CONCEPTION AND DEVELOPMENT OF REUSABLE AND MODULAR MOBILE CONTENT

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Abstract

The goal of this paper is to show the use of learning technology standards for mobile scenarios, identifying potentials and requirements for the next generation of standards.
Within the conception and development process of M-Learning scenarios, learning technology standards are often neglected because they do not take new M-Learning opportunities into account. E-Learning Standards support -among other areas- learning resources description (e.g. LOM), didactics (e.g. Learning Design) and actor description (e.g. LIP). Whereas E-Learning can actually be based on a technical platform like a web browser and related technology, this is not the case with M-Learning.
We describe our understanding of good M-Learning metadata usage focussing on the necessary extensions to standards. We focus on the didactic conception of learning scenarios. IMS Learning Design provides a standardized way of describing the learning-process and associates the learning process with adequate resources and services.

Finally, we summarize how the resulting metadata for the M-Learning scenarios can be used to enhance learning experiences for all actors within an M-Learning scenario.

1 Introduction

Within the E-Learning community, standards gain importance and help to design interchangeable content. This is achieved by providing standards to describe the content and specify a software interface to Learning Management Systems (LMS). Thus, two main problems with E-Learning content are addressed: The descriptive metadata enables indexation, retrieval, and thus reuse. Content packaging makes it possible to integrate the same content package into different LMS. Content packages describe the resources included in it along with a representation of the structure of included documents. See Pawlowski (2001) and Ellis (2005) on using standards in E-Learning.

Namely, there are two wide spread standards, which deal with content packaging: IMS Learning Design (IMS LD) (IMS 2003) and the Shareable Content Object Reference Model (SCORM) (ADL 2004). The main difference between SCORM and IMS LD is that IMS LD uses a generic language to capture the specifics of the underlying pedagogies of the content. SCORM on the other hand just captures the structure of the described content package from the metadata, without taking into account the pedagogic conception behind the content.

Content Packaging is being used increasingly in the E-Learning community and helps to make E-Learning more efficient and successful. This will –as we suggest in this paper- also happen for M-Learning. M-Learning itself needs to be integrated with traditional and E-Learning scenarios. This cannot be done without metadata and not without an established infrastructure. To actually use the infrastructure available, M-Learning not only has to adhere to established standards. More over the next generation of these standards need to include M-Learning specifics to more efficiently integrate mobility into learning processes.

1.1 M-Learning redefined

In the following, we will use a specific *definition of M-Learning*. First of all, *M-Learning is not restricted to a specific hardware*. M-Learning is –as we understand it– a form of learning in which the learner can use the learning resources in different locations and can organize his learning schedule himself. (Bryan 2004) discusses this definition of M-Learning in more detail with a focus on a *nomadic learning style*. As such, M-Learning needs a transparent pedagogical conception to enable the learner to successfully learn with the given resources. For instance, if a learning resource requires the learner to be in a specific location or in contact with other learners, the mobile learner has to know this and see if this fits to the situation he is in during his learning process. This also is the case, if the mobile device used by the learner just has not the capability to work with the given resources.

As an example, we illustrate the use of a learning resource on an integrated development environment for c++. At some point the learner is required to write and

compile a program. While learning using a smart phone, there is no access to such an environment. The learner would not have used the resource in the first place, if he had known that he is required to write a program at this stage in his learning process. Instead, he would have continued another learning process, which supported his situation -learning with a smart phone- better.

As a second case, the learner is required to take photos with his cellular phone camera to learn how to document a car accident for insurance purposes. Thus, this learning resource would be much more useful if accessed directly from the cellular phone instead of using a desktop computer in the learner's office.

To our understanding, this also means, that M-Learning must be carefully integrated into E-Learning and traditional teaching to make it successful. To deal with the requirements derived from these assumptions, IMS Learning Deign (IMS LD) is the most promising vehicle to meet the requirements. Thus, we suggest using IMS LD for content packaging for M-Learning resources.

1.2 M-Learning and E-Learning

Basically, the success of standards in E-Learning was achieved by using a widespread technical platform, which abstracts to hardware specifics: the internet browser, like Mozilla.org's Firefox (mozilla.org 2005), Microsofts's Internet Explorer (Microsoft 2005) or Netscape's Navigator (Netscape 2005) for instance. Thus, it was possible in E-Learning to more or less ignore the technical details of the learner's device. Only plug-ins are required which can easily be installed on the learners device. Looking at available devices to M-Learning, it becomes clear that this assumption does not meet the requirements of M-Learning. While notebooks and also tablet PCs actually could cope with normal E-Learning content, PDAs, smartphones and cellular phones are different. Smaller devices for instance have much smaller display-resolution and make it much harder to navigate through large documents. Thus, it is clear that we have to take into account which devices our learners want to use.

Another difference is how experienced they are with learning with mobile devices. Through the years, as the World Wide Web became a commercial success, even terms as "Internet Literacy" become well known (on Internet Literacy see Wing 2004). Computer literates became the main target group for E-Learning solutions. Cell phones and PDAs are nowadays primary used for personal communication, so learners can not be expected to know all functions of their devices. Especially the network connection, which most desktop computer now have, cannot be required from mobile learners, as network connection is much more expensive and even availability is not always self-evident. So "*Mobile Literacy*" is not as advanced as "Internet Literacy".

This has a big influence on the current M-Learning solutions. The learner has to know how to handle his mobile device and has to be willing to learn with it. It is very important that advantages of M-Learning are communicated to the learner to enable him to efficiently decide when to learn mobile and when not.

2 M-Learning scenarios and standards

In the following, we will analyse the most important standards in E-Learning and identify requirements and extensions to M-Learning. As a premise, metadata itself needs to be of high quality to be useful (Currier 2004). Firstly, we give a short description of the standards used in this article and then identify extension requirements and potential solutions.

2.1 IEEE Learning Object Metadata (LOM)

Learning Object Metadata (LOM) describe a minimal set of attributes needed to manage, locate, and evaluate learning objects. Typical attributes include the *type of the learning object, author, owner, terms of distribution and format of the learning object*. Additional support for pedagogical attributes is provided, like interaction style, grade level, mastery level or prerequisites. To accommodate specific needs, the standard does support local extensions to the basic fields Multiple LOM sets are possible for any given Learning Object (IEEE 2005).

LOM does not provide any information about the implementation of the described learning object, other than the format of the learning object. LOM provides metadata for retrieving and indexing learning objects, but does not help to integrate learning object in LMS or explain how learning objects are integrated in the learning process. Chan (2003) discusses a more elaborate right management, which can enhance informal learning by enabling automated rights validation. Additionally, M-Learning need more information on the nature of the materials to enable LMSs to evaluate which content can be delivered to a specific end user device. This should also be added to LOM metadata as an M-Learning extension.

2.2 IMS Content Packaging

"The objective of the IMS CP Information Model is to define a standardized set of structures that can be used to exchange content." (IMS 2004a).

The IMS Content Packaging (IMS CP) standard consists of two components: the *Information Model* (IMS 2004b) and its corresponding *binding* (IMS 2004c). The *IMS CP Information model* describes the data structure of IMS CP, which ensures the interoperability between LMS and authoring tools. The *IMS CP XML Binding Specification* describes the representation of the data structure using XML (W3C 2005).

While the *information model* describes the data used to

make IMS Content Packages interoperable, the XML Binding offers a technical solution to extract the data from each package. This is realized by adding one metadata file to each IMS Content Package which structures includes the metadata. This file is called *manifest* and added to the top level of the package which also includes all content files of the package.

The *manifest file* is structured in four categories: *Metadata*, *Organization*, *Resources*, and *Sub-Manifest*, which will be described in the following paragraphs.

The *General* section specifies an identification key, the version and the relative offset for included content files of the package.

The *Metadata* section can contain the metadata describing the package as a whole. IMS suggests the IEEE Learning Object Metadata (LOM) (IEEE 2005) to describe the package.

The *Organization* section is the key part for interoperability. It describes the structure of learning resources. A learning resource specifies either a structure of other learning resources or refers to a set of resources in the resource section. Each learning resource can be used on its own and thus represents reusable content. The hierarchical structure of the organization section is used to rebuild the default structure within applications using these packages. As an example, LMS are enabled to access the structure of IMS Content Packages and include the structure in the navigation. Each learning resource can include either inline metadata or refer to a file within the package which includes its metadata. IMS CP suggests IEEE LOM (see above) as metadata, but other metadata standards (such as Dublin Core, see Dublin Core Metadata Initiative, 2003) can also be included.

In the *Resource* section, resources refer to files or group of files within the package which are needed for learning resources specified in the organization section.

In the *Sub Manifest* section, different organizations can be specified and application using the package can provide learners with a variety of alternative navigations for the content.

Figure 1 shows how IMS CPs are integrated into the content management processes within a learning platform. The aim was to design a standardized way to specify LMS independent E-Learning content. IMS CP focuses on import and export functionalities for compliant LMSs and thus does not need to provide a full-fledged view on the content. It is tailored to help authors to produce E-Learning content which can be imported in and extracted from LMS easily. Other than that, the LMS has to cope with the content of the package on its own, as IMS CP does not support learning activities directly.

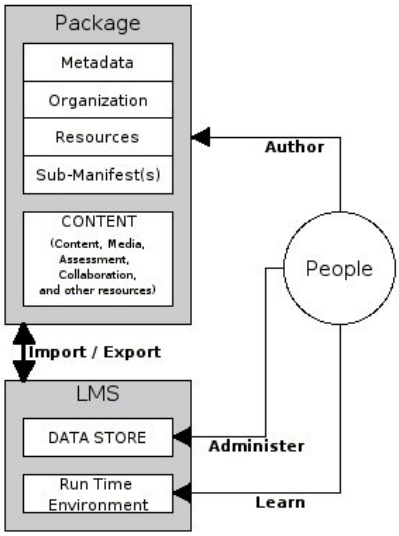

Figure 1: IMS CP framework

Content packaging in E-Learning is usually used to enable authors to reuse their work in different LMSs (Santally et al. 2004). In M-Learning even more as in E-Learning the need for learner individual content packages is more imminent, as learners cannot easily stay connected to the internet while changing their location. M-Learning packages have to address this to make full use of its potentials.

2.3 IMS Learner Information Package (IMS LIP)

The IMS Learner Information Package (IMS LIP) describes characteristics of a learner needed for a number of purposes involved in the learning process. It is designed to *record* and *manage learning-related history, goals and accomplishments* (IMS 2001).

The specification supports the exchange of learner information among a variety of systems, such as learning management systems, human resource systems, student information systems, enterprise e-learning systems, knowledge management systems, or resume repositories. The IMS Learner Information Package specification does not provide or suggest solutions for handling requests for learner information or other profile exchange mechanisms.

IMS LIP is divided in eleven categories to describe the learner. The following list, which is based on (IMS 2001) gives a short overview about these categories.

1. *Identification*: This category describes the biographic and demographic data relevant to learning.
2. *Goal*: Here the learner learning related objectives are described.
3. *Qualifications, Certifications and Licenses (qcl)*: The learner's qualifications, certifications and licenses granted by

recognized authorities are described here.

4. *Activity*: Here the learner can add any learning-related activity in any state of completion to his profile.
5. *Transcript*: A record that is used to provide an institutionally-based summary of academic achievement.
6. *Interest*: Additional information about the learner is described here, for instance his hobbies and recreational activities.
7. *Competency*: Skills, knowledge, and abilities the learner acquired in the cognitive, affective, and/or psychomotor domains are described here.
8. *Affiliation*: Membership of the learner in for example professional organizations can be added here.
9. *Accessibility*: General accessibility to the learner information.
10. *Security key*: The set of passwords and security keys assigned to the learner for transactions with learner information systems and services.
11. *Relationship*: The set of relationships between the core components.

In addition to the learner information described above, Chan et al. (2004) suggest adding a more dynamic structure for addressing learning activities and competencies to IMS LIP to cope with informal learning. These data should also include location data of the learner, technical options (such as available mobile devices) and specifically information on the environment, like for example learning in a noisy environment.

2.4 IMS Learning Design (IMS LD)

IMS Learning Design is a specification describing *pedagogical concepts* and promoting the exchange and interoperability of E-Learning activities. To cope with specifics of *pedagogical concepts*, a generic and flexible language is used (IMS 2003).

IMS LD uses IMS CP to describe resources used within learning activities and effectively replaces the manifest section with its own representation of learning processes. As this paper is intended to introduce IMS LD, we abstract from of details IMS LD and use a simplified version, as shown below in Figure 2.

A *pedagogical concept* is represented using by an IMS LD *Method*, which in turn consists of *Plays* and *Acts*. The whole learning process will be represented by such *Methods* and each *Act* will be detailed by describing intended *Actors*, their *Roles* and their planed *Activities*. The *Activities* are connected to the actual content and use the *Role* of the respective *Actor* to decide how the content has to be accessed.

Of particular interest to M-Learning are the *Services* of an *Environment*, which specify the software and other services like tutoring available within a specific *Environment*.

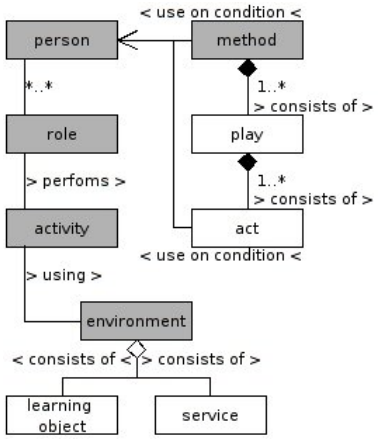

Figure 2: IMS LD structure

The above example shows how *Activities* in a *pedagogical concept* for a learning process can be represented by IMS LD. Paramythis et al. (2004) elaborate on this on behalf of adaptive learning environments. Further features of IMS LD include the description of prerequisites and intended outcomes to each *Act*. This represents the requirements to successfully use the described learning process. Additionally, intended Actors can be described by using IMS LIP and thus actual learner profiles can be matched with described learning process to see if a learner can actually use a learning resource. This is generally a difficult task, as there is no common taxonomy for knowledge's or learning objectives. For instance, corporate educational profiles can be used to build such taxonomy for a specific context. But even without such a predefined taxonomy the prerequisites make the learning process much more transparent for learners.

3 Successful conception of M-Learning scenarios

To illustrate the required changes and extensions to standards, we describe a sample M-Learning scenario. For this section, we deliberately took an example which is integrated in traditional learning and has a formal setting. The example is based on the "Mobile Lessons: concept and applications for 'on-the-field' georeferenced lessons" (Pintus et al. 2004).

3.1 Mobile Lessons - a short example of a M-Learning scenario

(Pintus et al. 2004) have developed a concept to carry the lessons directly on-the-field to enable all actors – including teacher, students and tutors- to move in a certain geologic regions and receive and add documents to GPS positions in the region. In tabular 1, the general concept of such a lesson is depicted. (Pintus et al. 2004)

describe how the Mobile Lesson should be designed and what devices are needed. As a base software for the devices, the "augmented" browser as described in (Carboni et al, 2004) is used. Additionally, a Website which interprets the GPS data send by the browser is necessary.

Design of mobile lesson	**Introduction of technology and topic**	**In the field**	**Discussion of solutions**
Teacher develops idea	Teacher introduces pupils to their assignments	Pupils solve their assignments	Pupils and teacher discuss their experience
Didactic conception: Exercise Oriented Learning, Investigation			

Tabular 1: Conception of "Mobile Lessons"

As an example, we show a *geologic Mobile Lesson*, in which the teacher wants his students do take samples of soil for a certain region, which will be used to produce a geologic map of the region. Each of the conception sections shown in figure 3 can be described by *IMS LD Plays*. The conception as a whole can be represented in IMS LD as a *Method called "Mobile Lesson"*.

In the first Play, the teacher goes into the field and adds information to specific regions using his augmented browser. In the second Play, the teacher explains his students the technology used in the field trip and also introduces their assignments for the field trip. The students start to plan their trip in the classroom and decided on tasks to do in the field and who will be assigned to each task. Then in the next Play the students and the teacher actually go on the field trip and solve the assignment. Later back in the class room, they conclude the field trip with the last Play, in which the results of the assignment are discussed.

In the following, we focus on the *"In the field" Play*, as this represents the mobile part of the students learning process.

3.2 Conception of the play "In the field"

In figure 3.1 and 3.2, a part of the IMS LD design for the *Play "In the field"* is shown. The Play includes four Acts, of which the Act "prepare for taking soil" is described in more detail. Both activities also use learning objects and services provided within the context. For instance, E-Learning objects about the tools used in the field are stored on a web server, which is accessible with the provided mobile devices. Additional students can call upon the teacher as an advisor, which in this case represents a service provided for the Activity.

First we need to look at the M-Learning specific of this conception. First of all, the locations the students are currently in have to be taken into account. None of the standards provides the entries for this directly, but it is important for the scenario, that the tutor and the web server have a way to locate students to fulfil their roles in the learning process. Thus, the location data would be a useful extension to IMS LIP as argued before. The documents delivered to the field by the server have to be useable on the respective end user device. This would either be a service of the web server, which then is supposed to prepare readable documents for different end user devices and thus this would be an M-Learning specific service for IMS LD. As an alternative, the documents themselves can be described in a way that it is clear which devices can actually use them. This would be an extension to LOM. So even in this very small and formalized setting, M-Learning specifics can be identified, which E-Learning standards do not take into account right now.

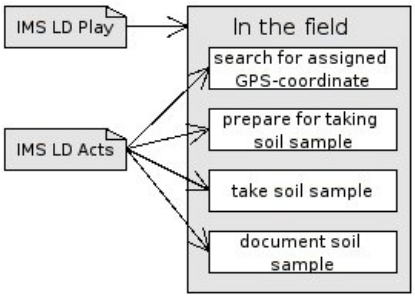

Figure 3.1: IMS LD "In the field" Play

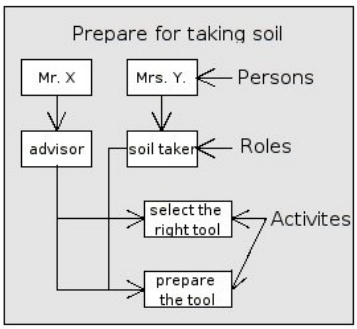

Figure 3.2: IMS LD "Prepare for taking soil" Activity

4 Using metadata in M-Learning

In this section, we show how the above described metadata can be tailored to the specific needs of M-Learning. This is done by analysing metadata for the respective users' point of view.

The section is divided into three subsections to explain how the different actors in a learning process can profit from the extra metadata provided with M-Learning tailored E-Learning standards.

4.1 How can authors profit from this conception?

First of all, authors can better analyse their intended target group, if detailed information on the learners is

provided. Thus, IMS LIP, with the above discussed extensions, additionally provides them with information about end user devices and learning locations preferred by the user. This way, authors are enabled to include these preferences in their conceptions and thus react much faster to the need of their learners.

Additionally, using IMS LIP, in combination with the respective evaluation of the learning scenario, will help the author to better recognize the needs of learners. Thus, successful conceptions can be reused with the same intended user group within other scenarios to improve the learning experience as a whole.

Last but not least, as in E-Learning, standards provide the most promising way to reuse M-Learning conceptions and contents in different scenarios.

4.2 How does the learner profit from the metadata?

M-Learning processes are much more transparent to learners and they can better decided, which conception does fit their needs best.

LMS can provide learners with M-Learning enabled resources and as such the learner can much easier identify which resources work in his current learning situation. Thus, he can better plan his learning process and can decided when and where to learn before hand, giving him the needed security that he can achieve the competencies without having to evaluate the whole scenario himself.

By browsing through the evaluation of different learning scenarios (M-Learning and traditional scenarios) and directly compare them, because they are described using the same criteria.

4.3 How can other actors profit form the metadata?

Several more actors are involved in mobile learning processes. We present some suggestions who might also profit from the tailored metadata.

- M-Learning service providers can better select which M-Learning conception and scenarios fit to their target group.
- HR managers can better select M-Learning solutions which fit into their company.
- Tutors can better provide adequate help on how to use the provided resources, if they are aware which device the learner is using.
- Tutors better react to different conceptions used for one learning objective by looking up the respective metadata on the progress of an individual learner.

5 Conclusions and future developments

In this article, we have shown how the development of M-Learning scenarios can be supported using E-Learning standards. We have identified weaknesses of existing standards. As an example, recent standards for not take location data into account. Therefore, several basic extensions of standards have yet to be established.

The most urgent extension is *Location Awareness*. The location should be added to learner profiles, documents and conceptions used in M-Learning as this is the key factor of M-Learning.

However, more elaborate functionalities can be build upon this base. For instance, the concept of trusted computing should be transferred to IMS LIP Repositories for "*trusted M-Learning*". Thus, learners are enabled to work with one profile in different LMS. Additionally, LMSs are enabled to identify the target platform the have to serve documents and services to.

Additionally, the concept of *Content Packaging* for E-Learning resources should be extended to the end user. Thus learner would be able to load these packages to their mobile devices and thus learn without being online. The conception of the package is the key factor, as it has to support this learning process.

These are just a few examples on how M-Learning might be enriched by the integration of standards in the workflows of the conception and use of M-Learning. To explore these opportunities is an important task for the M-Learning community as a whole.

References

ADL (2004). *Introduction to the SCORM for Instructional Designers*. At http://www.adlnet.org/scorm/articles/3.cfm, 1st August 2005.

Bryan A. (2004). Going Nomadic: Mobile Learning In Higher Education. In *EDUCAUSE Review Volume 39 Number 5*. At http://www.educause.edu/apps/er/erm04/erm045.asp, 1st August 2005.

Carboni D., Piras A., Sanna S. (2004). The Web Around The Corner: Augmenting the Browser with GPS. *In Proceedings of the WWW2004 conference, Alternate Track Papers & Posters*, 318 – 319. ACM Press.

Chan T., Sharples M., Giasemi V., Lonsdale P. (2003). Educational metadata for mobile learning. *In Proceedings of Wireless and Mobile Technologies in Education 2003 (WMTE2003)*.

Currier S. (2004). Metadata Quality in e-Learning: Garbage In - Garbage Out? At http://www.cetis.ac.uk/content2/20040402013222, 1st August 2005.

Dublin Core Metadata Initiative (2003). *Dublin Core Metadata Element Set, Version 1.1: Reference Description.* At http://dublincore.org/documents/dces/, 1st August.

Ellis R. K. (2005). *E-Learning Standard Update*. At http://www.learningcircuits.org/2005/jul2005/ellis.htm, 1st August 2005.

IMS (2001). *IMS Learner Information Packaging Best Practice & Implementation Guide*. At http://www.imsglobal.org/profiles/lipbest01a.html, 1st August 2005.

IMS (2003). *IMS Learning Design Best Practice and Implementation Guide*. At http://www.imsglobal.org/learningdesign/ldv1p0/imsld_bestv1p0.html, 1st August 2005.

IMS (2004a). *IMS Content Packaging Best Practice and Implementation Guide*. At http://www.imsglobal.org/content/packaging/cpv1p1p4/imscp_bestv1p1p4.html, 1st August 2005.

IMS (2004b). *IMS Content Packaging Information Model.* At http://www.imsglobal.org/content/packaging/cpv1p1p4/imscp_infov1p1p4.html, 1st August 2005.

IMS (2004c). *IMS Content Packaging XML Binding*. At http://www.imsglobal.org/content/packaging/cpv1p1p4/imscp_bindv1p1p4.html, 1st August 2005.

IEEE (2005). *The Learning Object Metadata standard.* At http://ieeeltsc.org/wg12LOM/lomDescription, 1st August 2005.

Microsoft (2005). *Microsoft Internet Explorer*. At http://www.microsoft.com/windows/ie/default.mspx, 1st August 2005.

Mozilla.org (2005). *Mozilla Firefox – Rediscover the web*. At http://www.mozilla.org/products/firefox/, 1st August 2005.

Netscape (2005). *The All New Netscape Browser 8.0*. At http://browser.netscape.com/ns8/, 1st August 2005.

Paramythis A., Loidl-Reisinger S., Kepler J. (2004). Adaptive Learning Environments and e-Learning Standards. *In Electronic Journal of e-Learning Vol.2 Issue 2, December 2004.*

Pawlowski J. M. (2001). Das Essener-Lern-Modell (ELM): *Ein Vorgehensmodell zur Entwicklung computerunterstützter Lernumgebungen*. Dissertation, University of Duisburg-Essen, Germany.

Pintus A., Carboni D., Paddeu G., Piras A., Sanna S. (2004) Mobile Lessons: concept and application of "on the field" georeferenced lessons. *In MLEARN2004 Conference Proceedings*. MOBIlearn 2004.

Santally M. I., Govinda M., Senteni A. (2004). Reusable Learning Objects Aggregation for e-Learning Courseware Development at the University of Mauritius. *In Proceedings of International Journal of Instructional Technology & Distant Learning.*

Wing C. (2004). An Introduction to Internet Literacy. *In The Media Freedom Internet Cookbook*, OSCE Vienna 2004. (http://www.osce.org/publications/rfm/2004/12/12239_89_en.pdf)

W3C (2005). *Extensible Markup Language (XML)*. At www.w3.org/XML/, 1st August 2005.