ALOs include full and summary text, figures, questions and answers, audio files. Requirements of Re-usability and of Inter-operability of Learning Content

C. Introduction

For re-usability, the following possibilities in mind: first, based on the same source content, we can make a selection of blocks we bring in the LO, second we bring more LOs with the same content, but presented in another layout fitting the preference of the user, and fitting the used appliance of the learner.

In our previous paper on the subject (15) we explained the re-usability and the operability of LO's and introduced the SCORM standard.

D. Dynamic LO's customised to the preferences and the used appliance of the learner

A dynamic LO will be created when the learner activates it. If the LO is available in more presentation layouts, then the learner can select its preferred layout.

For re-usability, the following possibilities in mind: first, based on the same source content, the teacher can make a selection of blocks, to bring into the LO. Second the teacher can create more LOs with the same content, but presented in another layout fitting the preference of the users and their learning styles. Third the same as the second one, but fitting the device of the user. Different presentation templates can be developed in advance and the LO can be presented in that way.

Furthermore, mobile devices such as PDAs and mobile phones have limited presentation facilities and as a consequence in the course design the screen layout has to be simplified. Flexibility of different devices means that course materials can be automatically adjusted in order to be accessed by a variety of devices. The e-learning system will identify the type of device used by the learner and starts the e-learning course in the most appropriate built in presentation design.

Several LO's can be built upon the same content.

The first LO includes all the source content and structured following the built in hierarchical structure. Another LO can be built on a selection of the source content. The first LO can contain the learning content on detailed level and the second one selects from all included topics the introductory blocks. F.e..

VI. DYNAMIC GENERATION OF LO'S: A THREE LAYER DEVELOPMENT MODEL

A customised e-learning module will be generated when the learner opens the e-learning course module.

The instructor or the e-course designer has built in more LO's on the same source content, by the way customising to different learner groups on point of learning content.

The learning content can be generated in more built in presentations formats corresponding to the preferences of the learner and the type of device he is using for learning.

The three layer e-learning development model consists of the input and structuring of the raw materials in the database, the dynamic generation of LO customised to the

learner group on point of content and the dynamic generation of LO's customised on point of presentation

(Fig. 5)

A. Dynamic generation of LO customised to the learner group on point of content

The instructor /designer can built in more learning objects customising the learning course to more learner groups, all having their own characteristics. So, more LO's can be built upon the same source learning content. The instructor /designer can make a selection of blocks and of ALO's linked with them. When the learner opens the e-course, dependent on his characteristics, the relevant e-learning course will open. One Lo can include f.e. all the source content and be structured following the built in hierarchical structure. Another LO can be buyilt on a selection of course content . F.e. it selects from all the topics only the introductory blocks.

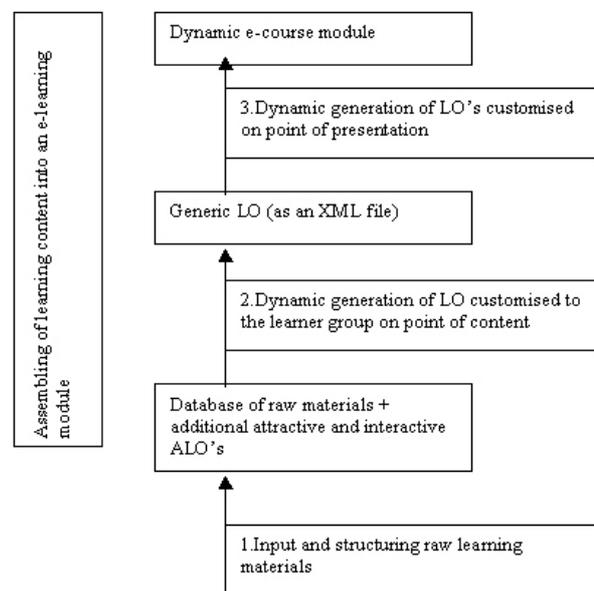


Figure 5. Dynamic generation of LO

B. Dynamic generation of LO's customised on point of presentation, fitting the preferences and the used appliances

The LO will be presented in a layout fitting the preference of the learner. Some types of learners prefer f.e. audio and others prefer to read some text.

The LO will fit the appliance used by the learner while learning. Flexibility of different appliances means tht course materials can automatically adjusted in order to be accessed by a variety of appliances. The e-learning system will identify the type of appliance used by the learner and starts theat version of the course being the most appropriate built in presentation design for a PDA or for a mobile . F.e. large schema's can not be shown in the way that it can be shown on a desktop screen.

VII. AUTHORING SYSTEM CREATING REUSABLE SCO'S: BEST PRACTICE: AGFA HEALTHCARE

In 2006, Agfa HealthCare, a leading provider of integrated IT solutions and state-of-the-art diagnostic

imaging for hospitals and other healthcare centers, deployed company-wide an e-learning authoring tool. The intention was to have Subject Matter Experts create e-learning courses without the need for programming skills. Since the main tool for internal communication was PowerPoint, the e-learning manager of Agfa HealthCare decided to introduce Articulate Studio, an off-the-shelf rapid e-learning software.

This set of PowerPoint plug-ins enable a subject matter expert to turn its presentations into self-paced e-learning courses, ready to be published on the corporate Learning Management System. This low cost entry tool allows to record speaker notes, and therefore to embed the presenter's explanation into the presentation. Additionally, the tool allows to embed Flash movies, structure into chapters and topics, include search functionality, etc. On top of that, the software contains a tool to add quizzes, with more than 10 different question types.

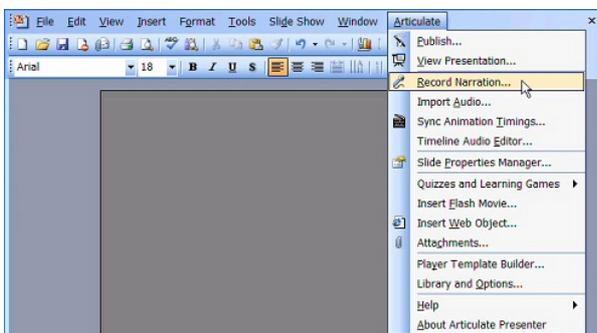


Figure 6. Articulate Studio

The author starts from a PowerPoint presentation, adding graphics, text and animation to each slide. Once the author is finished with the visuals, he can add the notes that will serve to record the presentation. The tool allows for a page by page recording, therefore being very flexible in creating and maintaining the e-learning course. The possibility to add structure, quizzes and animation make the presentation more interactive. Once the author is finished completing the course, he will publish the course to a web enabled format, i.e. Flash.

Automatically, the tool has the necessary tracking information created so that the LMS can track the users' progress.

Agfa HealthCare has customised the tool to allow page by page tracking (multi-sco) instead of the default single-sco tracking. If needed, authors can reuse the content previously created, or share among authors.

They simply need to exchange the source PowerPoint files, and combine several slides into one new presentation, publish the course with Articulate and upload to the LMS. Furthermore, this approach allows for a flexible and easy translation of content and audio.

This authoring strategy has allowed Agfa HealthCare to create more than a 100 courses in a year's time, and has more than 50 subject matter experts using the tool. Deploying the tool has enabled the company to address the need to speed up the time to knowledge, cost reductions in classroom training and travel, better retention and consistent availability of important information across the organisation.

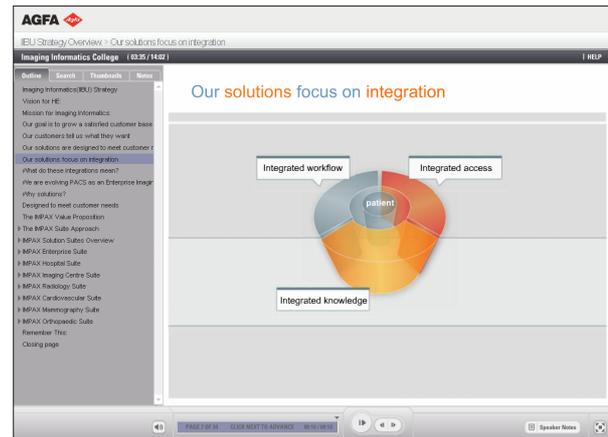


Figure 7. e-learning course AGFA Healthcare

## VIII. COMPARISON OF THE AGFA SOLUTION WITH THE THEORETICAL REQUIREMENTS OF INTEROPERABILITY, MAINTAINABILITY OF THE E-COURSES AND OF THE REUSABILITY OF THE LEARNING CONTENT.

We can evaluate the AGFA solution using 7 criteria:

### A. Delivery of SCO's and its interoperability

Most of the modern authoring systems, and also the system Articulate Studio, are delivering SCO's that are interoperable. Many Learning Management Systems have the functionality of packaging those SCO's.

### B. An user friendly solution and easy to use

The e-learning strategy of AGFA Healthcare implies the active role of the expert users in the development of e-learning materials. The tool, being an extension of powerpoint is easy to use because they are very familiar with powerpoint.

### C. Low cost

Compared to many other authoring tools Articulate Studio is not expensive. The development cost of an e-learning course is very low, in particular compared with a tailored programmed solution.

### D. Management of portfolio of learning materials and of e-learning courses and management of the learning activity of the learners.

All learning materials and all the SCO's and included metadata are organised in a Directory system on the central server, and managed by the Director of e-learning.

The LMS is a very advanced system. The administration and organisation functions are there. The integration of the SCO's in the LMS is complete. The tracking function of the LMS is active for those e-learning courses.

### E. Attractive e-learning courses

The tool includes the possibility of adding animations in flash. The tool creates the content structure and by the way the learners flexibility of selecting preferred e-learning modules.

#### F. Reusability of raw materials.

Each defined SCO corresponds to a html page. Each SCO can be found by simple search and can be reused by other authors and for other course modules. Thanks to an effective way of organising the content it can be reused.

#### G. Maintainability of the e-learning modules.

To make some changes in an e-learning module, the author needs the authoring system and has to start from scratch.

#### H. Dynamic generation of customised e-learning solution.

Because the system is not based on a database to store the raw materials, it is not possible to create dynamic LO's.

As a consequence the e-learning module will not be customised to the user starting the course. Nor will it not be possible to deliver a solution fitting the used appliance by the learner.

### IX. CONCLUSIONS

We set forward a dynamic generation of LO customised to the learner group on point of content. We also set forward a dynamic generation of LO's customised on point of presentation, fitting the preferences and the used appliances of the learner.

In view of reaching that goal, we need a LO assembling system fitting the requirements of interoperability and reusability and starting from selecting the raw learning content from the learning materials content database.

The SCO's being created will be interoperable and can be imported in many Learning Management Systems.

The company AGFA Healthcare is using an authoring system that creates SCO's and by the way e-learning modules being interoperable. Thanks to a good management is the solution a best practice, even it is not based on a database. Though they can not create dynamic solutions and cannot customise the e-learning module on the fly to the learners preference and the used appliance by the learner.

### REFERENCES

- [1] Jeanne Schreurs, A. Y. Al-Zoubi: A blended Learning Concept for guided self-instruction. Proceedings of IMCL2007 Amman; ISBN 978-3-89958-276-5.
- [2] Jeanne Schreurs, G. Ballet, R. Moreau, "An E-learning Concept Mindmap and the Management of the Underlying Learning Objects", *Lecture Notes in Computer Science*. Publisher: Springer-Verlag Heidelberg ISSN: 0302-9743, Vol. 3292/2004 : Title: *On the Move to Meaningful Internet Systems 2004*. Editors: Robert Meersman, Zahir Tari, Angelo Corsaro ; ISBN: 3-540-23664-3 DOI: 10.1007/b102133, p. 758.
- [3] J. Schreurs, R. Moreau: "Learning Objects Aligning Different Learning Styles", *Proceedings of the International Conference on e-Learning, ICEL2006*; University of Quebec Montreal, 22-23 June 2006, pp 415-422, ISBN 1-905305-31-5.

- [4] N. Friesen (2001) "What are Educational Objects?"; *Interactive Learning Environments*, 9:3, p. 219-230.
- [5] Wiley, D. A. (2000). *Connecting Learning Objects to Instructional Design Theory: A Definition, a Metaphor, and a Taxonomy*. In D. A. Wiley, *The Instructional Use of Learning Objects*. Bloomington: Association for Instructional Technology en Association for Educational Communications and Technology.
- [6] I. Varlamis and I. Apostolakis, (2006), *The Present and Future of Standards for E-Learning Technologies*. (A. Koohang, Red.) *Interdisciplinary Journal of Knowledge and Learning Objects*, 2, 59-76.
- [7] Masie. (2002, maart 8). *Making Sense of Learning Specifications and Standards: A Decision Maker's Guide to their Adoption*. Opgeroepen op mei 28, 2007, van The MASIE Center: [http://www.masie.com/standards/S3\\_Guide.pdf](http://www.masie.com/standards/S3_Guide.pdf).
- [8] K. Ryann: "E-Learning Standards Update", Learning Circuits 2005 <http://www.learningcircuits.org/2005/jul2005/ellis.htm>.
- [9] J. Schreurs, R. Moreau: "Converting Learning Content to Learning Objects (LO) and Atomic LO's", Proceedings of the Virtual Conference: *IADIS Virtual Multi Conference on Computer Science and Information Systems*, MCCSIS 2006, 15-189 May 2006, ISBN 972-8924-14-3.
- [10] A. Strijker: "Het maken van leerobjecten binnen de Digitale Universiteit" Digitale Universiteit 2006. <http://www.surffoundation.nl/du/MakenLeerobjecteDUhandboek.pdf>.
- [11] C. Larman, "(2002) *Applying UML and Patterns*", United States of America, Prentice-Hall.
- [12] Shepherd, C. (2000). Objects of interest. Opgeroepen op mei 28, 2007, van Fastrak Consulting Ltd.: <http://www.fastrak-consulting.co.uk/tactix/features/objects/objects.htm>
- [13] <http://lspserver.uhasselt.be/learning/Loms1280.htm>
- [14] [http://lspserver.uhasselt.be/eschemapers/mindmap/supply\\_of\\_ict\\_professionals.asp](http://lspserver.uhasselt.be/eschemapers/mindmap/supply_of_ict_professionals.asp)
- [15] J. Schreurs, A.Y. Al-Zoubi: "Converting Content to Reusable Learning Objects Adaptable to User Preferences and Infrastructure"; Proceedings ELEARNS2007; Quebec; ISBN: 1-880094-63-0.

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